T_CODE 2012

Cellular buildings - Themathic Studio

מבניים תאיים באדריכלות - סטודיו תמטי

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מנחה: ד"ר יאשה גרובמן

Technion, Faculty of Architecture and Town Planning, March 2012

הפקולטה לארכיטקטורה ובינוי ערים, הטכניון, מרץ 2012

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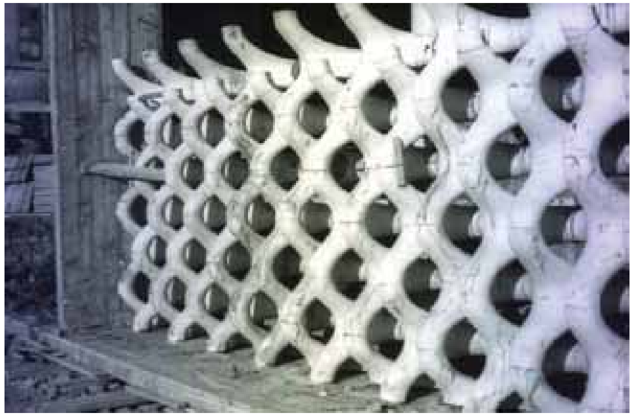


Ervin Hauer – Church in Liesing, Vienna, Austria, 1952 Church in Erdberg, Vienna, Austria, 1954
Sources: www.erwinhauer.com

Grimshaw Architects – Eden Project, Cornwall, United Kingdom, 2001
Sources: www.grimshaw-architects.com

חלקים ניכרים מהעולם בו אנו חיים מבוססים על הגיון תאי. הגיון מבני זה מתקיים החל מקנה המידה המיקרוסקופי של התא החי וכלה במערכות מורכבות של מבני צמחים ובעלי חיים יבשתיים וימיים. בנוסף, ניתן להבחין בהגיון תאי גם במבנה גבישים ומבנים גאולוגיים בקנה מידה גדול יותר.
מנקודת מבט אדריכלית ניתן להבחין בהיגיון תאי בסגנונות בניה ותקופות שונות לאורך ההיסטוריה, החל במבני מערות וכלה בס־גנונות כגון המטבוליזם במאה העשרים וסגנונות אחרים. גם הבניה האורטוגונלית המסורתית, המתבססת על חללים קובייתיים, יכולה להיתפס כבניה תאית (כלל חלל או חדר מהווה למעשה תא אחד).
למרות שהיו לאורך ההיסטוריה נסיונות לפתח מערכות גאומטריות תלת מימדיות מורכבות (לדוגמא, המבנים של יונה פרידמן או מבנים הכפופים לתאוריית "האלכסון" של פול ורליו), מרבית המבנים הבנויים מתבססים על גאומטריה אורטוגונאלית.
עם התבססות בשימוש בכלים מבוססים מחשב לעיצוב וייצור באדריכלות ניתן לבחון מחדש את האפשרויות הגלומות בפיתוח הגיון תאי באדריכלות המתבסס על גאומטריה מורכבת יותר. גאומטריה זו מבוססת על משטחים/מסות שאינם אורטוגונאליים אלא עקומים או אלכסוניים.
ניתן לפתח תפיסה תאית באדריכלות בשני רמות עיקריות: הרמה הראשונה מתייחסת לפיתוח מערכת מבנים תאית עליה תבו־סס גאומטריית המבנה כולו. הרמה השניה מתייחסת למעטפת הבנין בלבד. במסגרת כיוון זה ניתן לנסות ולשנות את התפיסה הדו מימדית של החזית המבוססת על הגיון של שכבות.
הסטודיו ישאף להתמודד עם האתגר הטמון בפיתוח מבנה המבוסס על הגיון תאי. במסגרת זו יתבקש כל סטודנט ולעצב בנין ציבור מודרני וחדשני המבוסס על הגיון תאי בשתי רמות אלה.
המחקר הראשוני, ניתוח האתר ועיצוב המבנה יעשו תוך שימוש בשיטות מתקדמות לתכנון וייצור המבוססים על השימוש במח־שב. שילוב שיטות אלה בתהליך התכנון מהווה מימד נוסף לאתגר איתו יתמודדו הסטודנטים בסטודיו.
הקורס מלווה בקורס תאורטי/מעשי משלים המקנה לסטודנט הבנה של ההקשר הרחב יותר של השיח האדריכלי באדריכלות דיגיטאלית בכלל ושיטות עיצוב וייצור מבוססות מחשב בפרט.

מטרות הסטודיו

התמודדות עם פיתוח מערכת תאית בקנה מידה של בנין ומעטפת
התמודדות עם פרוגרמה ועיצוב של מבנה ציבור בנוני (בשטח של כ 3000 מ"ר)
לימוד, פיתוח ויישום שיטות תכנון וייצור מבוססות מחשב
התמודדות עם סינטזה של רעיון אדריכלי (הכוונה לפתח רעיון אדריכלי החל משלב המיפוי דרך אנליזה של האינפורציה העולה מהמיפוי לכדי כיוונים אפשריים למחקר ויישום אדריכלי וכלה בסינטזה של רעיון מוביל המבוסס באופן ישיר (ורצוי אמפירי) על נתוני המיפוי.

הפרוגרמה והאתר

הפרוייקט יתוכנן על מגרש שמיועד למבנה ציבור בתב"ע החדשה למתחם שוק הכרמל בתל אביב. המיקום המדוייק יוצג במפגש הראשון.
התכנון יתמודד עם פרוגרמה של מרכז קהילתי לתושבי האזור השונים שיכלול גן ילדים, פעילות צהריים ואחה"צ לילידים (חו־

גים), פעילות מבוגרים (חוגים, ספורט, הרצאות) ומרכז לקשישים. המבנה יתוכנן באופו גמיש וורסטילי כך שיאפשר שימוש ע"י הקהילות השונות והגילאים השונים

הבניין יעמוד בחוקי התב"ע המוצעת מבחינת, קו בנין, אחוזי בניה וגובה. הבנין יעמוד בחוקי הבניה בישראל. הבנין יעמוד בתקן 5281 ותקן 5282 (בניה ירוקה).

הפונקציות הנדרשות בבנין:

גן ילדים טרום חובה וחובה - שתי כיתות של 30 ילדים + כל הפונקציות התומכות. חדרי חוגים (כולל חדרי סדנאות יצירה וחדר ספורט). אולם רב תכליתי של כ 150-200 מקומות ישיבה. אזור מולטימדיה - ספריה וירטואלית של ספרים וקלטות DVD. בית קפה. גלריה. משרדים. חדרי שרות ומחסנים. המבנה ישולב בחניון תת קרקעי של 4 קומות שישמש את תושבי השכונה, המבקרים בבנין ובאי השוק.

ציפיות מהסטודנט:

נוכחות מלאה בכל השיעורים - חיסור לא מוצדק (עפ"י כללי הטכניון) של יותר משני מפגשים אינו מאפשר קבלת ציון.
התקדמות ממפגש למפגש.
השתתפות בדיונים בסטודיו.
הגשת תרגילי התכנון בזמן עפי הפורמט הגרפי המופיע בנספח א'. פירוט ההנחיות לתרגילים מופיע בנספחים ג-ה.
הגשת הפרוייקט הסופי בזמן בהתאם לדרישות המפורטות בהמשך.
הגשת CD עם החומר של הפרוייקט בהתאם לפורמט הגרפי המתואר בנספח א'.

ומעל לכל התלהבות, סקרנות אינטלקטואלית והנאה - סטודנט המרגיש שאינו מקבל אחד או יותר מאילו כדאי שיפנה למנחה בהקדם.

דרישות להגשת פרוייקט סופי:

1. מצגת PDF עשויה לפי הפורמט הגרפי המתואר בנספח א'.
2. ספר פרוייקט המכיל את כל החומר על הפרוייקט (כולל אלטרנטיבות שלא נבחרו) וטקסט הקדמה באורך של כ 1000 מילים המציג את הפרוייקט.
3. לפחות 4 גליונות A0 המציגים את הפרוייקט.
4. מודל/ים פיזי/ים בקנ"מ 1:100 או 1:200 או 1:250 של הבנין
מודל רעיוניים ומודלים נוספים יתקבלו בברכה

דרישות תנאי לקבלת ציון:
1. הגשת הפרוייקט עפ"י ההנחיות הנ"ל.
2. הגשה של חומר הפרוייקט ע"ג CD עד שבוע לאחר מועד ההגשה הסופית. החומר יוגש בהתאם לפירוט בנספח ה'.

Antoni Gaudi – Casa Mila (La Padrera), Barcelona, Spain, 1910.
Sources: www.dianeobrien.wordpress.com, www.planetware.com

PTW Architects – Watercube – National Swimming Centre, Beijing, China, 2003.
Sources: http://www.flickr.com/photos/xiaming/484446352/lightbox/

הערכה:

30% - תרגילים (10% לכל תרגיל)
30% - עבודה לאורך הסמסטר
30% - הגשה סופית
10% - תרומה לסטודיו - השתתפות בחיי הסטודיו ותרומה לדיונים

חיי הסטודיו

העבודה בסטודיו תתחלק להנחיות אישיות והנחיות קבוצתיות. מפגש אחד בשבוע יוקדש להנחיות אישיות והמפגש השני להנחיה קבוצתית בה יציג כל סטודנט את התפתחות הפרוייקט ויתקיים דיון בנושא כיווני ההתפתחות הרצויים. במפגש זה ידונו גם נושאים תאורטיים שיהוו בסיס לפיתוח הפן התאורטי/ביקורתי של הפרוייקט האישי.

נקודות מוצא לתכנון

התרגילים הראשונים בסטודיו יקנו כלים תאורטיים ומעשיים לסטודנטים. נקודת המוצא לתכנון בסטודיו זה מתמקדת בגילוי צורה דיגיטאלי (digital form finding) ובעיסוק במערכות גאומטריות/חומריות. שיטה זו אינה באה להחליף שיטות תכנון אחרות שנל-מדו בעבר אלא מהווה נדבך נוסף באוספת הכלים ושיטות התכנון של האדריכל העכשווי.

שימוש בכלים דיגיטאליים.

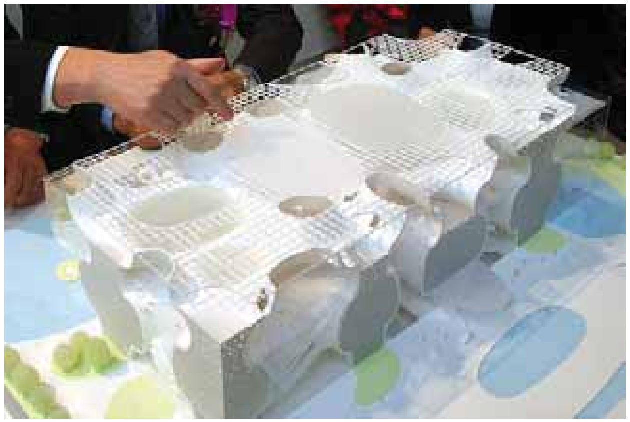
העבודה בסטודיו תעשה באמצעות הכלים הבאים:
כלי מידול:ריינו, מקס, רויט - ניתן להציג תוכנות נוספות שאינן מגבילות מבחינה גאומטרית (בהקשר זה סקטשאפ היא תוכנה מגבילה - מבוססת על אקסטרוזיה ישרה)
כלים פרמטריים: גראסהופר, פאראקלאוד ג׳ם וכלים נוספים.
כלים גרפיים: אילוסטרטור, פוטושופ, אין-דיזיין ואקרובט.

אין צורך בידיעת התוכנות לפני התחלת הסטודיו אם כי מומלץ להכיר תוכנה אחת מכל סוג..

שעות קבלה:

יום ראשון 13:30-14:30 בחדר 602 בנין סגו לפי תאום מראש:
yasha@technion.ac.il טל 04-8294041 (4041 פנימי).

Gramazio Kohler – The Dissolved Wall/Screens, 2006-2007. Source: F. Gramazio and M. Kohler, "Towards a Digital Materiality," in Manufacturing Material Effects: Rethinking Design and Making in Architecture, 1st ed., B. Kolarevic and K. Klinger, Eds. Routledge, 2008, pp. 103-118



Toyo Ito, Taichung Metropolitan Opera House. http://www.tropolism.com/2006/01/toyo_itos_structural_awesomene.php

פירוט המפגשים:

שבוע 1: הצגת הסטודיו, הפרוגרמה והתרגיל הראשון - תרגיל מחקר
שבוע 2: הגשת בניים תרגיל מחקר
שבוע 3: הגשה סופית תרגיל מחקר והצגת תרגיל מעטפת תאית
שבוע 4: תרגיל מעטפת תאית - הגשת ביניים
שבוע 5: הגשת תרגיל מעטפת תאית והצגת תרגיל מבנה תאי
שבוע 6: הגשת ביניים מבנה תאי
שבוע 7: הגשה סופית מבנה תאי
שבוע 8: הצגת רעיון צורני/פרוגרמטי ראשון למבנה/מעטפת והתיחסות ראשונית לאתר
שבוע 9: פיתוח תכנון
שבוע 10: פיתוח תכנון
שבוע 11: הגשת ביניים פרוייקט
שבוע 12: פיתוח תכנון
שבוע 13: פיתוח תכנון
שבוע 14: הדרכה לקראת הגשה סופית - אסטרטגיות הגשה

הגשה סופית תקבע בהתאם ללוח הזמנים השנתי.

Contemporary Architecture Practice (CAP) - Migrating Formations, New York, USA, 2008
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Kol/Mac architecture – INVERSAbrane - high-performance exterior building, membrane prototype, 2006.
Source: Y. Grobman and E. Neuman, Eds., Performalism: Form and Performance in Digital Architecture. Routledge, 2011. P. 120-121

Dom-In(fo) by Dagmar Richter (2002-2003)
Source: Anon, 2003. Architecture Non Standard, Centre Georges Pompidou Service Commercial,France. P. 81

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נספח א׳ - פורמט גרפי

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נספח ב' - תרגיל ראשון - תרגיל מחקר

מטרת התרגיל היא להתנסות במחקר נקודתי ולייצר מאגר מידע משותף בנושא בניה תאית לסטודיו.

התרגיל יעשה בקבוצות של 1-2 סטודנטים. כל קבוצה תייצר מסמך המרכז מידע שימושי על סמך בבליוגרפיה ראשונית שתתקבל מהמנחה ומקורות נוספים שתמצא. תוצרי המחקר יועלו למחיצה שתשותף בין הסטודנטים בסטודיו.

נושאי הקבוצות:

מבנים תאיים בטבע - עולם החי: מציאת דוגמאות של מבנים תאיים בעולם החי (תלי תרמיטים, עור של תנין, פקעות של זחלים, קיני צרעות ועוד). חקירת התנאים בהם הם מתקיימים והאסטרטגיה הצורנית והחומרית שהביאו לפתרון זה. יצירת קטלוג של אסטרטגיות שונות שקיימות בטבע והמצבים מולם הם מתמודדים.

מבנים תאיים בטבע - עולם הצומח: מציאת דוגמאות של מבנים תאיים בעולם הצומח (מבנה עצים, עלים, פרחים, פקעות, פירות ועוד). חקירת התנאים בהם הם מתקיימים והאסטרטגיה הצורנית והחומרית שהביאו לפתרון זה. יצירת קטלוג של אסטרטגיות שונות שקיימות בטבע והמצבים מולם הם מתמודדים.

מבנים תאיים בטבע - דומם: מציאת דוגמאות של מבנים תאיים בגאולוגיה, גבישים, בועות סבון. חקירת התנאים בהם הם מתקיימים (תנאי מז"א אויר וחומר) והכוחות הפיזיקאליים שיוצרים אותם. יצירת קטלוג של אסטרטגיות שונות שקיימות בטבע והמצבים מולם הם מתמודדים.

מבנים תאיים בטבע - המיקרו והננו - הסתכלות על עולם החי והצומח בקנה מידה מקרוסקופי וננסקופי. חקירת התנאים בהם הם מתקיימים והאסטרטגיה הצורנית והחומרית שהביאו לפתרון זה. יצירת קטלוג של אסטרטגיות שונות שקיימות בטבע והמצבים מולם הם מתמודדים.

מבנים תאיים בטבע - סביבה ימית: מציאת דוגמאות של מבנים תאיים החיים בסביבה מימית (ספוגים, אלמוגים ועוד). חקירת התנאים בהם הם מתקיימים והאסטרטגיה הצורנית והחומרית שהביאו לפתרון זה. יצירת קטלוג של אסטרטגיות שונות שקיימות בטבע והמצבים מולם הם מתמודדים.

גאומטריה תאית - פוליהדרלית. חקירה של סוגי גאומטריות פוליהדרליות תאיות. ניתוח וקיטלוג של החוקיות היוצרת את הצורות והתאמתם למבנים.

גאומטריה תאית - ספוגית. חקירה של סוגי גאומטריות פוליהדרליות תאיות. ניתוח וקיטלוג של החוקיות היוצרת את הצורות והתאמתם למבנים.

בניה תאית של מבנה - דוגמאות. מציאת תקדימים לבניה תאית/לפרוייקטים (לא בנויים)/ולתאוריות בדבר בניה תאית בהסטוריה האדריכלית.

טכנולוגיות בניה של אדריכלות תאית - מתכת ועץ. הצגת אפשרויות טכנולוגיות ליצירת מבנים תאיים במתכת ועץ תוך שימוש בטכנולוגיות ייצור בעזרת מחשב מתקדמות וטכניקות שונות (חיתוך בלייזר, הדפסה תלת מימדית, ואקום, יצירת תבניות ב CNC ועוד).

טכנולוגית בניה של אדריכלות תאית - בטון וחומרים מרוכבים. הצגת אפשרויות טכנולוגיות ליצירת מבנים תאיים בבטון, בטון מזויין וחומרים מרוכבים. שימוש בטכנולוגיות ייצור מסורתיות ומתקדמות בטכניקות שונות.

התרגיל יוגש תוך שימוש בפורמט הגרפי המופיע בנספח א.

נספח ג׳ - תרגיל שני - מעטפת תאית

מטרת התרגיל: התנסות בתכנון מעטפת תאית בגאומטריה מורכבת. התנסות בעבודה עם כלי מיחשוב מתקדמים.

דרישות התרגיל:
כל סטודנט יפתח חזית תלת מימדית המבוססת על גאומטריה תאית. החזית תתבסס על יחידה מודולרית/חזרתית פרמטרית שתשתנה מבחינה צורנית ויתכן גם מבחינת ביצועים כתלות במיקום הגאומטרי שלה ע״ג החזית וכתלות בפרמטרים אחרים שיוגדרו ע״י הסטודנט.
החזית תאפשר חדירה מסויימת/מבוקרת של אור יום (הכוונה לשליטה אמפירית על כמות האור והזמן בו הוא חודר את החזית).
בנוסף תתמודד החזית לפחות עם אחת מהדרישות הבאות:

א. יצירת בידוד באמצעות חללי אויר.
ב. יצירת מערכת ניקוז למי גשמים שמאפשרת אגירה של חלק מהמים ו/או עיכוב הגעת מי הגשמים למערכת העירונית.
ג. יצירת תנאים לגידול צמחיה (באופן פסיבי או בשילוב עם מערכת השקיים אקטיבית)
ד. שימוש במבנה התאים כחלק מהמערכת הקונסטרוקטיבית.

יוצגו תקדימים וניתוח השוואתי בין החזית הזו לחזית רגילה.

יעשה מאמץ לבחון את התוצר באופן סימולטיבי בתוכנת במחשב ובאופן פיזי. לטובת הבדיקה הפיזית יוכן קובץ STL של היחידה החזרתית ויודפס באחת ממדפסות התלת מימד בפקולטה.

התרגיל יוגש תוך שימוש בפורמט הגרפי המופיע בנספח א.

נספח ד' - תרגיל שלישי - מבנה תאי

מטרת התרגיל: התנסות בתכנון מערכת מבנית המבוססת על הגיון תאי בגאומטריה מורכבת. התנסות בעבודה עם כלי מיחשוב מתקדמים.

דרישות התרגיל:
כל סטודנט יפתח מערכת מבנית המבוססת על הגיון תאי. המערכת תתבסס על יחידה מודולרית/חזרתית פרמטרית שתשתנה מבחינה צורנית ויתכן גם מבחינת ביצועים כתלות במיקום הגאומטרי שלה בבניין וכתלות בפרמטרים אחרים שיוגדרו ע"י הסטודנט.
המבנה יאפשר פתרון לגדלים שונים של חללים במפלסים שונים תאפשר חדירה מסויימת/מבוקרת של אור יום (הכוונה לשליטה אמפירית על כמות האור והזמן בו הוא חודר את החזית). בנוסף יתוכנן המבנה כך שיהיה בעל הגיון קונסטרוקטיבי שיוכל לתת מענה לדרישות של מבנה ציבור בקנה מידה בנוני (כ 5000 מ"ר).

יוצגו תקדימים ותערך השוואה בין מבנה זה למבנה רגיל.
יעשה מאמץ לבחון את התוצר באופן סימולטיבי בתוכנת במחשב ובאופן פיזי. לטובת הבדיקה הפיזית יוכן קובץ STL של היחידה החזרתית ויודפס באחת ממדפסות התלת מימד בפקולטה.

התרגיל יוגש תוך שימוש בפורמט הגרפי המופיע בנספח א.

נספח ה' - הגשת חומר לקבלת ציון

יש להגיש את החומר יחד עם מסמך בידוק (checklist) זה מודפס ומלא - יש לסמן V בתוך הריבועים:

1. ☐ מועד ההגשה הסופית:
2. ☐ שם הסטודנט:
3. ☐ קובץ INDESIGN של ספר הפרוייקט יחד עם הלינקים (יש לעשות PACKAGE).
4. ☐ PDF של ספר הפרוייקט. יש לבחור באפשרות של HIGH QUALITY בזמן יצירת הקובץ.
5. ☐ תמונות של המודלים, רנדרים ב CMYK 300DPI.
6. ☐ קבצי אילוסטרטור במידה ונעשה בהם שימוש.
7. ☐ קבצי ריינו, גרסהופר, GEM, STL וכל תוכנה תלת מימדית/שרטוט אחרים מחולקים למחיצות עפ"י התרגיל לו הם שייכים.
8. ☐ קובץ INDESIGN של המצגת הסופית יחד עם הלינקים (יש לעשות PACKAGE).
9. ☐ קובץ PDF של המצגת הסופית. יש לבחור באפשרות של HIGH QUALITY בזמן יצירת הקובץ. המצגת הסופית תכיל טקסט באורך של כ 500 מילים שיתאר את הפרוייקט.
10. ☐ תקליטור צרוב עם כל החומר הנ"ל מסודר במחיצות לפי הסעיפים הנ"ל ולפי שלב הפרוייקט (תרגיל מחקר, תרגיל מעטפת, תרגיל מבנה, פרוייקט).

הגשת החומר מהווה תנאי לקבלת ציון. יש להגיש את החומר לתא של המנחה עד שבוע מסוף ההגשה הסופית.

Symmetries of patterns

Isometries of the Euclidean plane

Isometries of the Euclidean plane fall into four categories (see the article Euclidean plane isometry for more information).

:Translations

denoted by Tv, where v is a vector in R2. This has the effect of shifting the plane applying displacement vector v.

:Rotations

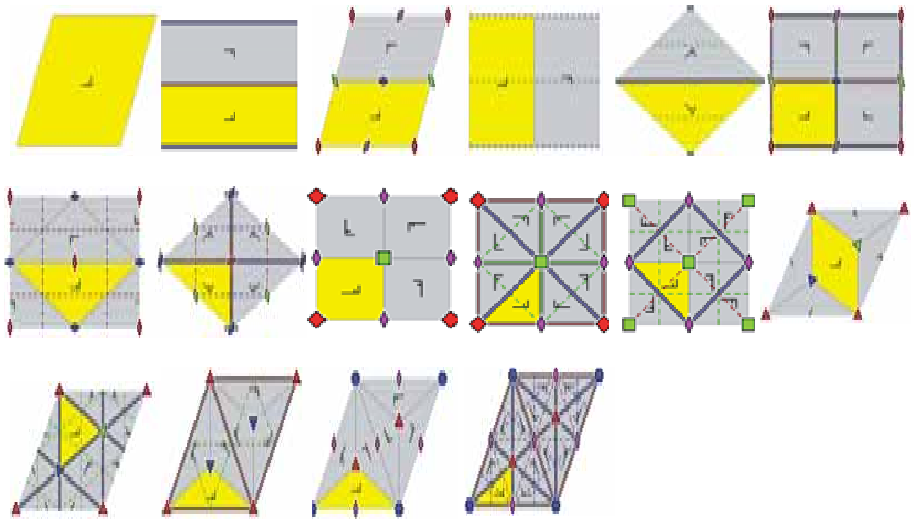
denoted by Rc,θ, where c is a point in the plane (the centre of rotation), and θ is the angle of rotation.

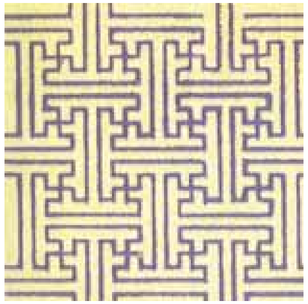
:Reflections

or mirror isometries, denoted by FL, where L is a line in R2. (F is for "flip"). This has the effect of reflecting the plane in the line L, called the reflection axis or the associated mirror.

:Glide reflections

denoted by GL,d, where L is a line in R2 and d is a distance. This is a combination of a reflection in the line L and a translation along L by a distance d.





porcelain, China

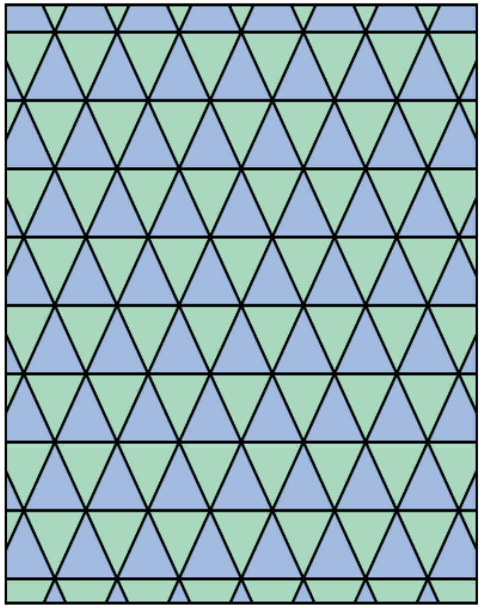
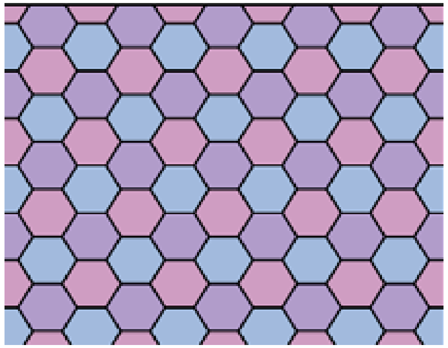
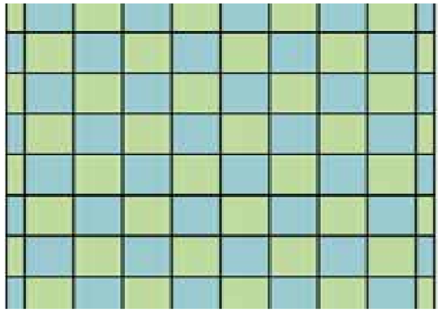
Example of an Egyptian design with wallpaper group p4m

Ceiling of Egyptian tomb

Infinite Tiling

For an infinite tiling, let be the average number of sides of a polygon, and the average number of sides meeting at a vertex. Then . For example, we have the combinations (3, 6), (313, 5), (334, 427), (4, 4), (6, 3), for the tilings in

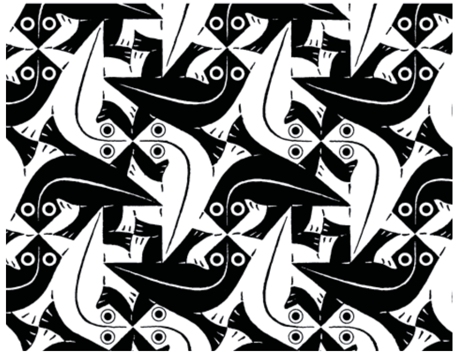
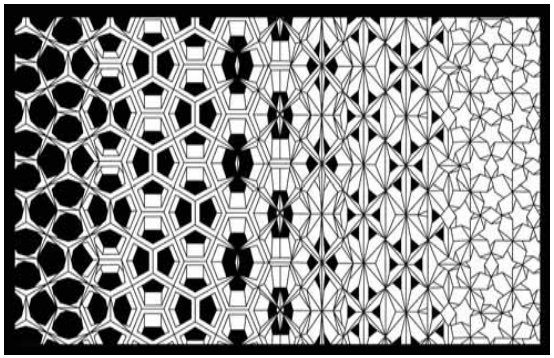
$(a-2)(b-2)=4$

http://www.qhull.org/html/qvoronoi.htm

Tessellation

Tessellation is the process of creating a two-dimensional plane using the repetition of a geometric shape with no overlaps and no gaps. Generalizations to higher dimensions are also possible. Tessellations frequently appeared in the art of M. C. Escher, who was inspired by studying the Moorish use of symmetry in the Alhambra tiles during a visit in 1922. Tessellations are seen throughout art history, from ancient architecture to modern art.


http://urioste.weebly.com/tessellations.html

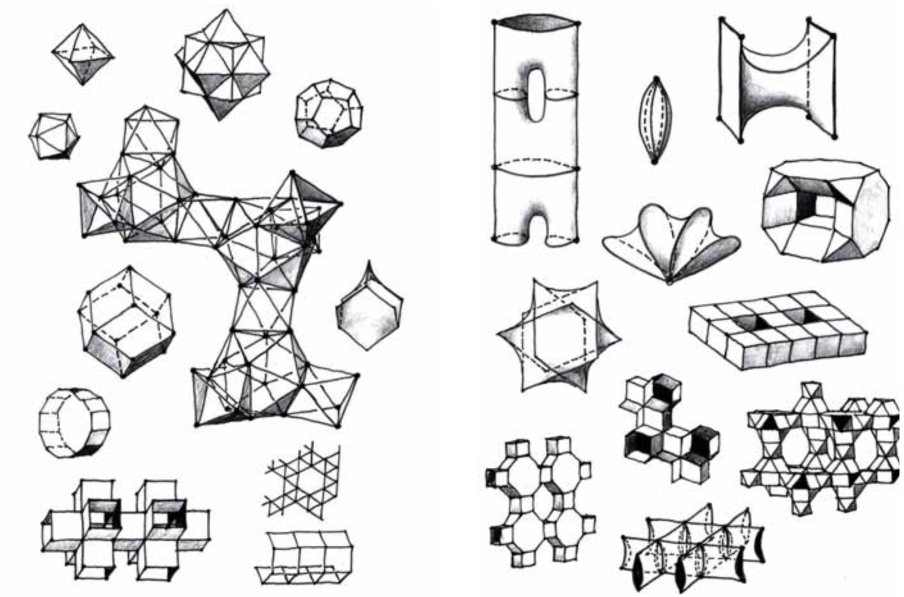
POLIHEDRICE STRAC

In elementary geometry a polyhedron (plural polyhedra or polyhedrons) is a geometric solid in three dimensions with flat faces and straight edges. The word polyhedron comes from the Classical Greek πολύεδρον, as poly- (stem of πολύς, “many”) + -hedron (form of έδρα, “base”, “seat”, or “face”).

A polyhedron is a 3-dimensional example of the more general polytope in any number of dimensions.
The Euler characteristic χ relates the number of a polyhedron:
vertices V
edges E
faces F

$$\chi = V - E + F$$

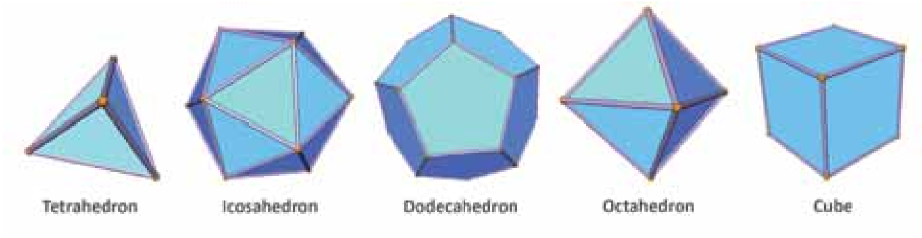
For a convex polyhedron or more generally for any simply connected polyhedron whose faces are also simply connected and whose boundary is a manifold, χ = 2. For a detailed discussion, see Proofs and Refutations by Imre Lakatos.



Michael Burt, The Periodic Table of the Polyhedral Universe, Technion 2011

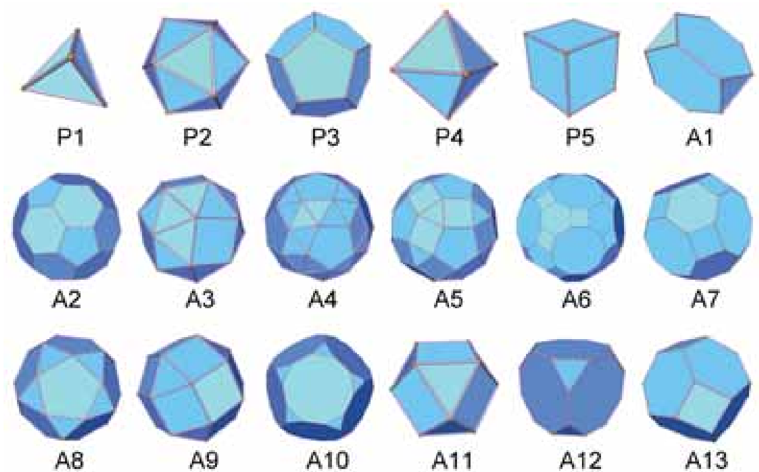
Platonic solid

In geometry, a Platonic solid is a convex polyhedron that is regular, in the sense of a regular polygon. Specifically, the faces of a Platonic solid are congruent regular polygons, with the same number of faces meeting at each vertex; thus, all its edges are congruent, as are its vertices and angles.
There are exactly five Platonic solids



Archimedean solid

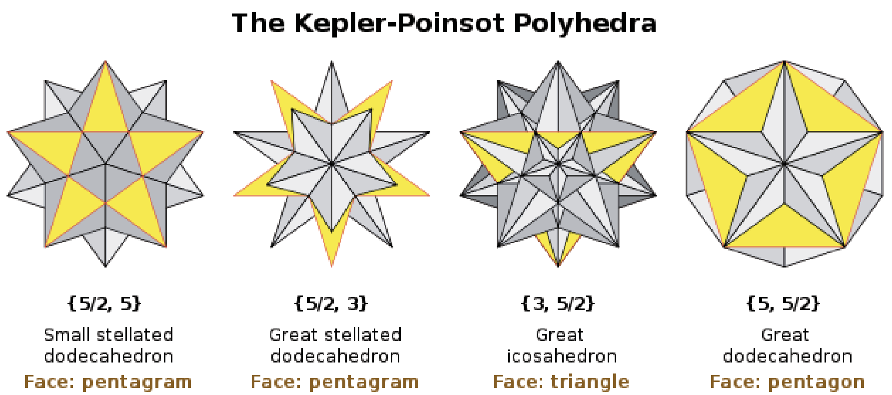
n geometry an Archimedean solid is a highly symmetric, semi-regular convex polyhedron composed of two or more types of regular polygons meeting in identical vertices. They are distinct from the Platonic solids, which are composed of only one type of polygon meeting in identical vertices, and from the Johnson solids, whose regular polygonal faces do not meet in identical vertices.

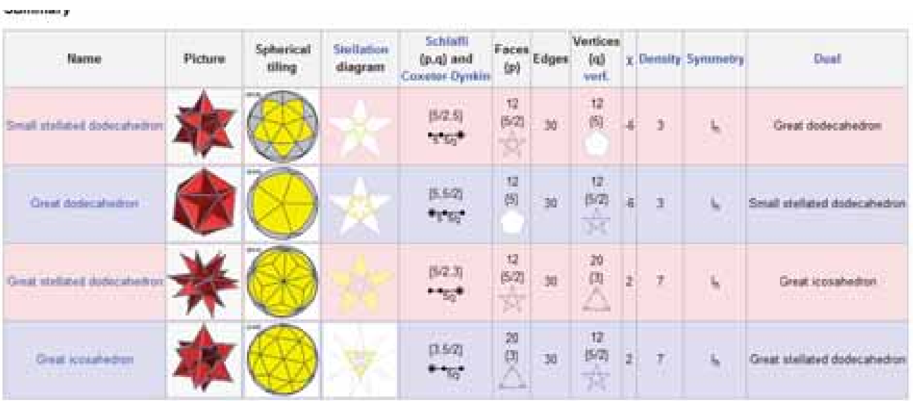


http://en.wikipedia.org/wiki/Platonic_solid

Kepler–Poinsot polyhedron

In geometry, a Kepler–Poinsot polyhedron is any of four regular star polyhedra. They may be obtained by stellating the regular convex dodecahedron and icosahedron, and differ from these in having regular pentagrammic faces or vertex figures.



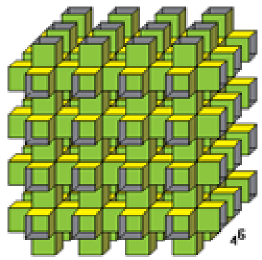
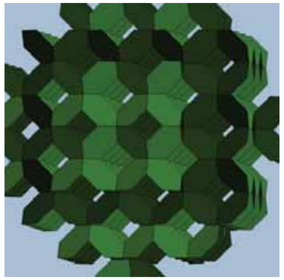
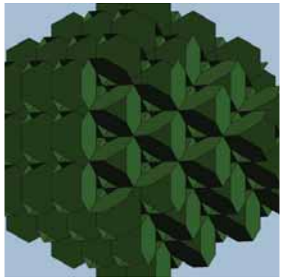
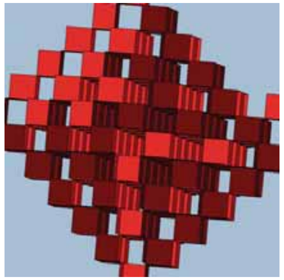
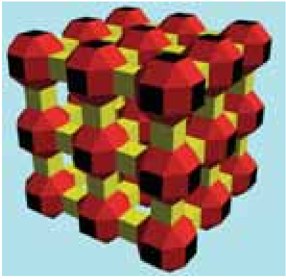
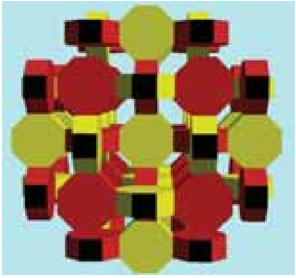


Name	Picture	Spherical tiling	Stellation diagram	Schläfli {p,q} and Coxeter-Dynkin	Faces {p}	Edges	Vertices {q} verf.	χ	Density	Symmetry	Dual
Small stellated dodecahedron				{5/2,5}	12 {5/2}	30	12 {5}	-6	3	I_h	Great dodecahedron
Great dodecahedron				{5,5/2}	12 {5}	30	12 {5/2}	-6	3	I_h	Small stellated dodecahedron
Great stellated dodecahedron				{5/2,3}	12 {5/2}	30	20 {3}	2	7	I_h	Great icosahedron
Great icosahedron				{3,5/2}	20 {3}	30	12 {5/2}	2	7	I_h	Great stellated dodecahedron

http://en.wikipedia.org/wiki/Kepler%E2%80%93Poinsot_polyhedron

Infinite Skew Polyhedron

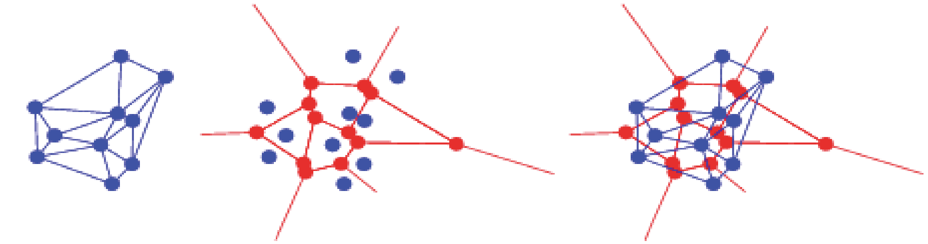
In geometry, an infinite skew polyhedron is an extension of the idea of a polyhedron, consisting of regular polygon faces with nonplanar vertex figures, allowing the figure to extend indefinitely without folding round to form a closed surface.
Infinite skew polyhedra have also been called polyhedral sponges, and also hyperbolic tessellations because they can be seen as related to hyperbolic space tessellations which also have negative angle defects. They are examples of the more general class of infinite polyhedra, or apeirohedra.

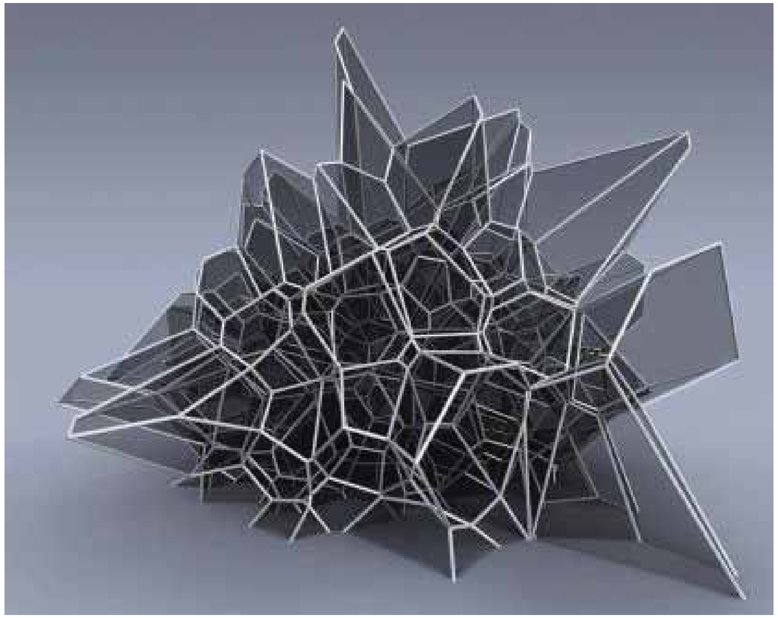
http://en.wikipedia.org/wiki/Infinite_skew_polyhedron

Voronoi diagram

Let be a space (a nonempty set) endowed with a distance function . Let be a set of indices and let be a tuple (ordered collection) of nonempty subsets (the sites) in the space . The Voronoi cell, or Voronoi region, , associated with the site is the set of all points in whose distance to is not greater than their distance to the other sites , where is any index different from



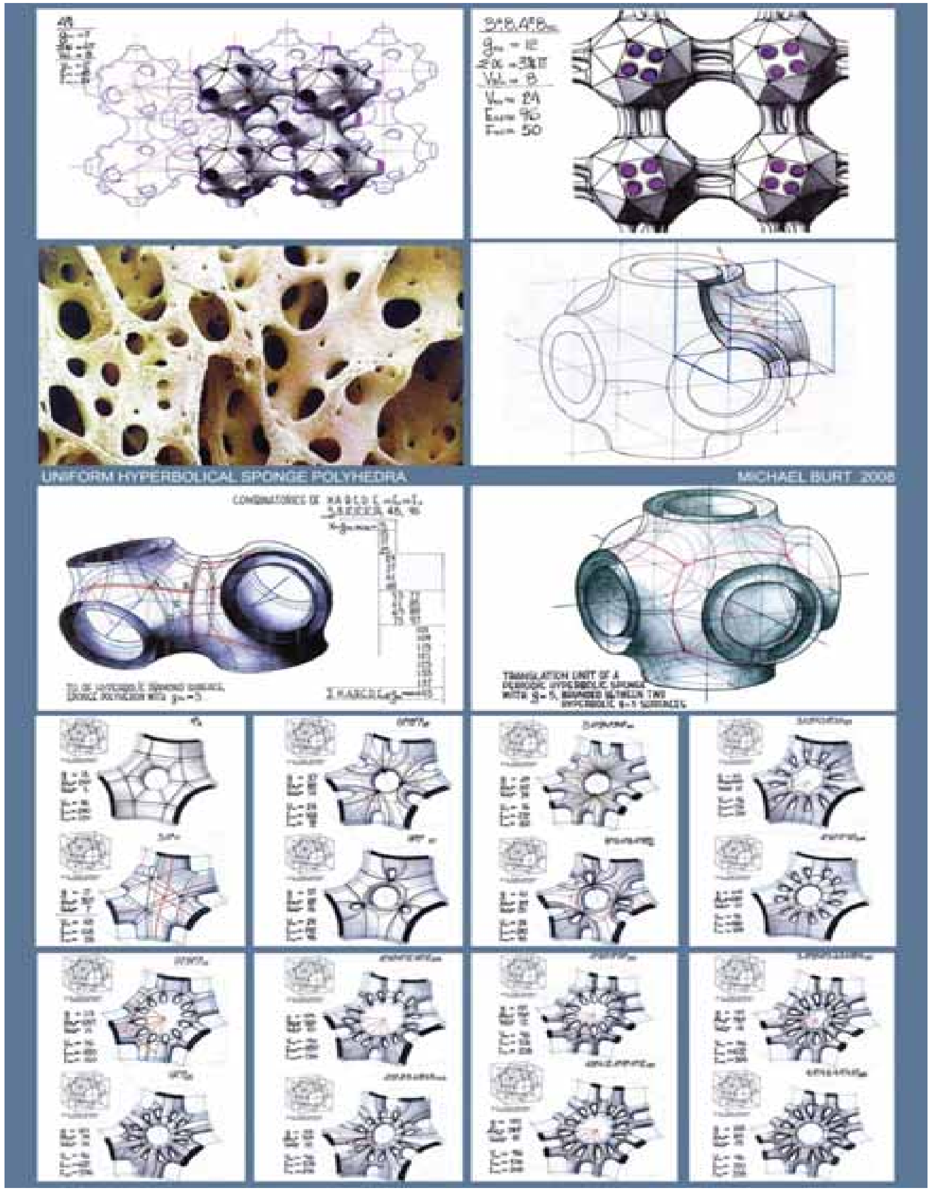
Delaunay triangulation *Voronoi diagram* *Delaunay and Voronoi*



http://www.qhull.org/html/qvoronoi.htm

http://www.qhull.org/html/qvoronoi.htm

Infinite Minimal Surfaces Polyhedra



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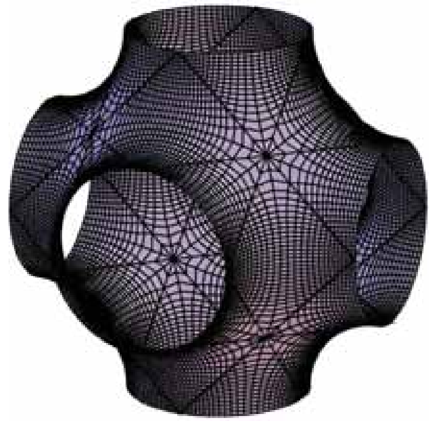
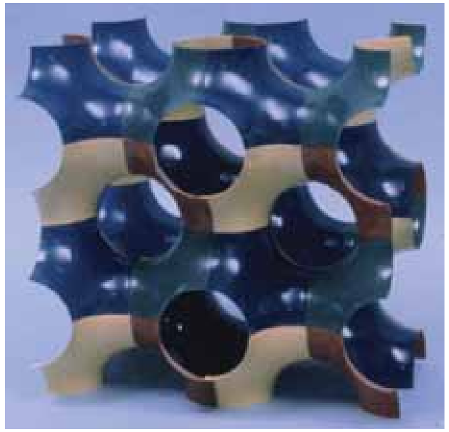
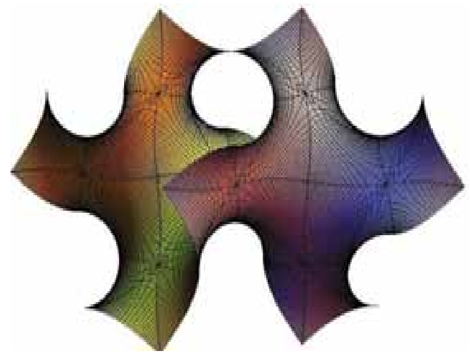
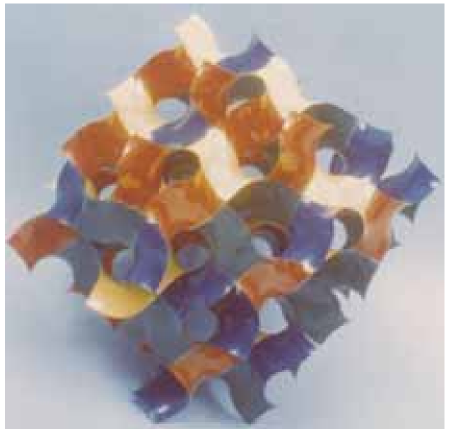
Schwarzs primitive surface
A cubically symmetrical translation fundamental domain of the primitive triply periodic minimal surface P. It was discovered and analyzed by H. A. Schwarz in 1866 together with its adjoint surface D





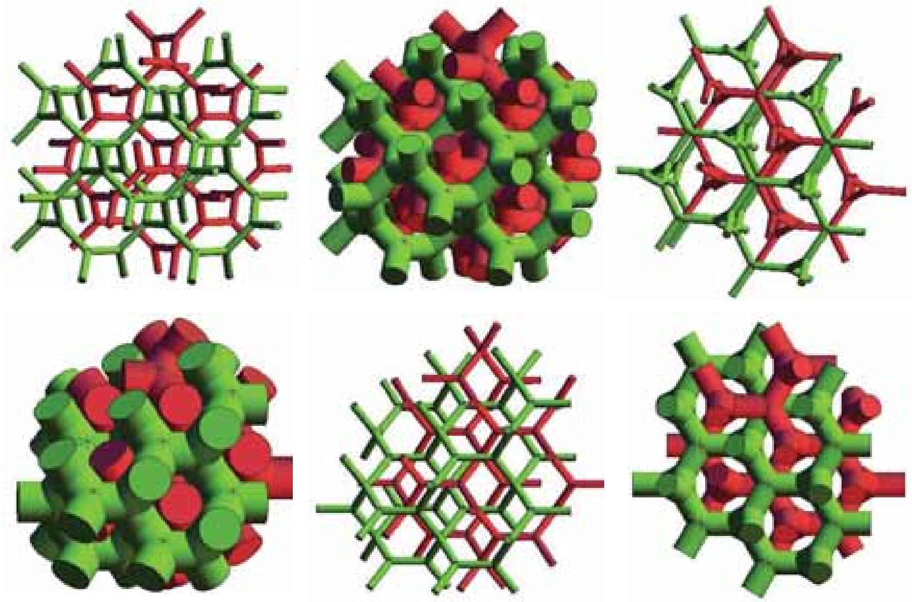
Gyroid surface (G)
G is a minimal surface that is associate (cf. Fig. E1.22) to the Schwarz P and D surfaces. It contains neither straight lines nor mirror-symmetric plane lines of curvature.Each of the eight curvilinear hexagons in this translation fundamental domain is related to each of its four neighboring hexagons by a half-turn about an axis perpendicular to the surface at the midpoint of their common edge.

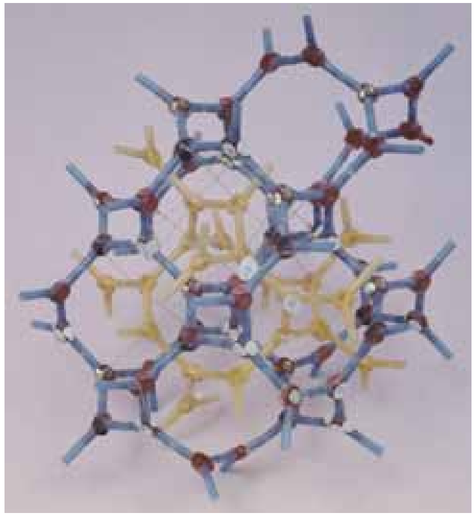


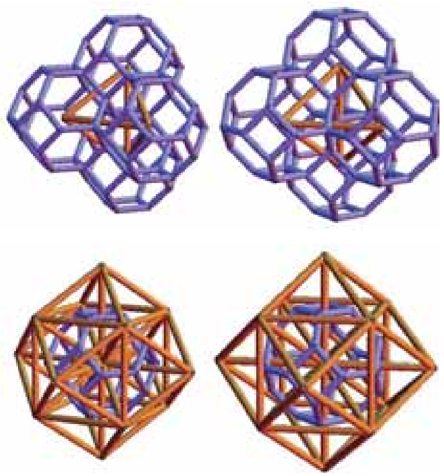


http://schoengeometry.com/e_tpms.html

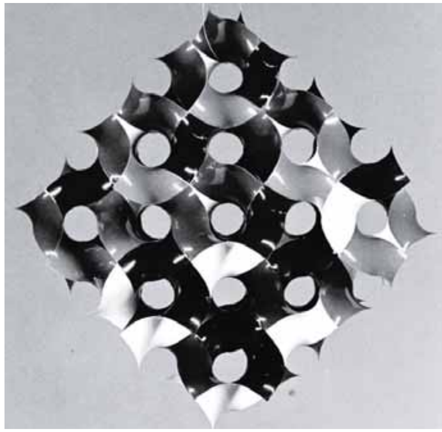
Dual Laves graphs

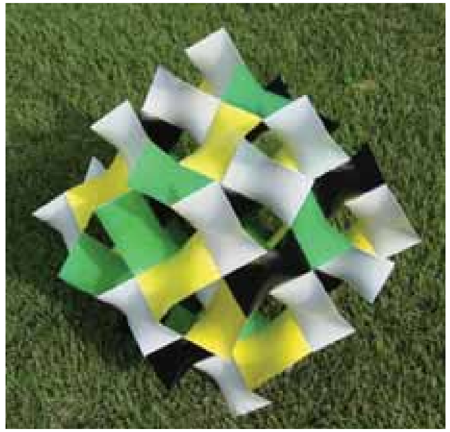






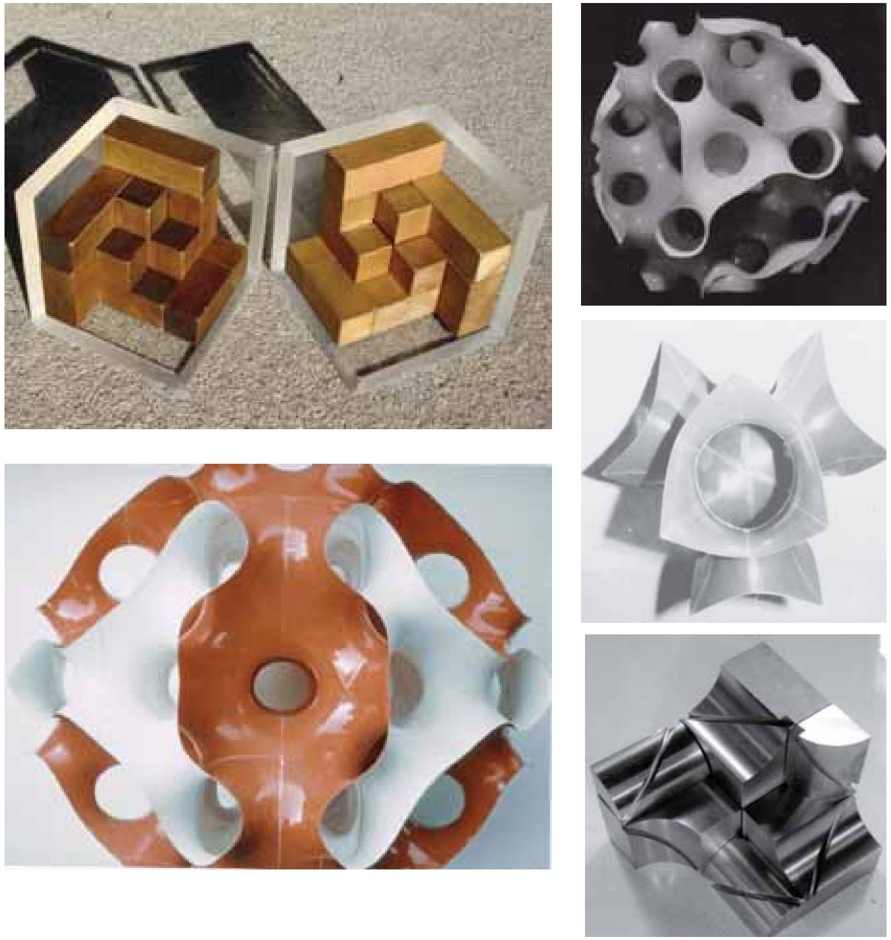
http://schoengeometry.com/e_tpms.html





http://schoengeometry.com/e_tpms.html

Cubic unit cell of G



http://schoengeometry.com/e_tpms.html

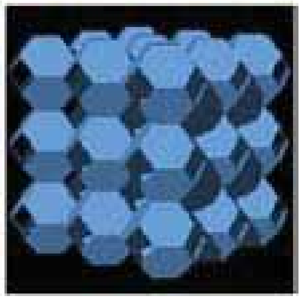
http://schoengeometry.com/e_tpms.html

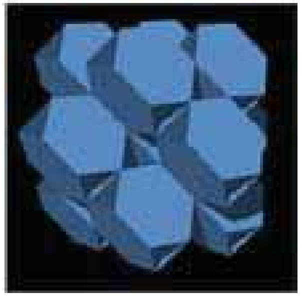
Infinite Polyhedron (Polyhedral Sponges)

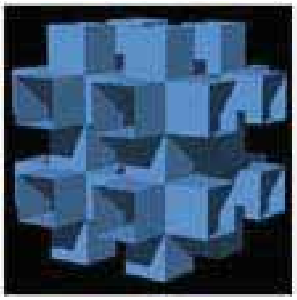
In geometry, an infinite skew polyhedron is an extension of the idea of a polyhedron, consisting of regular polygon faces with nonplanar vertex figures, allowing the figure to extend indefinitely without folding round to form a closed surface.

Regular infinite polyhedra

Consists of identical polyhedrons, involves infinetly to each direction (x,y,z). There are only 3 regular infinite polyheda:


{6,4|4}


{6,6|3}


{4,6|4}

Semi-Regular infinite polyhedra

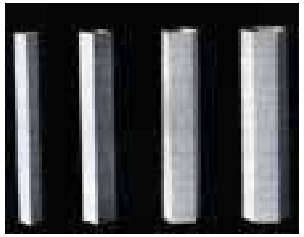
There are many other semiregular (vertex-transitive) infinite skew polyhedra. Wachmann, Burt and Kleinmann (1974) discovered many examples but it is not known whether their list is complete.

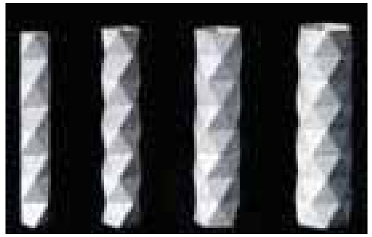
There are 3 groups of semi-regular infinite polyhedra:

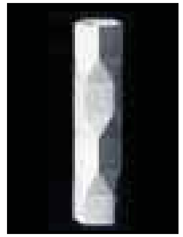
- One direction copy (Cylindrical polyhedra)
- Two direction copy (One layer polihedra)
- Tree direction copy (Multi layer and multi direction)

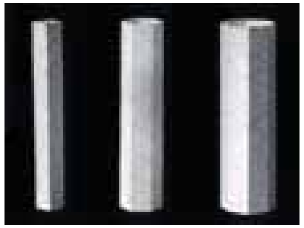
One Direction Copy // Cylindrical Polyhedra

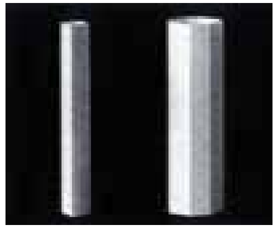
6 types of cylindrical polyhedra:

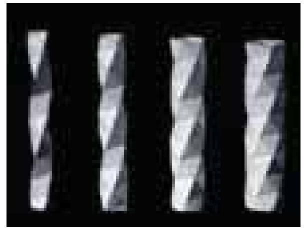

1 Prismatic rings.


2 Anti-prismatic rings.


3 Prismatic and anti-prismatic rings, alternately.


4 Regular triangles strips.

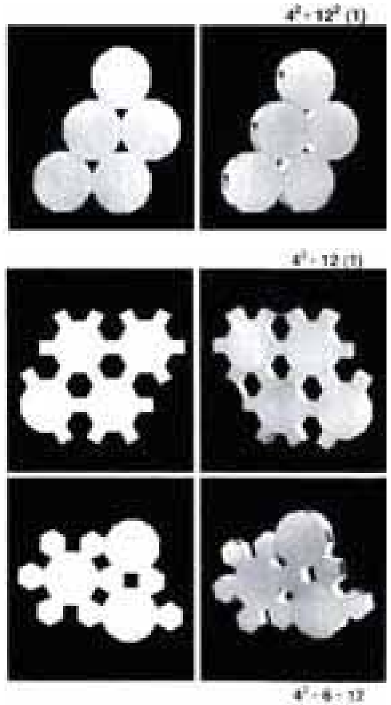

5 Regular triangles and squares alternately, strips.

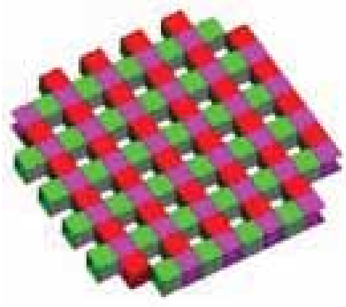

6 Spiralic strips of regular triangles.

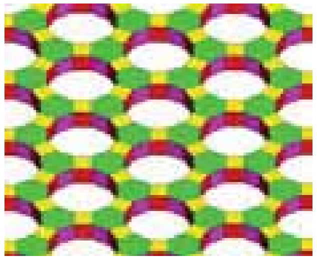


Arata Isozaki, Art Tower Mito (Mito, Japan, 1990)

Two Directions Copy // One Layer Polyhedra





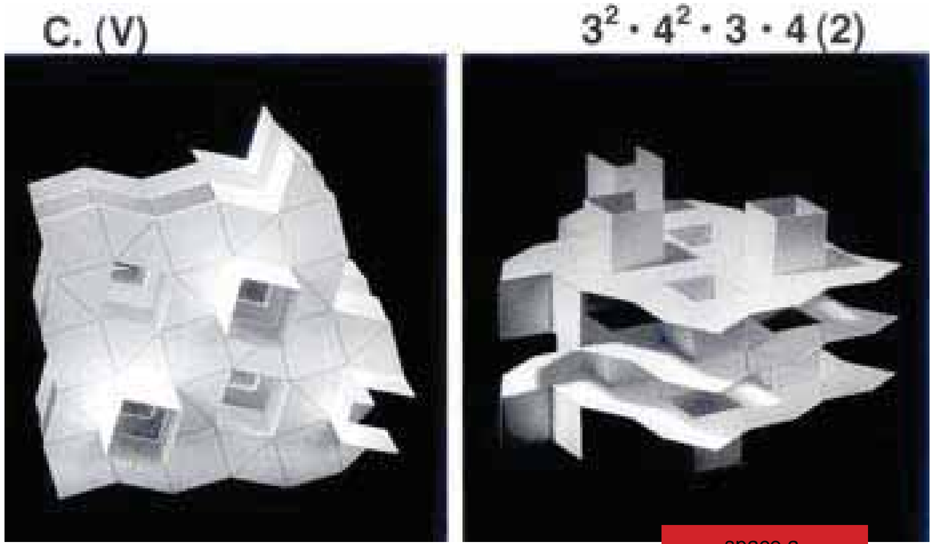


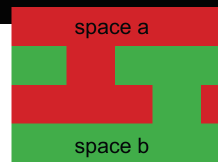
Geometric facade (Osaka, Japan)

שיכון שטיח, שכונה ה׳,באר שבע

Three Directions Copy // Multi Layer Polyhedra

A combination of tiling and prismatic and anti-prismatic rings.





Three Directions Copy (Multi Direction Polyhedra)

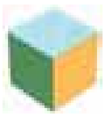
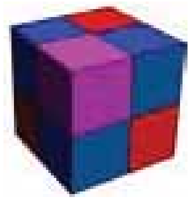
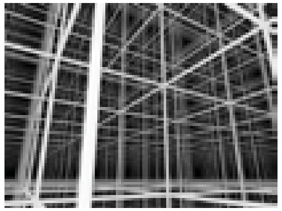
Multi direction polyhedra is a way of packing the space with polyhedrons. There are 2 ways to do that:

1. packing the space without gaps.
2. packing the space with gaps

Packing the space without gaps // Honeycombs

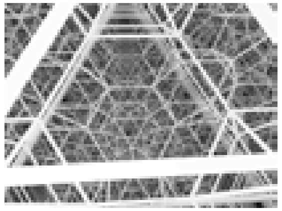
A honeycomb having all cells identical within its symmetries is said to be cell-transitive or isochoric. A cell of such a honeycomb is said to be a space-filling polyhedron. Known examples:

Cube

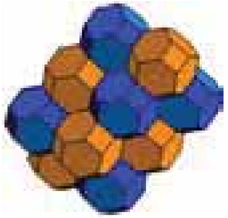
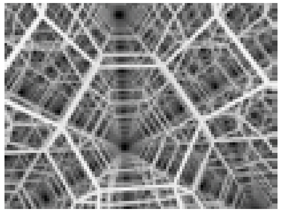




Rhombic Dodecahedron





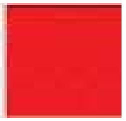
Truncated Octahedron

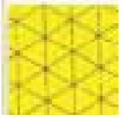

Micro Dweling, N55

Prismatic Polyhedrons

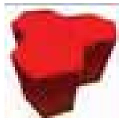
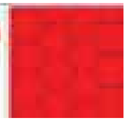
cubic

hexagonal

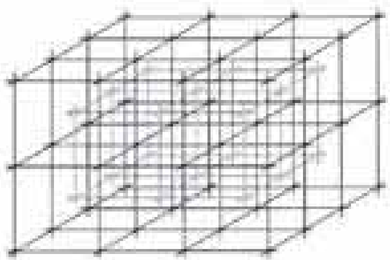




trianglural

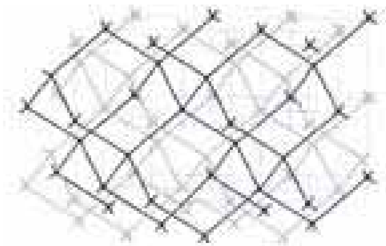



Packing the space with gaps

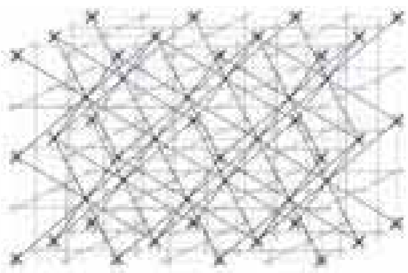
There are 7 pairs of nets that fit most of the infinite polyhedrons:



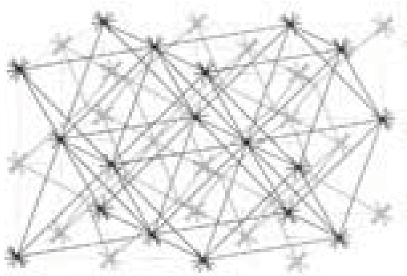
C (cubic)



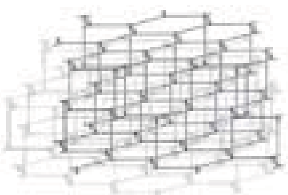
D (diamond)



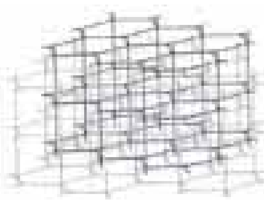
CC (cube centered)



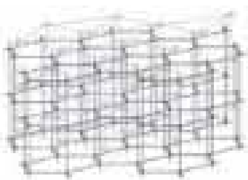
OT (octahedra tetrahedra)



G (grafit)

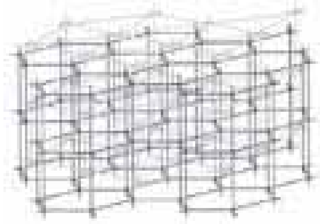


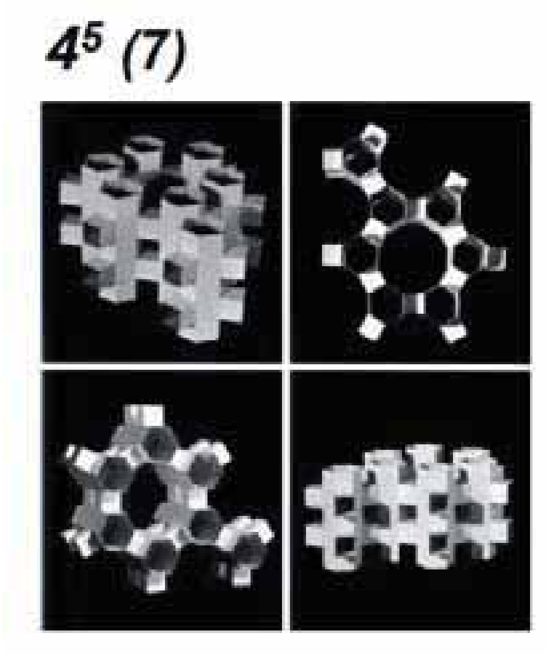
TP (trihedra petrahedra)



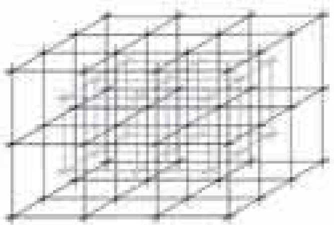
PO (prismatic)

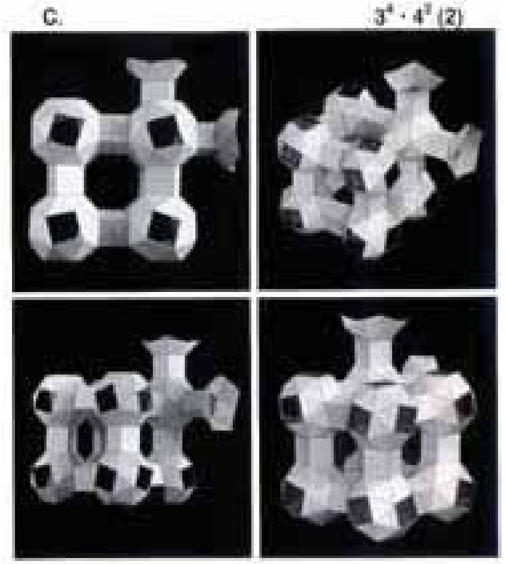
PO (prismatic)

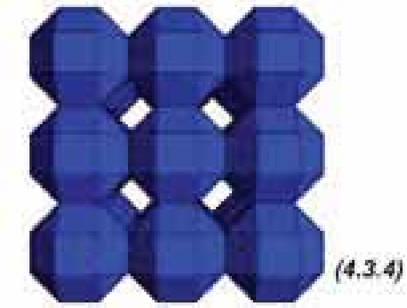


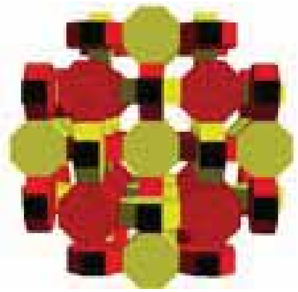


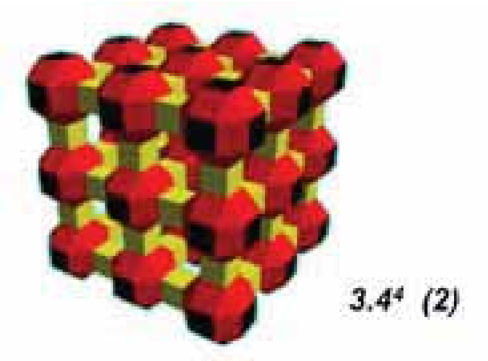
C (cubic)

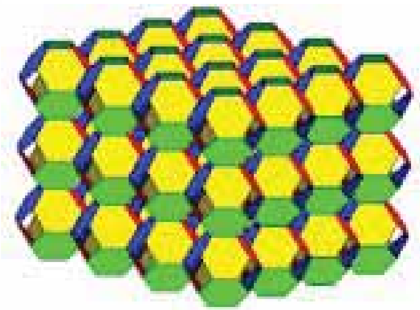


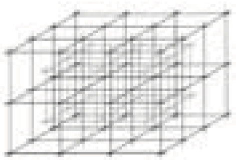








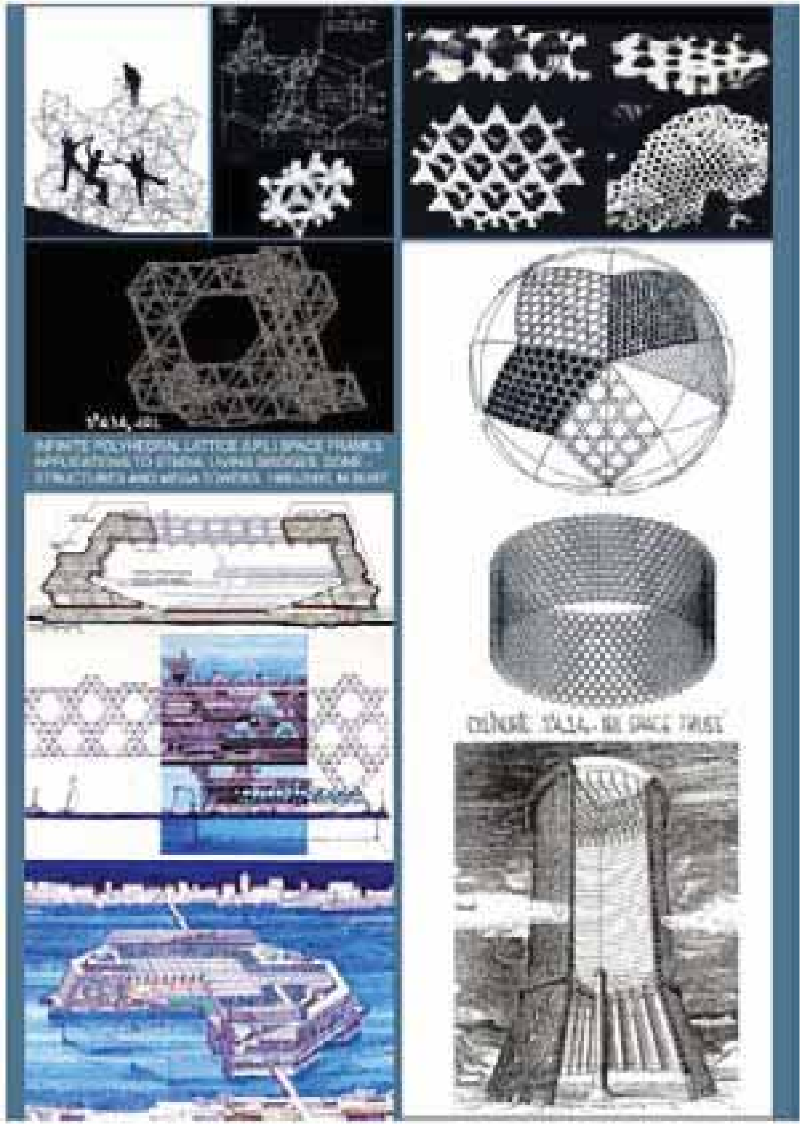




Toyo Ito museum

PERIODIC SPONGE SURFACES AND UNIFORM SPONGE POLYHEDRA IN NATURE AND IN THE REALM OF THE THEORETICALLY IMAGINABLE.

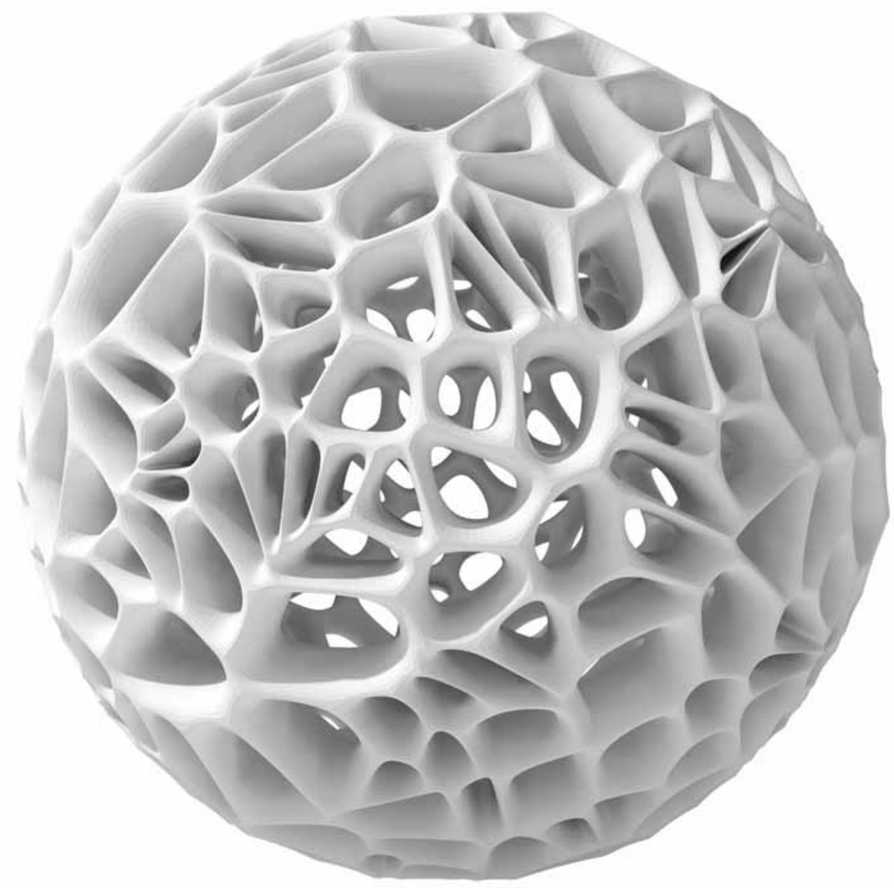
Michael Burt



Cellular structures and cell-in-cell structures

Microscope and nanoscopic measurement -

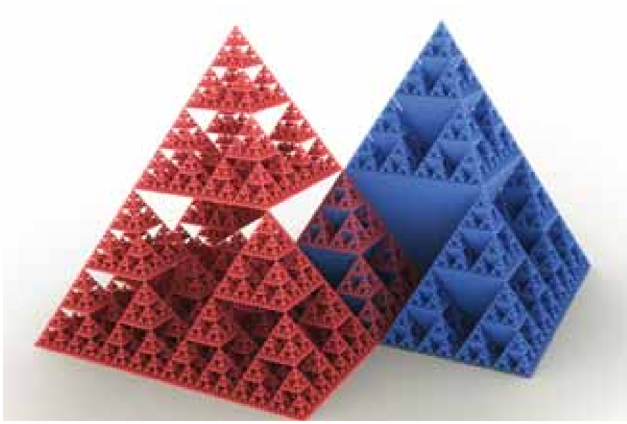
The flora and fauna.



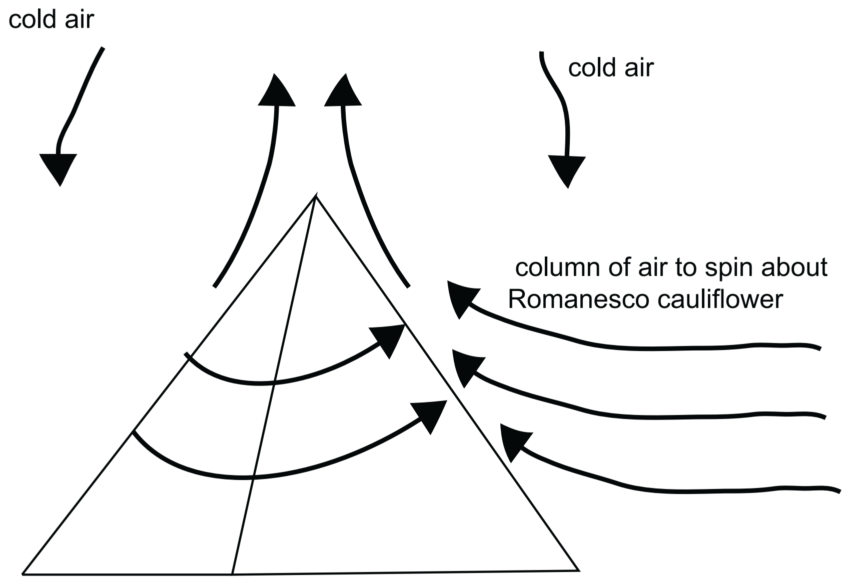
http://www.grasshopper3d.com/photo/radiolarian-03

Fractal objects

Fractal objects that have the property of self similarity, in that the organization of the constituents parts that make up the object reflect that of the whole and overall object



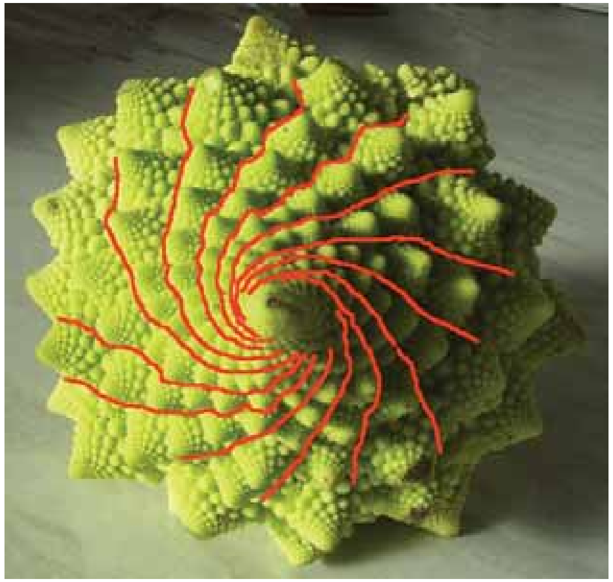
climate model

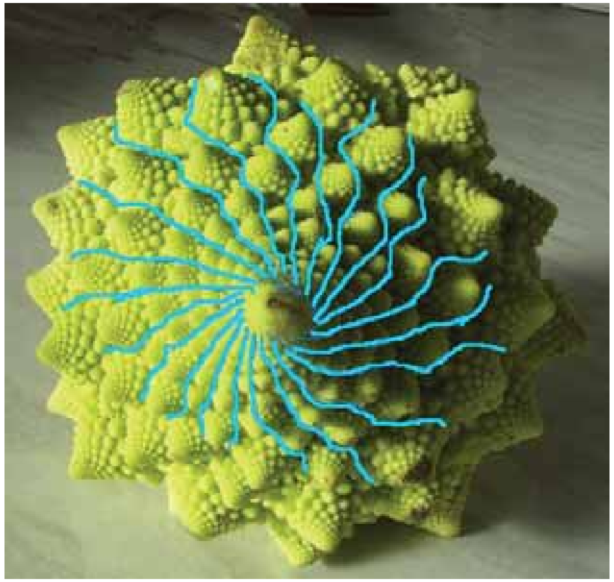


The head of a Romanesco cauliflower

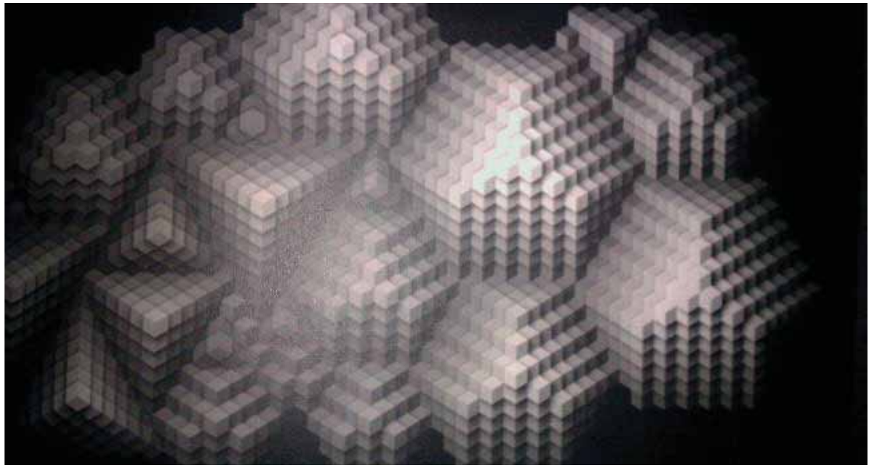
http://www.easybloom.com/plantlibrary/plant/cauliflower-4

http://morrisonworldnews.com/?p=28397





http://davesgarden.com/guides/pf/showimage/176595/

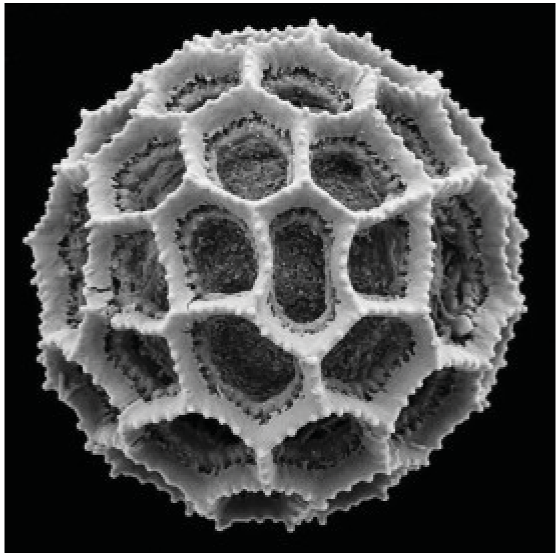


Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.

http://morrisonworldnews.com/?p=28397

The tree- rayed networks pollen

such patterns of the surfaces of the pollen grains are determined, for the most part, by the genetic programming of the plant

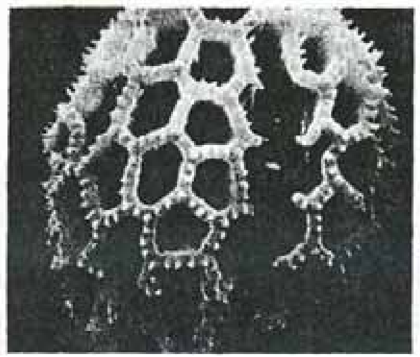


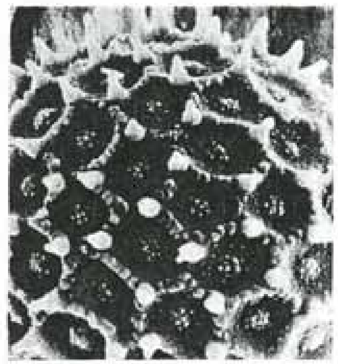
scanning electron microscopy photography by The University of Edinburgh

http://sacrit.blogspot.com/2010/11/epic-art-science-exhibit-exploration.html

naturally occuring tree- rayed hexagonal networks is to be found in giraffe skin.
The extremely uniform reptile skin is a packing of circles in which small triangles appear at the interstices.

Giraffe skin

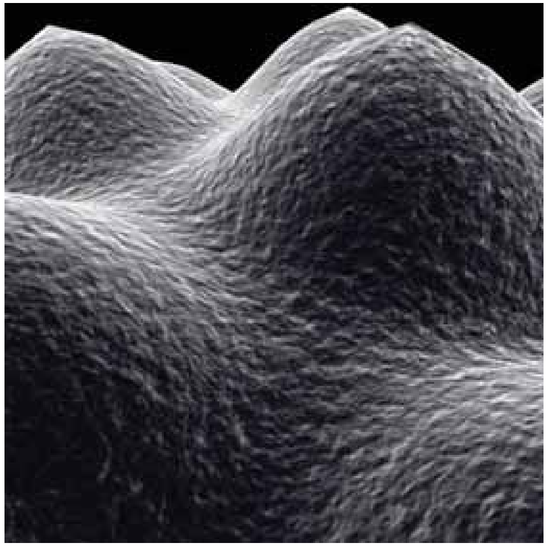


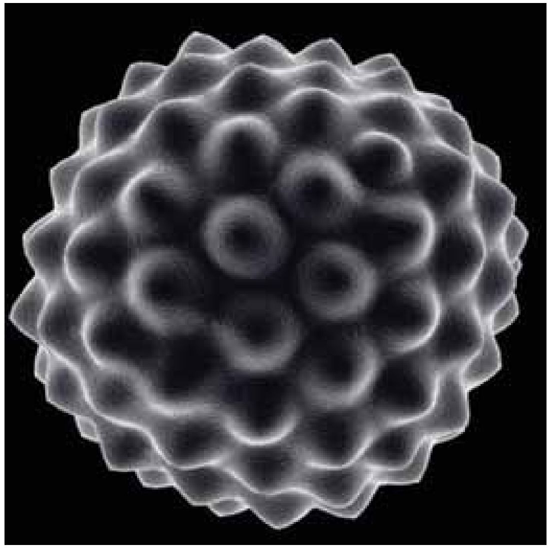


Pollen grain of morning glory and thrift pollen (copyright 1969, patrik echlin & cambridge scientific instruments).

Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

Pollen





http://www.turbosquid.com/3d-models/3d-model-microscopic-pollen/307565

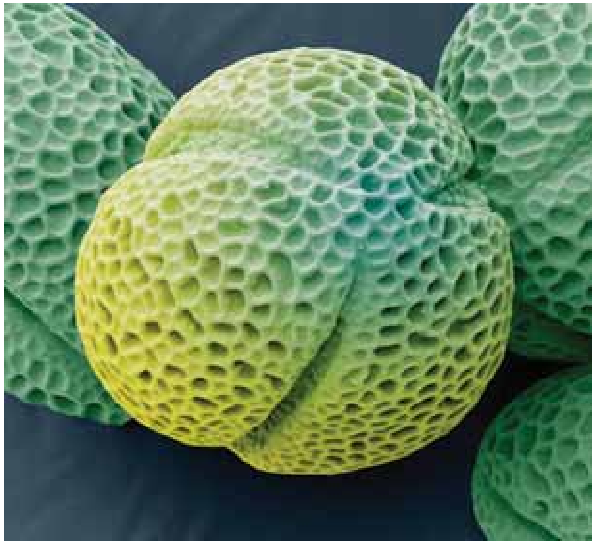
http://www.phombo.com/art/microscope-images-of-pollen-grains/823606/popular/

The structure and formation of pollen

Pollen itself is not the male gamete.[1] Each pollen grain contains vegetative (non-reproductive) cells (only a single cell in most flowering plants but several in other seed plants) and a generative (reproductive) cell containing two nuclei: a tube nucleus (that produces the pollen tube) and a generative nucleus (that divides to form the two sperm cells). The group of cells is surrounded by a cellulose-rich cell wall called the intine, and a resistant outer wall composed largely of sporopollenin called the exine.

Pollen is produced in the 'microsporangium' (contained in the anther of an angiosperm flower, male cone of a coniferous plant, or male cone of other seed plants). Pollen grains come in a wide variety of shapes (most often spherical), sizes, and surface markings characteristic of the species (see electron micrograph, right). Pollen grains of pines, firs, and spruces are winged. The smallest pollen grain, that of the forget-me-not (Myosotis spp.), is around 6 µm (0.006 mm) in diameter. Wind-borne pollen grains can be as large as about 90-100 µm.[2] The study of pollen is called palynology and is highly useful in paleoecology, paleontology, archeology, and forensics.

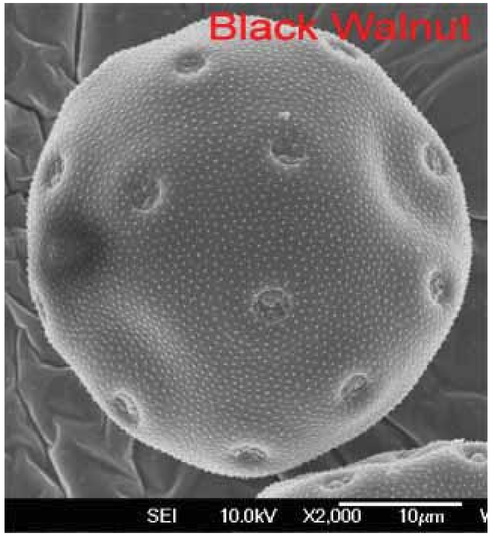
In angiosperms, during flower development the anther is composed of a mass of cells that appear undifferentiated, except for a partially differentiated dermis. As the flower develops, four groups of sporogenous cells form within the anther. The fertile sporogenous cells are surrounded by layers of sterile cells that grow into the wall of the pollen sac. Some of the cells grow into nutritive cells that supply nutrition for the microspores that form by meiotic division from the sporogenous cells. In a process called microsporogenesis, four haploid microspores are produced from each diploid sporogenous cell (microsporocyte), after meiotic division. After the formation of the four microspores, which are contained by callose walls, the development of the pollen grain walls begins. The callose wall is broken down by an enzyme called callase and the freed pollen grains grow in size and develop their characteristic shape and form a resistant outer wall called the exine and an inner wall called the intine. The exine is what is preserved in the fossil record.



http://www.madmoizelle.com/forums/forum-delirium-tremens/48722-le-meilleur-des-images-du-net-195.html

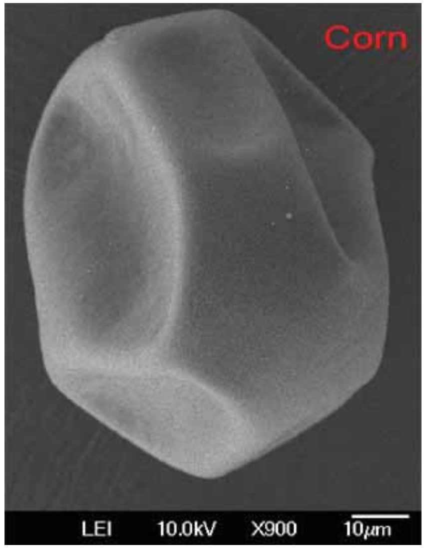
The structure and formation of pollen

The pollen wall protects the sperm nucleus while the pollen grain is moving from the anther to the stigma; it protects the vital genetic material from drying out and solar radiation. The pollen grain surface is covered with waxes and proteins, which are held in place by structures called sculpture elements on the surface of the grain. The outer pollen wall, which prevents the pollen grain from shrinking and crushing the genetic material during desiccation, is composed of two layers. These two layers are the tectum and the foot layer, which is just above the intine. The tectum and foot layer are separated by a region called the columella, which is composed of strengthening rods. The outer wall is constructed with a resistant biopolymer called sporopollenin. The pollen tube passes through the wall by way of structures called apertures.[3]
Pollen apertures are any modification of the wall of the pollen grain. These modifications include thinning, ridges and pores, they serve as an exit for the pollen contents and allow shrinking and swelling of the grain caused by changes in moisture content. The elongated apertues/ furrows in the pollen grain are called colpi (singular: colpus) which along with pores, are a major criterion for the identification of classes of pollen .[4]it leaves the microsporangium, with the generative cell forming the two sperm cells.



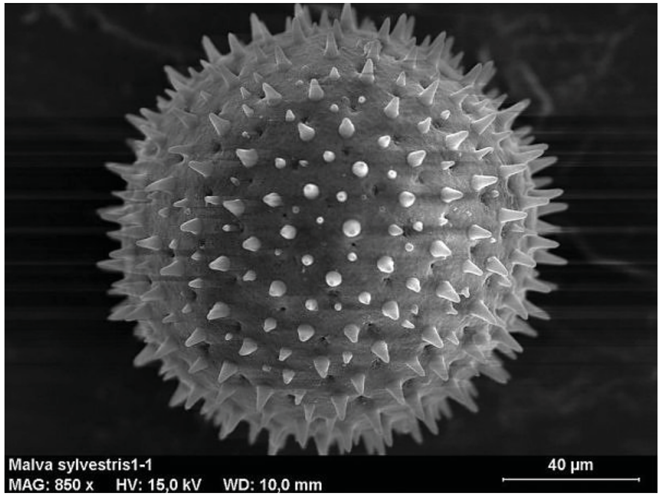
Dint

Pollen grains may have furrows, the orientation of which (relative to the original tetrad of microspores) classify the pollen as colpate or sulcate. The number of furrows or pores helps classify the flowering plants, with eudicots having three colpi (tricolpate), and other groups having one sulcus.[5][6] Except in the case of some submerged aquatic plants, the mature pollen-grain has a double wall, a thin delicate wall of unaltered cellulose (the endospore or intine) and a tough outer cuticularized exospore or exine. The exine often bears spines or warts, or is variously sculptured, and the character of the markings is often of value for identifying genus, species, or even cultivar or individual. In some flowering plants, germination of the pollen grain often begins before

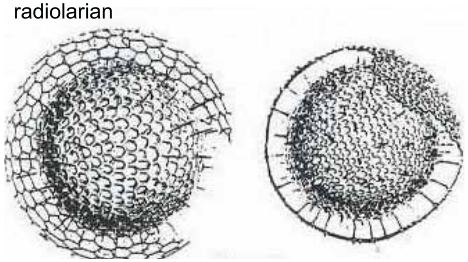


http://www.me.jhu.edu/lefd/BioComp/PollenDensity/PollenImages.htm

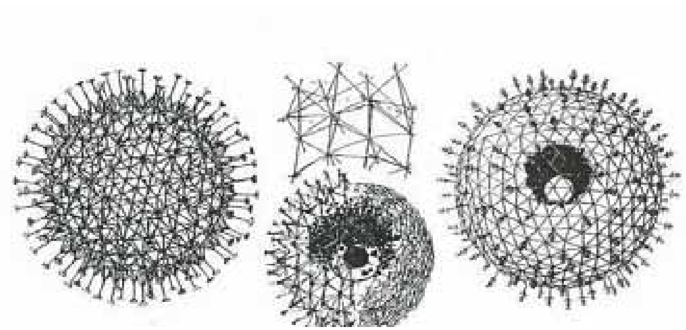
Radiolarian



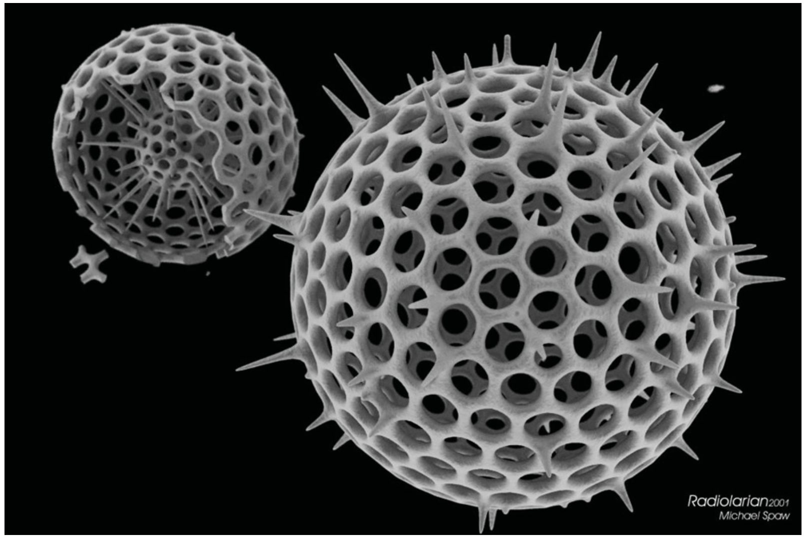
radiolarian



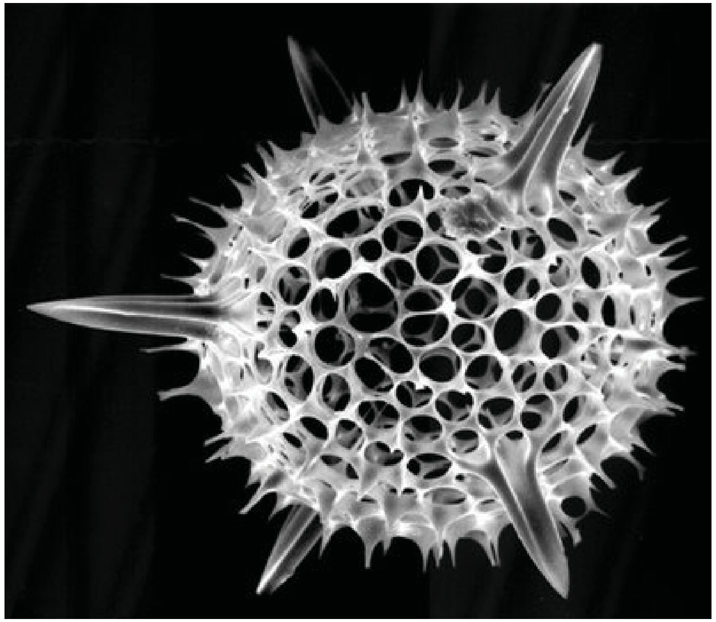
spherical radiolarian skeletons of radiolarian vesicles



triangula radiolarian skeletons
Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

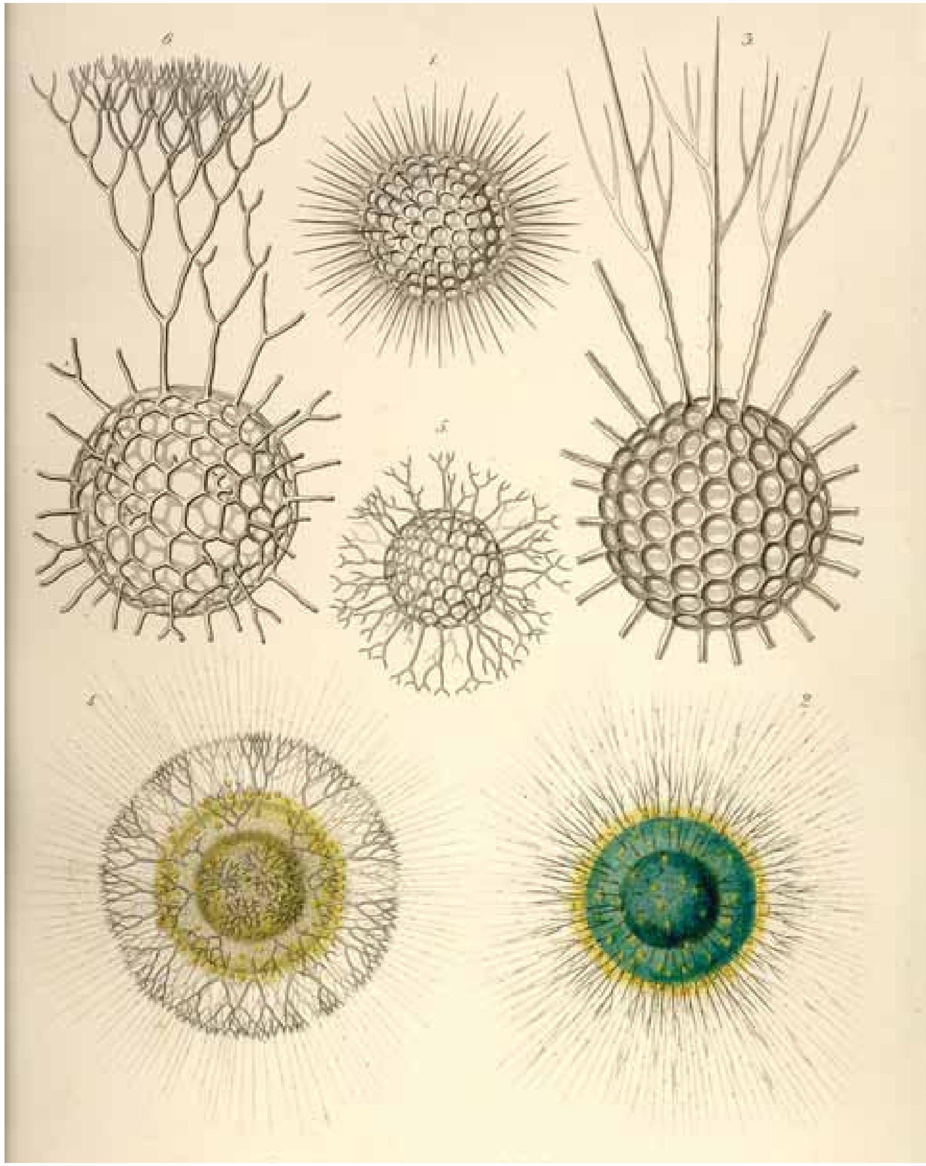


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html



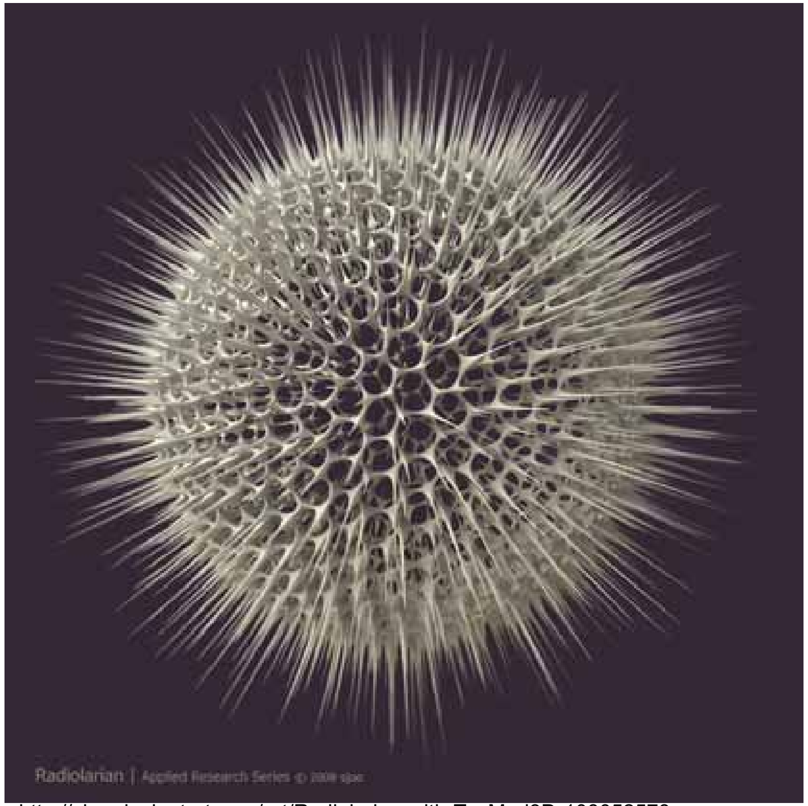
http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

shell



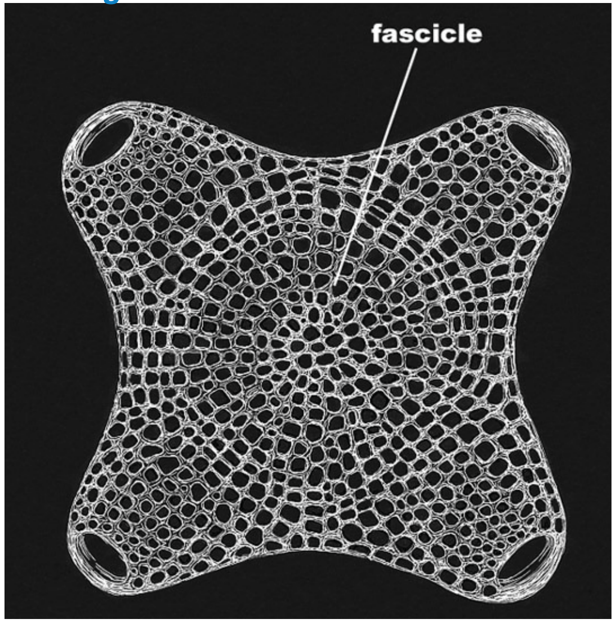
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

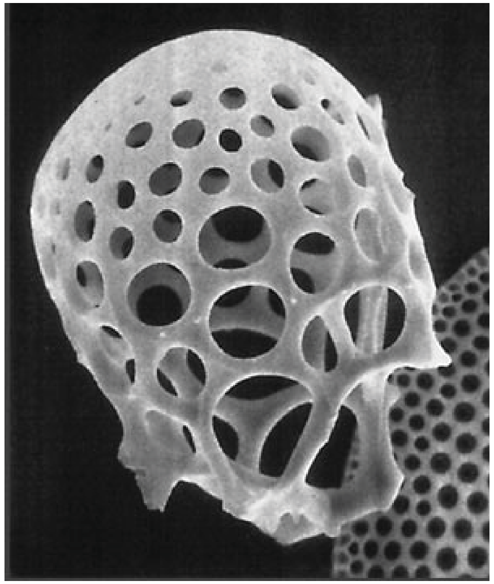
radiolarian



http://sjoo.deviantart.com/art/Radiolarian-with-TopMod3D-108052578

filtering





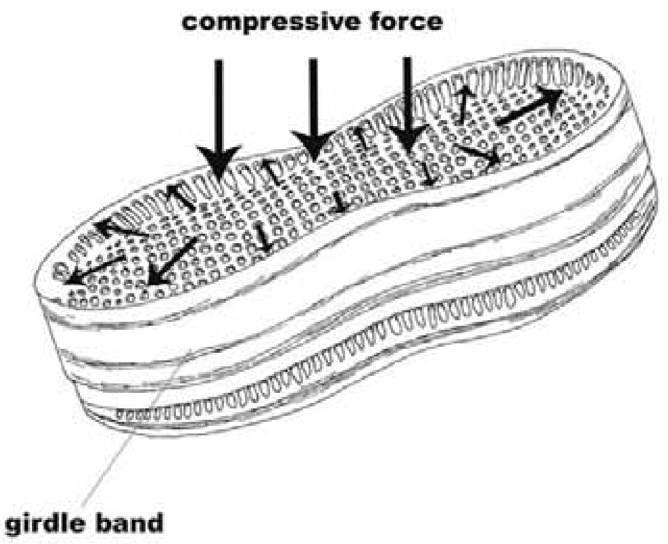
http://www.viewsfromscience.com/documents/webpages/methods_p3.html

Function

The holes in radiolarian and diatom shells respectively exist for differing reasons. Both types of skeleton are formed from silicon compounds.

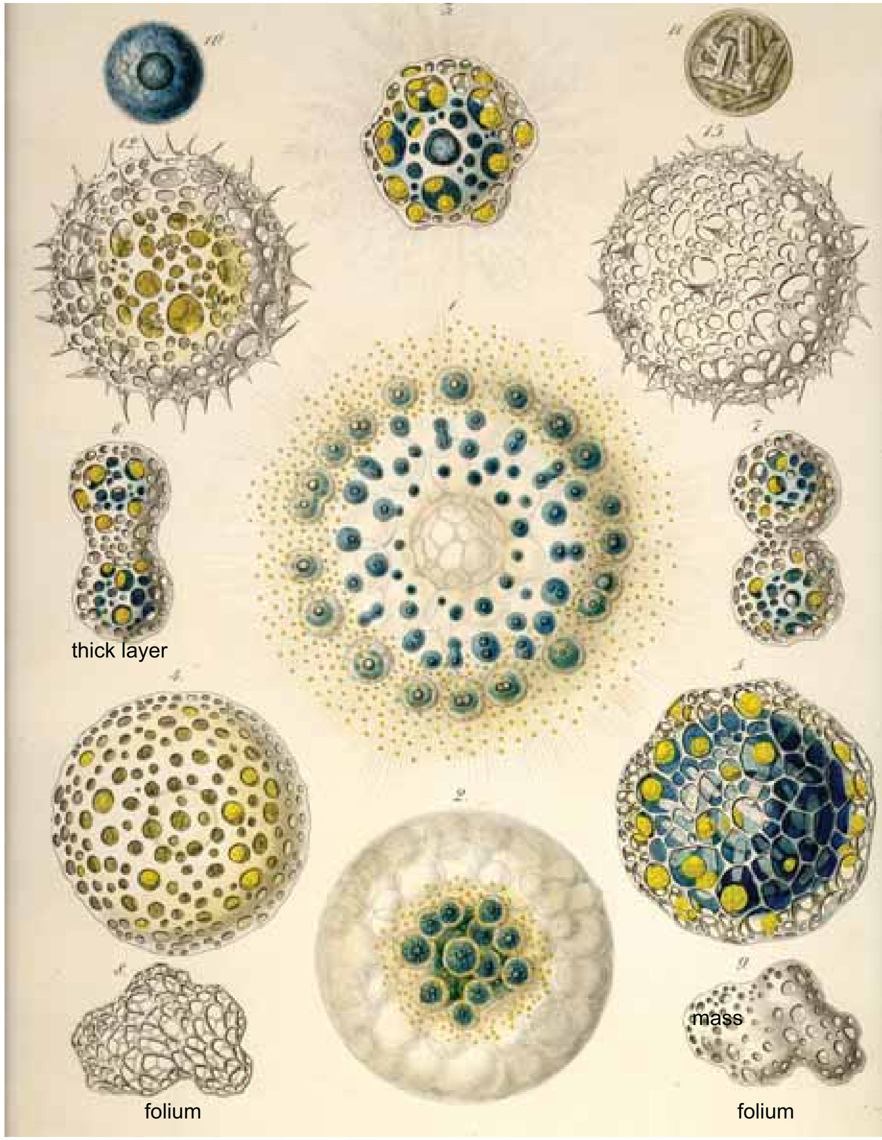
In diatoms, the holes collectively take on the role of a sieve, a two-way filtration mechanism across which water and nutrient molecules permeate the cell. The holes can range from several micrometres down to 100 nanometres in diameter.

A typical diatom frustule is perforated rather than solid, for two reasons. Firstly, the perforated construction allows for a more economic use of silica, especially where low levels of dissolved silica are present. Silicon is also relatively dense, so the structure promotes lightness. Perforations in the frustule also endow the diatom with considerable compressive strength, which explains the frustules' ability to survive undamaged under layers of sediment. When compressive force is applied to a frustule, the lines of force are concentrated along the lines of the silica lattice and continued to the girdle band, which has a greater ability to withstand stress. Costae, or ribs, will also strengthen the upper and lower surfaces of the frustule.



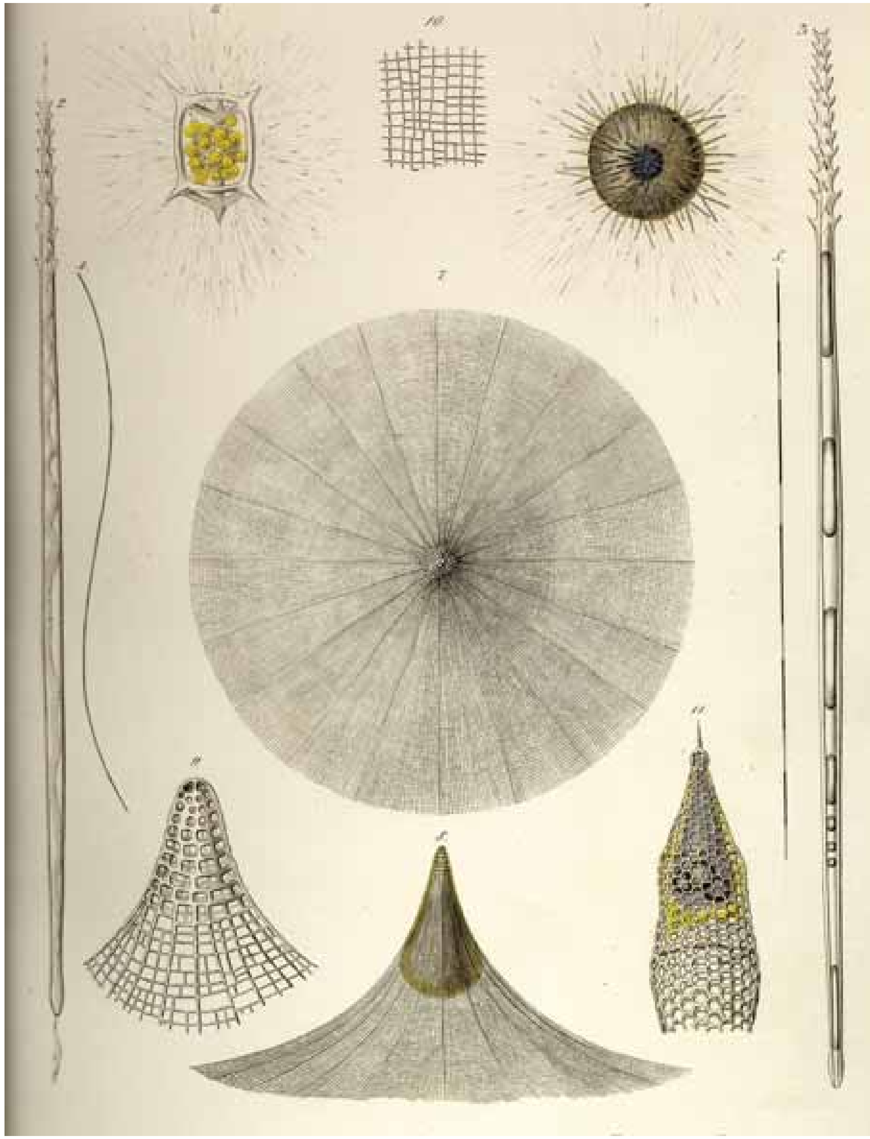
http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artfeb05/cbdiatoms.html

layers



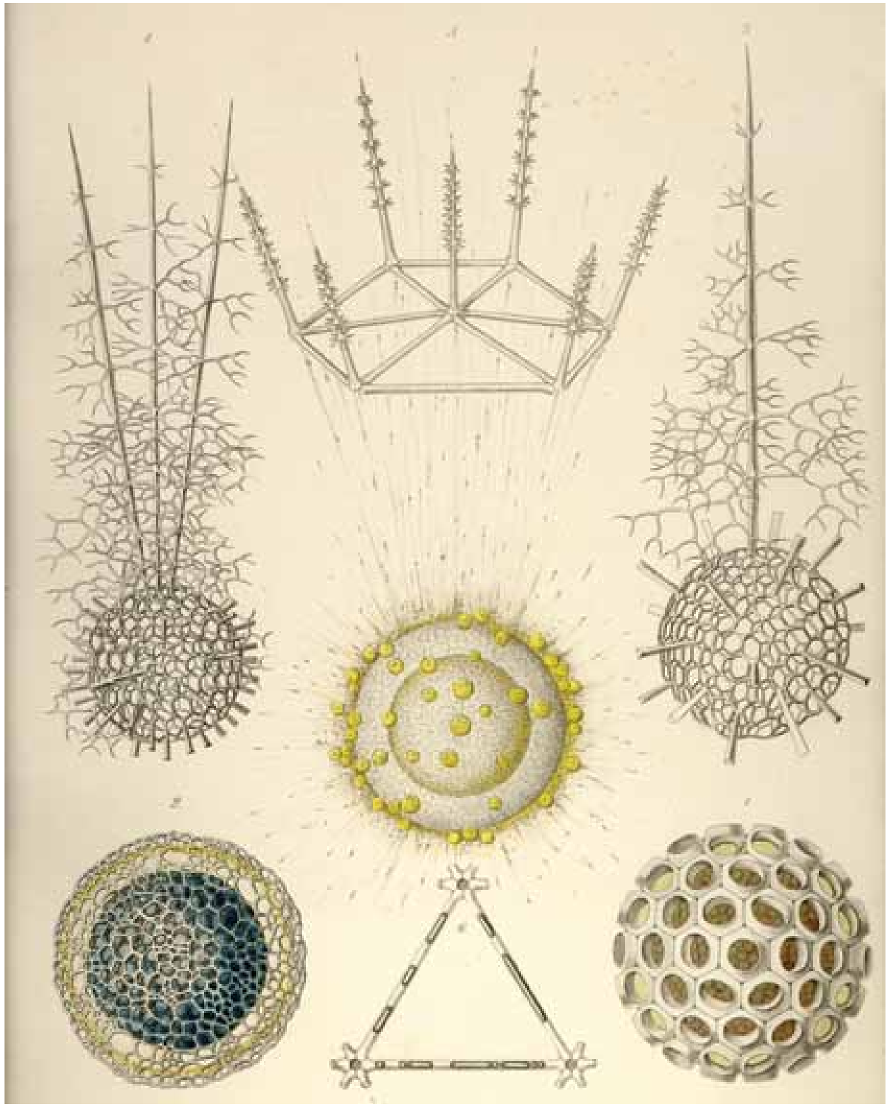
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

cover



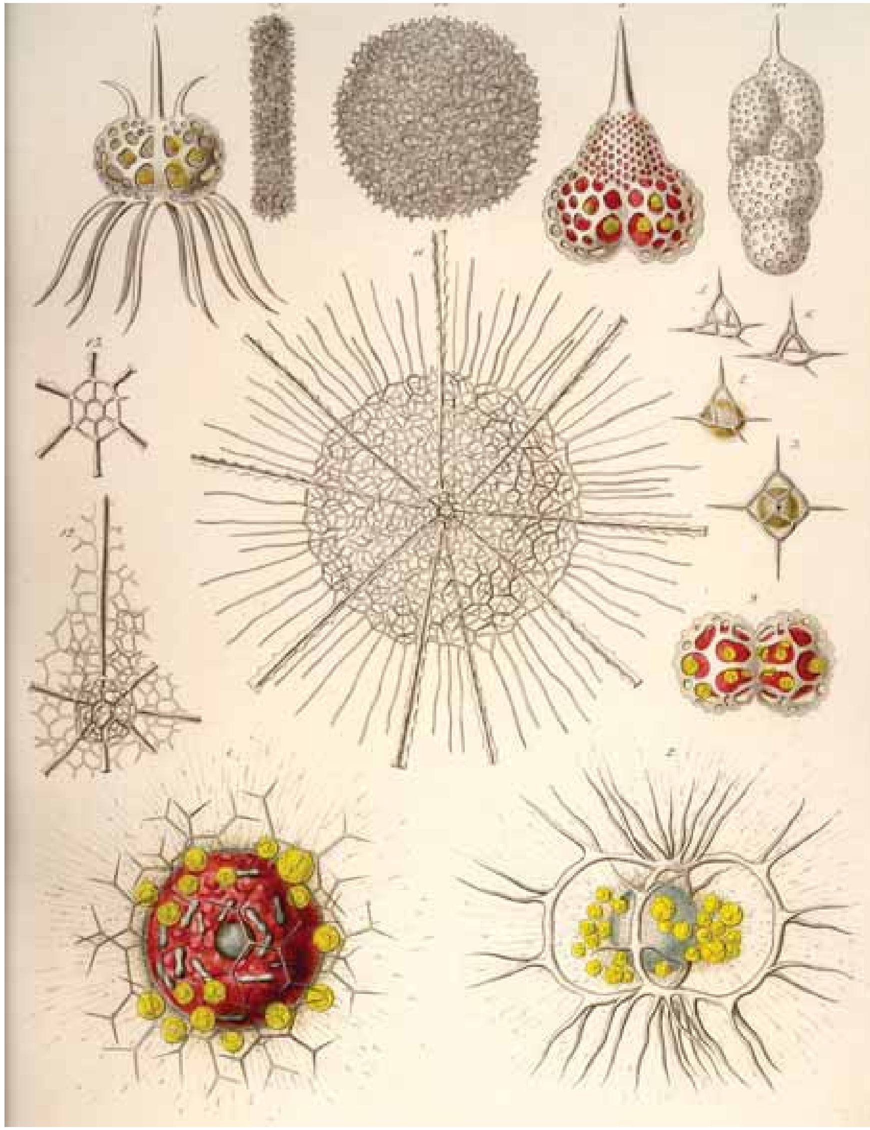
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

Constructive element



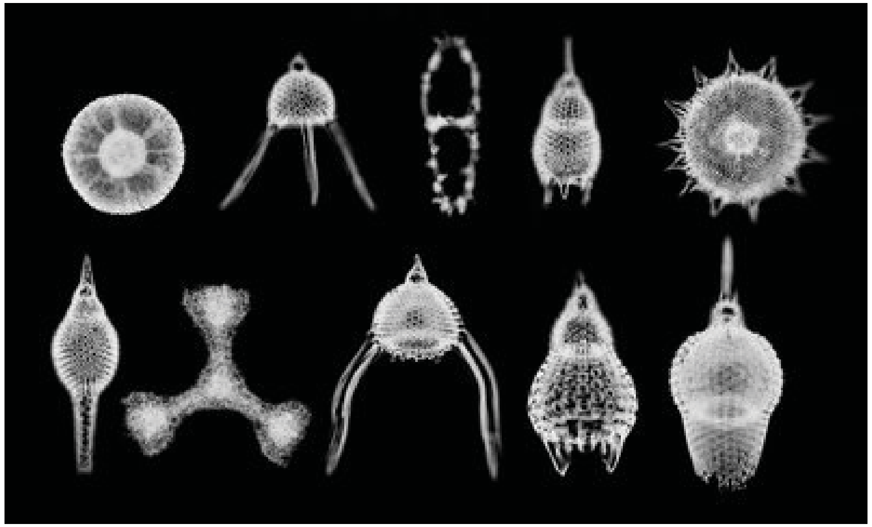
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

mutation

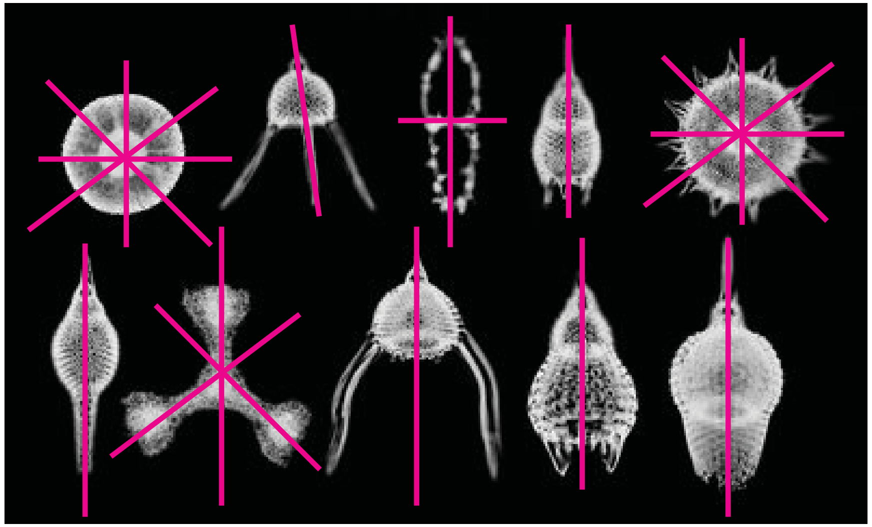


Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

Duplication

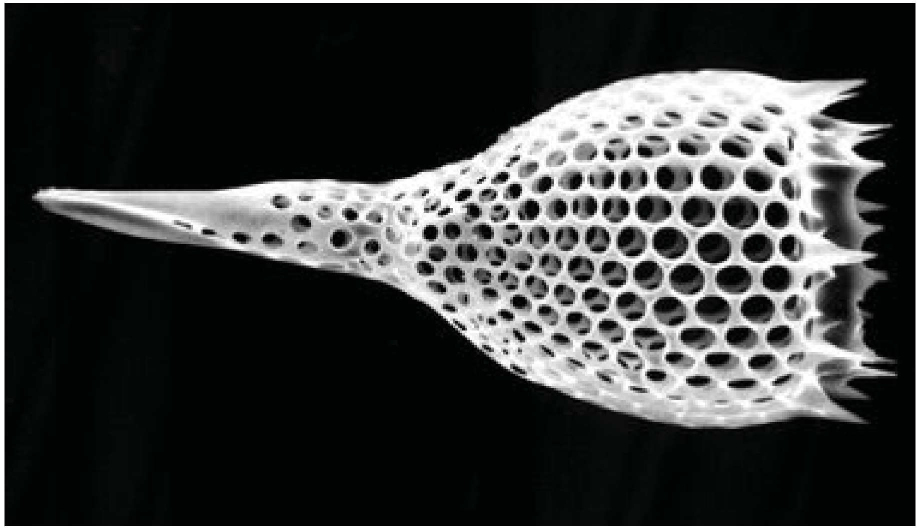


Symmetry

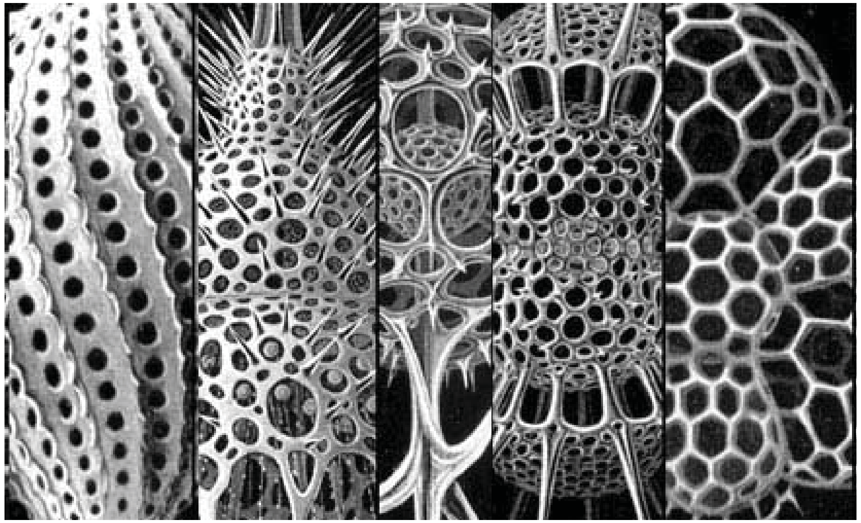


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

radiolarian lattices

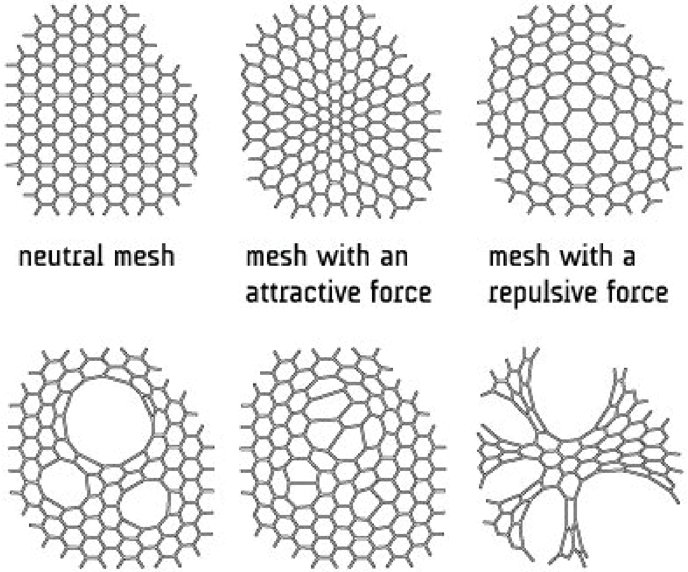


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

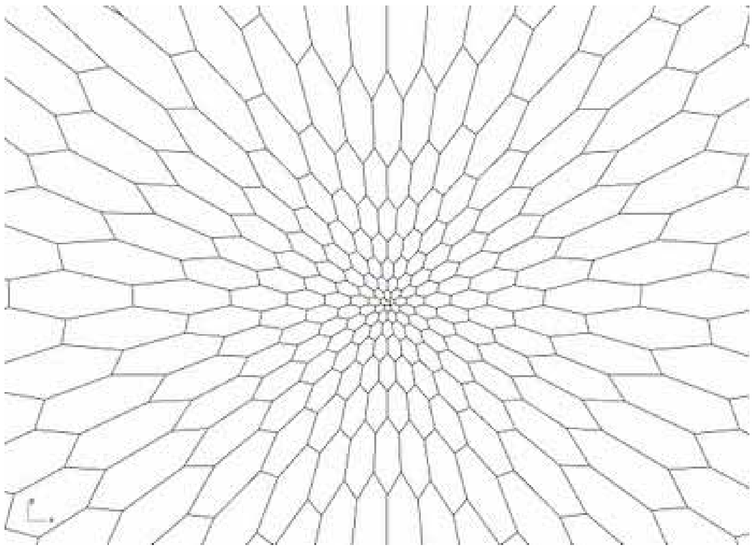


http://www.ucmp.berkeley.edu/people/klf/MicroGallery.htm

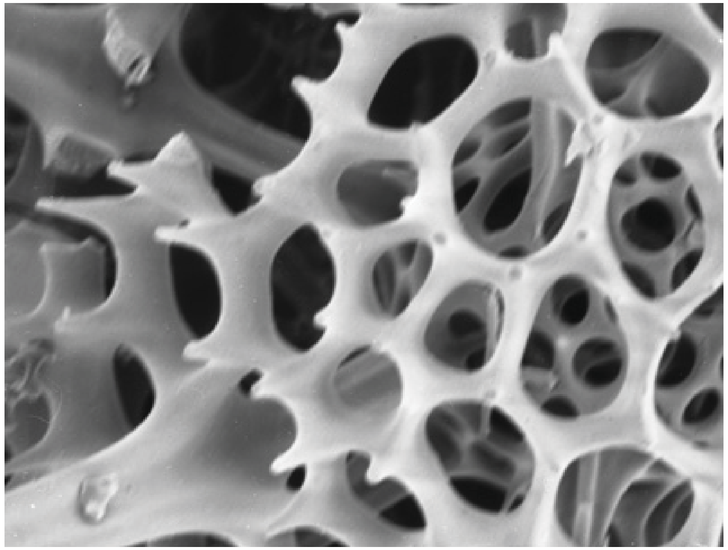
.RADIOLARIAN



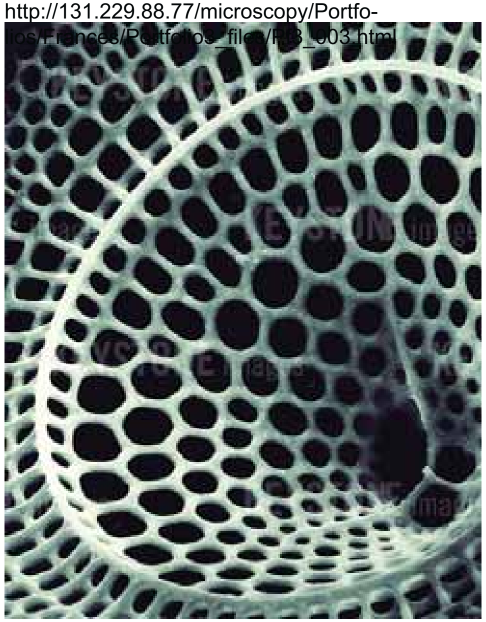
http://sa-mariavera.blogspot.com/2009/03/radiolaria-applet.html



Radiolarian vector deformation
logspot.com/2010/02/radiolarian-vector-deformation-02.html

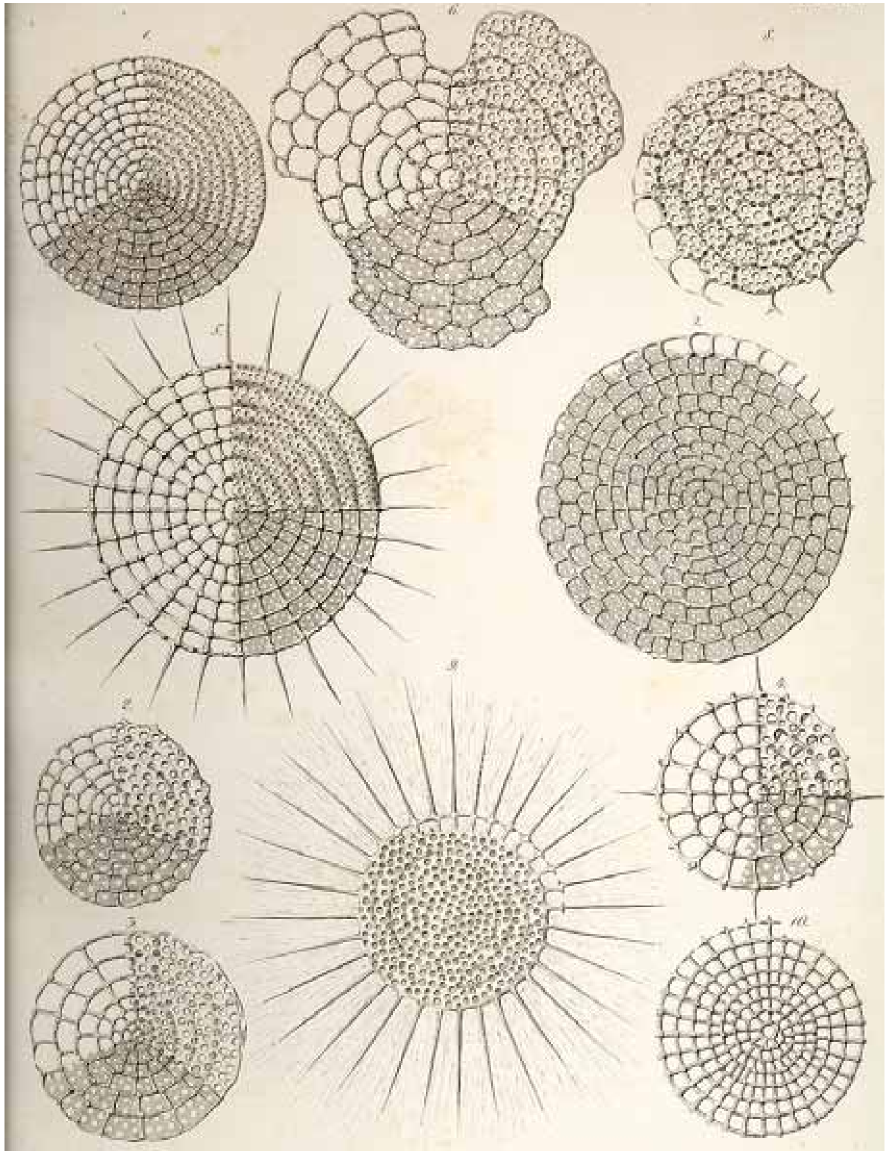


Radiolarian Skeleton
http://131.229.88.77/microscopy/Portfolios/Frances/Portfolios_files/FB3_003.html

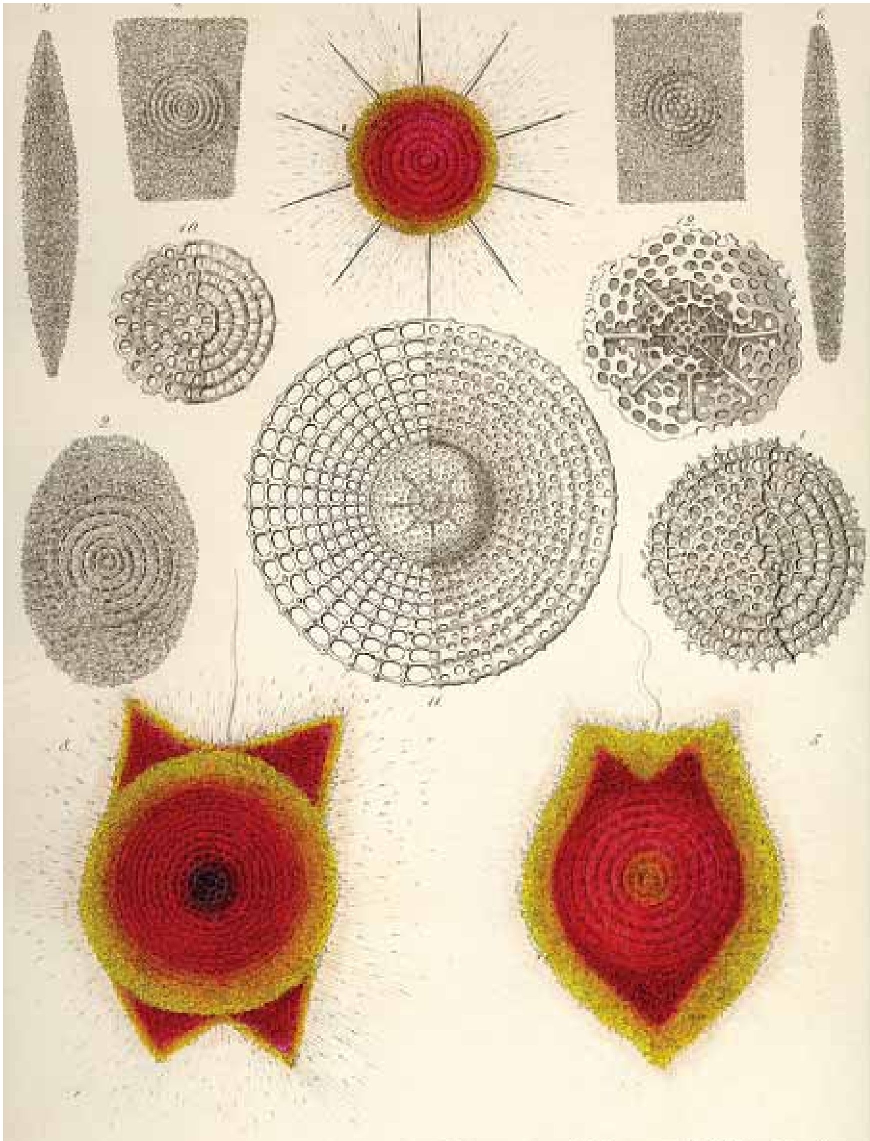


Inside the shell of a single-celled marine animal called a radiolarian. SEM x2700.
http://gallery.bestpicture.ch/bestpicture/category-2/picture-353/?q7=en

Different level of filtering - different microclimate



Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.



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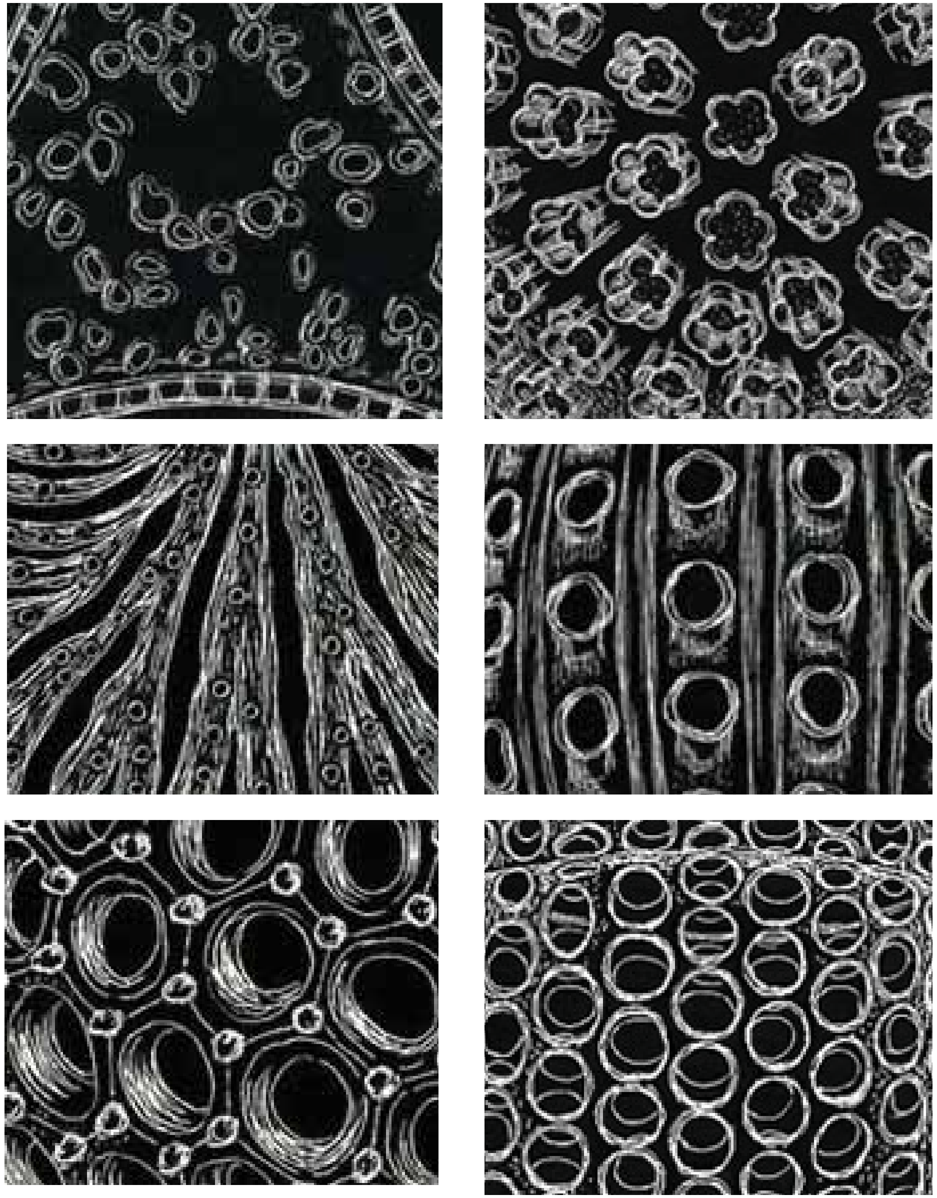
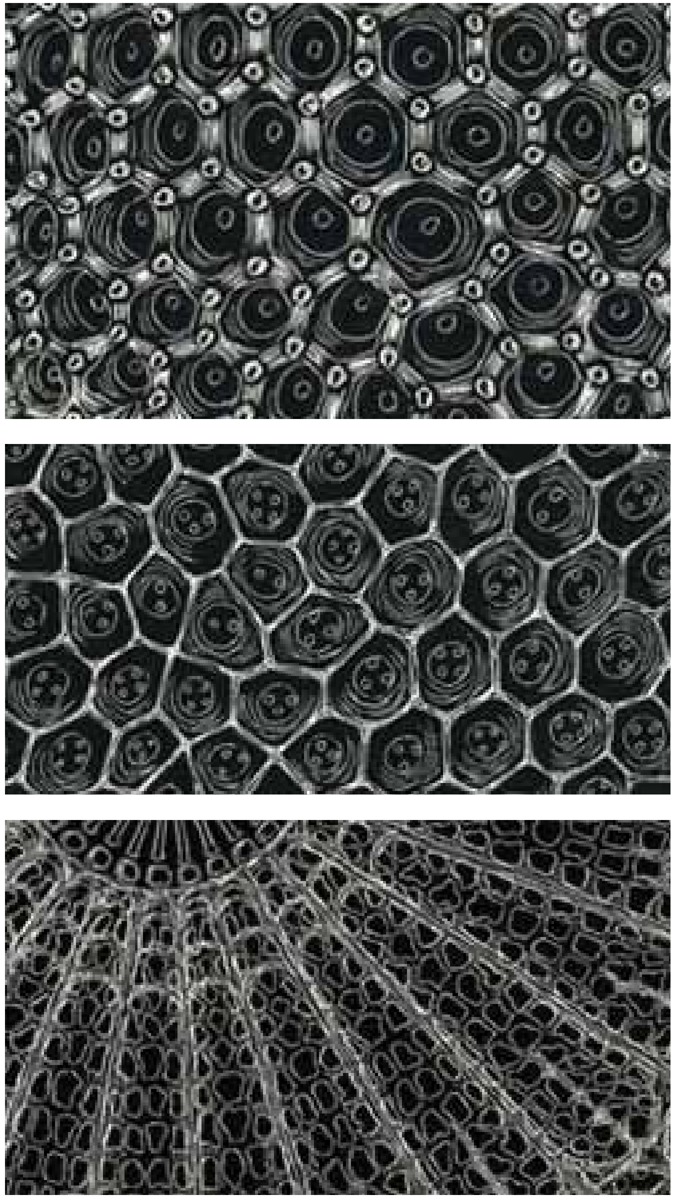


http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/art-feb05/cbdiatoms.html

Geometry and patterns

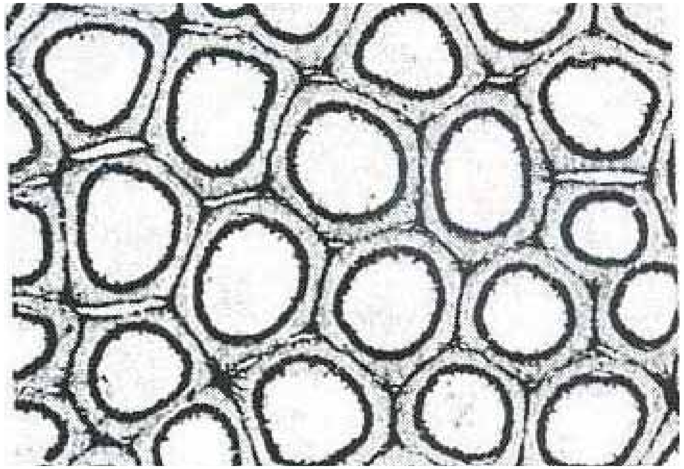


http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/art-feb05/cbdiatoms.html

closest packed tubules

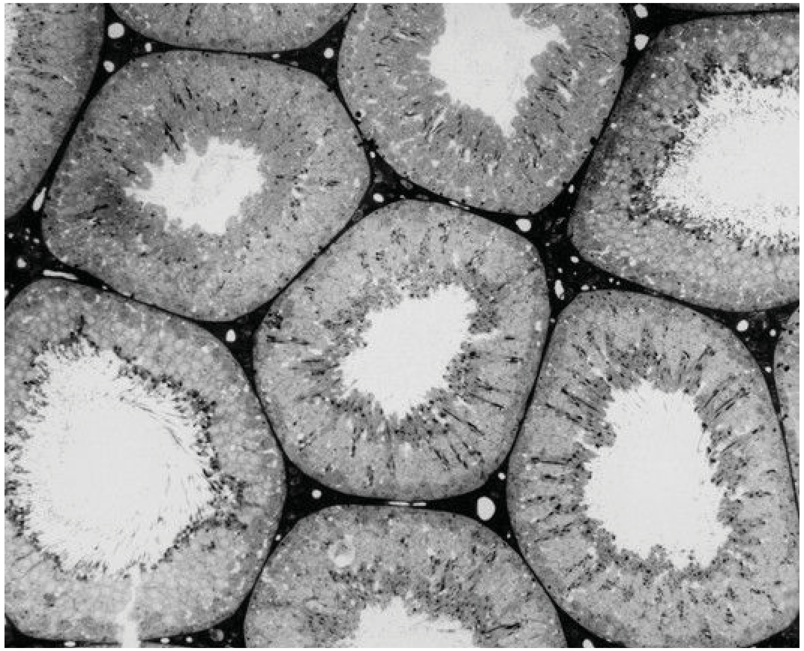
Mushrooms spores

http://morrisonworldnews.com/?p=28397

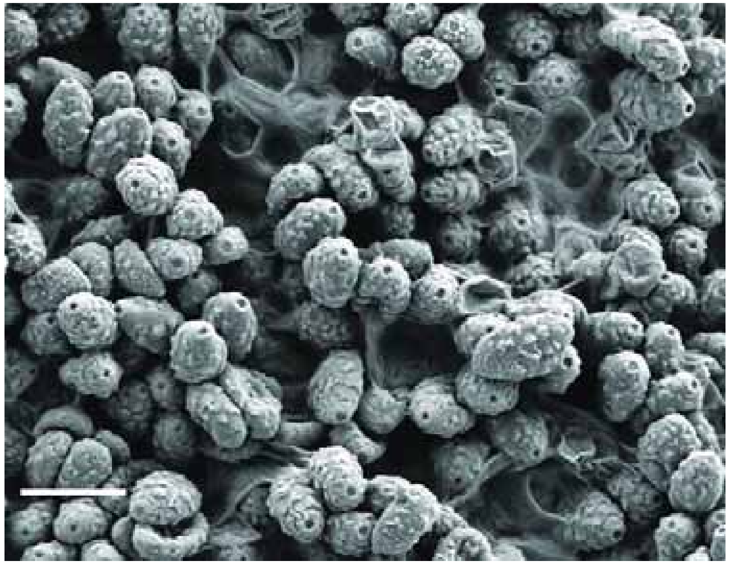


underside of a mushroom (jirovec)

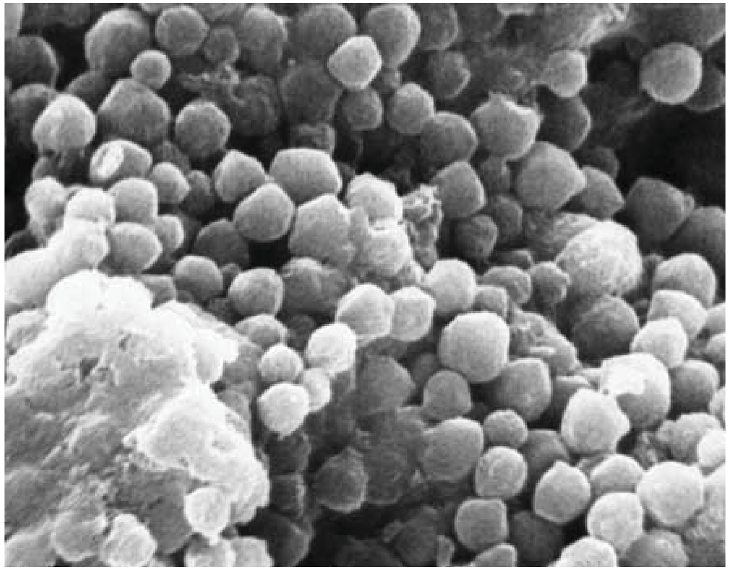
Transmission electron micrograph (TEM) of a transverse section through a number of seminiferous tubules in a mammalian testis, the site of production of sperm. The testis is packed with numerous tubules which are lined by a stratified epithelium consisting of 2 distinct groups of cells; the central white area is the tubule lumen (interior). One group of cells is the spermatogenic series, ie those cells involved in both spermatogenesis (production of male gametes) and subsequent spermiogenesis (evolution of male gamete into motile spermatozoon). The other group are non-spermatogenic cells called Sertoli cells, which nourish the developing spermatozoa.



closest packed tubules

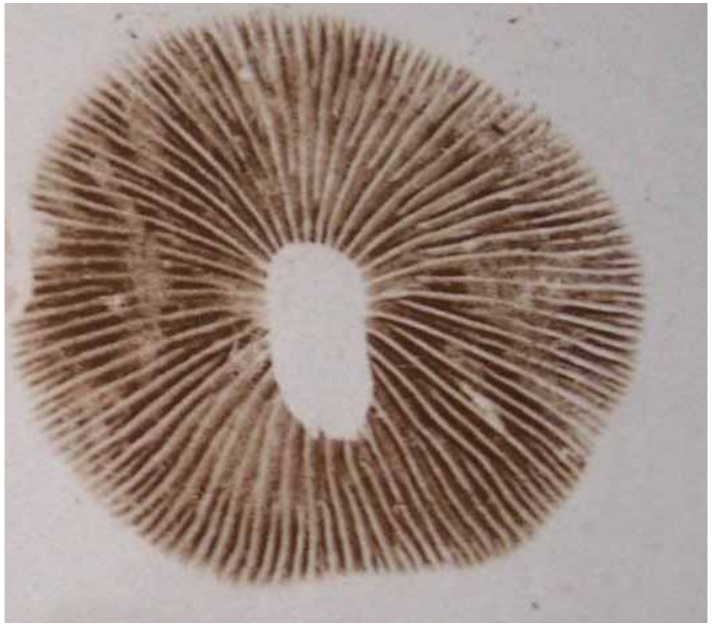


mushroom spores



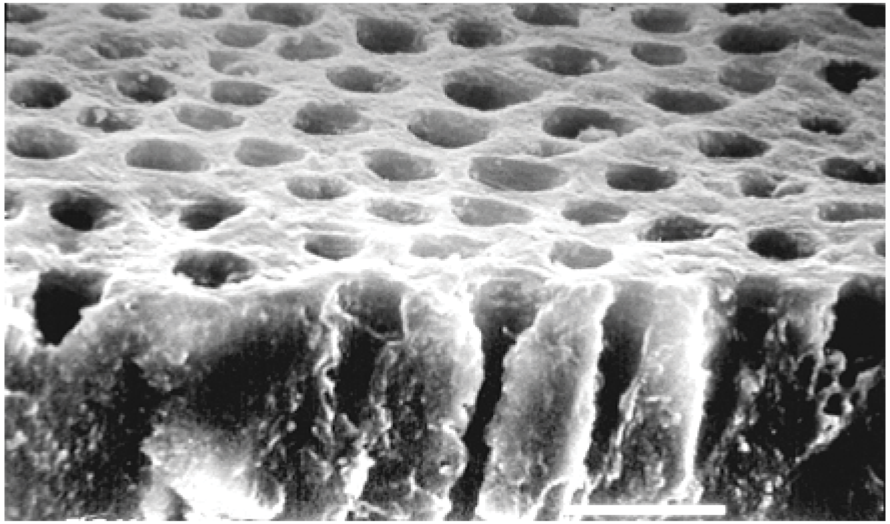
http://newswatch.nationalgeographic.com/2011/06/16/weird-wild-spongebob-mushroom-named/

Unit geometry

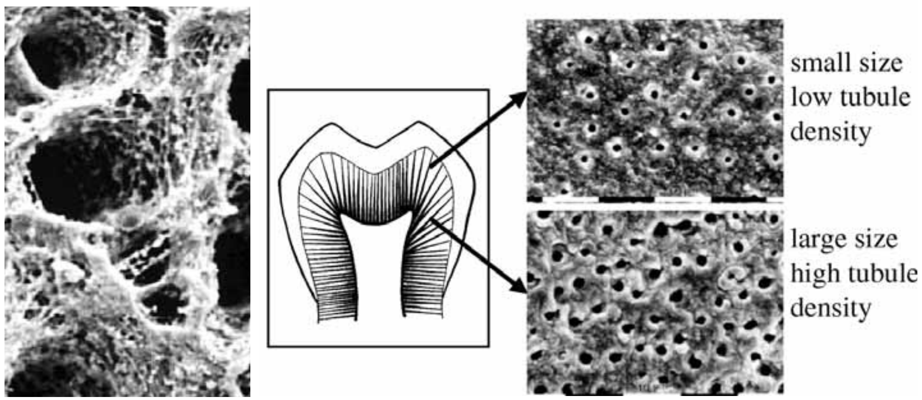


http://www.mushroomsfmrc.com/gpage11.html

Denisty
Dentin tubules



SEM micrograph showing the spatial distribution of dentin tubules.
Misra A et al. J. R. Soc. Interface 2005;2:145-157



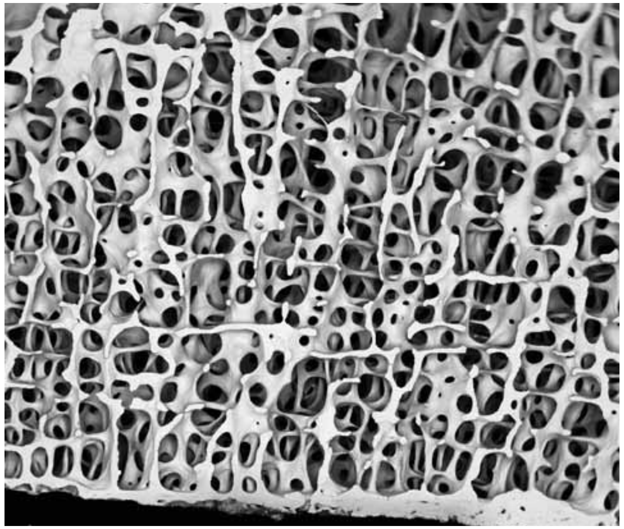
As is evident, the structure and properties of dentin substrate vary with location and can affect the bond formation (Marshall et al. 1997).

Misra A et al. J. R. Soc. Interface 2005;2:145-157

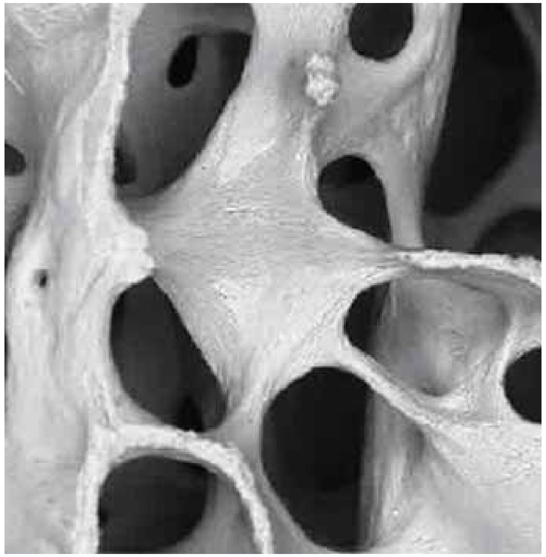
Mushrooms spores

Mushrooms spores. Coloured scanning electron micrograph (SEM) of spores (round, brown, left and right) of the Agaricus bisporus fungus. The spores are the reproductive structures of the fungus, formed by and released by mushrooms, the fruiting bodies of a fungus. Magnification: x480 when printed 10cm wide.

Human bone - porosity

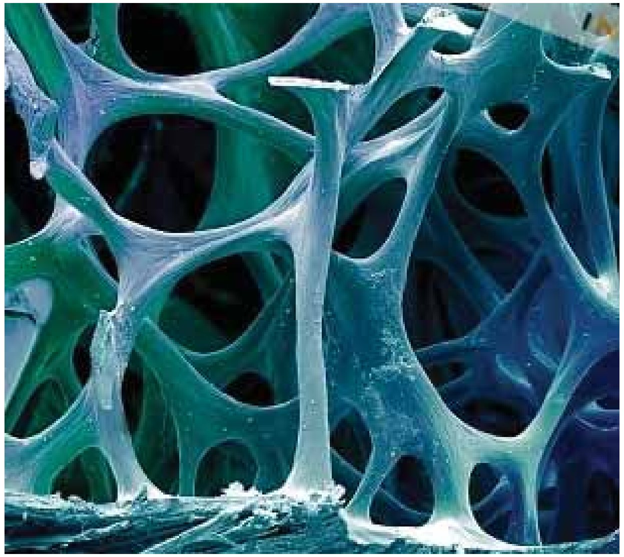


http://joshjung22.blogspot.com/2012_03_01_archive.html



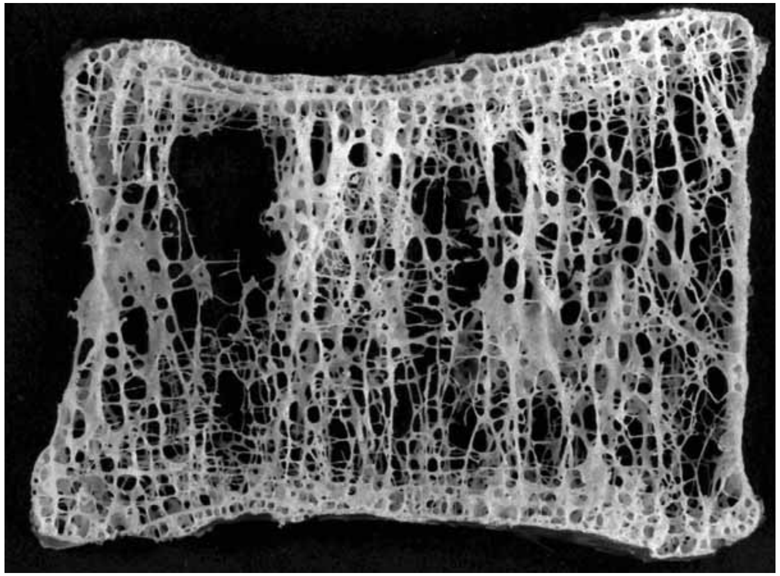
Human Bone Microscopy Image

http://www.microscopicpictures.com/microscope-Human_Bone.php

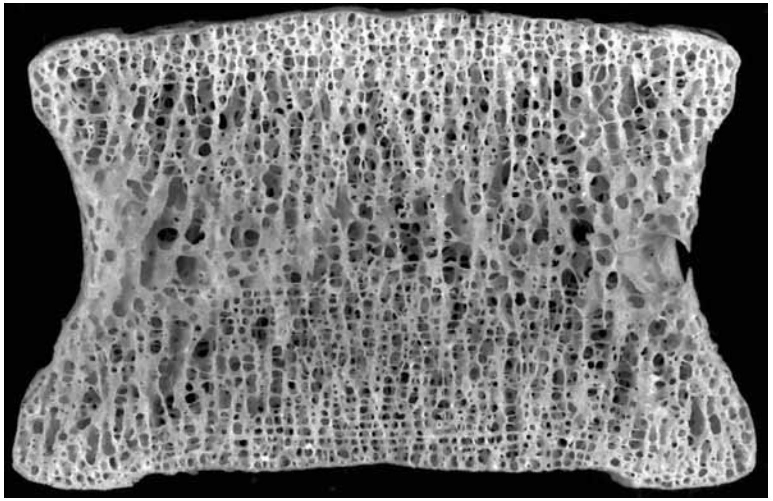


-Microscope bones
http://www.ectsoc.org/gallery/#myGallery-picture(16)

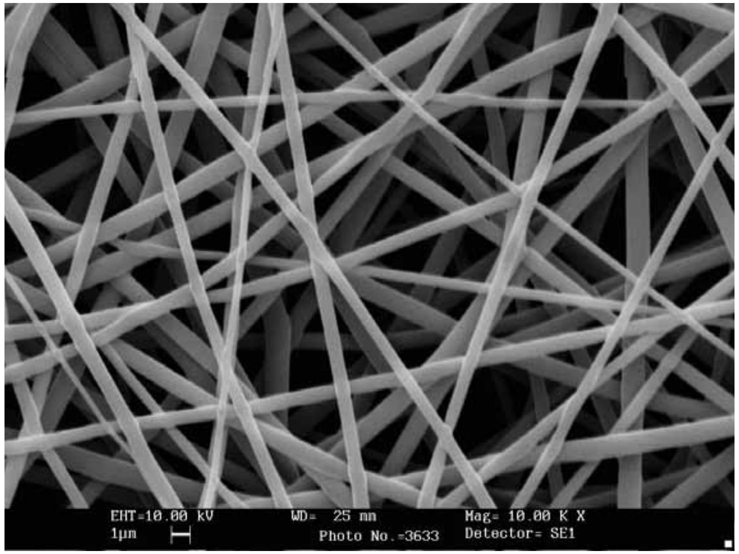
porosity



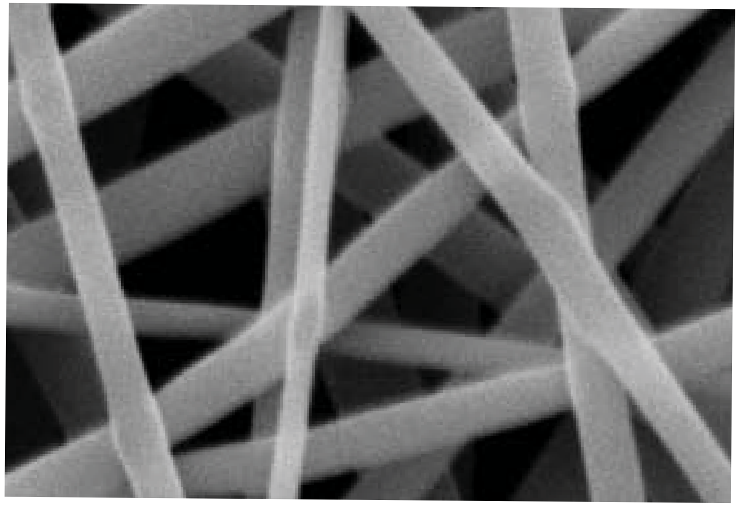
bone,
Human Bone, Osteoporosis ,male,89
copyright Professor Alan Boyde QMUL



bone, healty women,50
copyright Professor Alan Boyde QMUL



Microscope image of electrospun fibres
http://www.stfc.ac.uk/News+and+Events/5584.aspx



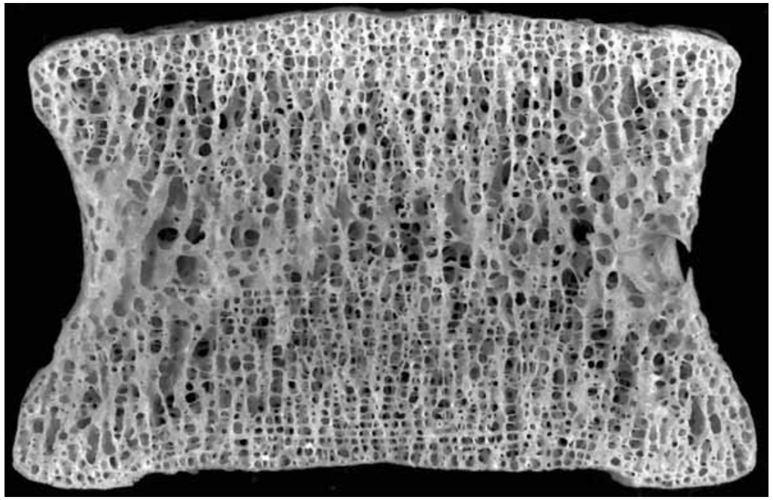
Porosity

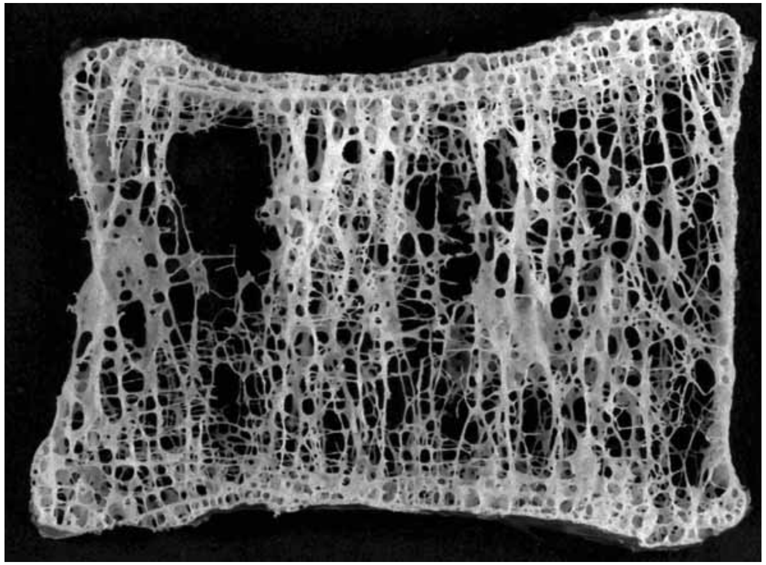
TABLE 3.1 Range of Porosity Values	
Soil Type	Porosity, p_t
Unconsolidated deposits	
Gravel	0.25 - 0.40
Sand	0.25 - 0.50
Silt	0.35 - 0.50
Clay	0.40 - 0.70
Rocks	
Fractured basalt	0.05 - 0.50
Karst limestone	0.05 - 0.50
Sandstone	0.05 - 0.30
Limestone, dolomite	0.00 - 0.20
Shale	0.00 - 0.10
Fractured crystalline rock	0.00 - 0.10
Dense crystalline rock	0.00 - 0.05
Source: Freeze and Cherry (1979).	

Source: Freeze and Cherry (1979).

material	poroslty
soil	0.55
clay	0.55
silt	0.425
sand	0.375
Osteoporosis human bone	0.369
gravel	0.325
fractured basalet	0.25
karst limstone	0.225
sandstone	0.155
Healthy human bone	0.121
limestone, dolomite	0.1
granite	0.1
dense crystalline rock	0.05
fractured crystalline rock	0.05
shale	0.05

porosity





Radiographs of sections through human lumbar vertebrae (L1) (a) normal bone (b) osteoporotic bone, showing thinning and resorption of trabeculae. (Reproduced with permission from Vajjhala et al., 2000, published by the American Society of Mechanical Engineers.)

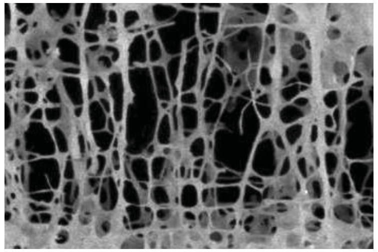
http://mccormickdc.com/osteoporosis

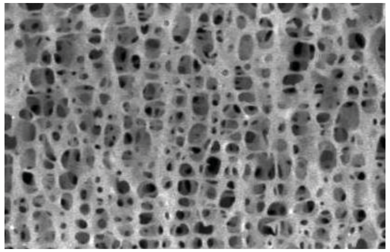
$$\frac{\text{void}}{\text{valid space}} = \text{porosity}$$

Healthy 0.121 = porosity

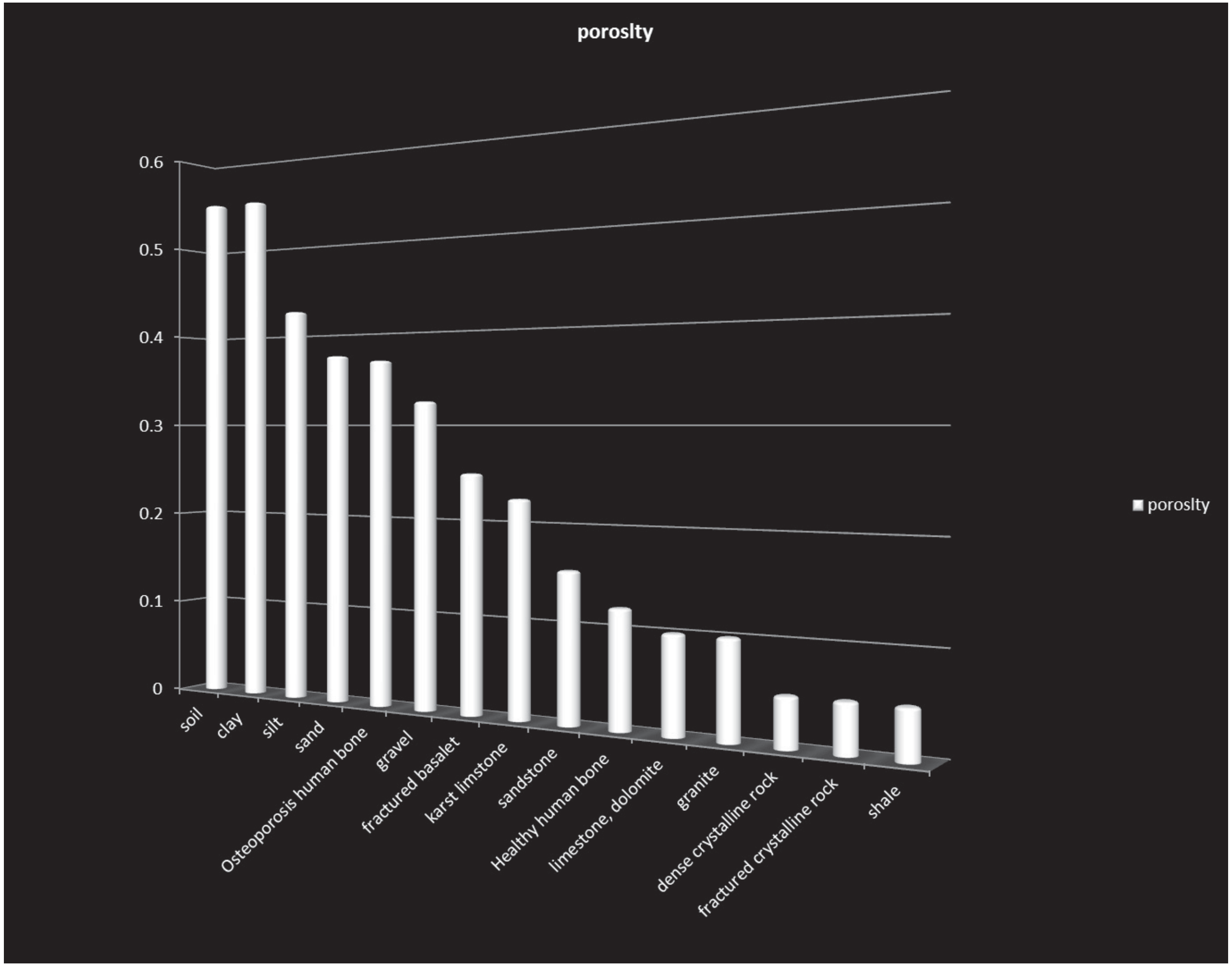
Osteoporosis 0.369 = porosity

Osteoporosis valid space > Healthy valid space

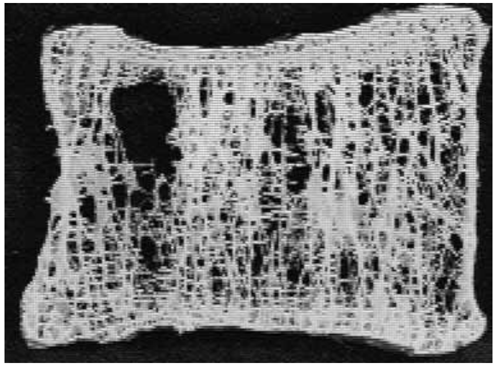




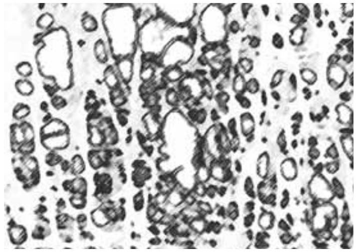
Porosity

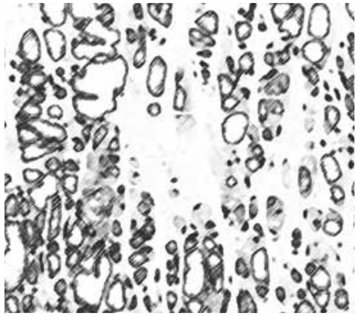


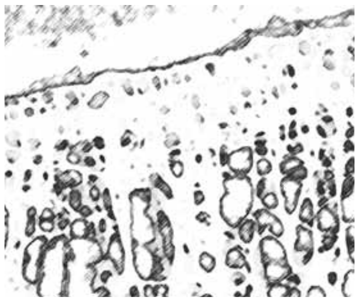
material	poroslty
soil	0.55
clay	0.55
silt	0.425
sand	0.375
Osteoporosis human bone	0.369
gravel	0.325
fractured basalet	0.25
karst limstone	0.225
sandstone	0.155
Healthy human bone	0.121
limestone, dolomite	0.1
granite	0.1
dense crystalline rock	0.05
fractured crystalline rock	0.05
shale	0.05

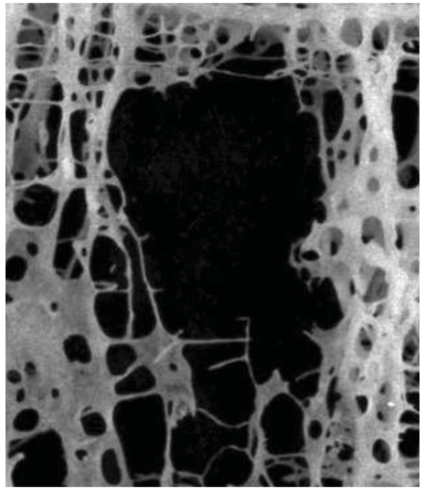


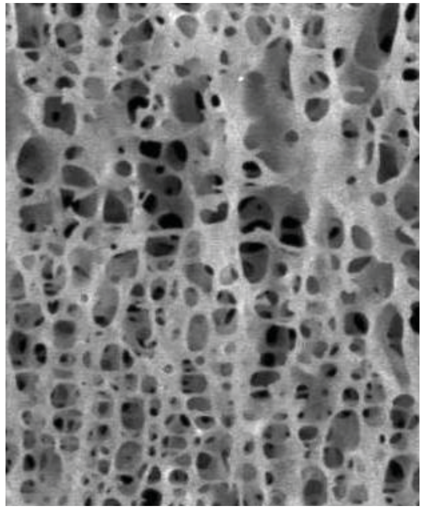
Surface





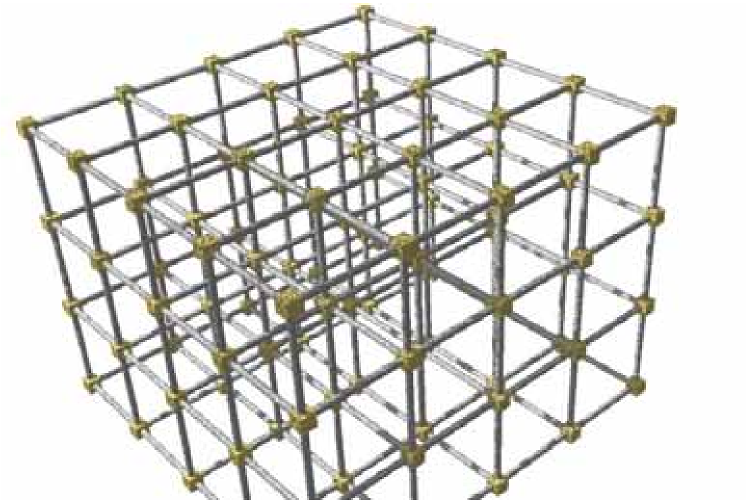


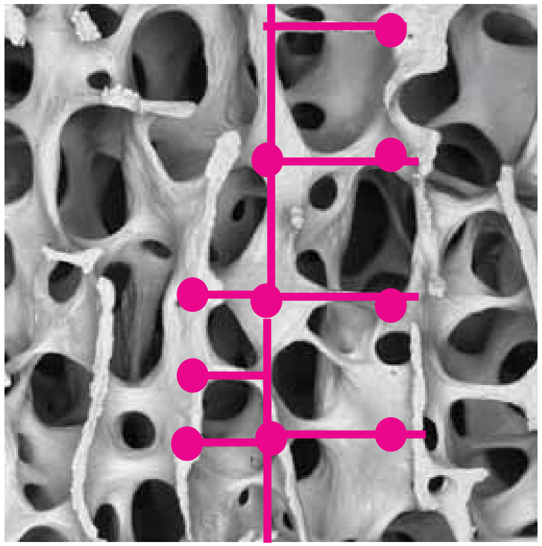


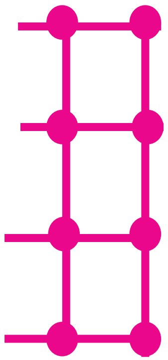


Constructive logic - framework

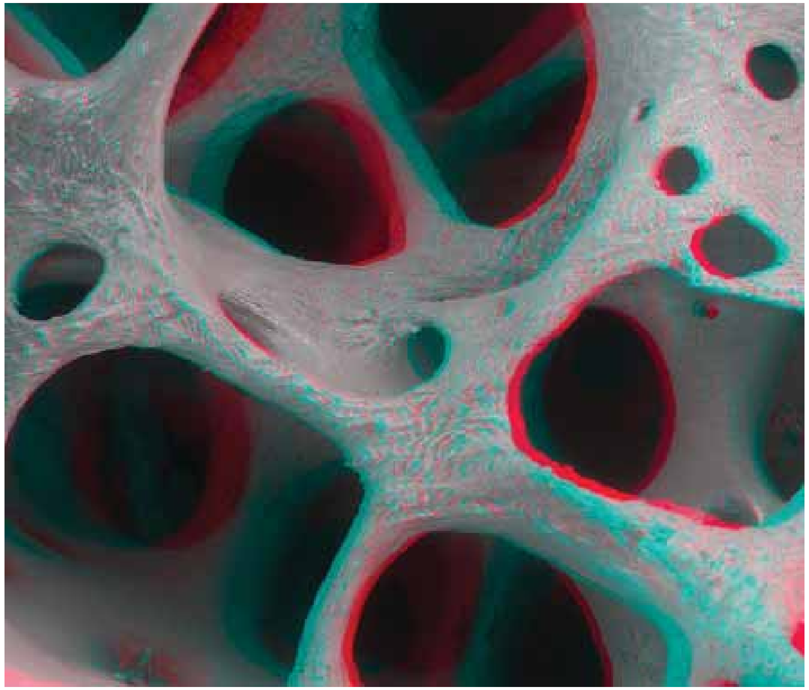
conventional formwork techniques to construct a highly differentiated tower

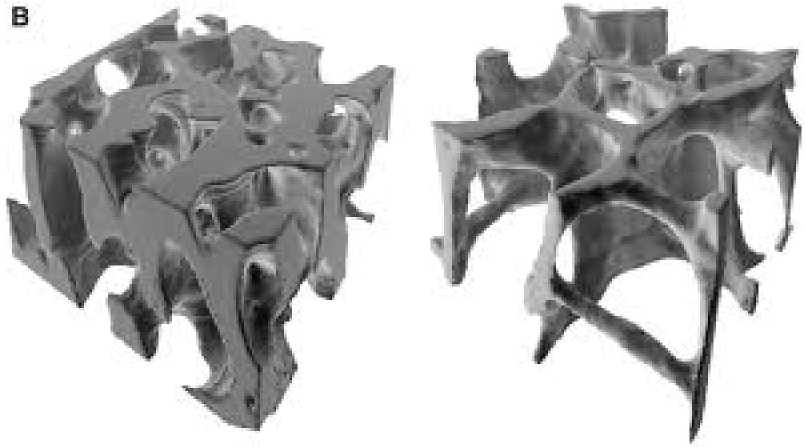






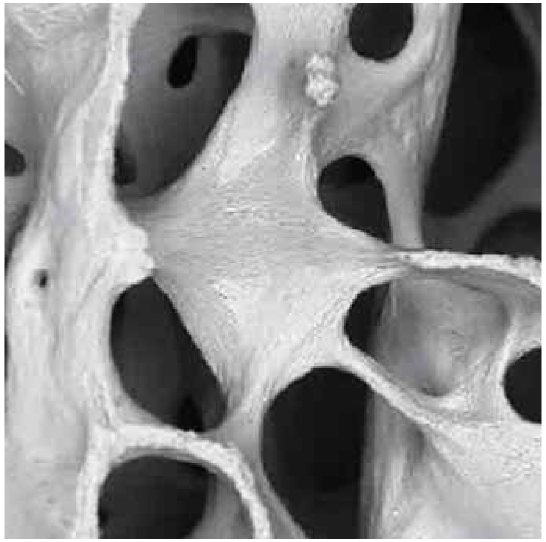
Bone in 3d - geometric design

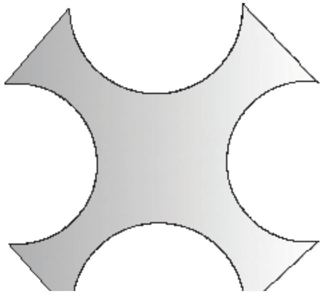




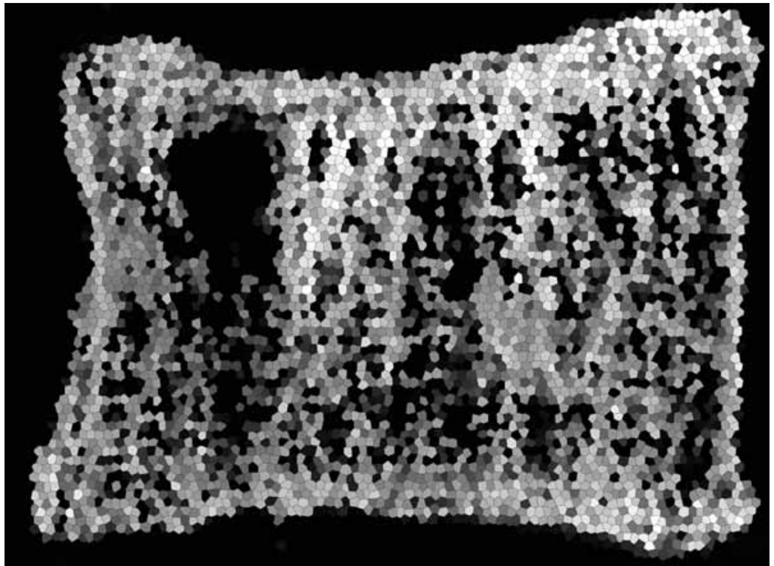
Separate unit

Branches of connection



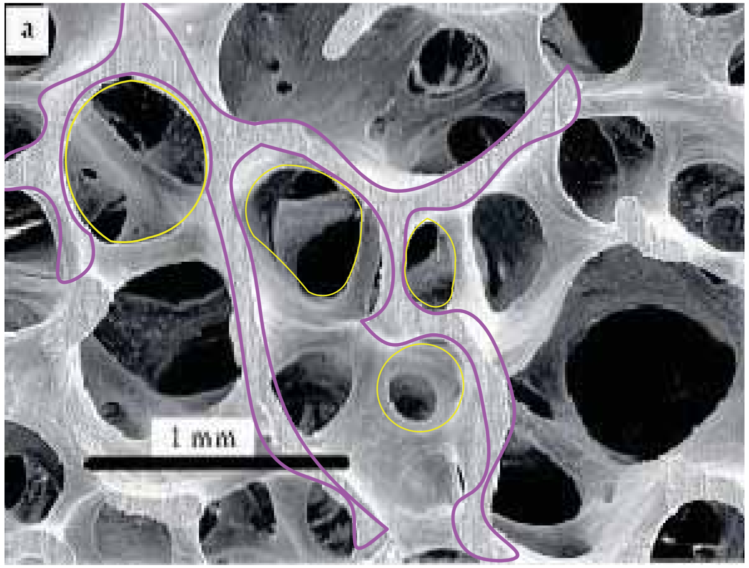


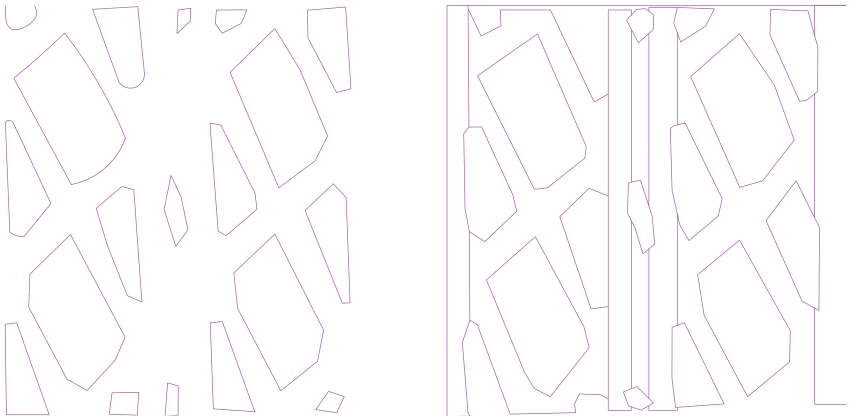
physical unit



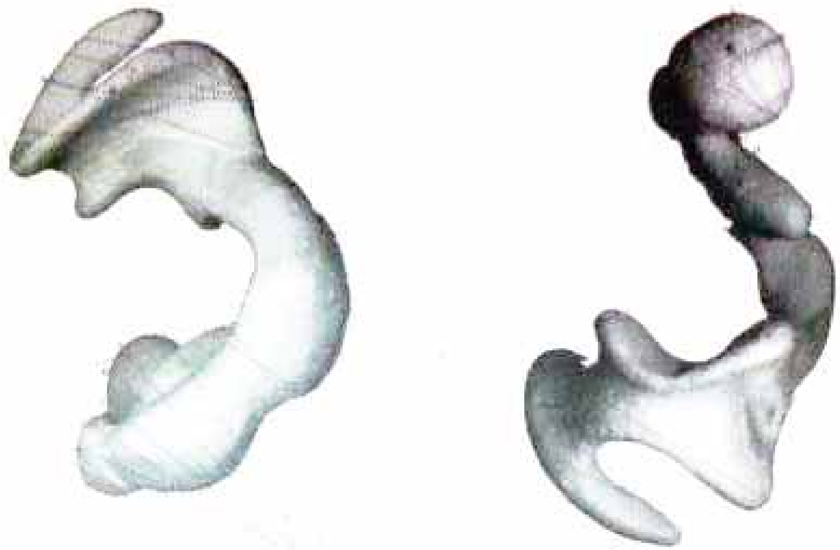
location by color

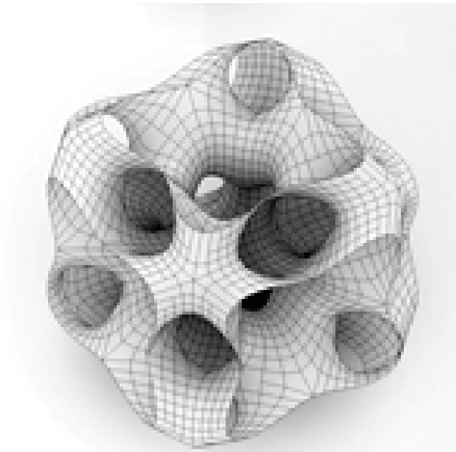
geometric diagnosis



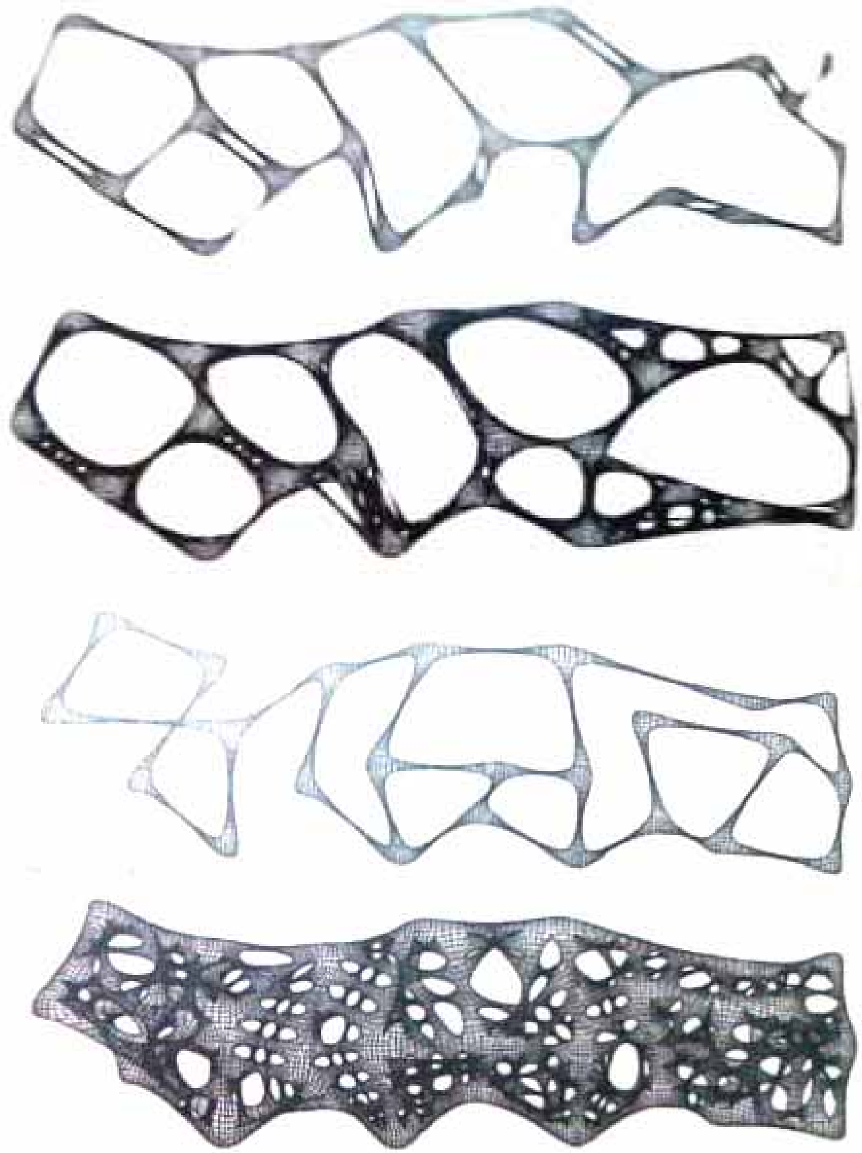


Structure





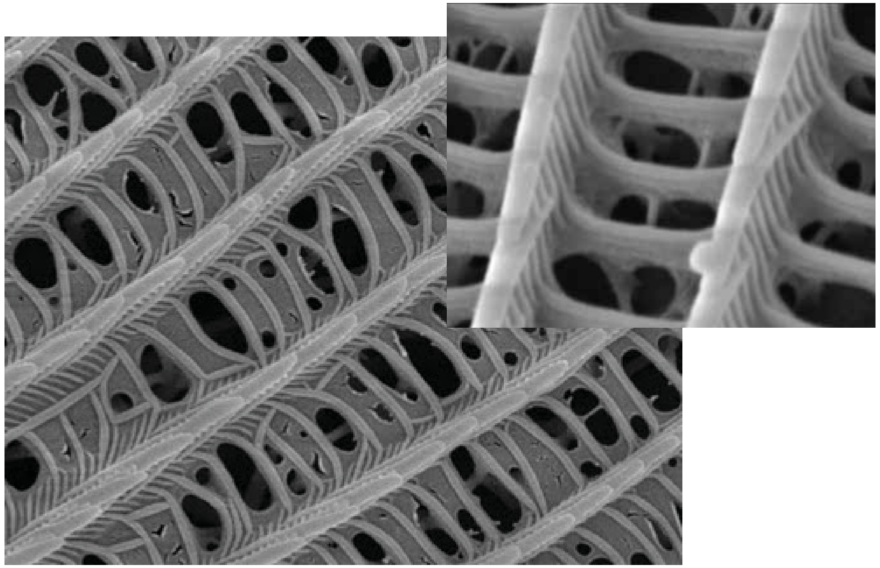
Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.



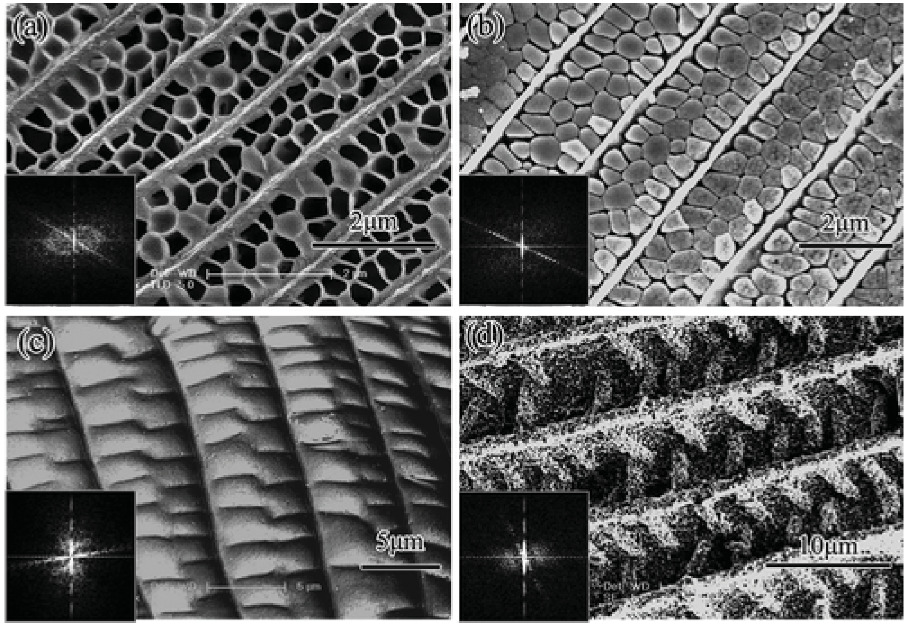
Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.

Biomimicry of butterfly wings for more powerful solar cells

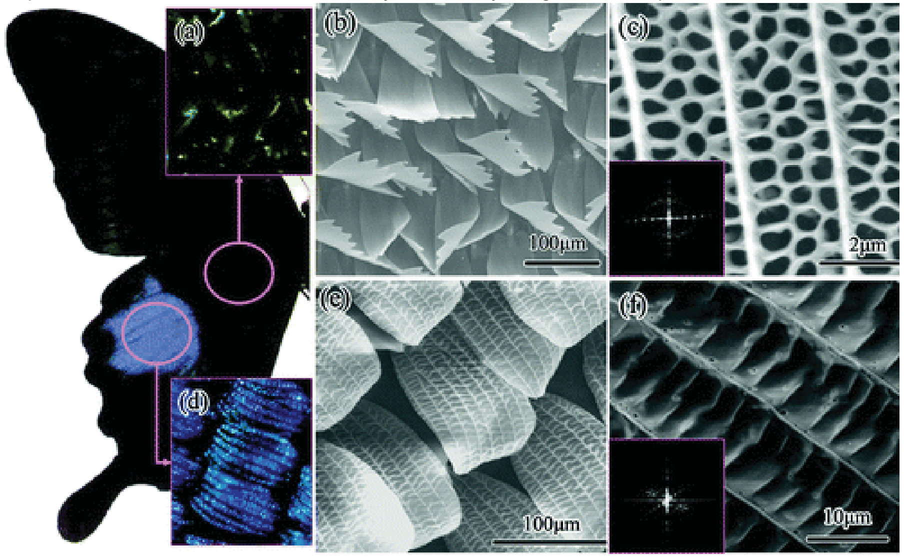
The discovery that butterfly wings have scales that act as tiny solar collectors has led scientists in China and Japan to design a more efficient solar cell that could be used for powering homes, businesses, and other applications in the future. The researchers turned to the microscopic solar scales on butterfly wings in their search for improvements. Using natural butterfly wings as a mold or template, they made copies of the solar collectors and transferred those light-harvesting structures to Grätzel cells.Laboratory tests showed that the butterfly wing solar collector absorbed light more efficiently than conventional dye-sensitized cells. The fabrication process is simpler and faster than other methods, and could be used to manufacture other commercially valuable devices, the researchers say.



This is a SEM (Scanning Electron Microscope) image of butterfly wing scale. The instrument magnification was set at 10,000x. The distance between the parallel main ribs is about 750 nanometers
http://kqedscience.tumblr.com/post/11917017860/this-is-a-sem-scanning-electron-microscope-image
http://www.trincoll.edu/~alehman/



http://www.robaid.com/bionics/biomimicry-of-butterfly-wings-for-more-powerful-solar-cells.htm

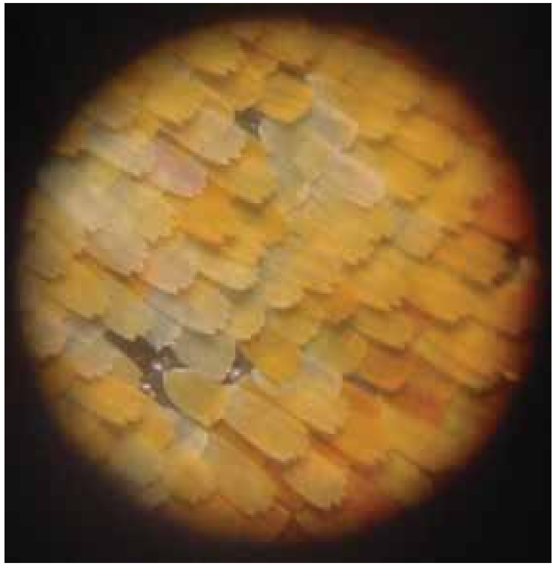


http://www.robaid.com/bionics/biomimicry-of-butterfly-wings-for-more-powerful-solar-cells.htm

co- equal tensions & hexagonal network

butterflywing

Zoomed-out view of an Inachis io.



High magnification of the coloured scales (probably a different species).

Closeup of the scales of the same specimen.

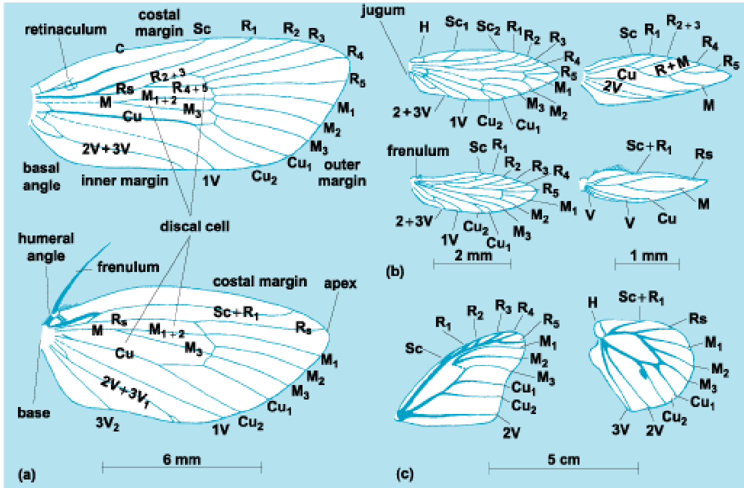
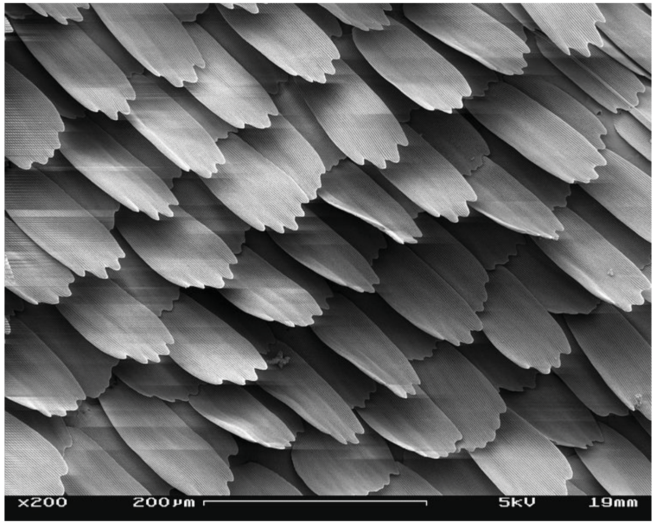
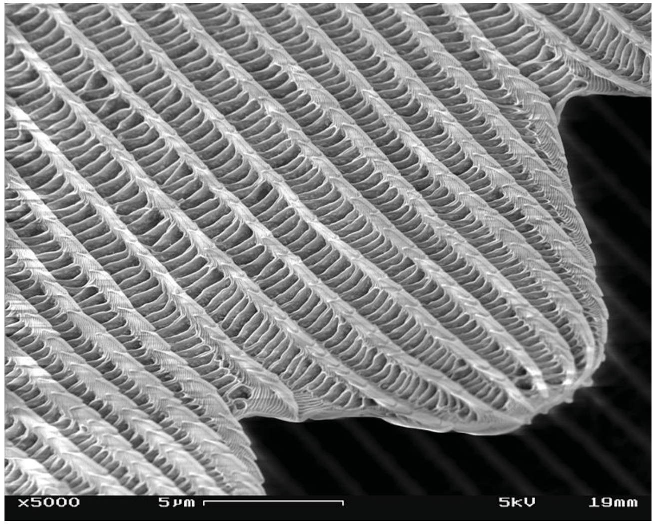


Fig. 4 Wing venation patterns with the veins labeled. (a) Male Acrolophus popeanellus (Tineidae). (b) Epimartyria (Micropterygidae) and Nepticula nyssaefoliella (Nepticulidae). (c) Danaus plexippus (Nymphalidae). C = costa; Sc = subcosta; R = radius; Rs = radial sector; M = media; Cu = cubitus; 1V, 2V, 3V = vannal or anal veins; H = humeral vein; subscripts refer to branches (for example, R2 is second branch of radius).

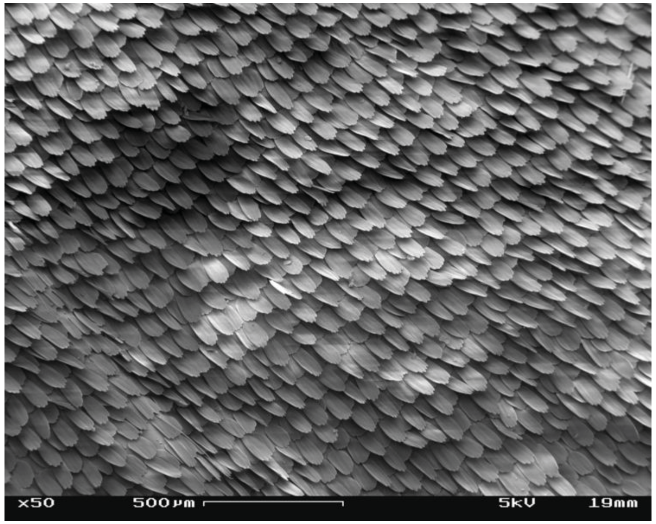
Co- equal tensions & hexagonal network



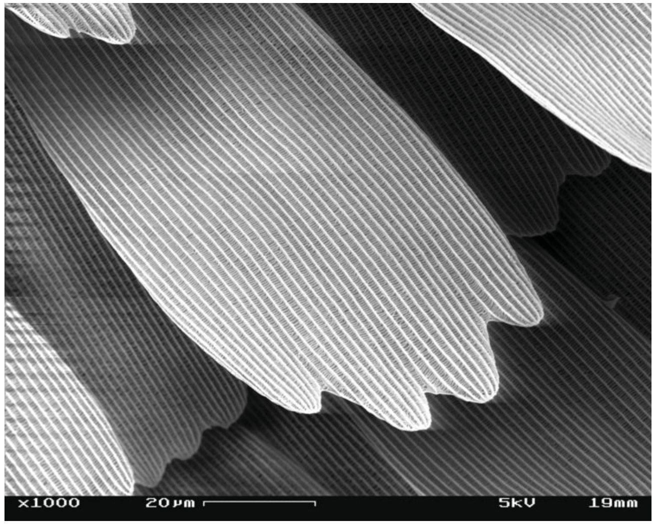
Scales close up



Microstructure of a scale

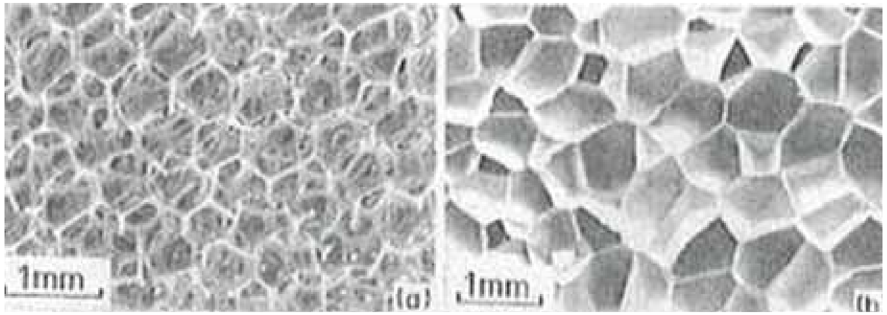


A patch of wing



A single scale

The rule of three edges meeting at a point, but there is a d ١٢٠ strong tendency for each point to be surrounded by .angle



Natural cellular

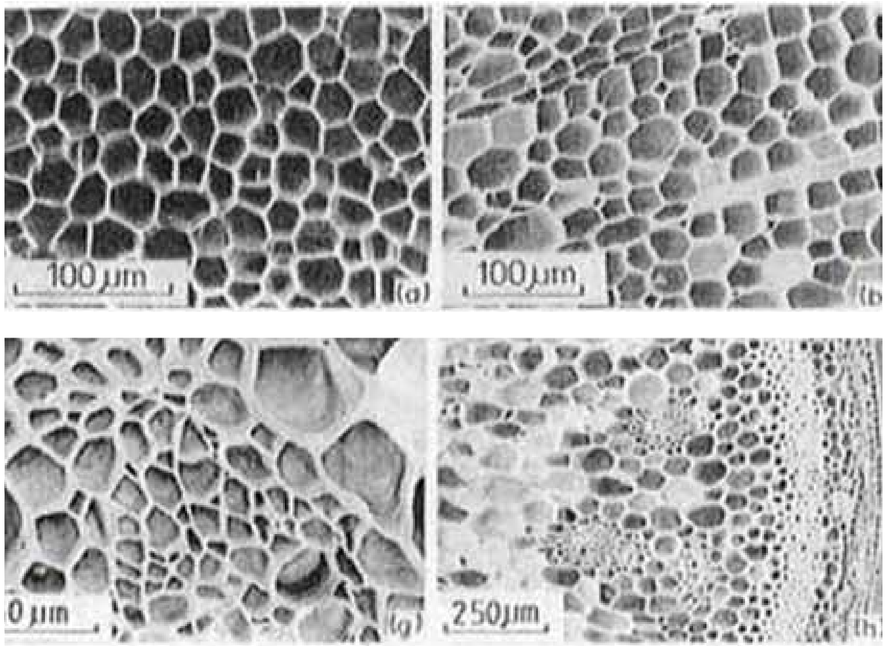
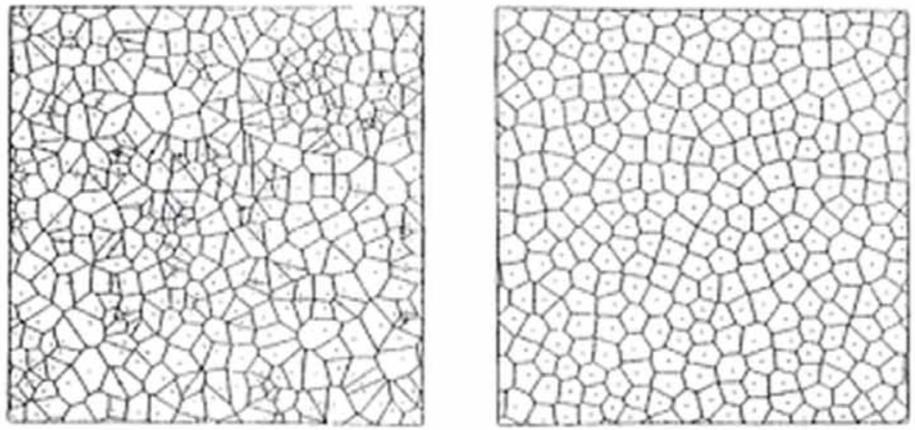


Figure 2.6 Natural cellular materials: (a) cork, (b) balsa, (c) sponge, (d) cancellous bone, (e) coral, (f) cuttlefish bone, (g) iris leaf, (h) stalk of a plant.

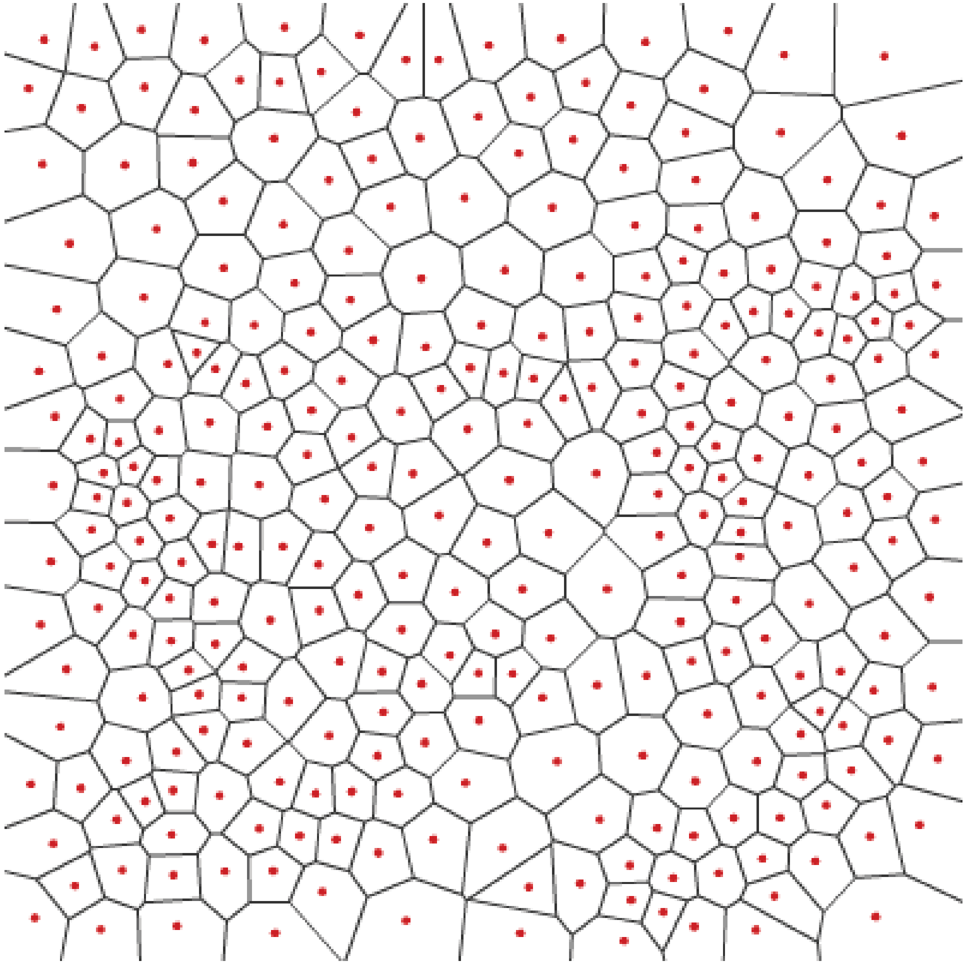


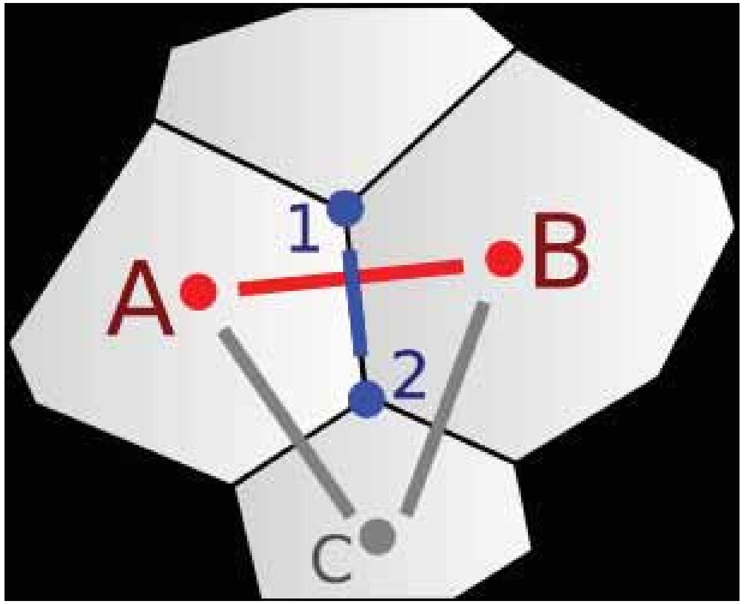
(a) (b)

Figure 2.14 (a) A Voronoi honeycomb for a set of random points (marked). (This is the structure that would form if cells nucleate at random points, all appearing at the same instant, and grow with the same linear growth rate.) (b) A Voronoi honeycomb for a set of points, initially random, from which all points closer than a critical spacing were removed. (This is the structure that would form if cells cannot nucleate closer together than a critical spacing and grow with the same linear growth rate.)

Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

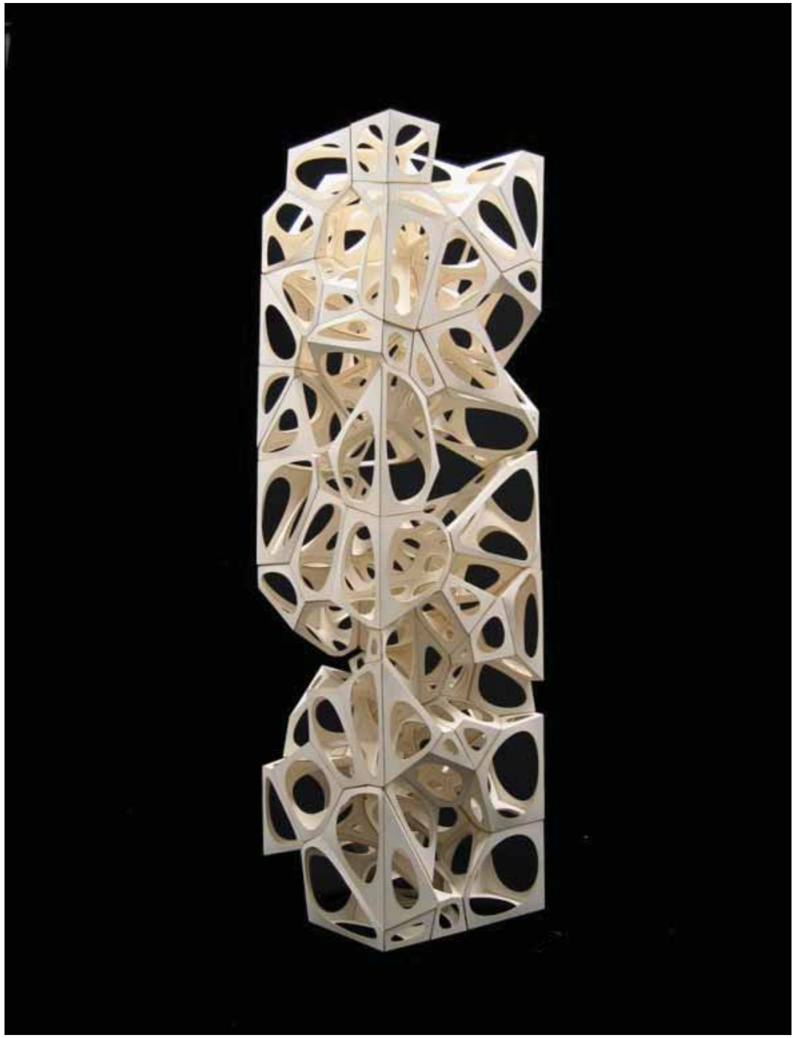
Voronoi corners



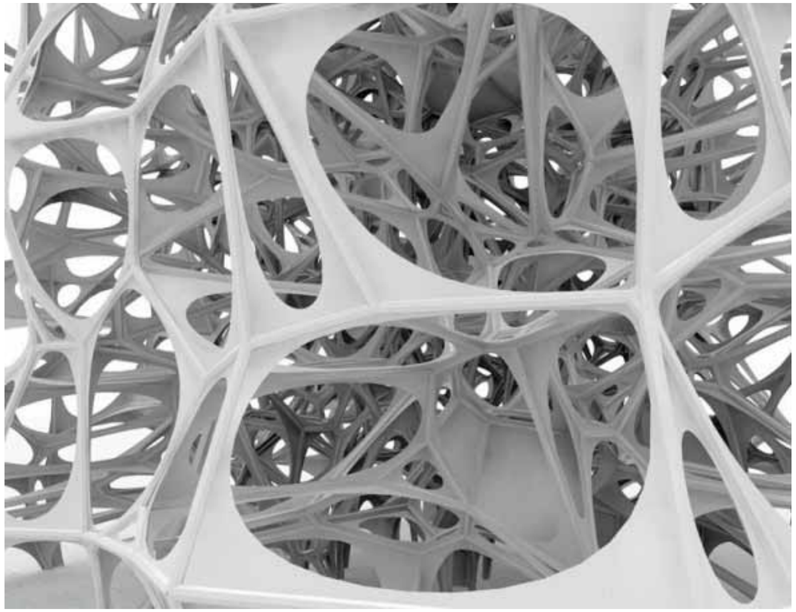


http://www-cs-students.stanford.edu/~amitp/game-programming/polygon-map-generation/

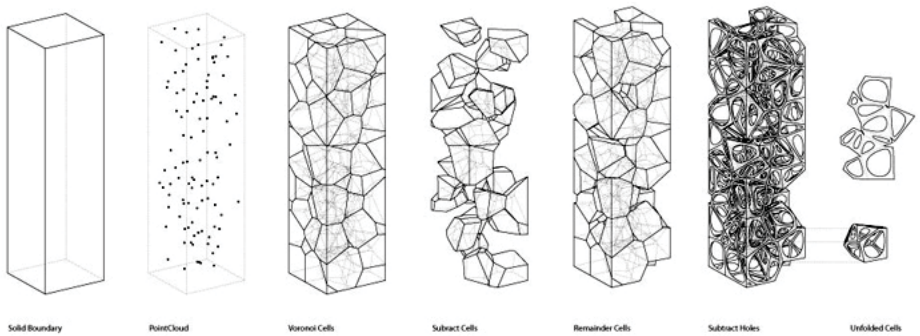
VORONOI MORPHOLOGIES



paper prototype
http://matsysdesign.com/category/projects/voronoi-morphologies/

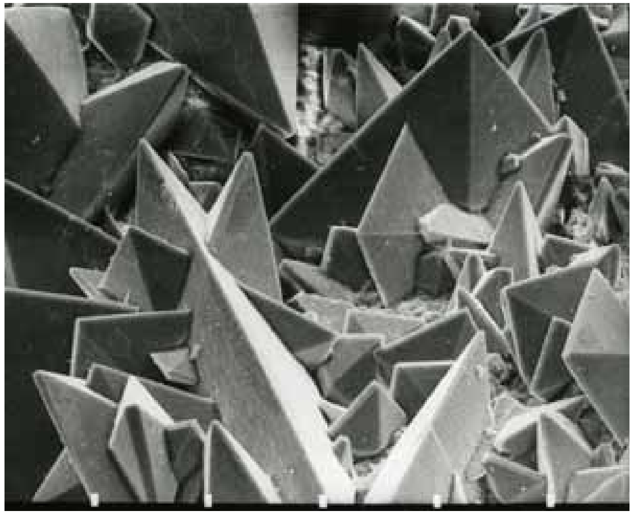


Prototype detail
http://matsysdesign.com/category/projects/voronoi-morphologies/

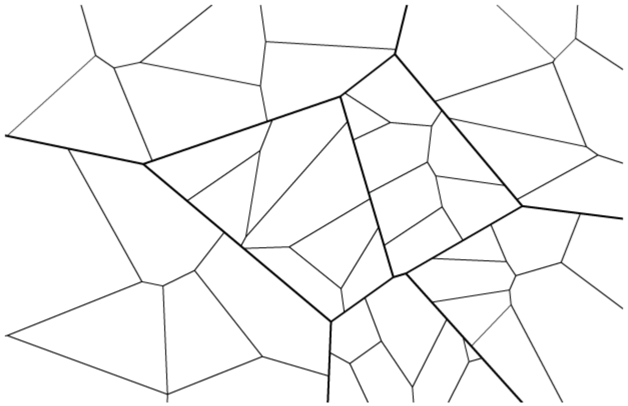


voronoi drawings
http://matsysdesign.com/category/projects/voronoi-morphologies/

Scanning electron microscope

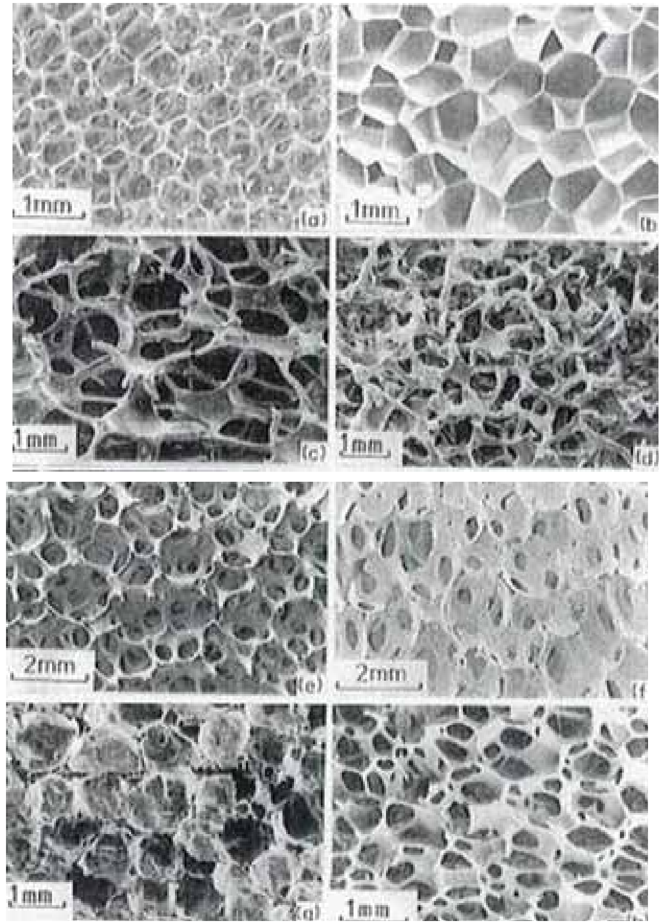


Scanning Electron Micrograph of the surface of a kidney stone showing tetragonal crystals of Weddellite (calcium oxalate dihydrate) emerging from the amorphous central part of the stone



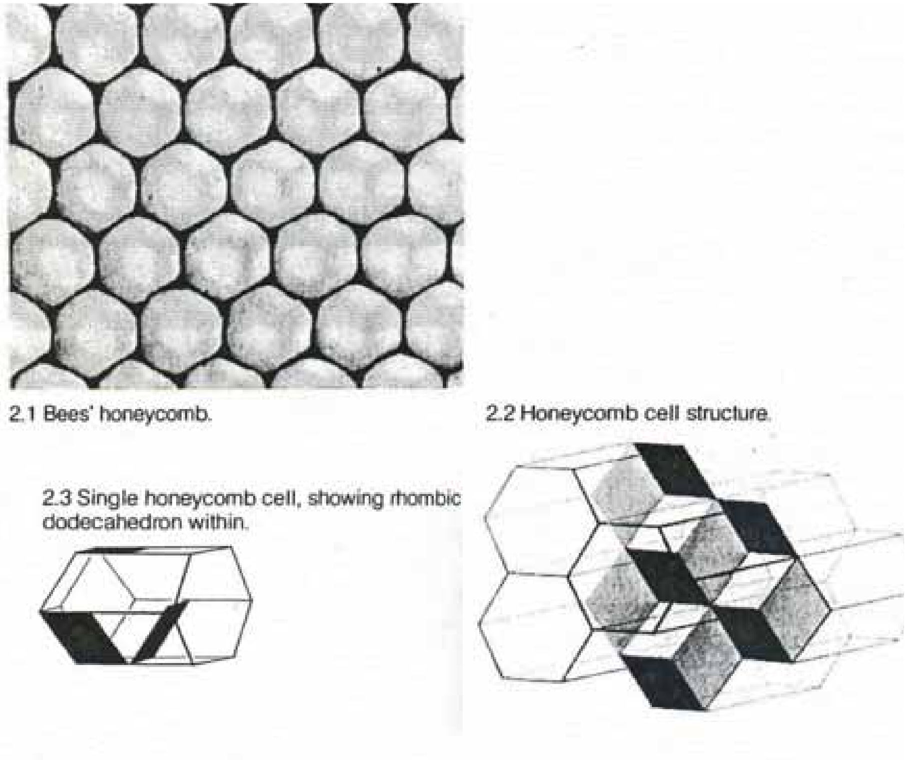
Voronoi Fractal http://blog.inspirit.ru/?p=96

Three diemensional cellular



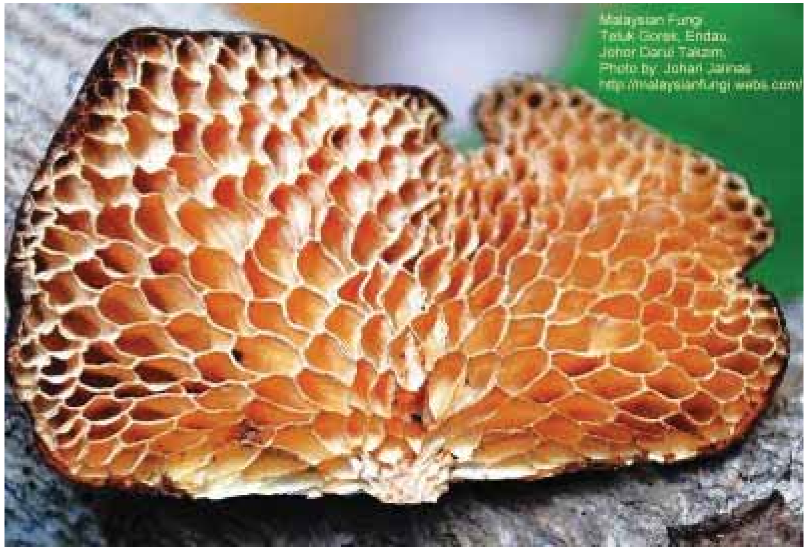
Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

closest packing in nature



least energy
the honeycomb consists of teo set of contiguous cells, positioned back to back. The back to back cells are staggered in such a way that the centers of the set of cells on one side are positioned exactly over helf of the tree rayed intersections of cell walls of the set of cells on the other side. this arrangement corresponds to a packing of two layers of rhombic dodecahedra or
two layers of closet packed spheres .
That closest packing is simply a reflection of nature`s tendency to coordinate extrinsic forces in the most the most economic way.

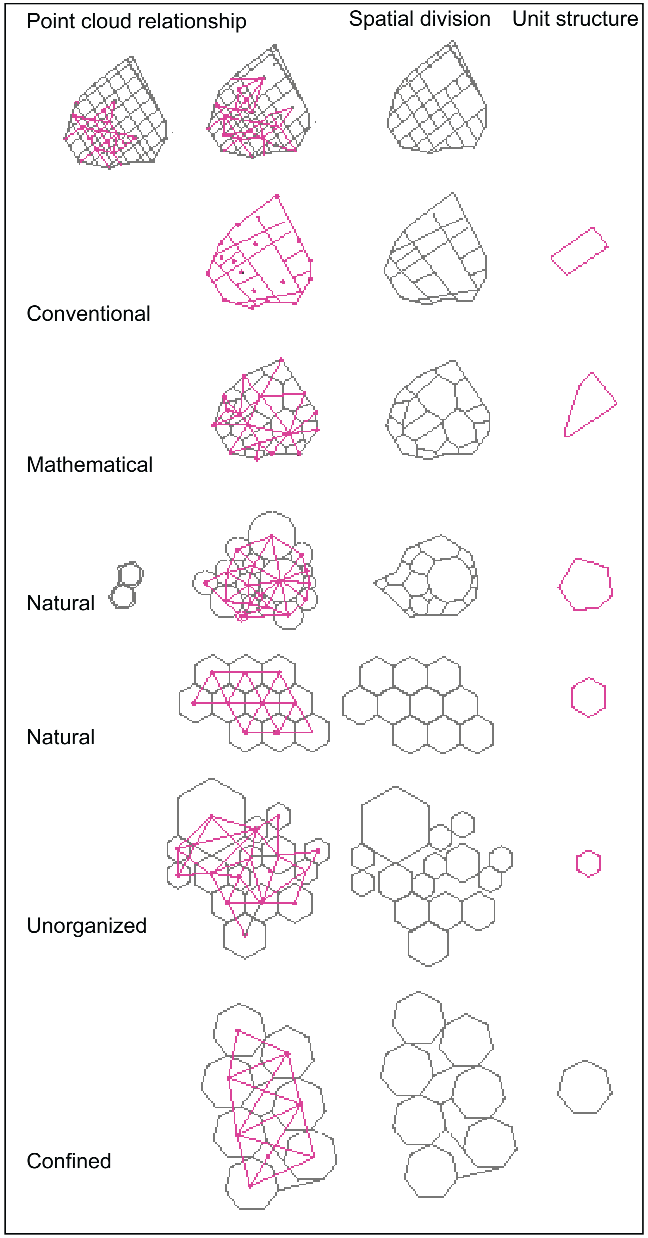
Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.



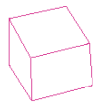
HONEYCOMB- Favolus alveolaris
ttp://malaysianfungi.blogspot.com/2009/10/honeycomb-favolus-alveolaris.html

http://article.wn.com/view/2010/08/18/City_bees_get_richer_diet_than_bees_from_farm-lands_Study/

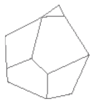
Lattice structure



minimal surface minimal materials



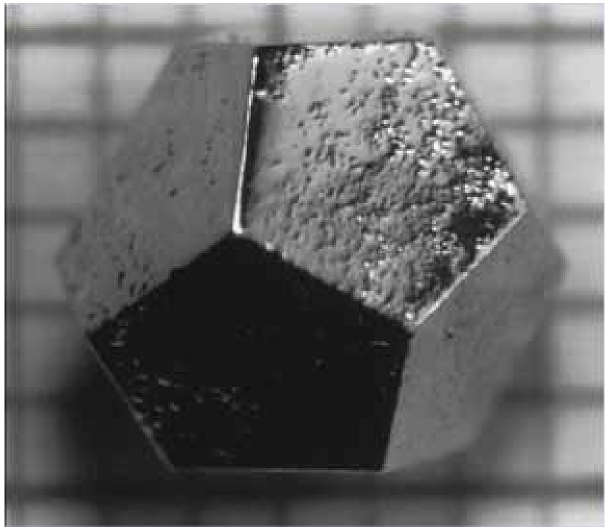
volume (cm) 118.55
surface area (sq m) 2.37



volume (cm) 118.55
surface area (sq m) 2.11

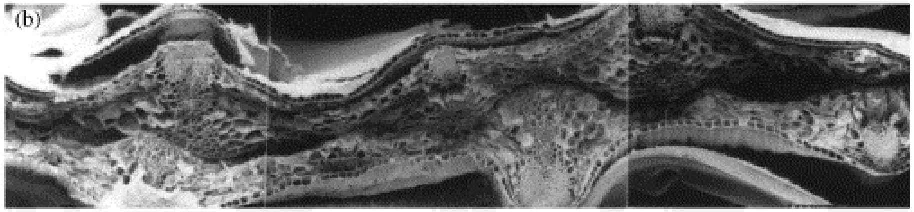
material reduction 32%

http://he.wikipedia.org/wiki/%D7%A7%D7%95%D7%91%D7%A5:Honey_comb.jpg

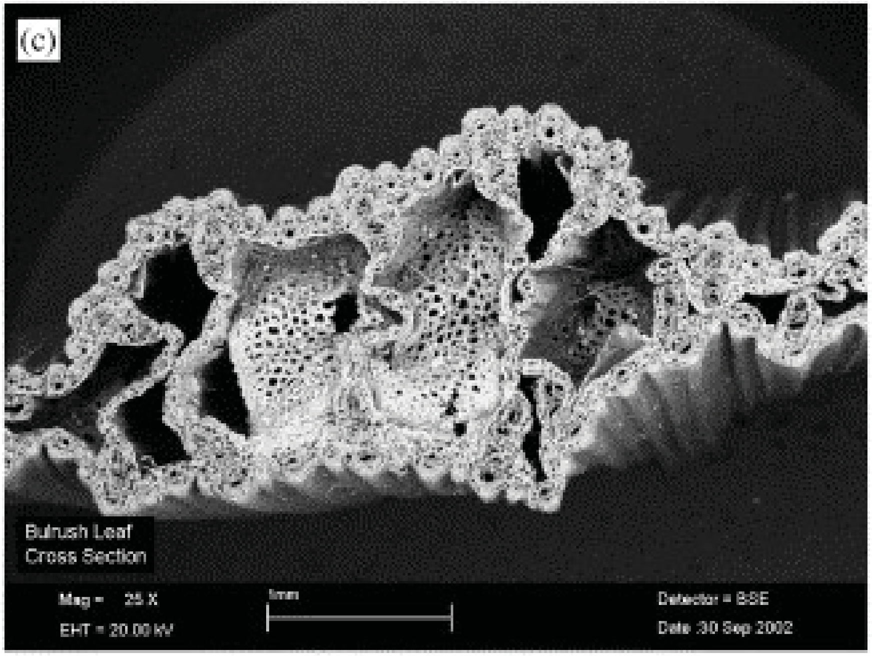


איור מס' 2 : קווזי-גביש יחיד של הולמיום-מגנזיום-אבץ שמתגבש בתצורה דודקהדרית. בעל סימטריה איקוסהדרית כמו גביש האלומיניום-נחושת-ברזל שבאיור מס' 1 [א]. הגביש מצולם מעל קנה-מידה מילימטרי. גביש זה הוצמח על ידי איאן פישר במעבדות איימס שבמדינת איווה בארה"ב. [I.R. Fisher et al., PRB 59 (1999) 308-321]

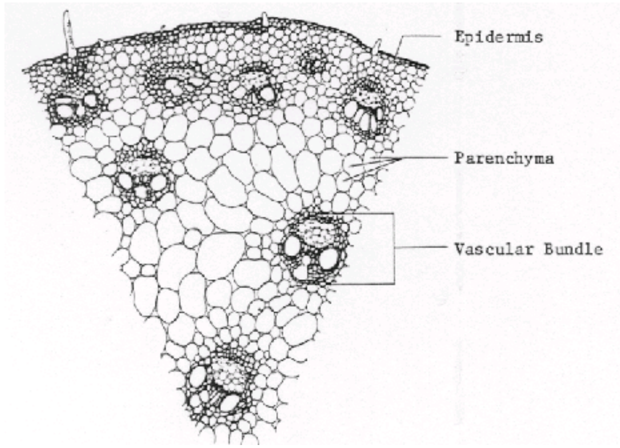
Natural sandwich structures



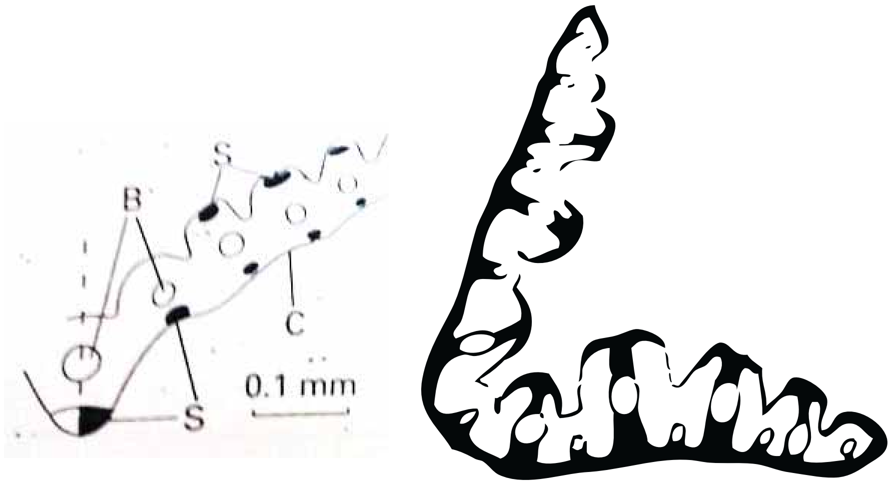
iris leaf MICROSCOPIC
http://www.sciencedirect.com/science/article/pii/S0021929004004919



cattail leaf http://www.sciencedirect.com/science/article/pii/S0021929004004919



Monocot stem,
http://www2.volstate.edu/msd/bio/1020/lab11seedplants.htm



Leaf Structure Illustrations
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Pods, 2010. Epic Art Science Exhibit & Exploration. SaCrIt. Available at: http://sacrit.blogspot.com/2010/11/epic-art-science-exhibit-exploration.html [Accessed March 20, 2012].

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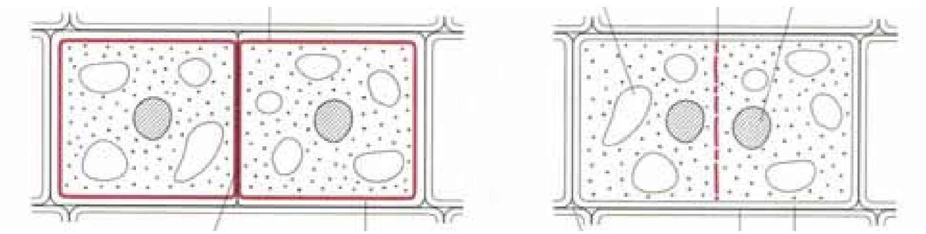
Zheng, W. et al., 2012. Endothelialization and patency of RGD-functionalized vascular grafts in a rabbit carotid artery model. Biomaterials, 33(10), pp.2880–

strucural presure tension

cell wall

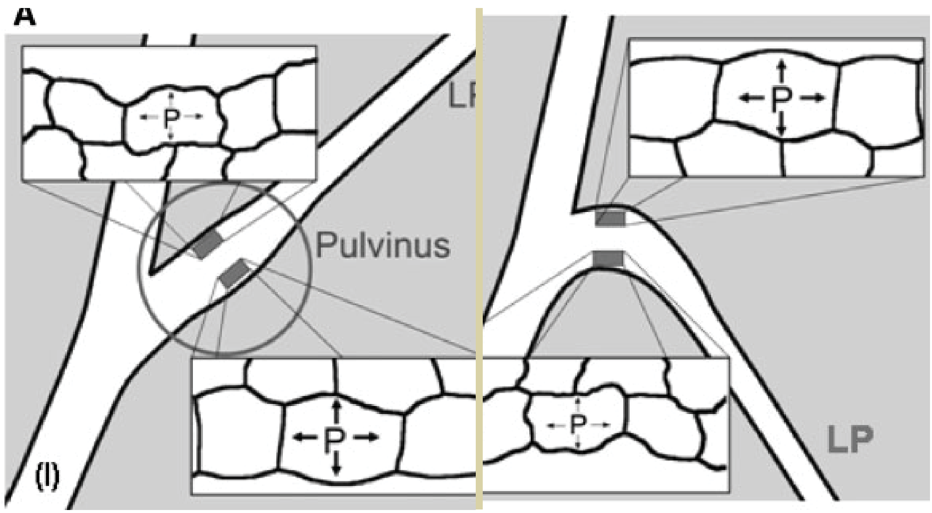
a wall surraunds all somatic plant cells for most cells in plant this wall consists of a single layer . the is created by the cell during its division.the wall's physical properties are controled by the orientation of microfibers witch are normaly laid down along the the long axis of the cell. this creats a hope like arrangment of microfibes witch favours the enlongation of one axis over the other and therefore controles the devolpment of plants.
For a plant cell to grow, the cellulosic wall that surrounds it must be stretched. Cells achieve this by building a high internal hydrostatic pressure known as turgor.



Leyser, O., 2003. Mechanisms in Plant Development. Blackwell, Oxford.

ability of cells to control their direction of growth is arguably the most important tenet of plant morphogenesis because it provides an explicit mechanism for how shape is controlled at the molecular level.

Schematic drawing of a pulvinus at the base of a leaf petiole (LP) adapted.
(I) Inclined state with insets showing cells of the upper side with a low turgor (P) and cells of the lower side with high turgor; (II) declined state with turgor distribution reversed.
stress-generation principle in reaction wood of trees and the role of microfibril orientation in the cell walls, (I) compression wood in gymnosperm trees (II) tension wood in angiosperm trees; arrows indicate sense and magnitude of stress generation.

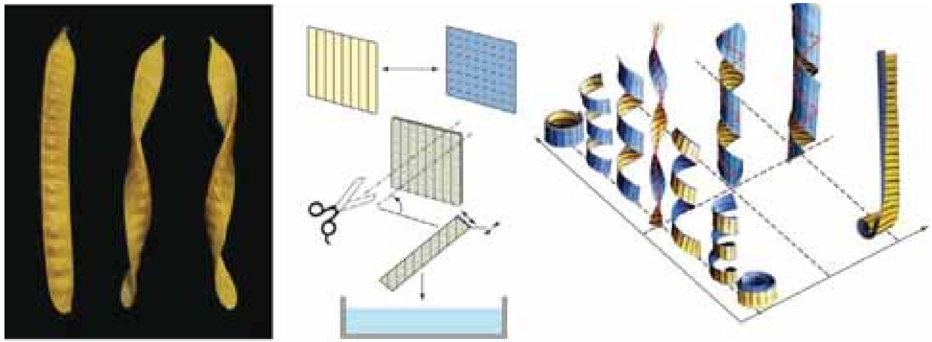


Martone, P.T., Boller, M., Burgert, I., Dumais, J., Edwards, J., Mach, K., Rowe, N., Rueggeberg, M., Seidel, R., Speck, T., 2010. Mechanics without muscle: biomechanical inspiration from the plant world. Integrative and Comparative Biology 50, 888–907.

Generating Helices

Macroscopic helical structures formed by organisms include seashells, horns, plant tendrils, and seed pods The helices that form are chiral; like wood screws, they have a handedness. Some are helicoids, twisted helices with saddle-like curvature and a straight centerline; others are cylindrical helices with cylindrical curvature and a helical centerline .

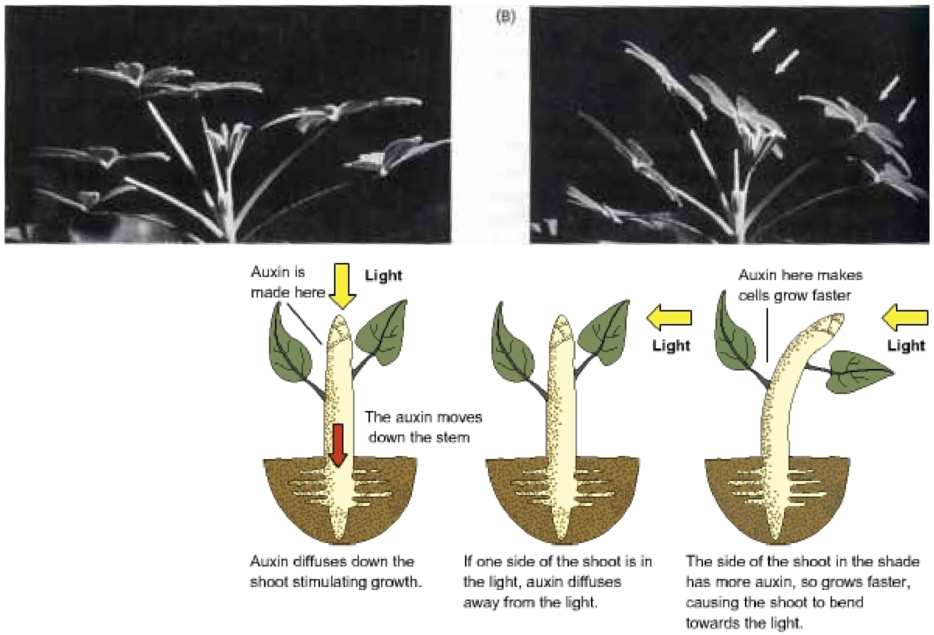
In the paper bilayers, the handedness of the helix is determined by the orientation of the principal fiber directions with respect to the long axis of the strip, and can be reversed by simply cutting the strip at an angle below or above



Forterre, Y., Dumais, J., 2011. Generating Helices in Nature. science 333, 1715–1716.

90°. That this versatility can be achieved with a mere piece of paper should convince anyone of the power of this approach to build materials with exciting new properties.
To pass from one state to another, elastic energy is stored slowly, and once an energy barrier is overcome, it is rapidly released. This snap-through mechanism in bodies with opposite intrinsic curvatures is found in some plants to speed up their movement and is used in deployable structures such as tape springs.

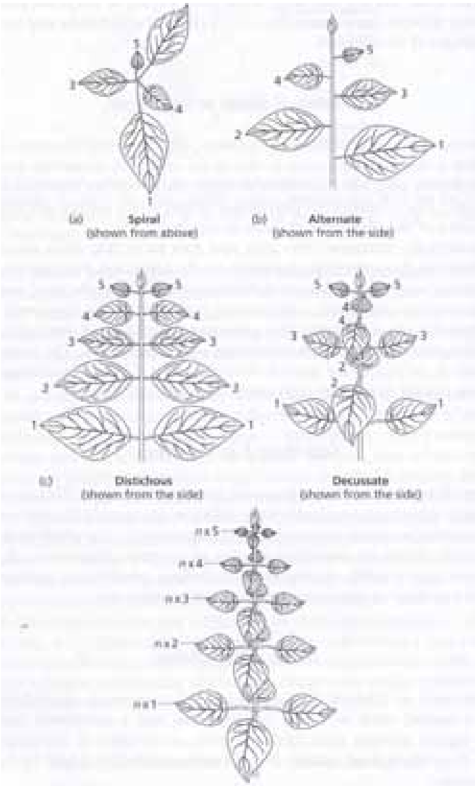
the angle of the leaf relative to the sun will determine the amount of sunlight incident upon it , if the sun is overhead , the horizontal leaf will receive much more sunlight than a leaf a steeper angle. thats why plants control thier light absorption by solar tracking , which means their leafs continuosly adjust their angle so that they remain perpendicular to the sun.
solar tracking is a light responce and the sensing of light is made made by blue light sensors located on the upper surface of the leaf , the sensors are conected to a specialized organ called pulvinus that controls the orientation of the leaf which is found at the junction between the blade and the petiole.
the pulvinus contains motor cells that change their osmotic potential and generate mechanical forces that enables the orientation.



Taiz, L., 2010. Plant Physiology, 5th ed. ed. Sinauer Associates, Sunderland, Mass.

plant grouth

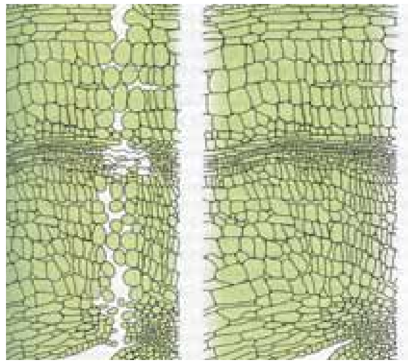
the main types of phyllotaxy :
a. spiral phyllotaxy: a single leaf developes at each node and successive leaves are arranged in a spiral pattern. this is the most common type of phyllotaxy .
b. alternate phyllotaxy: a single leaf develops at each node and successive leaves are produced on alternate sides of the shoot.
c. distichous and decussate phyllotaxy: a pair of leaves is producced at each node .
d. whorled phyllotaxy : a whorl of leafs develops at each node.

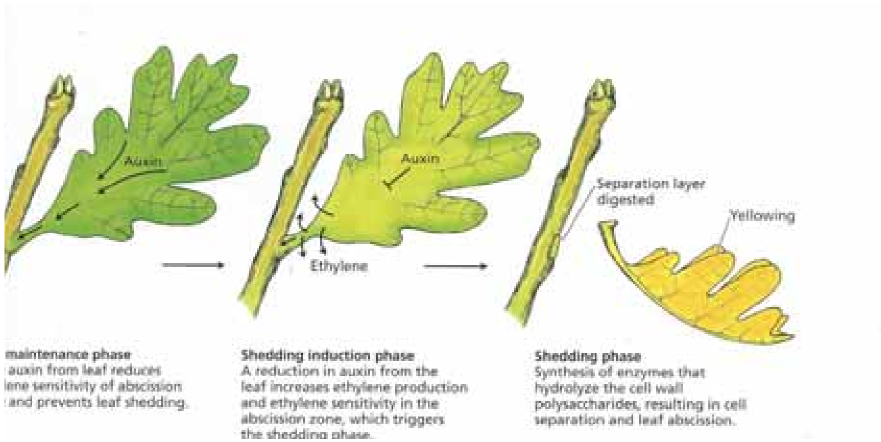


Leyser, O., 2003. Mechanisms in Plant Development. Blackwell, Oxford.

Plant abscise

A plant will abscise a part either to discard a member that is no longer necessary, such as a leaf during autumn, or a flower following fertilisation, or for the purposes of reproduction. Most deciduous plants drop their leaves by abscission. also called a separation zone, is formed at the base of the petiole. It is composed of a top layer which has cells with weak walls, and a bottom layer which expands in the autumn, breaking the weak walls of the cells in the top layer. This allows the leaf to be shed.
The reduction of chlorophyll production in leaves due to decreased sunlight in the fall explains why some leaves turn yellow. The loss of chlorophyll may also contribute to the abscission process.

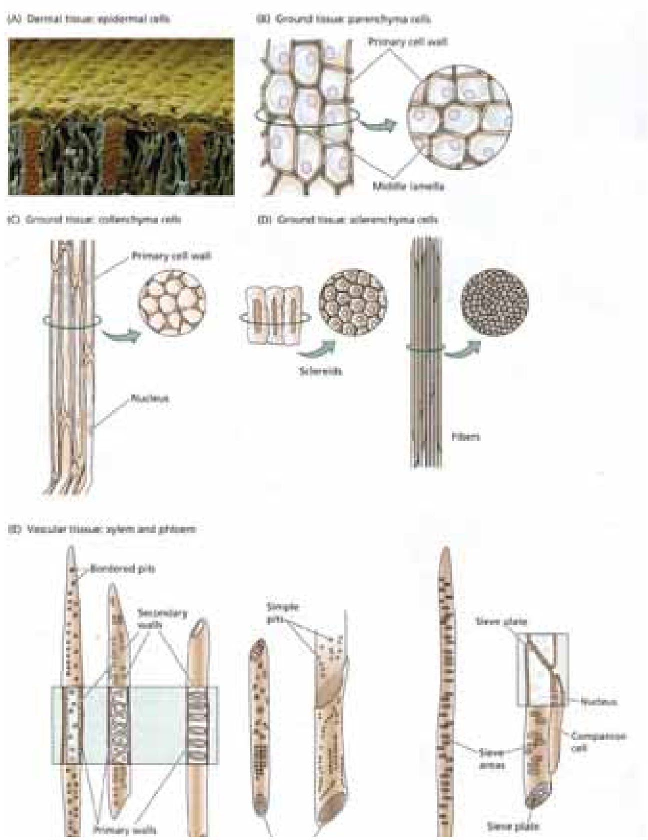




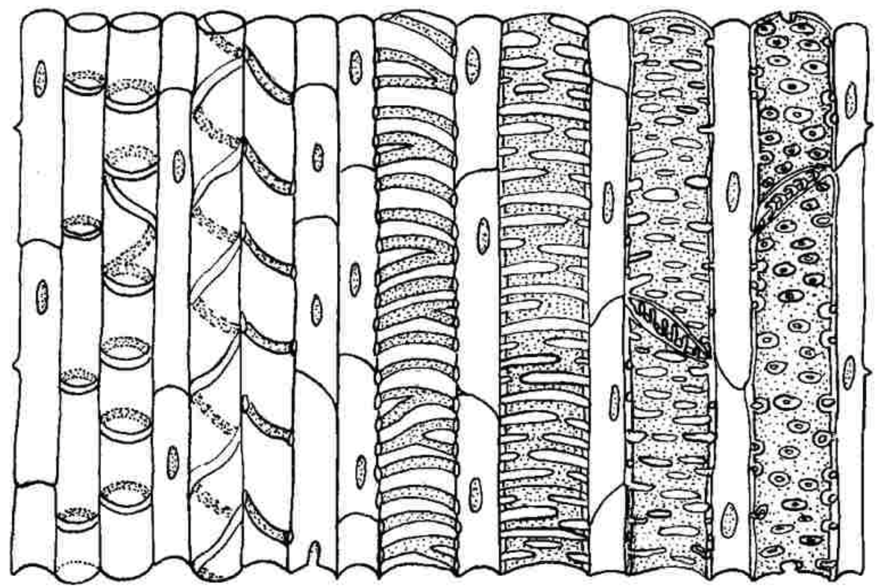
Taiz, L., 2010. Plant Physiology, 5th ed. ed. Sinauer Associates, Sunderland, Mass.

secondary cell wall

the secondary cell walls are thicker and stronger than the primary cell wall and are deposited when most cell enlargement has ended . the secondary cell wall gain their strength and thoughness from glewlike material called lignin . circular gaps in the secoundary cell wall give rise to simple pits . the evolution of lingified secondary cell walls provides plants with the stuctural rienforcements necessary to grow vertically above the soil and colonize the land .
plants which lake lignified cell walls are un able to grow more than a few centimetres above the gound



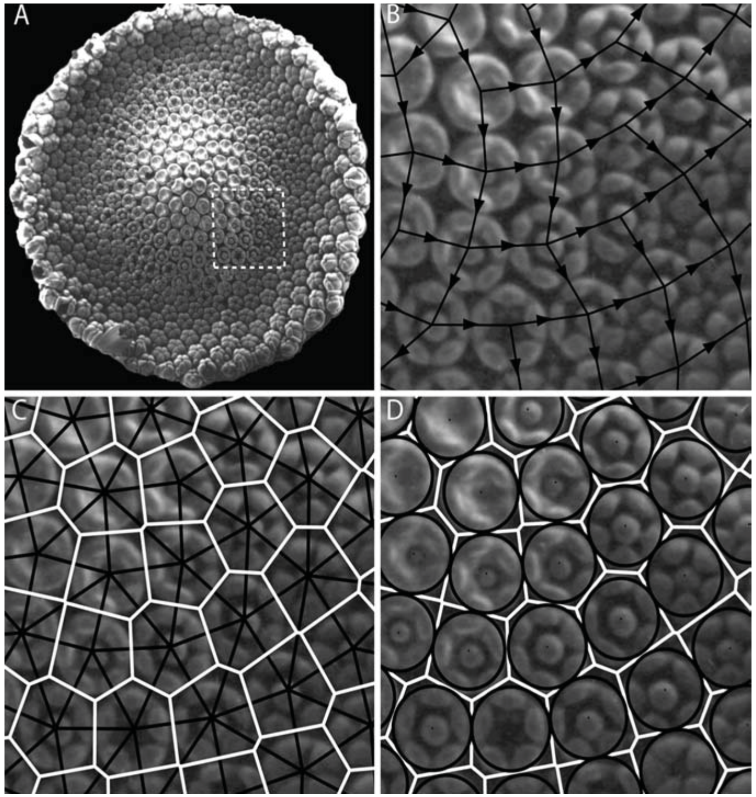
Taiz, L., 2010. Plant Physiology, 5th ed. ed. Sinauer Associates, Sunderland, Mass.



http://www.nsci.plu.edu/~jmain/b359web/pages/cell_wall.htm

cellular geometry

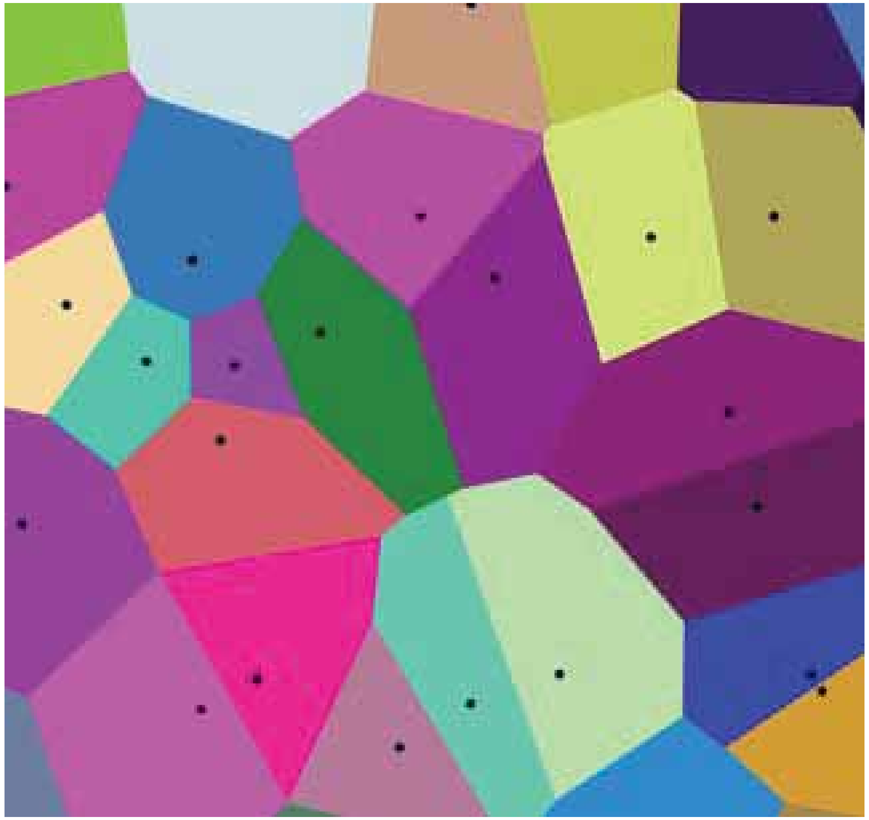
Ontogenetic graph, a subset of the Delaunay triangulation. The initiation of flower primordia proceeded approximately from the lower right corner of the panel to the upper left corner. Arrowheads show the local direction of the graph. Edges leaving a primordium point to the parents of that primordium. (C) The Voronoi cells and Delaunay triangulation of the pattern. (D) Voronoi inscribed circles. Note that the small spheres at the center of many flowers are small air bubbles that were trapped when the mould was made.



Hotton, S., Johnson, V., Wilbarger, J., Zwieniecki, K., Atela, P., Golé, C., Dumais, J., 2006. The possible and the actual in phyllotaxis: bridging the gap between empirical observations and iterative models. Journal of Plant Growth Regulation 25, 313–323.

vornoi diagram

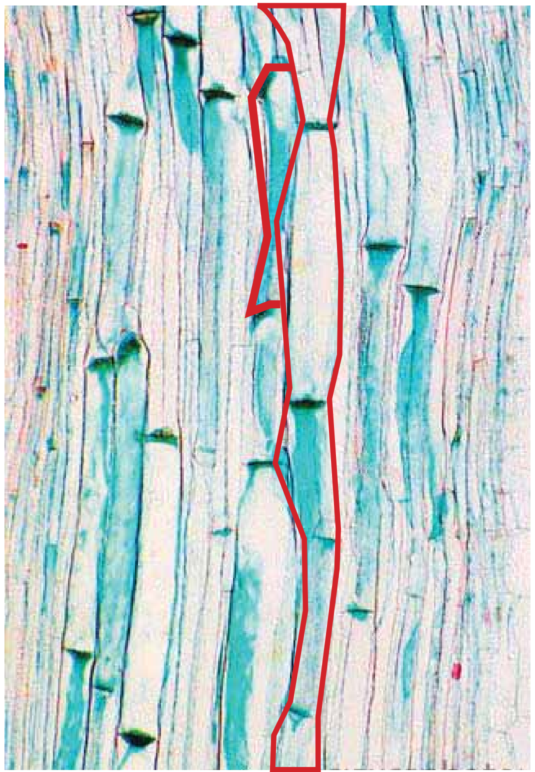
Voronoi diagram is a special kind of decomposition of a given space, e.g., a metric space, determined by distances to a specified family of objects in the space. These objects are usually called the sites or the generators and to each such object one associates a corresponding Voronoi cell, namely the set of all points in the given space whose distance to the given object is not greater than their distance to the other objects.



http://en.wikipedia.org/wiki/Voronoi_diagram

Cell Arrangement

In the Y direction the cells are arranged and organized in a vertical row, however on the X axis theres a sligh diffusion between the cells and they are not aligned. In my opinion, this arrangement on the Y axis gives the plant a maximal lengh, however the diffuse on the X axis provides the plant constructive strengh.



http://www.sciencephoto.com/media/99715/enlarge

negative spaces

The gaps created between the cells, which can be seen as the indirect creation of the cells, or in other words the inbetween or negative of the matter, however these gaps, or negatives are usefull spaces for the whole organism to function and work in a systematic way. these extra gaps have a complete different geometry, and if we connect it to our field, architecture, we can talk about the 2 opposites, negative and positive, or matter and antimatter, and this leads to the idea of, looking at the system as a whole, negative and positive working together.theres not a partition anymore between the 2, we can look at the whole system as something that works together and thus achieve better functinality and efficency.

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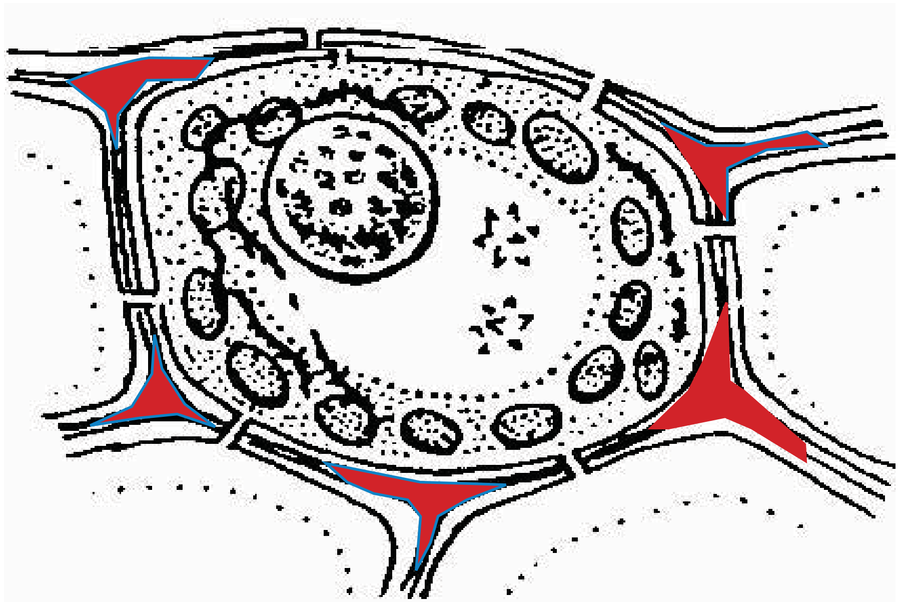
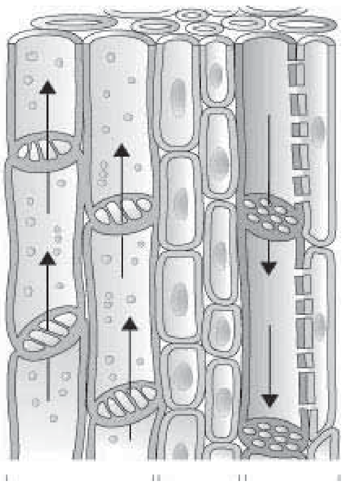


https://wiki.rockwallisd.org/groups/mstoddart/wiki/ace7b/

Cell patterns and texture

I've noticed that there is more than one type of development of the cell texture and typology. these features and variety of the cell formation and the texture it creates can be a source of inspiration for us as architects to use it as architectural design and patterns.



Pipes

The pipes can be seen in the core of the plant, these are pipe-like cells which function as the transition of different materials like water, sugar and other materials to the different parts of the organism.This is one of the types of the cells which make up the whole.

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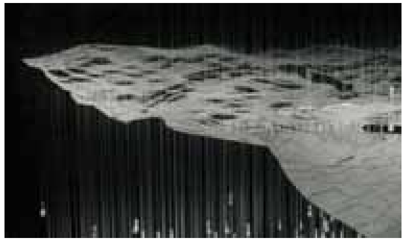
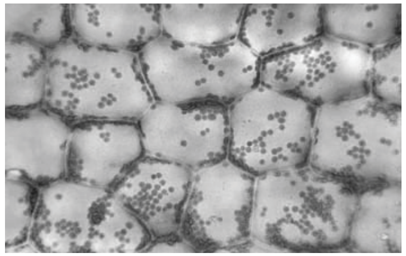
https://sites.google.com/site/husnasreflections/animal-plant-cells



Waves

These cells are seen on the surface of the leaves of the organism, these cells form a wave-like pattern which functions as a method of keeping the water from flowing off the leave, using the bumpy areas to preserve the water.

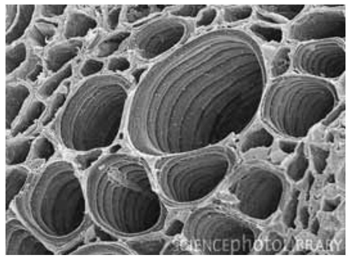
http://pruned.blogspot.com/2010_06_01_archive.html



Voronoi

This is another texture pattern which can be seen in the cells which play a major role of delivering different materials between different cells.this formation of the voronoi enables and maximizes the transition of these mterials in an equal efficient way between all the cells.

https://wiki.rockwallisd.org/groups/mstoddart/wiki/ace7b/



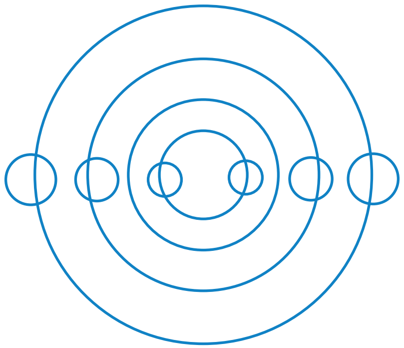
Hierarchy

Theres a variety of scales of the cells making up the whole organism, this hierarchy of the scales, plays a major role in dividing the uses and functions of each element, and when put alltogether it functions as a whole system.

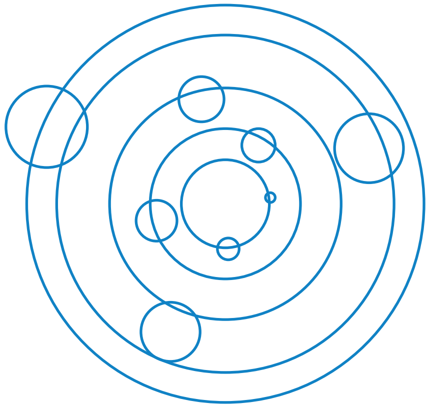
http://www.sciencephoto.com/media/77007/enlarge

plant growth

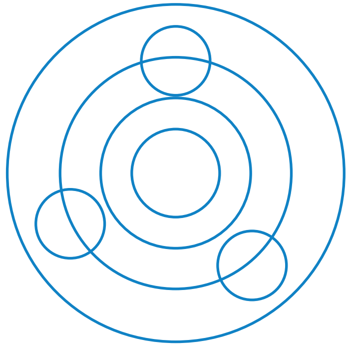
Theres a common fact between all the plants i've experimented and analysed, which is the fact that all of these organisms grow and develop around a clear vertical axis, I could sum up all the results in 4 different types of egocentric development depending on the orientation and facing of the leaves.These shapes and orientation of the leaves, were created and formed , based on the context these plants evolved in over time, for example if we look at plants in a sunny and hot climate such as a desert, we can see that the leaves are slightly this and sharp like a pin and the reason to that is to minimize the loss of water in evaporation.



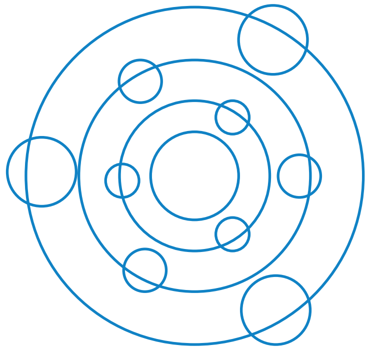
http://www.givingplants.com/by-plant-type/bonsai.html



Pronk, I.A.D.C., Blacha, M., Bots, A., 2008. Nature's Experiences for Building Technology. Building Technology Department Eindhoven University of Technology, Eindhoven, Netherlands.



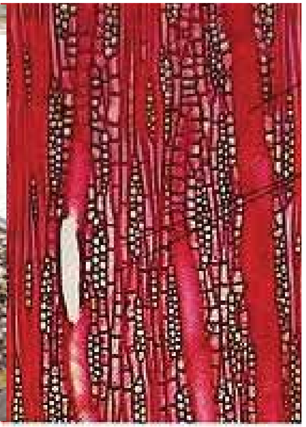
https://wiki.rockwallisd.org/groups/mstoddart/wiki/ace7b/

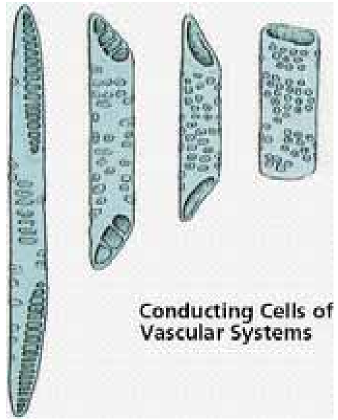


Pronk, I.A.D.C., Blacha, M., Bots, A., 2008. Nature's Experiences for Building Technology. Building Technology Department Eindhoven University of Technology, Eindhoven, Netherlands.

tubular cells


organ tubular cells


tissue tubular cells in stem

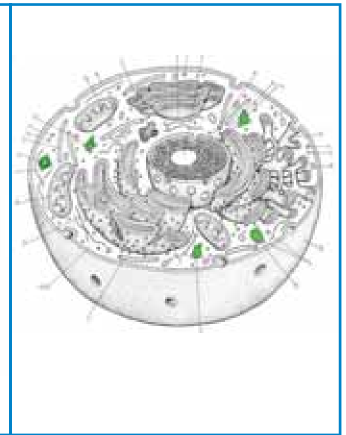


basic tubular cells in stem

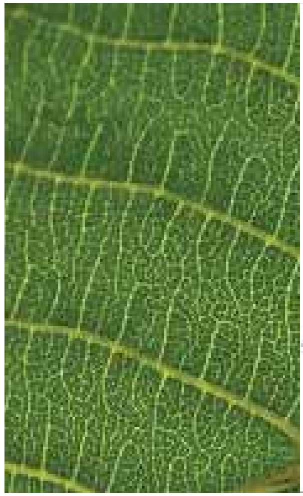
radial symetry in cells

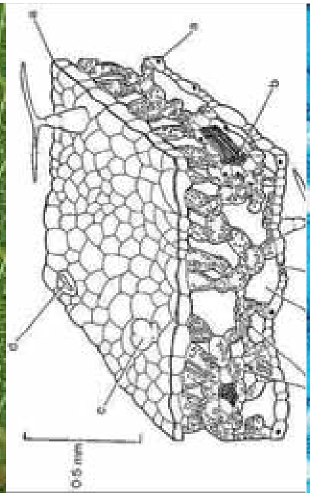

organ radial symetry cells

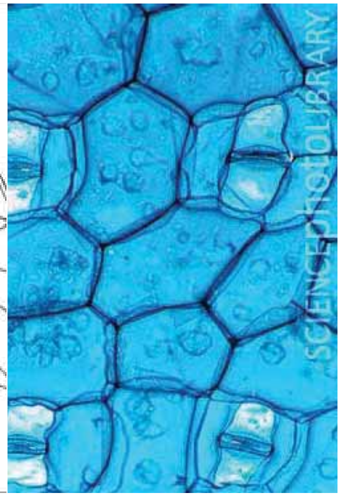

tissue radial symetry cells


radial symetry in a single cell

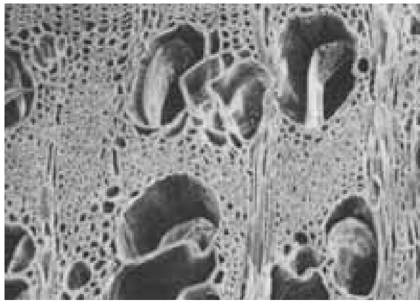
surfuse cells

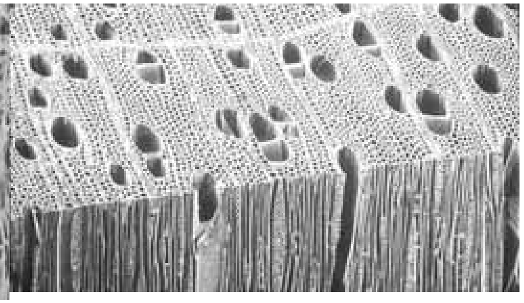






anisotropic cells structures in wood

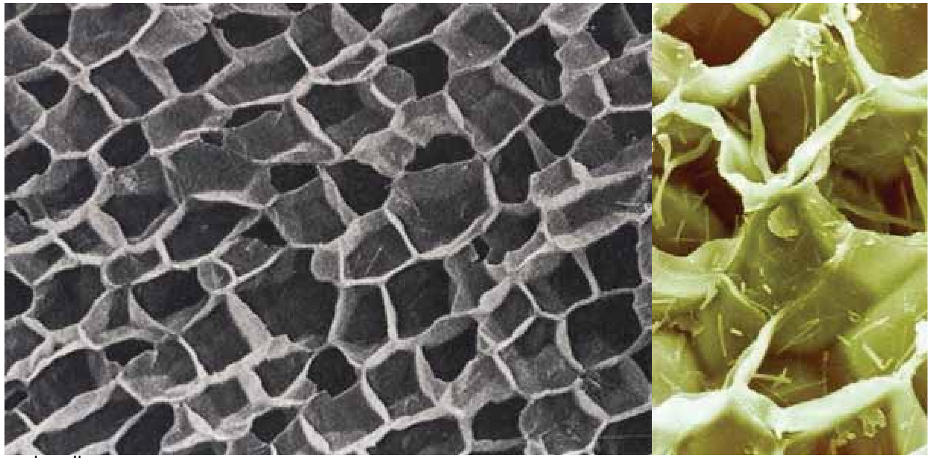




This is a scanning electron micrograph of a eastern spruce wood block, a softwood. Most cells run longitudinally, but some cells, run horizontally. The big hole is called a resin canal. The majority of the cells shown here are called "longitudinal tracheids". On different surfaces, the wood structure appears differently. This is called anisotropic or orthotropic structure. This unique structure differs from other raw material, e.g., metal, plastic, concrete and rocks.

low Specific gravity cells

lufa fruit



cork cells

dynamic fruit cells - spreading seeds

by air and wind

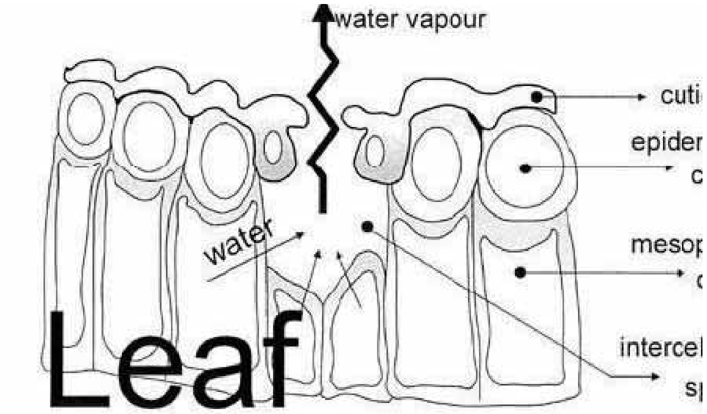
by floating on water. above-by animals stomach

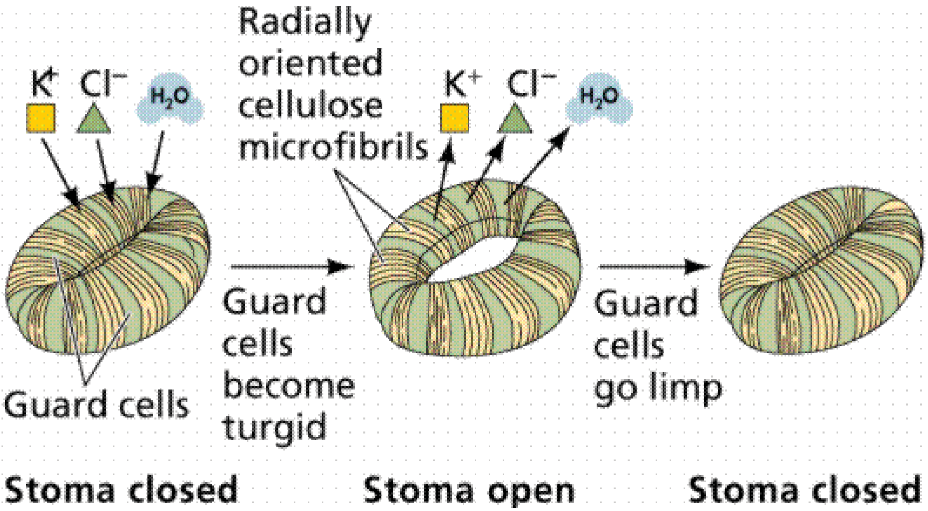
by jetstream preasure

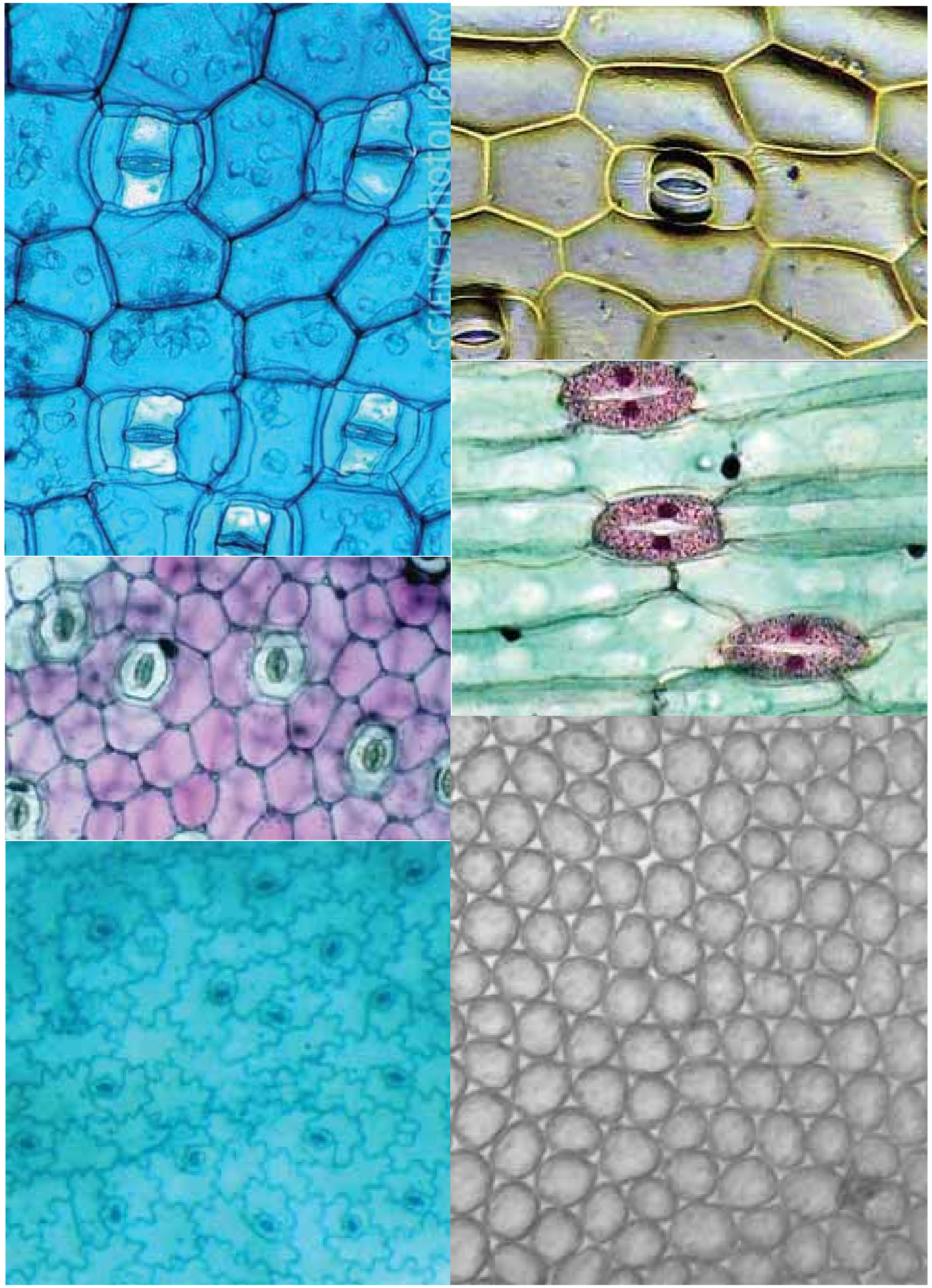
by clinging on animal's fair

stomata distribution

Stomatal density refers to the number of stomata per squared millimeter. Typical densities can vary from 100 to 1000 depending on the plant species and the environmental conditions during development. More stomata are made on plant surfaces under higher light, lower atmospheric carbon dioxide concentrations and moist environments. Grasses typically have lower stomatal densities than deciduous trees. The size and shape of stomata also vary with different plant species and environmental conditions. For example, grasses have guard cells that resemble slender dumbbells whereas trees and shrubs have guard cells that resemble kidney beans.

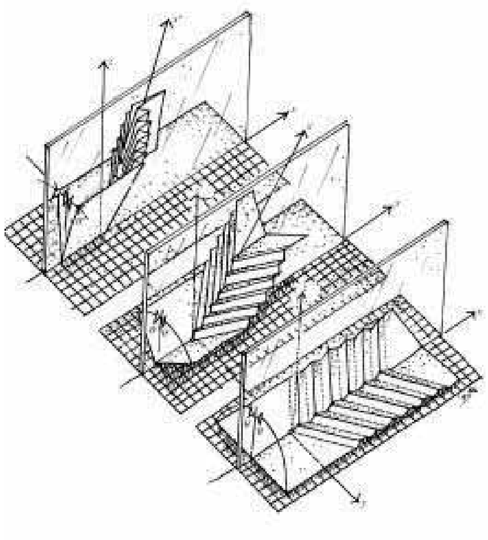


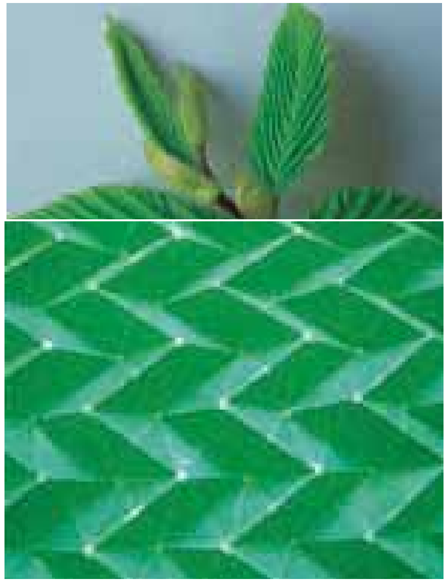




other water accumilation, anti vapor and micro climate strategies in plants

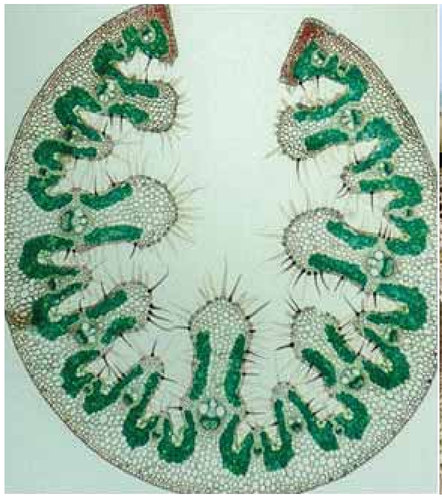
1. folding leaves





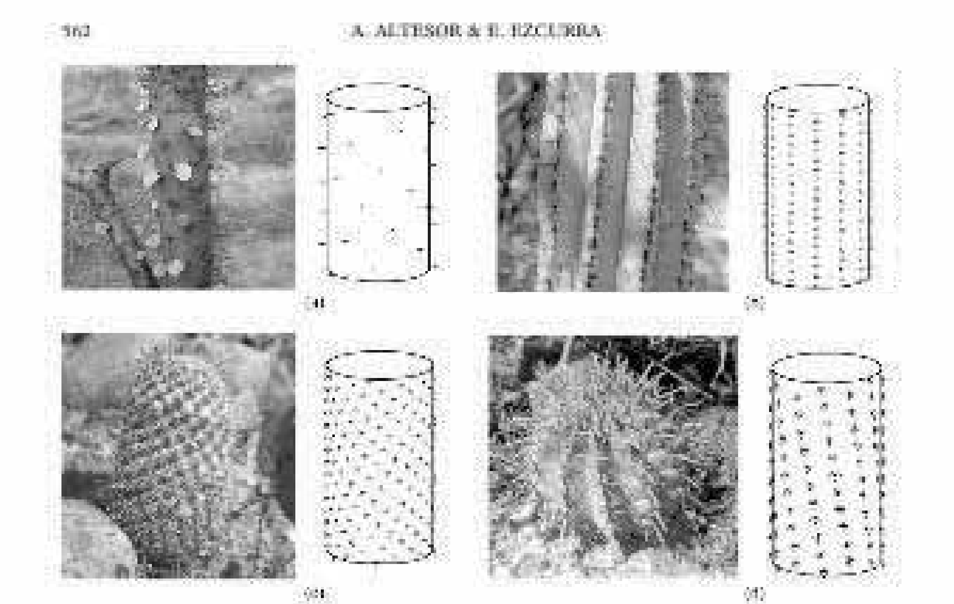
2. funnel shaped leaves towards center & stem

2. funnel shaped leaves , sunken stomata



3. maze texture

efficient compact morphology of stem & areoles
convection upwards



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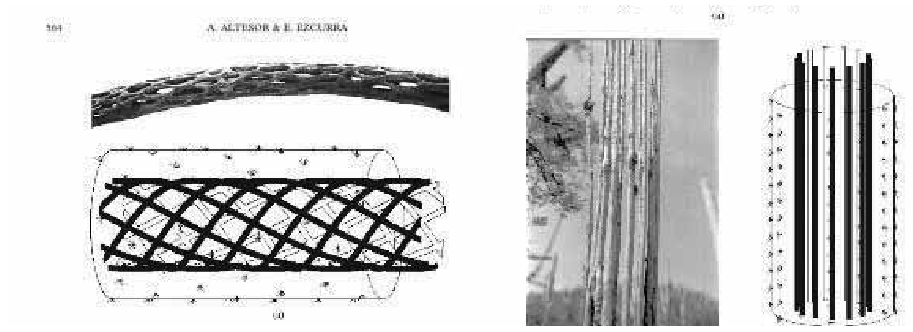

ribs increase surfuse by %80
ribs shade % 60 of the surfuse
ribs reduce wind speed - creating insulating air layer

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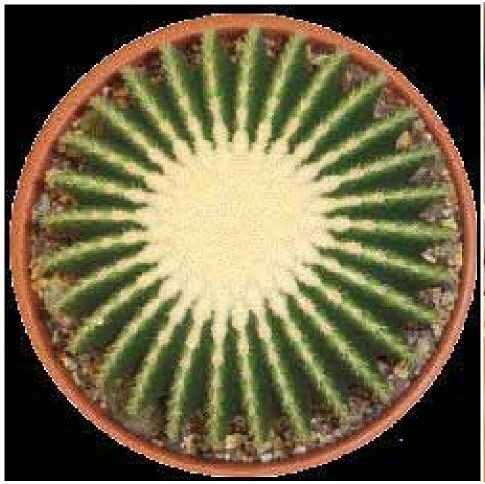


unifomaly dense spines & areoles for shading and protection

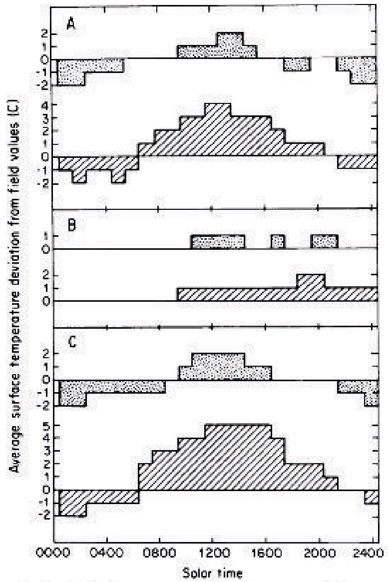


FIG. 7. Deviations in average surface temperature from predicted field values for simulated modifications in surface morphology. A: Spines removed; B: ribs removed; C: no spines or ribs. Data are for winter (stippled) and summer (cross-hatched) days for field g_w, patterns (Fig. 3).

high density, bright spines at the apex for shading and reflection of thermal energy
low density, dark spines at the base for ventilation and thermal energy absorption

leaf hair microclimatic effect

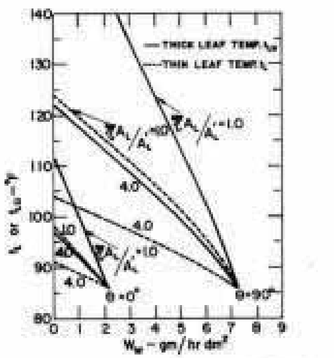
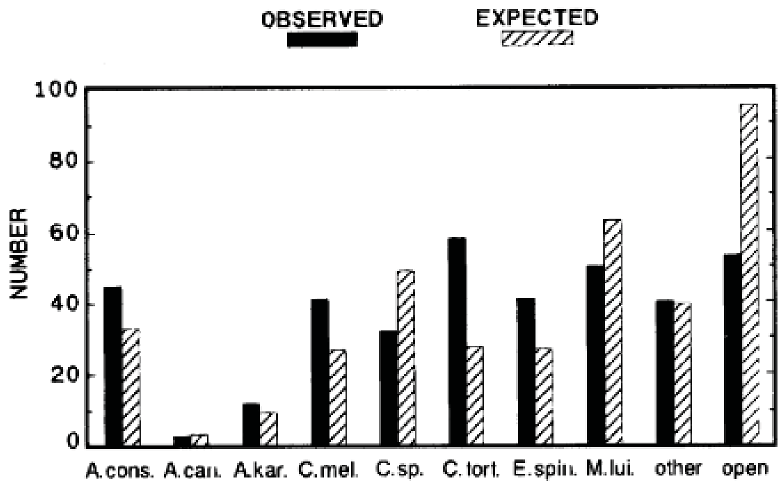


Fig.4. LEAF TEMPERATURE vs. WATER EVAPORATION RATE IN STILL AIR WITH LEAF ORIENTATION, θ; THICKNESS; AND AMOUNT OF SURFACE HAIR, AS PARAMETERS

nurse shrubs cooling effect even greater considering water compatition



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Pattern analysis indicated that the establishment of two columnar cacti, Neobuxbaumia tetetzo and Cephalocereus hoppenstedtii, and of three small globose cacti, Coryphantapallida, Mammillaria colina andM casoi, is aggregated and associated with perennial nurse shrubs. Some nurse species, Castela tortuosa, Caesalpinia melanadenia and Eupatorium spinosarum have a higher number of cacti beneath their canopies than would be expected by chance. A replacement pattern was found between the columnar cacti and their nurses, an aspect which was not found with the globose cacti. Following the assumption that protection against excessive radiation is the main factor determining the nurse effect, the azimuth orientation of the cacti with respect to their nurses was evaluated. Only Coryphanta pallida presented a non-random distribution with a tendency towards the North and West. The difference in maximum temperature between the soil surface under the different nurse species and of open spaces, which is reached at midday, was 16 °C. No significant differences were found in beneath-canopy temperatures for the three nurse species considered. Soil nitrogen levels were significantly lower beneath the different nurse plants than in open spaces. This result suggests that soil fertility is not an important factor in the nurse-plant phenomenon in Zapotitlán.

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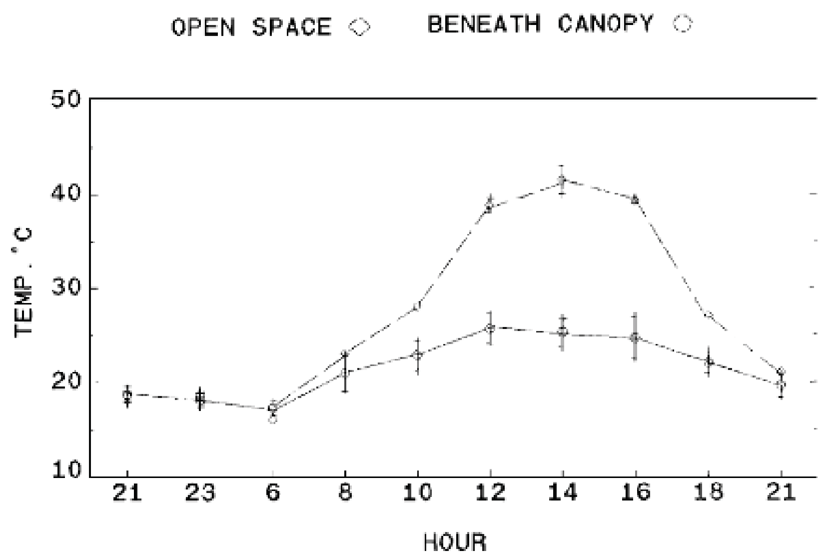

Fig. 5. Temperatures on the soil surface beneath the canopy of *Mimosa luisana* ($n = 5$) and in open space ($n = 2$) for a 24-hour period (July 23, 1988).

spines contribution to protection and micro climate

TABLE 4. Effect of spines on the simulated surface temperature at various locations on *Mammillaria*. Microclimatic conditions are from Lewis and Nobel (1977)

Condition	Surface temperature (°C) Midheight Minimum	Midheight Maximum	Apex Minimum	Apex Maximum
Winter day				
no spines	9.1	29.1	7.2	22.3
½ spines	9.6	26.8	8.5	20.5
usual	10.0	24.5	9.6	19.2
1½ spines	10.4	21.0	10.1	18.1
Summer day				
no spines	23.8	52.2	19.8	46.4
½ spines	24.6	49.4	21.9	42.4
usual	25.2	46.7	23.8	39.1
1½ spines	25.9	44.8	25.1	37.7

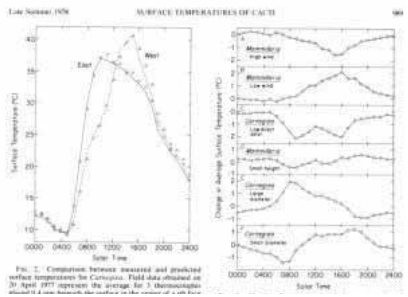

TABLE 6. Comparison of simulated stem surface temperatures for 3 species of cacti under identical microclimatic conditions. The temperatures were determined for the coldest (31 March 1977) and hottest (21 July 1976) days examined

Taxon	Min temp on coldest day (°C) Midheight	Apex	Max temp on hottest day (°C) Midheight	Apex
Mammillaria	3.0	1.8	46.7	39.1
Ferocactus	2.1	1.8	48.6	36.5
Carnegiea	1.8	1.2	53.0	36.1

Interspecific morphological differences and intraspecific morphological changes with latitude were evaluated to help examine the distributional ranges of Carnegiea gigantea, Lemaireocereus thurberi, Lophocereus schottii, Pachycereus pecten-aboriginum, and P. pringlei in the Sonoran Desert (USA and Mexico). A computer model, which predicted the average surface temperature of the stem within 1@?C of that measured hourly throughout a 24-h period, was particularly useful in studying the thermal relations of the stem apex, where the lowest surface temperature occurred. Simulated increases in stem diameter raised the minimum apical temperature for C. gigantea and may help account for the extension of its range to higher latitudes than the other species studied. However, diameter increases led to a slight decrease in minimum apical temperatures for Lophocereus schottii. The immature stems of L. schottii are morphologically distinct from the mature stems which caused minimum apical temperatures to be 1.6@?C lower for the immature stems under given environmental conditions; thus, freezing damage to the immature stems could limit the northward extension of the range of this species. As the apical pubescence in the simulations was increased up to the normal amount (10 mm), the minimum apical temperature for the stem of C. gigantea increased 2.4@?C. Simulated increases in spine shading of the apex also raised the minimum apical temperatures, again indicating the influence of morphological features on the temperature of the meristematic region. Under the same environmental conditions the minimum apical temperatures were 7.7@?C, 5.9@?C, and 3.9@?C for C. gigantea, Lemaireocereus thurberi, and immature stems of

Root contraction aids in lowering the internal stem temperature, when combined with the cooling effects of the rocky surface

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"Ariocarpus fissuratus earned its nickname "living rock" because it blends into the rocky surroundings with its small stature that is level with the soil's surface. The researchers hypothesized that the cactus could "escape" high temperatures by moving more of itself below the soil surface where it is cooler.
To find out, the researchers mimicked summer desert conditions by growing plants on a rooftop in Los Angeles, where air temperature was above 99°F for several days. All the cacti were grown in sandy soil, but half had rocks covering the surface of the soil, similar to their native habitats. For plants grown in rocky soils, the internal temperature of the stem was about 7°F lower than those grown in sandy soils alone. While this may seem like a small decrease, it had a significant effect on the health of the plants.
Unlike the cacti grown in sandy soil which all died, those grown in rocky soil survived the intense heat. Root contraction aided in lowering the internal stem temperature, but only when combined with the cooling effects of the rocky surface. The opposite was true in sandy soil where cacti planted higher above the surface had slightly lower stem temperatures than those planted close to the surface. "Even in rocky soil, experimental plants attained nearly lethal temperatures during a summer heat wave in Los Angeles" said North. "Thus, root contraction and rocky microhabitats may not provide enough protection should desert temperatures get much higher due to global warming.

cactus cooling tools contribution

nurse shrubs
0.8C (-16c soil temperature)

Root contraction to rocky surface
0.5C

spines
6C-1.4C

leaf hair
11C

ribs
2C

SPONGES (porifera)

Sponges are colorful component of many seascapes. Although their similary to plants, they are animals of the phylum porifera.
They are multicellular organism and have a body full of pores and cannals which water circulated through them. Sponges have a unique system for filter feeding. the separation of the food from the water is by passing them through a mesh which strains out the food.
The body wall consists of two layers of thick cells, interior and exterior, and between them- the construction of the sponge.

<u>The filter feeding body of the sponge is built around one of three anatomical designs:</u>
1.asconoid- hollow cylinder body
2.syconoid- tubular body
3.leuconoid- largest body size


1.asconoid


2.syconoid


2.syconoid

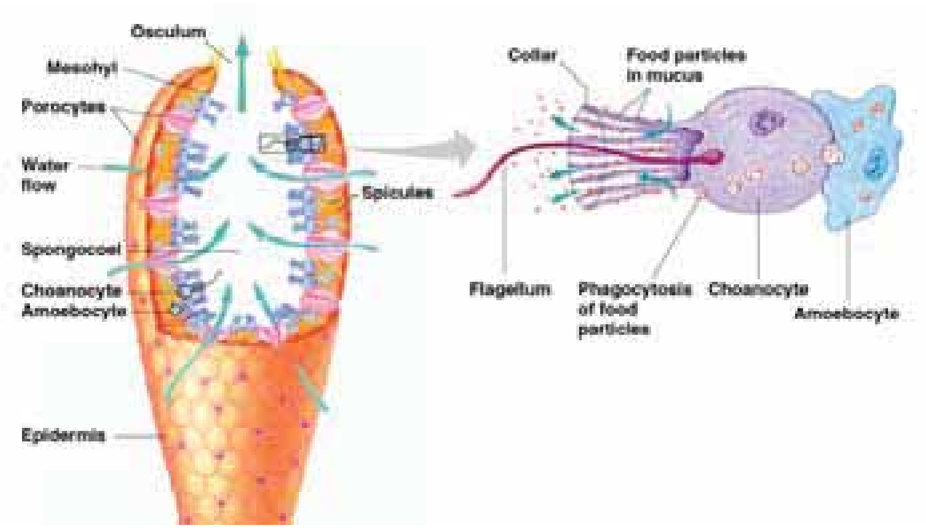

3.leuconoid

1. http://www.google.co.il/imgres?um=1&hl=iw&tbm=isch&tbnid=hk5-
2. Europe, O., 2005. EUO © OCEANA Houssine Kaddachi, Available at: http://www.flickr.com/photos/oceanaeurope/6393809915/ [Accessed March 23, 2012].
3. http://www.google.co.il/imgres?um=1&hl=iw&sa=N&tbm=isch&tbnid=rcQzwK3eO1YJjM:&imgrefurl=http://www.noelways.com/courses/Zoology/Dissections/Phylum_Porifera/Leuconoid_1/Leuconoid_1.html&docid=ACbtCpOh1pGpHM&imgurl=http://www.noel-

ASCONOID - Cylinder form

It has a form of hollow cylinder attached by its base to the substratum. The body surface in covered by a monolayer of flat cells. The hollow interior is lined with a monolayer of “collar cells”

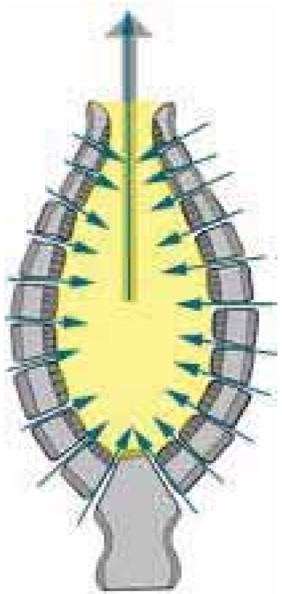
The flagellum in the collar creates a unidirectional water flaw which enterns through little pores (ostium) to the atrium and going out through a larger openning at the upper.



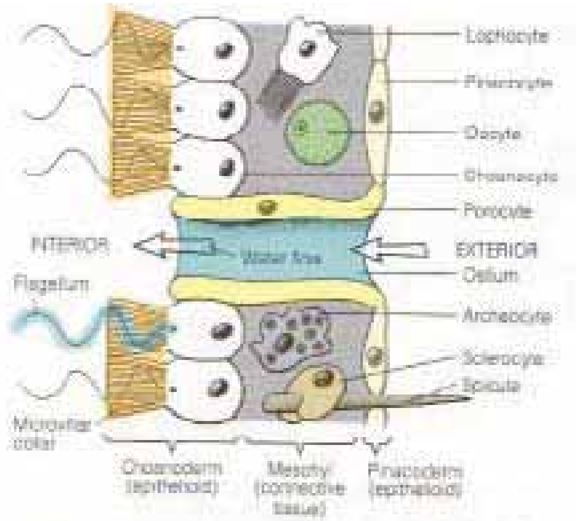
Filter Feeding by collar cells

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

<u>The three parts of this sponge are detailed at the section below:</u>
1.Exterior layer of the body wall
2.Interior layer consist of collar cells which taking part of the filter feeding and “help” the water going out of the sponge
3.Sponge construction between them.



1.Section through the sponge



2.Section through the body wall

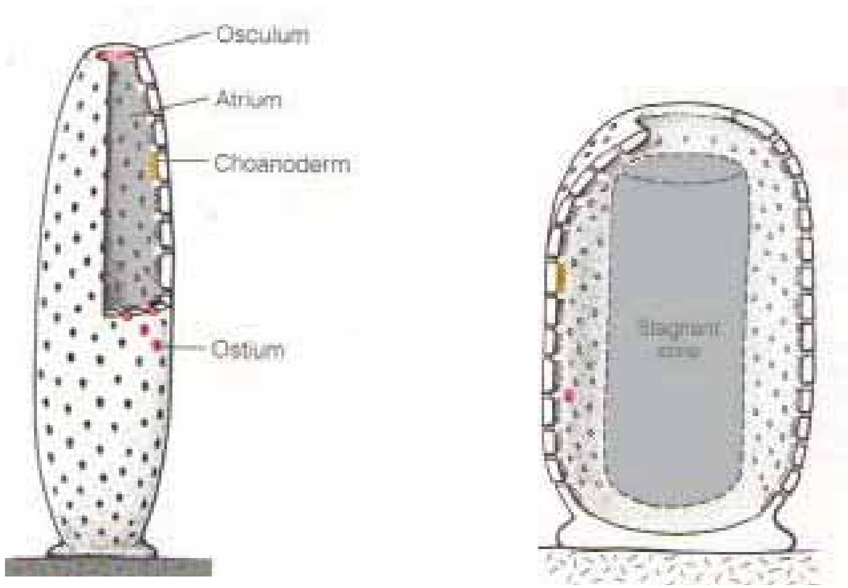
Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

SYCONOID - cone form

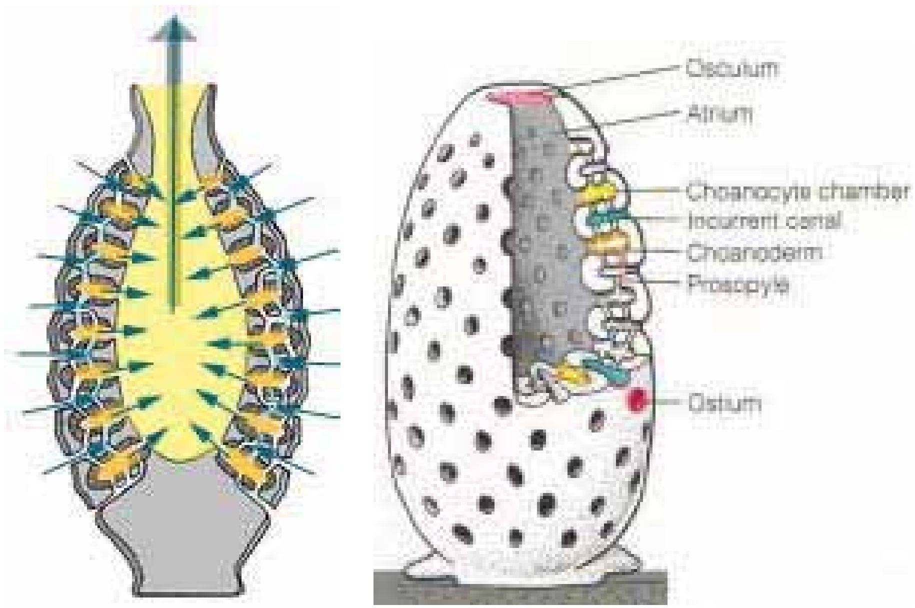
This design increase surface area and reduce atrial volume by forming alternating inpockets and outpockets, like folding the sponge body wall.

the amount of water flow through the asconoid can couse a problem due to volume increases faster than area with growth, the body volume soon ex-ceeds the pumping.

there for the syconoid design if more efficient.
water flow through it:
incurrent canals--->prosoplys--->choanocyte chambers---> astium-->osculum



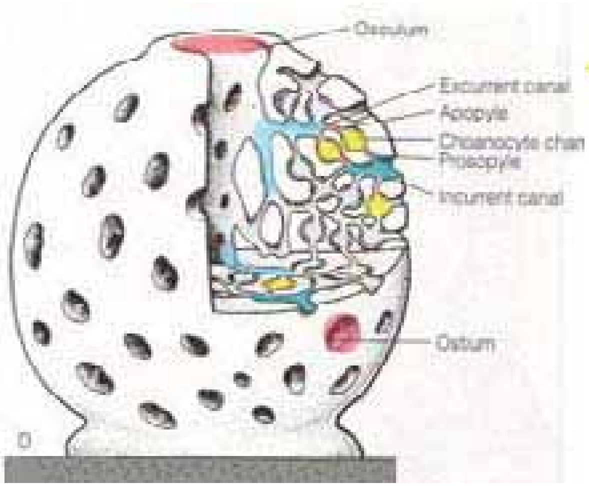
Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.



Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

LEUCONOID- the largest body sizes

It ranges from a few centimeters to more than one meter. At this kind of sponge the filter feeding system is a complex network. It consist of spherical “rooms” at the intersection of enterns and exits cannals.



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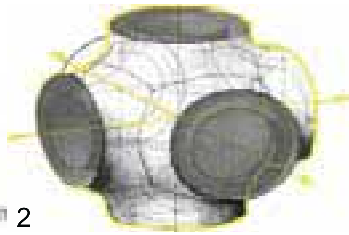
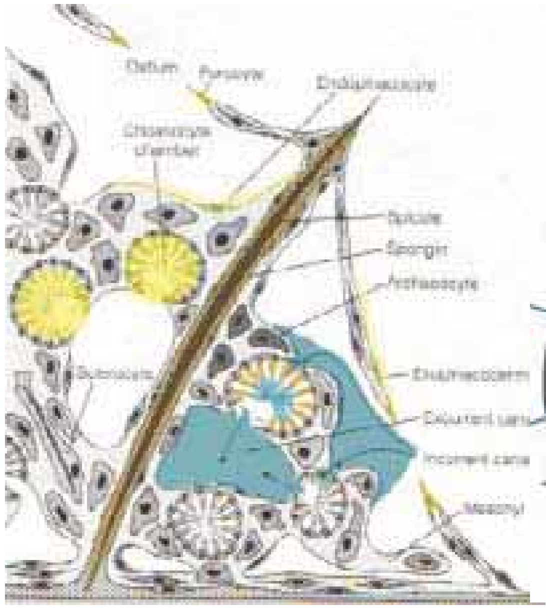


2

3

1.Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.
2. Translation unit of periodic hyperbolic sponge, Michael Burt
3. http://www.google.co.il/imgres?um=1&hl=iw&tbm=isch&tbnid=QiXl0GzX_

Water enterns through surface pores into interior cannals to inner rooms and then through back cannal to the atrium on its way out through the “osculum” As seen at the section through the body wall.



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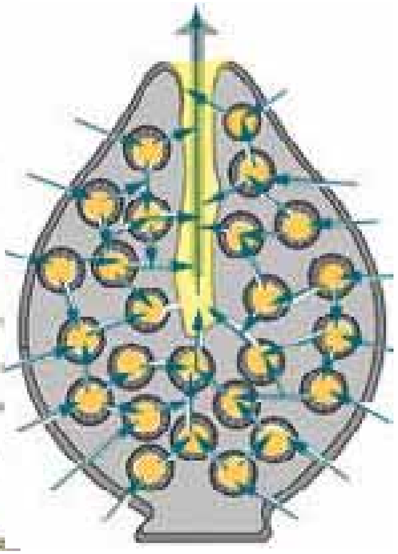


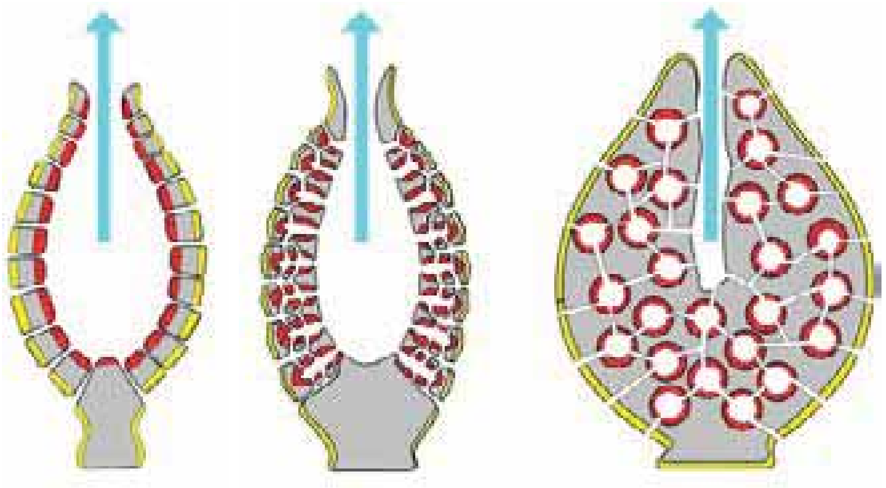
2

1.Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.
2. Sara, 2009. Standup Architecture - SuA: Basic structure.........................Form and function. Standup Architecture - SuA. Available at: http://sara-standuparchitecture.blogspot.com/2009/02/basic-structureform-and-function.html [Accessed March 23,

UNDERSTANDING THE SPONGE FORM

The all three sponge designs have similar characteristic. They all have exterior layer of cells, pores at their surface, collar cells for the filter feeding and atrium with larger openning which the water comes out of.

Nevertheless there are some remarkable differences.



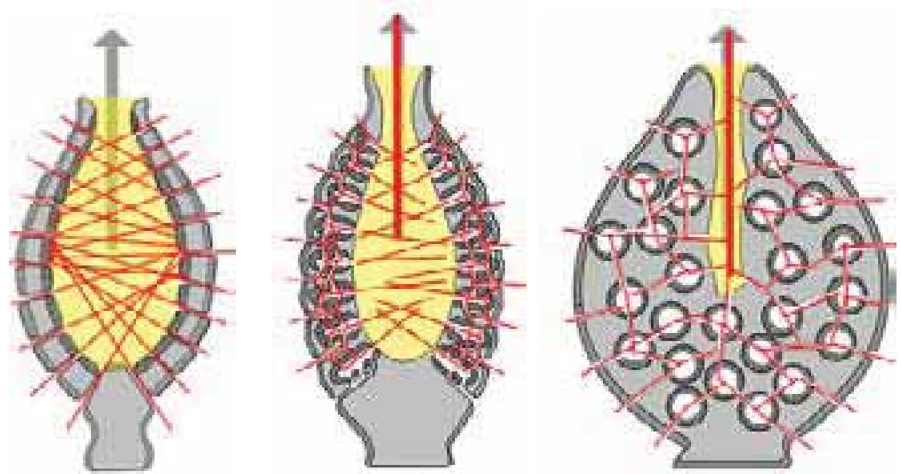
Comparing the three sponges form

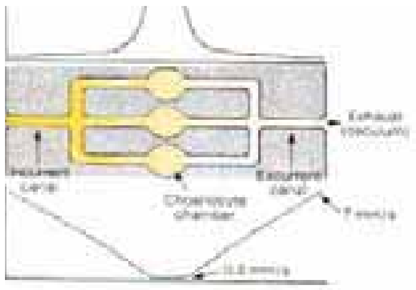
Sara, 2009. Standup Architecture - SuA: Basic structure.........................Form and function. Standup Architecture - SuA. Available at: http://sara-standuparchitecture.blogspot.com/2009/02/basic-structureform-and-function.html [Accessed March 23, 2012].

Water flow

asconoid(1) water flow directly to the atrium
syconoid(2) water flow first through an “entrence hall” and then enterns the atrium.
leuconoid(3) water flow through rooms and cannals until it arrives to the atrium.

If we will connect the flow lines of the water we will get a network which we can learn from - entrance of air and light or motion in a building.



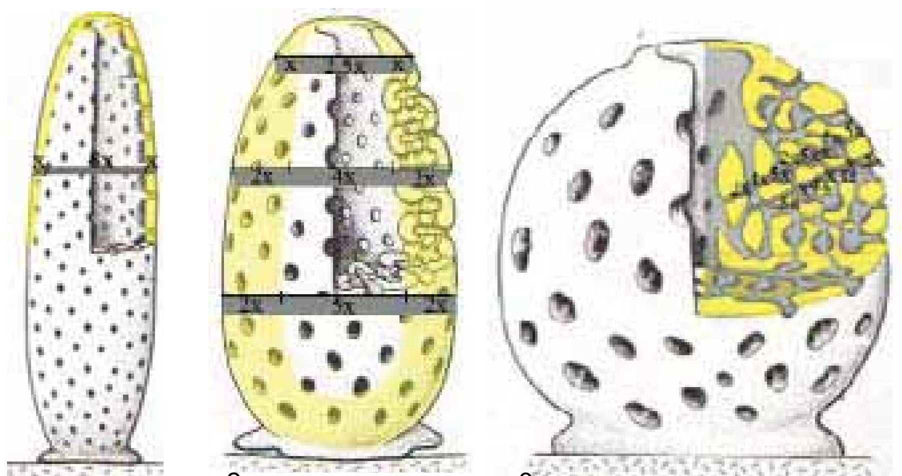


Water flow network

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Body wall thickness

<u>Estimated ratio of: body wall thickness - interior:</u>
1. ratio of 1:8
2.ratio of 1:2.5, 1:2
3.serial no. of 2,5,1,4,1,3,1,5 between the little cannals or 2,4,5,2,5,1,5,5 between the rooms.

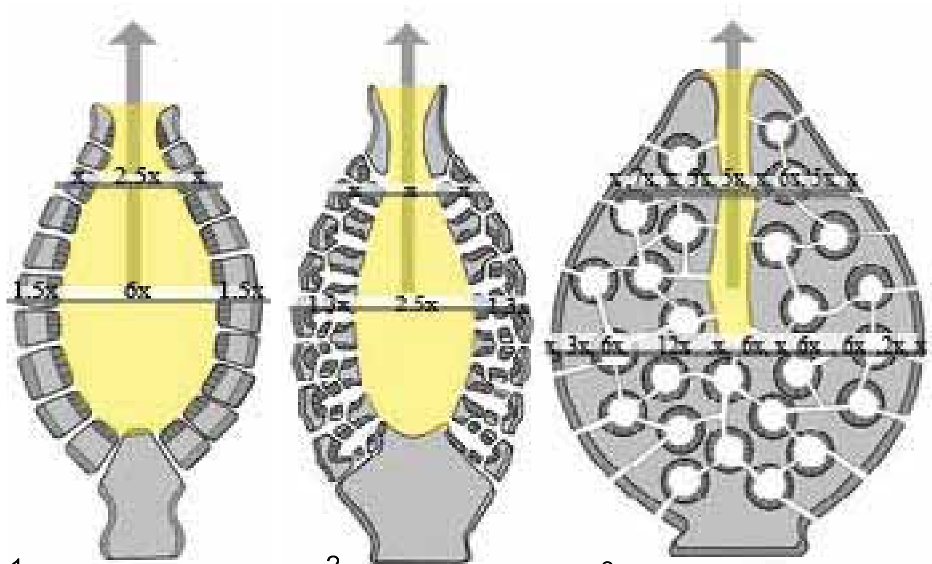


1 2 3

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Conclusions:

1.The asconoid has a thick body wall comparing its atrium.
2.The syconoid tries to reduce the atrium by enlarge body wall thickness.
3.The leuconoid body has a thick "skin" around complex matrix of minimum space for water inside the construction.



1 2 3

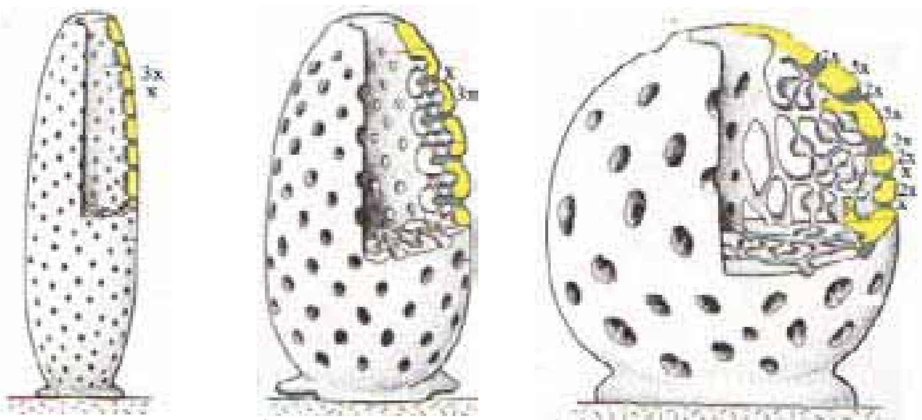
Sara, 2009. Standup Architecture - SuA: Basic structure........................Form and function. Standup Architecture - SuA. Available at: http://sara-standuparchitecture.blogspot.

Pores Size

<u>Sponge surface size of the sponge body divided into sealed area and pores</u>:
1.ratio of 3:1
2.ratio of 3:1
3.ratio of 2:1 or 5:2. series of: 1,2,1,2,2,5,2,5,2..

Conclusion

The sponge kind has no influence on the sealed area-pores ratio.
All kinds have almost the same ratio.



1 2 3

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

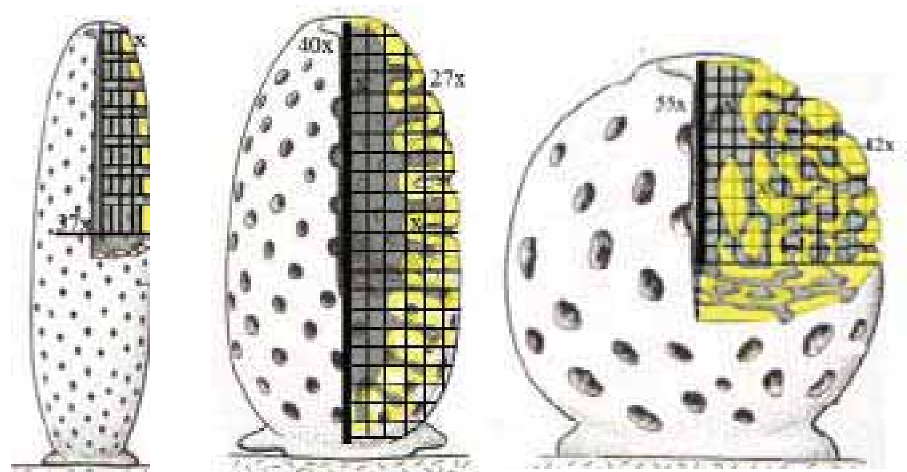
Built - Empty

<u>Sponge construction area comparing to its empty area for water to flow through:</u>
1.ratio of 7:37 = 1:5.3
2.ratio of 27:40 = 1:1.5
3.ratio of 42:59 = 1:1.4

It is possible to take a peace of it in order to misure because its symetric body.

Conclusion

we can see that sponge no.3 is the most efficient.

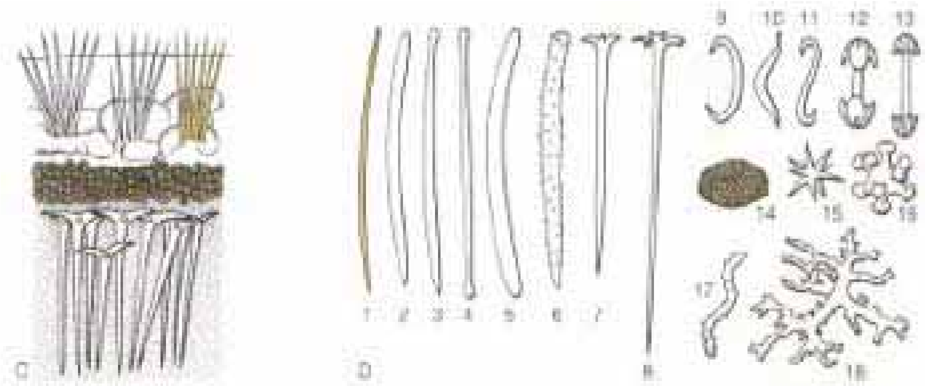


1 2 3

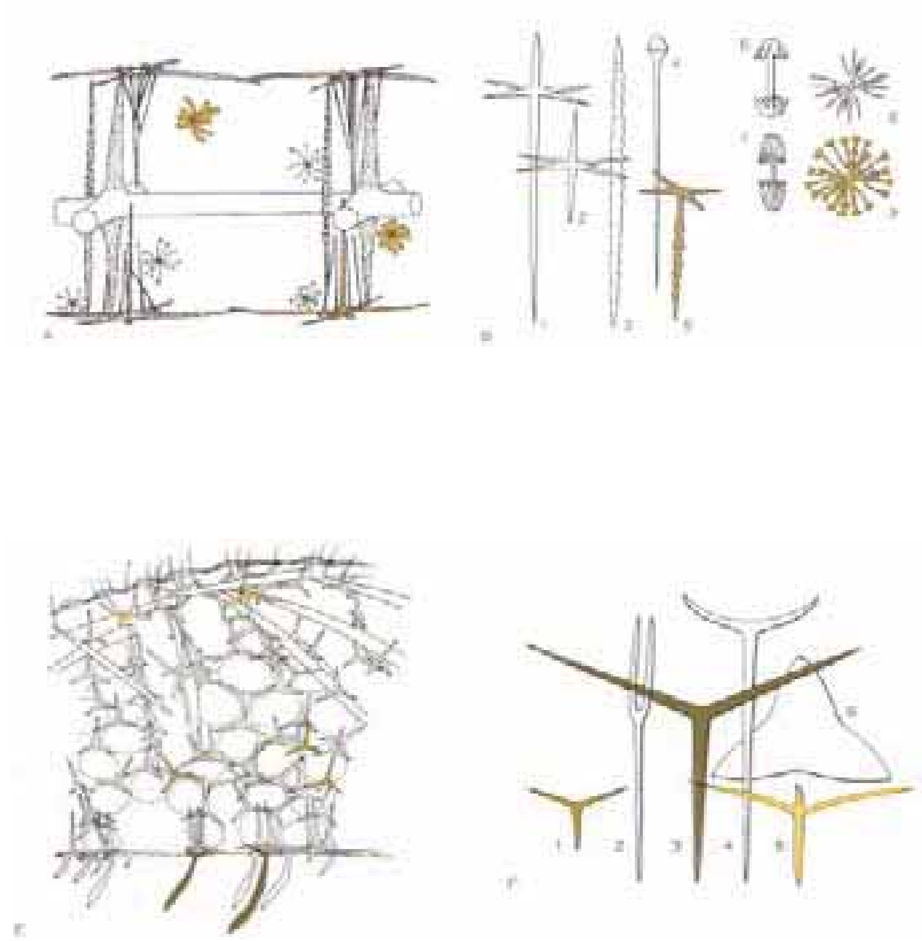
Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Sponge skeleton

Whatever their growth form, most sponges live in moving water and support-themselves with a well-developed skeleton.
The stiffness of the skeleton varies widely among species and growth forms.



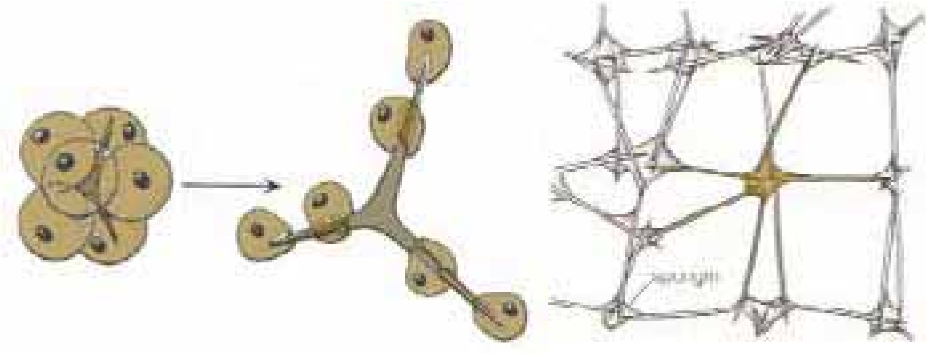
Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.



Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Skeleton components

Spicules and spongin are the main components.
there are some “relationship” between them which design the construction of the sponge.



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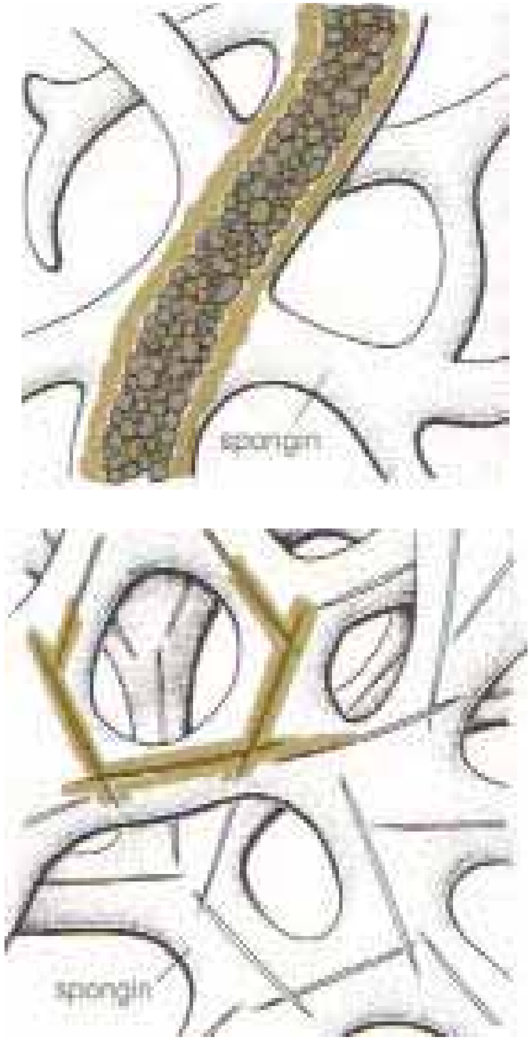
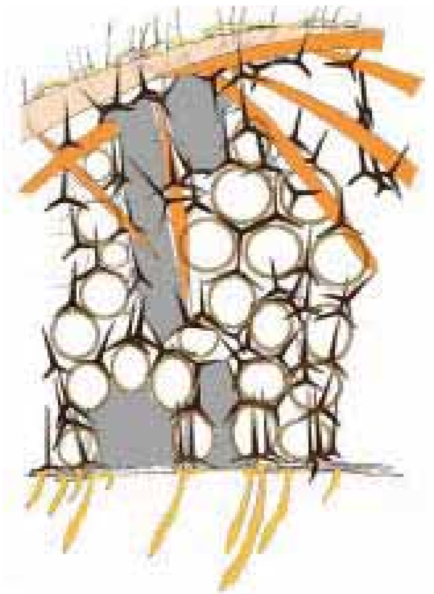


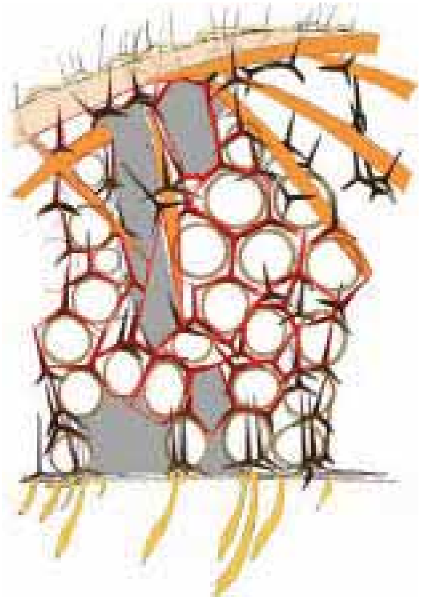
Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Skeleton geometric

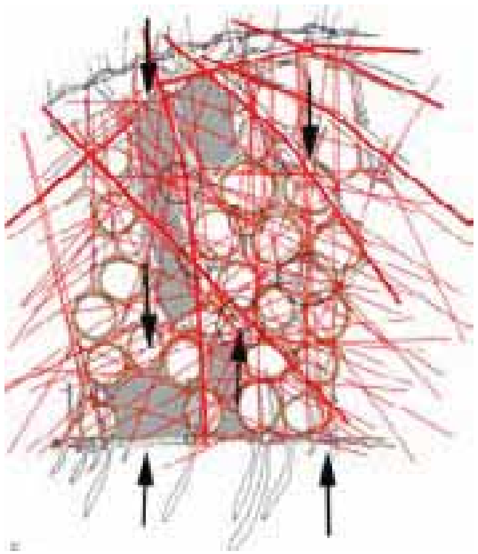
The skeleton includes components which support each other.



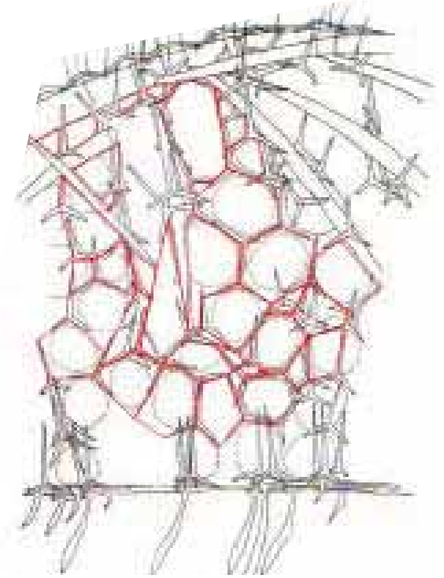
several kinds of components



Figuring out the shapes



Places of forces



Geometry between the spicules

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

Dynamic Combinations

ההתיחסות לכל חומר כשני מרכיבים- מרכיב חומרי ומרכיב ריק. שיכולה לבוא ע"י ביטוי בחזיתות, מחיצות או חיפויים. הניסוי שיוצג בסרטון הינו שילוב בין שני פטרנים שונים למען יצירת דינמיות אחרי פירוק הפטרן למרכיביו: השחור והלבן. להלן כמה דוגמאות

http://animals.nationalgeographic.com

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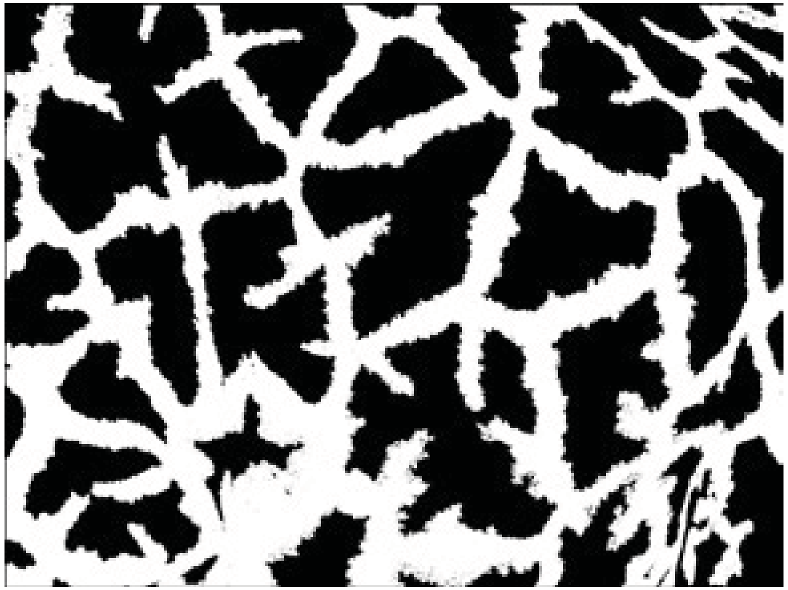
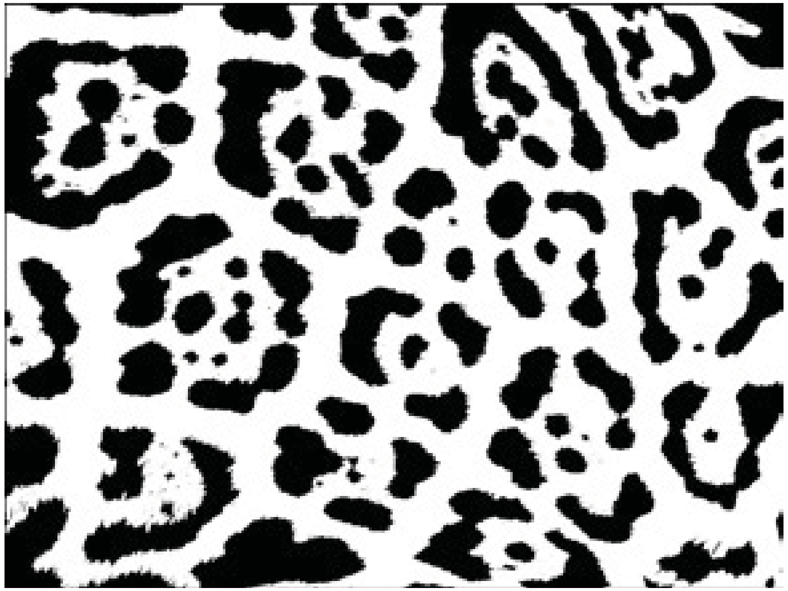
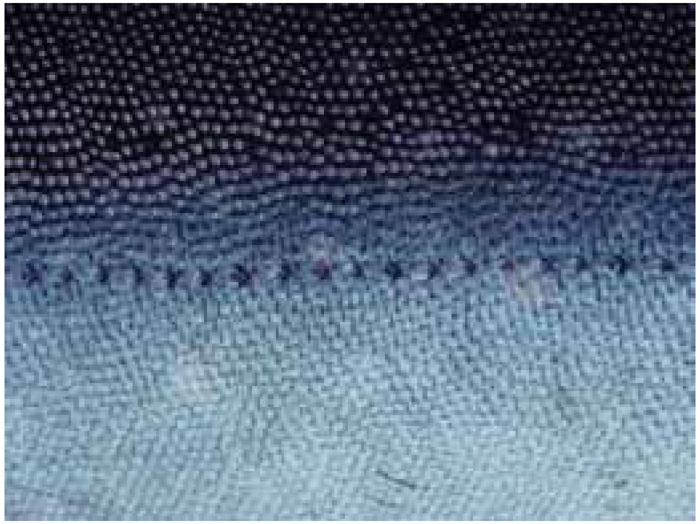




Material Textures

עוד התייחסות שעניינה אותי היא דימוי מבנים תאיים מן הטבע לטקסטורת חומרים קיימים,
הן לפי הצורניות והן לפי אופי וקשיחות

http://animals.nationalgeographic.com



http://animals.nationalgeographic.com

http://mayang.com/textures/Fabric/html/Other%20Fabrics/index.html

http://www.featurepics.com/online/Carpet-Texture-Macro-906052.aspx


http://animals.nationalgeographic.com


http://animals.nationalgeographic.com


http://designm.ag/resources/free-concrete-textures/


http://designm.ag/freebies/cracked-concrete-textures/

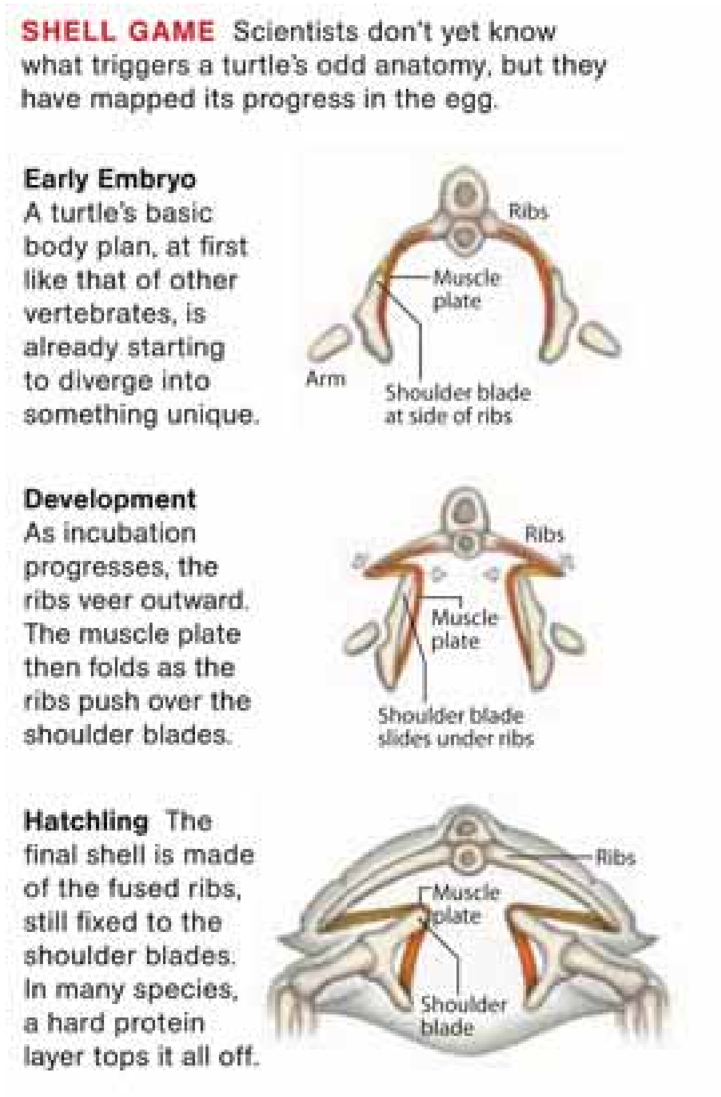
Structures And Textures

ההתיחסות בחלק זה היא למבננים תאיים טבעיים וניסיון דימויים לסטרוקטורות מבניות קיימות אם זה מבחינת החומר או מבחינת חיפוי וכדומה

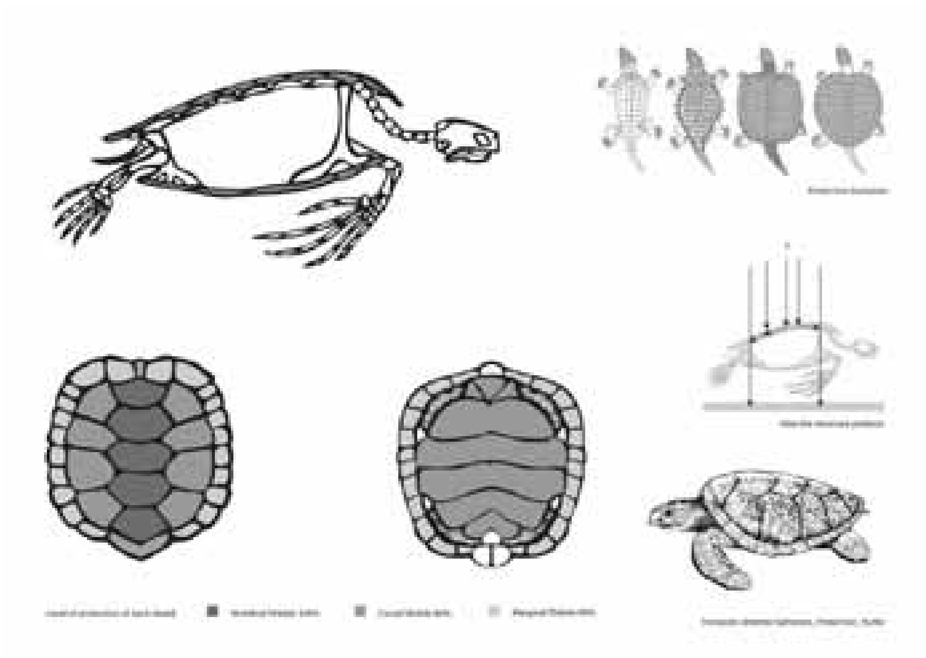
http://animal-world.com/encyclo/reptiles/turtles/OrnateWoodTurtle.php

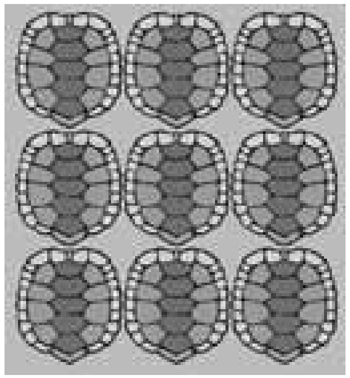
לדוגמה שריון של צב, אשר מתפתח עם הזמן ונהיה יותר קשיח ומתאים את עצמו להתפתחות גופו של הצב. השריון מורכב ממספר מרכיבים חשובים: צלעות הנעות לאורך גופו של השריון, פתחים לאיברי הצב וחלל פנימי המשרת את הצב ומתאים את עצמו עם הזמן להתפתחות גוף ושרירי הצב כך שתהיה הומוגניה בין שני הגופים

צורתו ותפקודו של שריון צבי יכולות להשתלך על חזית בניין וכך לשרת את אותו בניין לפי תכונותיו של השריון. החלק החיצוני יגן על אותו בניין והחלל הפנימי בתוך השריון יקבל את "החיים" של אותו בניין בכך שהוא יוכל לאגור אינרגיה א להכיל אלמנטים שיעזרו לבניין לתפקד. החרים בצדדים ישרתו את החיבור בין השריונים וכך אותו שריון יזכיר לנו חיפוי אבן או בנייה בלבנים או בלוקים



http://blogs.ngm.com/.a/6a00e00982269188330147e1ad86b8970b-800wi

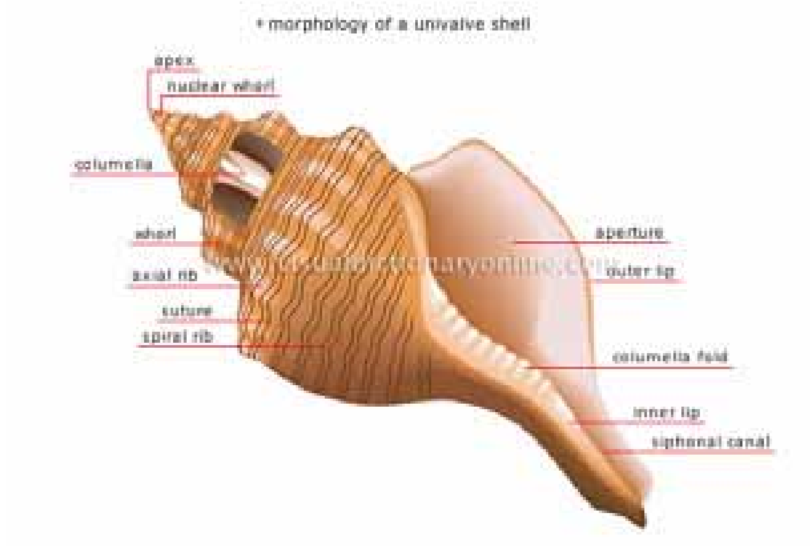




שיכפול היחידה וסידורה בדוגמאות בצד
שמאל מזכיר חיפוי קיר אך באמצעות
אלמנת קשיח מעולם החי. בחתך יש
ניסיון להשתמש בשלד של הצב עצמו
כדי לקשר בין כל "לבנה" ו"לבנה
כדי ליצור דופן

http://technologylanguage-protection.blogspot.com/2010/11/jimenez-salmeron-protection-turtle.html

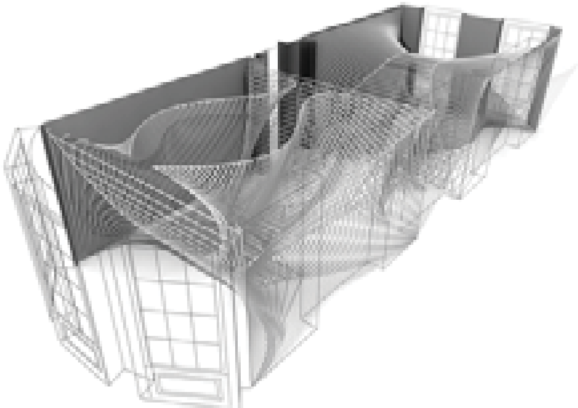
באותה שיטה אפשר לטפל בגופים יותר רכים, יכולים ליצור אלמנטים פנימיים בשימוש ממשי
באותה קונכייה או מעבר לחזית אם משתמשים בצורניות עצמה אך מקשיחים אותה



http://visualdictionaryonline.com

Buildable Elements By Nature

דוגמה לנקודת התייחסות זו היא רשת עכביש, אשר מבחינה חומרית מזכירה כבלים או חבלים. דוגמה זו יכולה לבוא לידי ביטוי בבנייה קלה או עיצוב צורות ומחיצות פנימיות.
בהפשטה אפשר לראות את היחס בין הבנוי לפנוי כאשר אפשר להתייחס לאותה צורה באופן הפוך ולקבל חומר "מלא" יותר

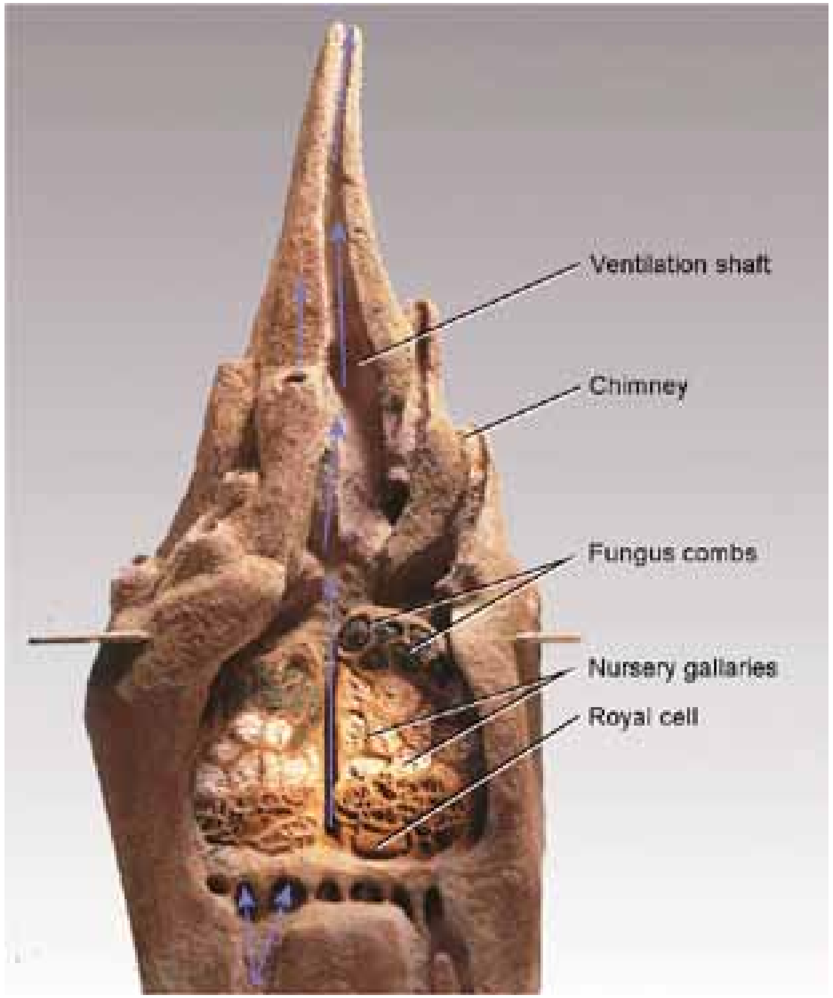


http://www.opensysdesign.com/2008/09/cable-structures.html

http://www.featurepics.com/online/Natural-Wood-Texture-Background-536039.aspx

Imitate Nature - Termit Mounds

מבנים מן הטבע.. מעשה יצורים חיים.. טכנולוגיה משרתת את אותו בעל חיים בכל מיני אופנים. דוגמה מובהקת לסוגייה זו היא מבני טרמיתים אשר יכולים להגיע לגבהים אדירים. מבנים אשר מתייחסים לשמש ויוצרים חלל פנימי למחייה ואחסון וגם מסלולים ונתיבי תנועה נוחים לאותו בעל חיים המתאכלס בתוכם. אפשר לראות בחתך האופייני את ההתייחסות הזו באופן די ברור



http://termite-guides.blogspot.com/2011/08/lots-termite-mounds.html

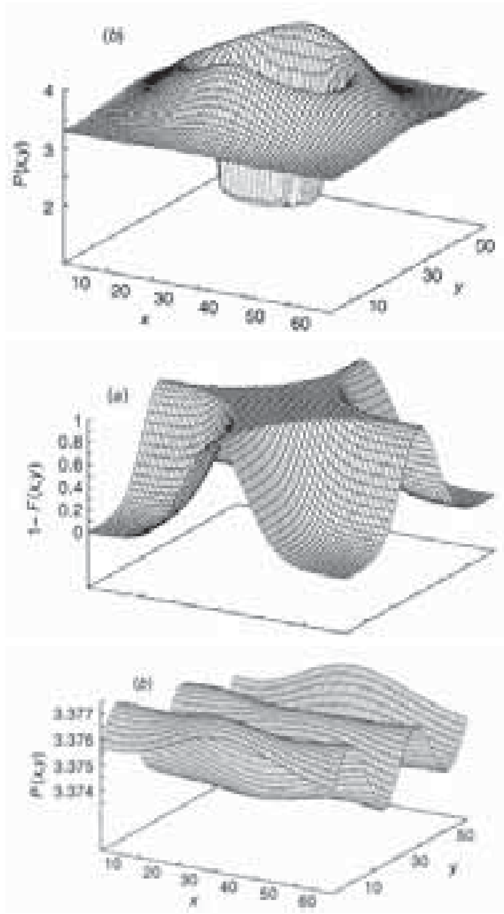
לפי התזה של אולגה לינארדו 2008 החוקרת את תלי התרמיטים, ההתייחסות למבנה כזה היא בדו מימדיות שלו. מבנה כזה בנוי כמעטפת העוטפת את מגוריהם של התרמיטים ומספקת תנאים אקלימיים נוחים והגנה מסכנות בטבע

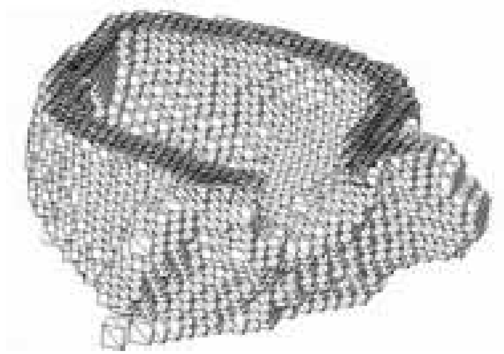
היא חילקה את המבנה הזה ל3 חלקים מרכזיים

א. שלד
ב. מלט
ג. שביל

היא מתייחסת לתרמיט כ"סוכן בונה" ולמבנה עצמו יש כמה עקרונות שלא משתנים בשינוי צורתו או מיקומו על פני כדור הארץ

א. אוורור טבעי
ב. קונסטרוקציה
ג. מבנה הומוסתטי- הנטייה של המערכת לשמור על יציבות לכל מצב גירוי





Towards Homeostatic Architecture: simulation of the generative process of a termite mound construction

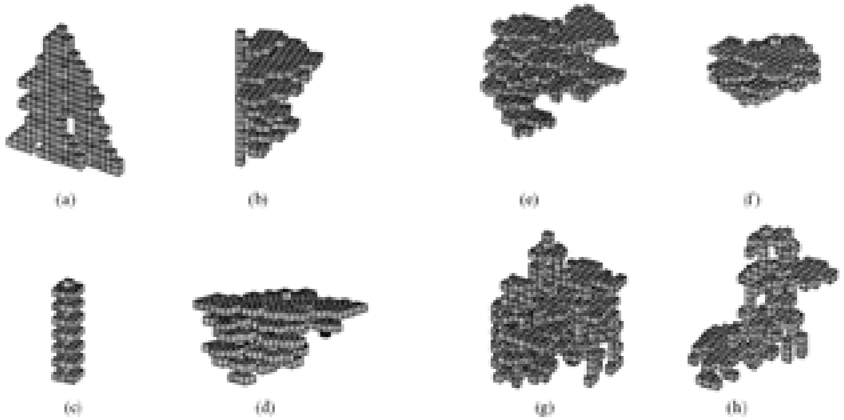
Olga Linardou

2008

Towards Homeostatic Architecture: simulation of the generative process of a termite mound construction

A thesis presented for the degree of
MSc in Adaptive Architecture & Computation

עוד מקרה מבחן שהתזה מתייחסת אליו הוא קני צרעות. אך לעומת תלי התרמיטים ההתייחסות למבנים כאלה היא בתלת מימדיות שלהם. ז"א אם ההתייחסות לתלי התרמיטים הייתה יותר כמעטפת דו מימדית, במקרה של קני הצרעות ההתייחסות היא לגושים הקונסטרוקטיביים התלת מימדיים שאותו סוכן בונה לעצמו



Towards Homeostatic Architecture:
simulation of the generative process of
a termite
mound construction

Olga Linardou

2008

Inanimate cellular structures

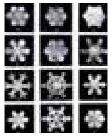
soap bubble

http://www.eikongraphia.com/?p=63

crystals

amethyst quartz

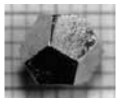
halite



ice

calcite

Pyrite



Ho-Mg-ZnQuasicrystal

Insulin

source of the above images: http://en.wikipedia.org/wiki/

minerals

Quartz Crystal
http://en.wikipedia.org/wiki/File:USDA_Mineral_Quartz_Crystal_93c3951.jpg

Closeup of Fluorite crystals

Different Minerals
http://en.wikipedia.org/wiki/File:Different_minerals.jpg

rocks

petoskey stone

http://www.petoskeystonefestival.com/geo.htm

uplifted gneiss

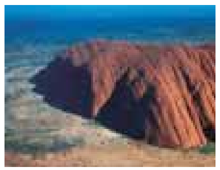
http://blogs.agu.org/georneys/2011/12/13/tuesday-geology-picture-a-gneiss-double-arch-bridge-in-valle-verzasca/

Waffle Rock
http://www.geulogy.com

Rapid cooling of molten lava
http://tucsoncitizen.com/lizard/category/geology/

Rock at Meteora, Greece

http://www.smashingapps.com/2010/12/19/50-stunning-masterpieces-of-geological-photography.html



Uluṟu – Kata Tjuṯa National Park

http://en.wikipedia.org/wiki/Uluru

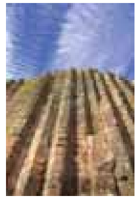
horizontal land surfaces

Pamukkale - Denizli Province - Turkey
http://gianf.deviantart.com/art/Cotton-Castle-66648901

Mud Cracks Tonoloway formation east coast of North America
http://notnecessarilygeology.wordpress.com/2010/05/28/mud-cracks/

Dried Mud Lava at Gobustan, Azerbaijan
http://farm1.staticflickr.com/44/140567290_2b941dcce3_o.jpg

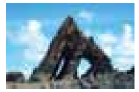
vertical surfaces



Giant's Causeway, Ireland.
http://dakq.deviantart.com/art/Ireland-011-Giant-s-Causeway-175271723

Bryce Canyon, national parks, Bryce, utah

http://www.astronomynotes.com/nature/images/bryce-thor4.jpg

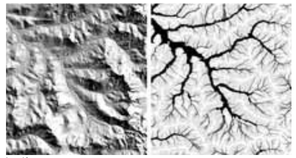


Blackchurch Rock at Mouth Mill near Clovelly
http://explorethecoast.org/pagegallery/Blackchurch

Folded rock formation near Moruya, New South Wales, Australia
http://upload.wikimedia.org/wikipedia/commons/0/0a/Folded_Rock.jpg

Landscapes

Planet



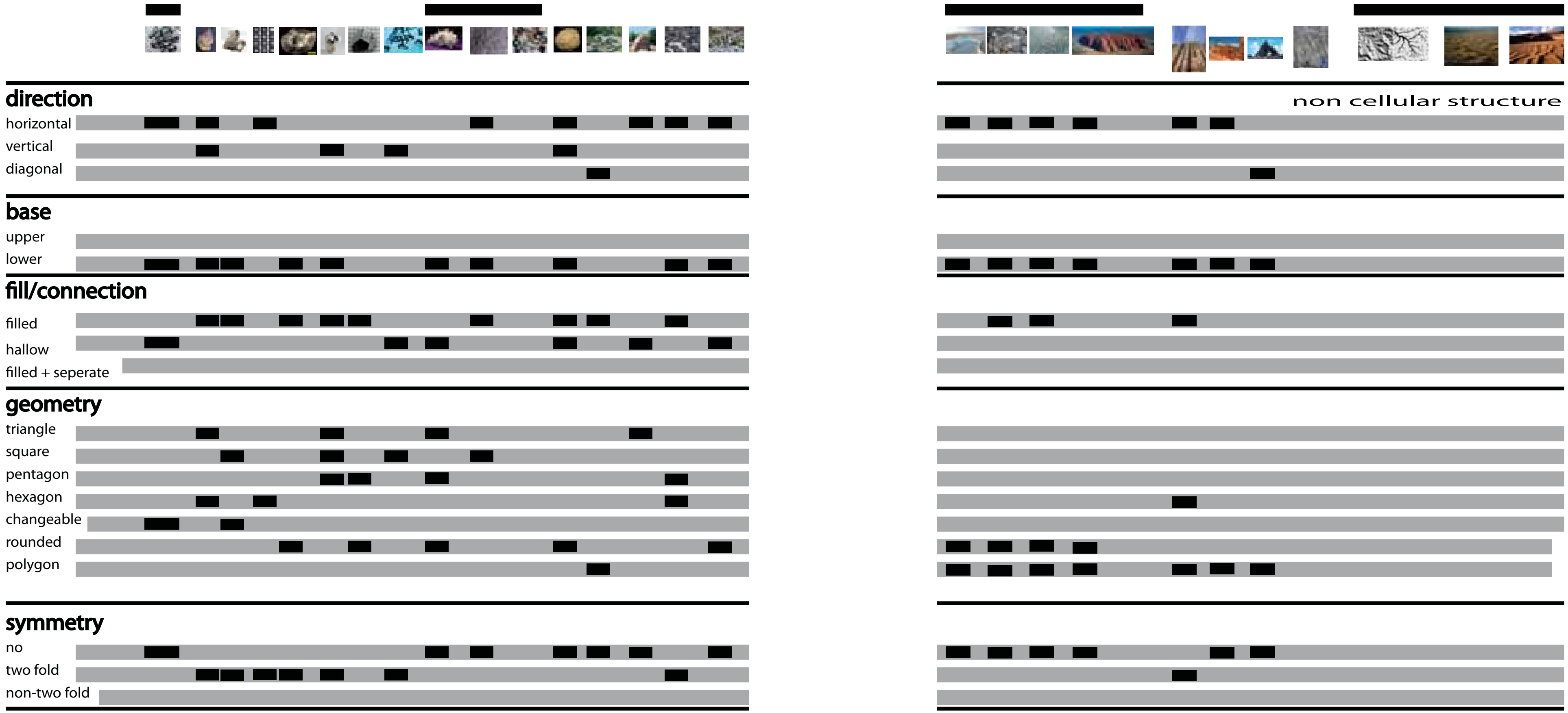
landform unit partitioning
https://www.soils.org/images/publications/jeq/39/1/16fig3.jpeg

Swakopmund Dune Fields, Namibia, 2000. Photograph by Cary Wolinsky
ngphotooftheday.blogspot.com

Great Sand Dunes National Monument Colorado
http://www.citypictures.net

scale oriented list.

Inanimate cellular structures



Characteristics map. in search of an underlying order.

Digital Wood Manufacturing

Timber and other natural organic materials were among the very earliest building materials and in its modern form timber continues to serve as a basic building material. Its properties greatly affect architectural design. Timber has a high strength to weight ratio. Its strength and stiffness are dependent on the direction of load in relation to the grain. It is strong and relatively stiff parallel to the grain. However, it is prone to cleavage along the grain if tension stresses are perpendicular to it. It has low shear strength and shear modulus. Higher moisture content reduces both the strength and elasticity, and a part of the original strength will anyway be lost over time. Under load, timber creeps and deforms. Serviceability therefore often governs structural analysis. Structural analysis, detail design and processes of technology take care of a number of the specific problems of timber structures, such as buckling, behaviour around notches, prevention of interstitial condensation, protection against moisture, insect and fungal attack, and fire.

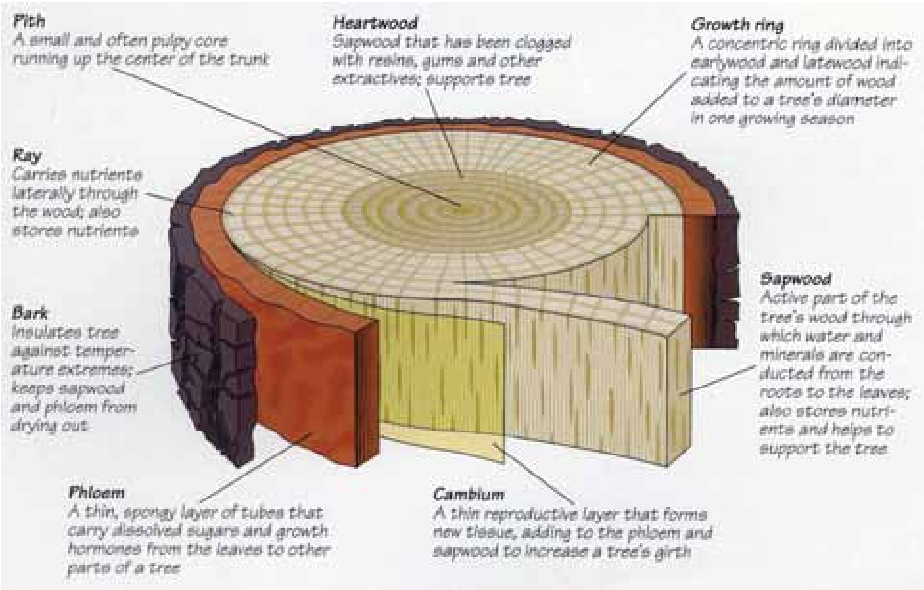
Technical progress in the use of timber has some major repercussions on architecture:
• selection of the type of timber
• transformation of the basic timber material into one with new properties
• new timber products, for example, stressed skin panels and various types of boards (plywood, fibreboard, particleboard, oriented stranded board, waferboard, flakeboard), tapered, curved or pitched cambered beams, glued thin-webbed beams, sandwich panels, portal frames and arches
• new types of organic adhesives, including those able to withstand outdoor exposure
• improvement of properties and performances (e.g. improving behaviour in fire)
• enhancement of the structural performance of softwoods for use in glued structures
• use of new fasteners, hangers, connectors
• new principles in structural analysis and design, including adequate consideration of the interaction between loads and material properties.

(Sebestyen and Pollington, 2003)

Wood structure

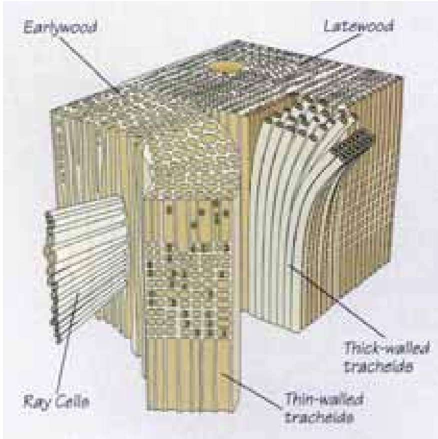
Trees are roughly divided into softwoods and hard woods.

The differences between soft wood and hard wood are readily apparent when viewed under a microscope's magnification. The cell structure of soft woods is much simpler than that of hardwoods.



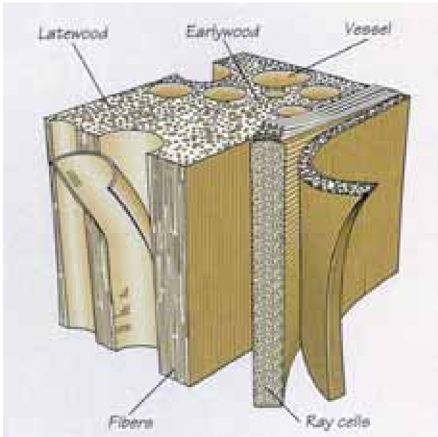
Wood structure (Arno, 1993)

Almost all softwood cells are long, thin tracheids, which support an unbroken column of sap that can tower more than 200 feet. The tracheids in latewood become thicker-walled than those in earlywood.



(Arno, 1993)

In hardwoods, the sap is conducted through vessels, a series of tubelike cells stacked one atop other. Support for the trunk is provided by fiber cells. In the ring-porous hardwood shown, vessels are more prominent in earlywood; fibers are the predominant cell type in latewood. (Arno, 1993)

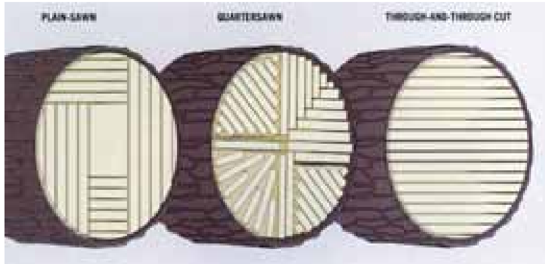


(Arno, 1993)

Lumber

Stages of preparing lumber are: selecting the trees in the woods according to their purpose, cutting trees with chainsaw and removing the branches, transporting the logs to sawmill, cutting the logs, usually with a bandsaw or a circular saw.
The position and direction of tree rings affects on differernt lumber properties in future.

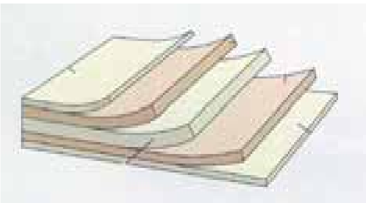
Sawill Bandsaw (Arno, 1993)



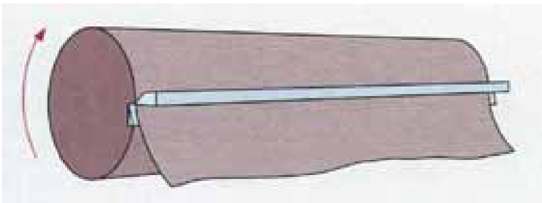
Three methods of sawing logs (Arno, 1993)

Plywood

Plywood is a flat panel made by bonding together, and under pressure, a number of thin layers of veneer, often referred to as plies (or laminates) (Porteous and Kermani, 2008).
It comes in a wide range of standart thiknesses and sizes. Plywood is dimensionally stable and is unlikely to warp. It is available with just about any commonly available veneer on it's faces. Plywood layers are created by rotary wood cutting.



Plywood (Arno, 1993)



Rotary cutting (Arno, 1993)

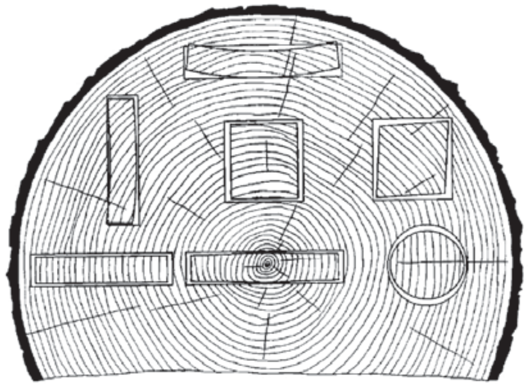
Wood moisture

Wood is a hygroscopic material: It absorbs and releases moisture depending on the humidity of the air around it. As wood soaks up moisture, it swells; when it expels moisture, the wood shrinks. (Arno, 1993)

These factors should be taken into consideration when planning wood structures. For example, the joinery methods should allow movement.

Wood holds moisture in two ways: as free water in cell cavities and as bound water in cell walls. As wood dries, free water is expelled first. When this is all discharged, the wood reaches what is termed its fiber saturation point (FSP). At this point, the cell cavities are empty, but the bound water remains, permeating the cell walls. For most woods, the FSP occurs between 23 percent and 30 percent moisture content. The point is that at the fiber saturation point, there is no dimensional change in wood from its freshly cut size. It simply weights less. (Arno, 1993)

Fresh wood has high moisture content. This log of Eastern hemlock contains almost 6 litres of water. Completely dry, the log would weight one-half as much as its green weight. (Arno, 1993)

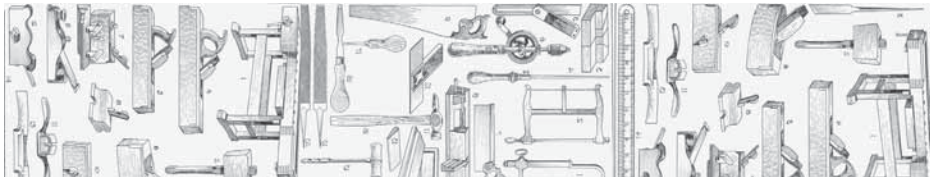


Characteristic shrinkage and distortion of flat, square, and round pieces as affected by direction of growth rings. Tangential shrinkage is about twice as great as radial. (Agriculture, 1999)

Wood processing

Wood processing tools can be divided into three cathegories:

Handheld tools, which provide immediate control of the tool's manipulation of the material. Such as saws, chisels, files, etc.



http://www.gutenberg.org

Conventional machines, in which instead of guiding a handheld tool, the user guides the material through the machine. This includeds different types of saws, drill presses, miling machines, routers, etc.

http://jawoodworking.com

Digital fabrication methods, where drawings are directly transferred to computer numerically controlled (CNC) tools and the user has almost no control of the tool at the moment it is manipulating the material.

CNC processes are substrative fabrication methods, when objects are created by removing material from a starting block, rod, or sheet through computer controlled movements.

CNC Milling is used to create forms from blocks of material. This fabrication process is most useful for creating small, singular architectural components.

Similar digital fabrication process is CNC Routing, which works in a similar fashion to milling except it is meant to cut large, flat sheet materials versus smaller, block materials.

CNC Milling. http://sjet.wordpress.com

CNC Waterjet machining is also used to cut large, flat sheets of material. An advantage the waterjet cutter has over the table router is the wide spectrum of materials it can cut. In addition to plywood and foam, it can cut metal, stone, glass, rubber, composite materials and more.

Laser cutters - typically cut thin, sheet materials such as wood, paper, plastics. (Seely, 2004)

Waterjet cutting. http://www.wordsun.com

Laser cut woodden cube.
http://mcnabbstudio.wordpress.com

Wood joinery

The most popular joining method is wood glue. The strength of the glue is higher than the wood itself, but usually it is not enough to attach two flat surfaces to each other since the demands in wood fabrication are higher than in nature. One of the possibilities is to enlarge the area of glued surfaces, to make the connection stronger. Hundreds of joint types were developed in order to provide maximal strength to the glued area and aestetic look also.

(Arno, 1994)

Box joint

The project “Better, Cheaper, Faster” asks the question, What if bottom-line development and good architecture were the same thing??

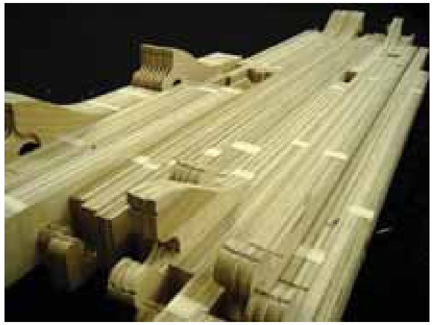
Its designers David Benjamin and Soo-in Yang believe that new computer-based fabrication techniques can offer a link between good architecture and the bottom line mentality of real estate developers.

They designed a lightweight, collapsible framing system of CNC-milled 1/4-inch Baltic birch plywood that could replace typical balloon framing and its formal limitations. The designers tested the system by building a 10-foot cube.

We wanted to use CNC technology for its efficiency rather than for form,, Benjamin explained, and in the process develop new ways for architects to engage the process of design and construction.

(http://archpaper.com/news/articles.asp?id=123)

Simple wood joints are used to produce a self supported structural system
Nik Werenfels. http://parametricwood2011.wordpress.com



http://archpaper.com

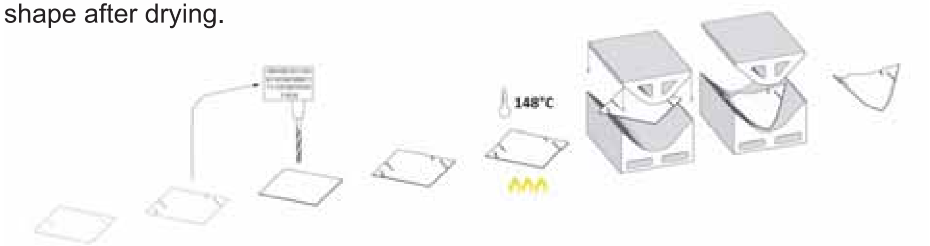
(Borden and Meredith, 2011)

Curved geometry

Curved geometry in wood can be achieved in different ways.
Thin sheets of wood can be easily bent in one direction, without any additional equipment. In order to create structural parts a few layers of wood are glued together after bending.

Bent wood laminations before glue up.
http://ocw.mit.edu/ans7870/4/4.296/s05/lecturenotes/gallery2/8.html

Moisturing and heat can be used to bend thiker wood parts. In the Dragon Skin Pavillion, steam is applied on CNC precut plywood parts, in order to create curved parts. Wood is pressed inside molding template and saves the shape after drying.



http://www.archdaily.com/215249/

As seen in “Better, Cheaper, Faster” project, it is not a must for the laminated layers to have the same shape, to start or end in the same place. That simplest thing it means, that one can create larger wood parts, that can be possible with solid wood.

Technion pool wood structure

Bonatti Bridge – Firenze. Length - 76m
http://www.habitatlegno.it/en/wood-accomplishments/bonatti-bridge/

In the same manner, it is not a must to glue the whole surface of the layers, it can be glued partially (Bae Sehwa bench).

And, in the end, the wood layers can not only follow the same surface, different layers can be glued in different combinations, to create complex forms (Aleksandra Jaeschke - Continuous Laminae)

Bae Sehwa bench
http://www.seomituus.com

Aleksandra Jaeschke - Continuous Laminae
http://www.achimmenges.net

Milling wood

Classical way to create complexed geometry is substracting material from a solid wood block. Before contemporary digital technologies woodcarving/sculpting was done mainly by handheld tools and required a high professionalism and a lot of time.
Today, CNC Milling allows to produce complex curved forms from solid wood. The result can be very precise and done in relatively short times.

The Norwegian Wild Reindeer Centre Pavilion, the building of the year 2011.
http://www.archdaily.com/180932

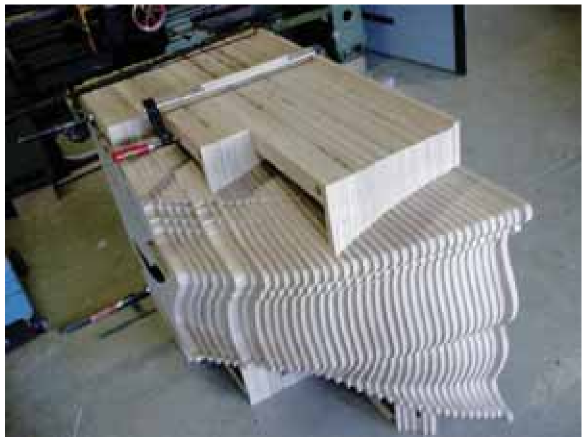
Next project combines art and technology in order to create ambient topographic surface. This table also was created by CNC milling of glued plywood layers. The top and the stand topography uses the same inversed pattern, which allows them to fit each other presisely.

http://dornob.com/

Curved surfaces can be acheived not anly by complex 4 or 5-axis CNC routers, but also with simpler machines that can cut only flat sheets of material. First, the shape is created in CAD modeling software, next, the object is slised into layers, according to the used material's thickness. The layers are converted to flat drawing and transferred to CNC router. Each layer is cut separately and after that all the layers are glued together and form the modeled shape. Last step to achieve smooth surface should be mentioned - sanding the product in order to blur the transition areas between layers. In complex cases this step can be performed using hand power tools, or even hand sanding only.
Similar technique was used to create the Cinderella Table by dutch designer Jeroen Verhoeven:

http://cunicode.com/cinderella-table-by-demakersvan

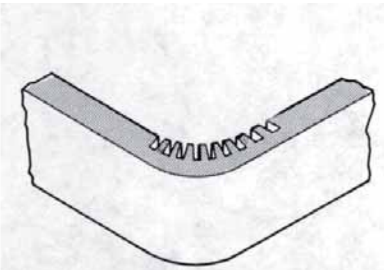
http://www.flickr.com



http://www.behindthescene.org

Wood kerfing

Kerfing is in simple terms the act of cutting a series of kerfs (cuts) in a piece of wood in close proximity, so the wood can be curved. It is important not to make the cuts too deep, resulting in the wood cracking completely through, or not deep enough so instead of bending, it snaps (and therefore weakens the wood). The wood needs to be cut to the point that the remaining fibres are free to bend. You can only kerf by crosscutting- you cannot kerf with the grain as the likelyhood of the workpiece splitting is huge. This doesn't have to be solid stock either – you can kerf whole sheets and bend entire panels. (http://stusshed.com)

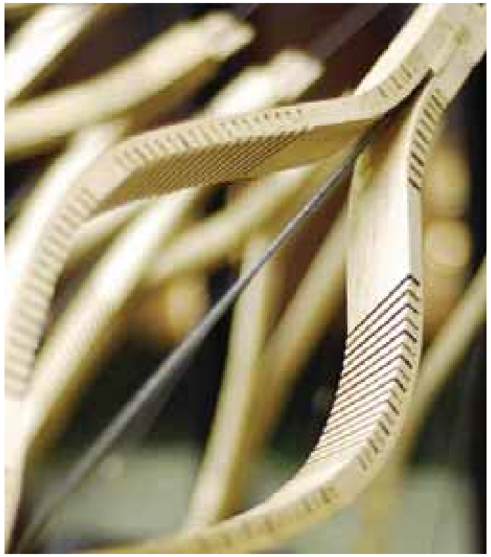


http://www.shopsmith.com

http://stusshed.com

Guitar body
http://gicl.cs.drexel.edu

In 2010, Achim Menges' students develop digital manufacturing techniques in order to create kerf-based complex wood systems.



http://www.achimmenges.net

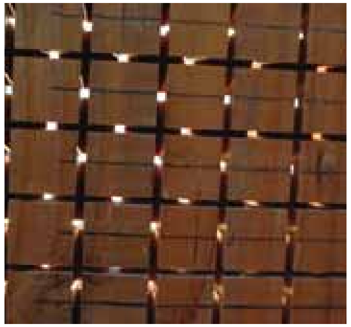
In 2007 *designtoproduction* developed a method that makes it possible to fabricate single curved panels from any plain material without molds or jigs. The Zip Shape system uses two individually slotted panels that interlock when bent to the predefined curvature. (http://www.designtoproduction.ch)
The parts are cut by an computer controlled circular saw in a way, that allows only pre-planned connection and curvature.

http://parametricwood2011.wordpress.com

http://www.designtoproduction.ch

The parametric wood seminar takes the technique of kerfing to a higher level by trying to make two-directional cuts on both sides of wood panel in what makes possible to bend the panel in any direction.

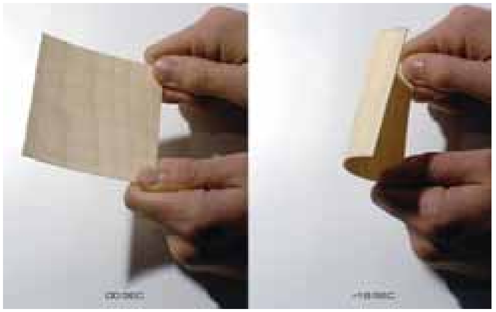
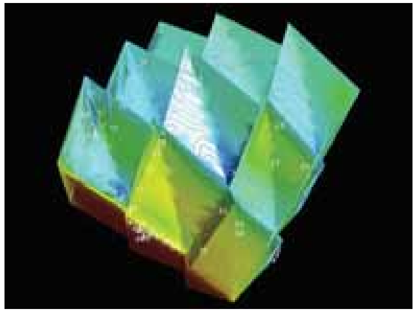
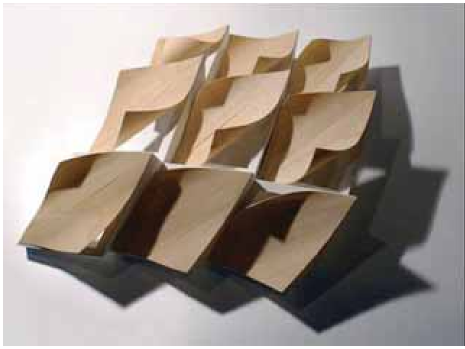
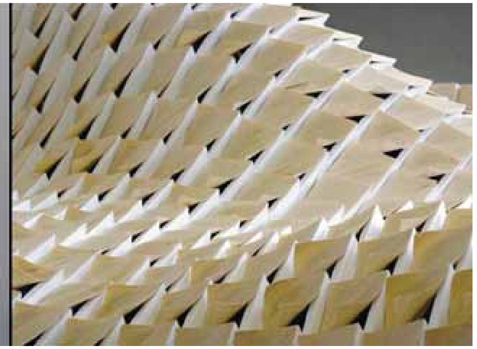





http://parametricwood2011.wordpress.com

Responsive Veneer Surface Structure

The main focus of this project is utilizing the hygroscopic characteristics of wood in the development of a surface structure capable of adapting its porosity to changing humidity levels. Rather than employing complicated electro-mechanical control devices, the project aims at employing the shape change of simple veneer elements triggered by changing bound-water content. The gaps opening up between the deformed veneer elements and the substructure locally regulate the structure's degree of porosity. At any stage in the design process, the complex reciprocal modulation of environmental conditions triggering changes in thermodynamic behavior and at the same time affecting the material response to changes in relative humidity needs to be considered. (Menges, 2009)

http://parametricwood2011.wordpress.com

Medium Density Fibreboard - MDF

MDF is a type of hardboard, which is made from wood fibres glued under heat and pressure.

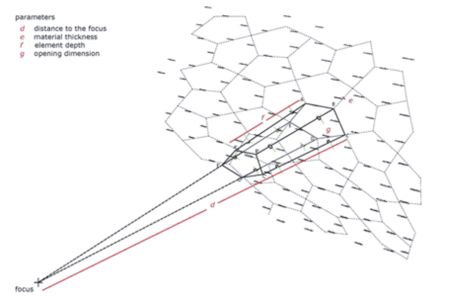
There are a number of reasons why MDF may be used instead of plywood or chipboard. It is dense, flat, stiff, has no knots and is easily machined. Because it is made up of fine particles it does not have an easily recognisable surface grain. MDF can be painted to produce a smooth quality surface. Because MDF has no grain it can be cut, drilled, machined and filed without damaging the surface. MDF may be dowelled together and traditional woodwork joints may even be cut. MDF may be glued together with PVA wood glue. Oil, water-based paints and varnishes may be used on MDF. Veneers and laminates may also be used to finish MDF

MDF can be dangerous to use if the correct safety precautions are not taken. MDF contains a substance called urea formaldehyde, which may be released from the material through cutting and sanding. Urea formaldehyde may cause irritation to the eyes and lungs. Proper ventilation is required when using it and facemasks are needed when sanding or cutting MDF with machinery. The dust produced when machining MDF is very dangerous. Masks and goggles should always be worn at all times. Due to the fact that MDF contains a great deal of glue the cutting edges of your tools will blunt very quickly. MDF can be fixed together with screws and nails but the material may split if care is not taken.
If you are screwing, the screws should not be any further than 25mm in from the edge. When using screws always use pilot holes. Urea formaldehyde is always being slowly released from the surface of MDF. When painting it is good idea to coat the whole of the product in order to seal in the urea formaldehyde. Wax and oil finishes may be used as finishes but they are less effective at sealing in the urea formaldehyde
MDF may be used to make display cabinets, wall-panels and storage units.

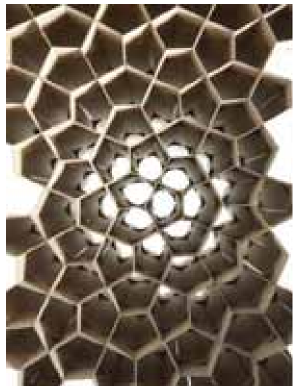
(http://www.design-technology.org)

3D2REAL: MDF Honeycomb Structure
ILEK – Institute for Lightweight Structures and Conceptual Design, University of Stuttgart

This is a project by ILEK students, where they have created an exhibition stand out of and irregular honeycomb structure that will exhibit objects. The screens are made up of 3mm and 10mm MDF, that has been CNC-cut into 2,142 pieces joined by 1,376 unique pairs of connecting components.



The system serves as a filter between observer and object. The planar elements of the honeycomb-like structure are oriented at specific angles so that only a portion of the area behind the wall is revealed to the viewer. From the outside, only objects that lie within these defined focal points can be seen. Each of the items on display receives its own focal point, according to its size and location. Inside the wall the opposite effect is achieved – the view to the outside from the focal points is completely unobstructed, allowing a panoramic perspective as the honeycomb elements are aligned perpendicular to the observer’s eye.



All of the above - http://www.core.form-ula.com

Flexible Plywood

This flexible plywood panel is commonly called ‘bendy plywood’ or ‘flexiply’, and is used extensively in furniture and shopfitting, wherever curves are desirable, thus demanding a panel that is extremely flexible. Plywood with this flexible characteristic is manufactured from specially treated veneers, usually with a thinner central core veneer and two thicker ‘tenderized’ outer veneers. The special construction of particular species of veneers gives an unusually large degree of flexibility and offers a most cost-effective way of producing rounded columns and other curved structures of very small radius in rounded or S-shaped structures without water or the need for heat-forming.

http://parametricwood2011.wordpress.com

Bendy plywood is more convenient and much lower in cost than premade wooden forms, as this flexible plywood will hold its shape once it is glued, laminated or veneered. This ability offers significant time savings, as curves & circular designs can be produced using flexible plywood without the need for a structural skeleton or special support.

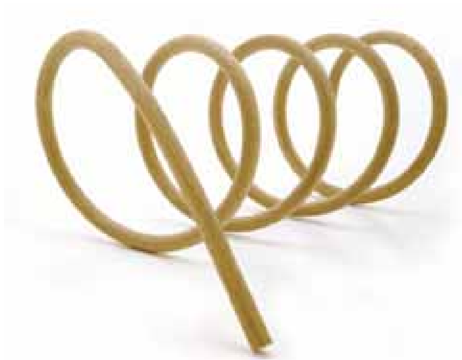
Available in both long grain (‘column wrap’) and cross grain (‘barrel wrap’) orientation, a wide range of finished thicknesses can be created by bonding more than one sheet of bendy plywood together. As it does not require any special equipment or prior experience, the use of flexible plywood in any curved project helps reduces the cost in labour and material to a minimum. (http://www.winwood-products.com)

Wooden fiberboard panel

Is a panel consisting of fast-growing trees such as aspen poplar, southern yellow pine, mixed hardwoods, and other suitable species. Wood is processed into strends, which can be bound with different matherials, such as portland cement or gypsum. Such panels can be used for breathable coverings, thermal insulation, support for gypsum board slabs and other coverings.

BendyWood

Bendywood is wood that has been pre-compressed so that it can be easily bent by hand. The tension that forms on the outside of a bend merely returns the plant cells to their former shape, and the wood doesn’t break. The material is delightfully flexible and pliable. Bendywood was developed for indoor uses such as furniture, handrails, or curved mouldings, and it shows enormous promise. Materials like Bendywood amplify the appealing properties of familiar materials so that it’s even easier to use them to our benefit. (http://www.architerials.com)



http://www.architerials.com

http://transmaterial.net

Additional projects

Aggregated Lamination
Performative Wood Studio (Achim Menges)
Yarinda Bunnag, Aaron Goldstein, Marcin Mejsak, Paul Merrill
Harvard University Graduate School of Design, 2010

One of wood's defining characteristics is its anisotropy resulting from its fibrous structure. Many manufacturing methods and engineering processes in wood lamination have tried to overcome this inherent natural quality, attempting to create a more homogeneous, isotropic composite. This research projects aims at investigating whether there can exist an in-between state of operation that takes advantage of both anisotropic natural qualities as well as isotropic lamination techniques, where a hierarchical organization of localized, heterogenous laminated constructs coupled with the global arrangement precalculated assembly system can create an engineered three-dimensional matrix of lamination whose reaction is as predictable as a manufactured composite but whose performance is as particular as that of natural wood.

By introducing specific weaknesses into a 2-ply maple laminate, one is able to control its deformation when force is applied. When two different laminates with specific weaknesses are bonded together through clamp molding, a "notch" with precise local geometry is created. This resultant notch has specific angular directionality that is related to its two 2-ply maple laminate components. Therefore, the global geometry is informed by the accumulation of local angles.


http://www.achimmenges.net

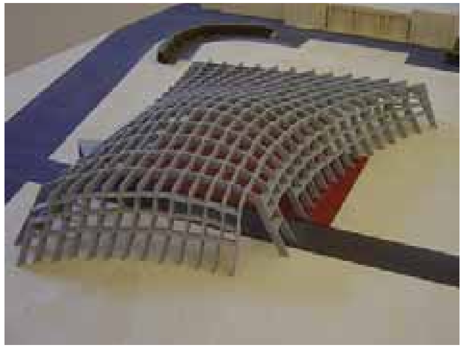
The final prototype takes advantage of the grain direction, which runs parallel to gravitational forces, along with an even distribution of notches. Arranging the notches along curved paths prevents global buckling by distributing the weaknesses. The related fabrication process utilizes both the vacuum and clamp molding. The molds are constructed so that variation between the notches is minimized. This precision allowed to accurately predict the resultant angles and to properly size and locate each plate.

The developed system incorporates a number of morphological features that allow for assembly and stiffness: [i] The channel that runs along the flat area of each laminate stiffens this section so that the geometric control of each unit occurs only in the notch. [ii] The "feet," the section of each unit that meets the ground, is molded with additional curvature to increase the stiffness of this area. In addition, varying the depth and length of the feet adds structural depth to this area. [iii] The plates made from 1/8" plywood prevents local sheering, distributes the compressive forces along the edge of each notch, and locks each notch into its intended location. [iv] The threaded rod runs through seven laminated units and allows pre-stressing the entire structure.
(http://www.achimmenges.net)


http://www.achimmenges.net

Serpentine Pavillion
Alvaro Siza, 2005

The pavilion was designed in Portugal, engineered in England, and fabricated in Germany using Finnish technology, fusing diverse elements of European design into one project. The innovative multi-use temporary design is an inspiring example of architecture that rivals the Serpentine Gallery's art exhibitions.

http://alvarosizavieira.com

The roof of the pavilion undulates in a slight irregular curve that resembled an armadillo reaching up to meet the surrounding trees while standing on sturdy legs. Closer inspection reveals that the panels and timber legs are all different sizes — this is what creates the fluid shape. Polycarbonate is a semi-opaque material that glows when sunlight hits it and casts tree shadows during the day. Solar panels in the center of each roof panel soak up power, which is used to illuminate the pavilion at dusk.

http://alvarosizavieira.com

During the day, the open structure served as a comfortable café that offered light fare and coffee to visitors to the gallery and to Hyde Park. The open plan of the timber "legs" allowed for natural ventilation through cross breezes that circulated the interior. The interior tables were designed by Siza. Visitors seated at the tables could see clear across the park through the timber legs. Affixed with traditional woodworking mortise and tenon joints, the pavilion was kept secure with heavy bolts. The timber and metal frame was filled out with panes of polycarbonate, which create a scale-like exterior. Jutting up in slightly asymmetrical patterns, the panels formed a shell-like structure.


http://tumblr.com

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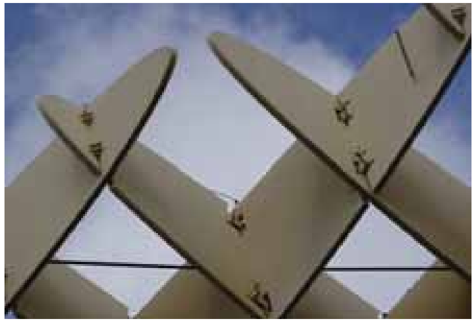
Metropol Parasol

The award-winning design for Metropol Parasol was developed by architect Jürgen Mayer H and Arup.

The project consists of six large timber parasols shading the Plaza de Encarnacion in the centre of Seville and protecting an archaeological site. The timber mega-structure is around 150m long, 75m wide and 28m high.

http://www.jmayerh.de

http://www.jmayerh.de

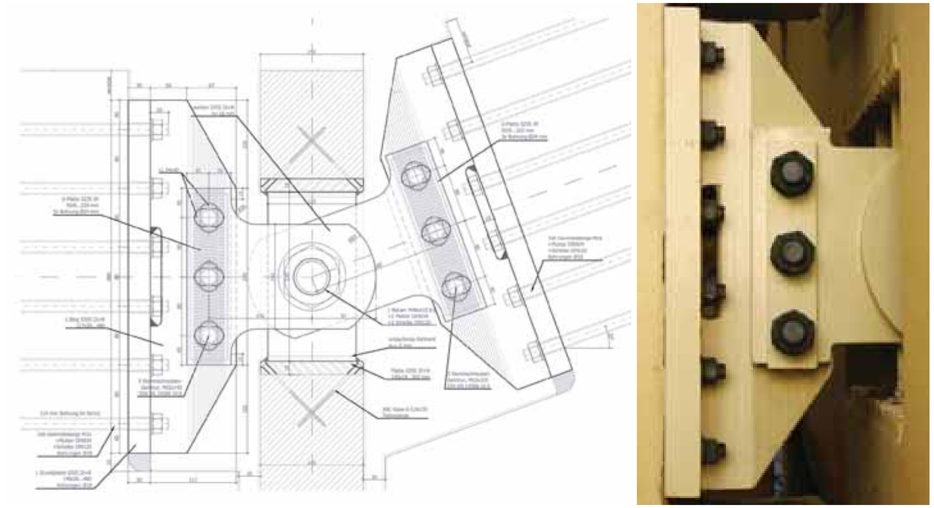


http://sofiarodrigues.com

Crucial for the behaviour of the Metropol Parasol are the 3000 connection nodes at the intersections of the timber elements.

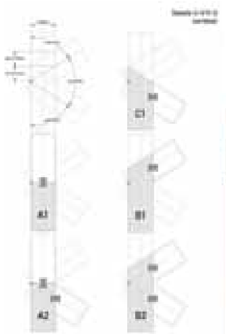
Engineers at Arup and FFM developed an innovative connection detail based on glued-in steel bars, which at the same time are optimized for rapid erection on site.

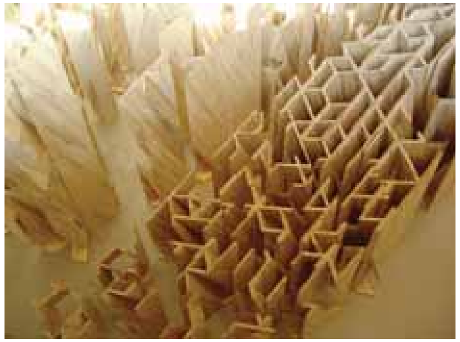
A thermal analysis revealed that the hot climate of southern Spain would be a particular challenge for the connection detail, engineers had to develop a new bonding process, specifically for use in this climate. Any detail adjustments and pre-assembly of the connection elements were carried out in Germany before the 3000 elements were sent by truck to southern Spain. (http://www.arup.com)



http://europaconcorsi.com

Libeskind's Futuropolis
St. Gallen, 2005



http://www.designtoproduction.ch

Echinoids
Marc Fornes & THEVERYMANY

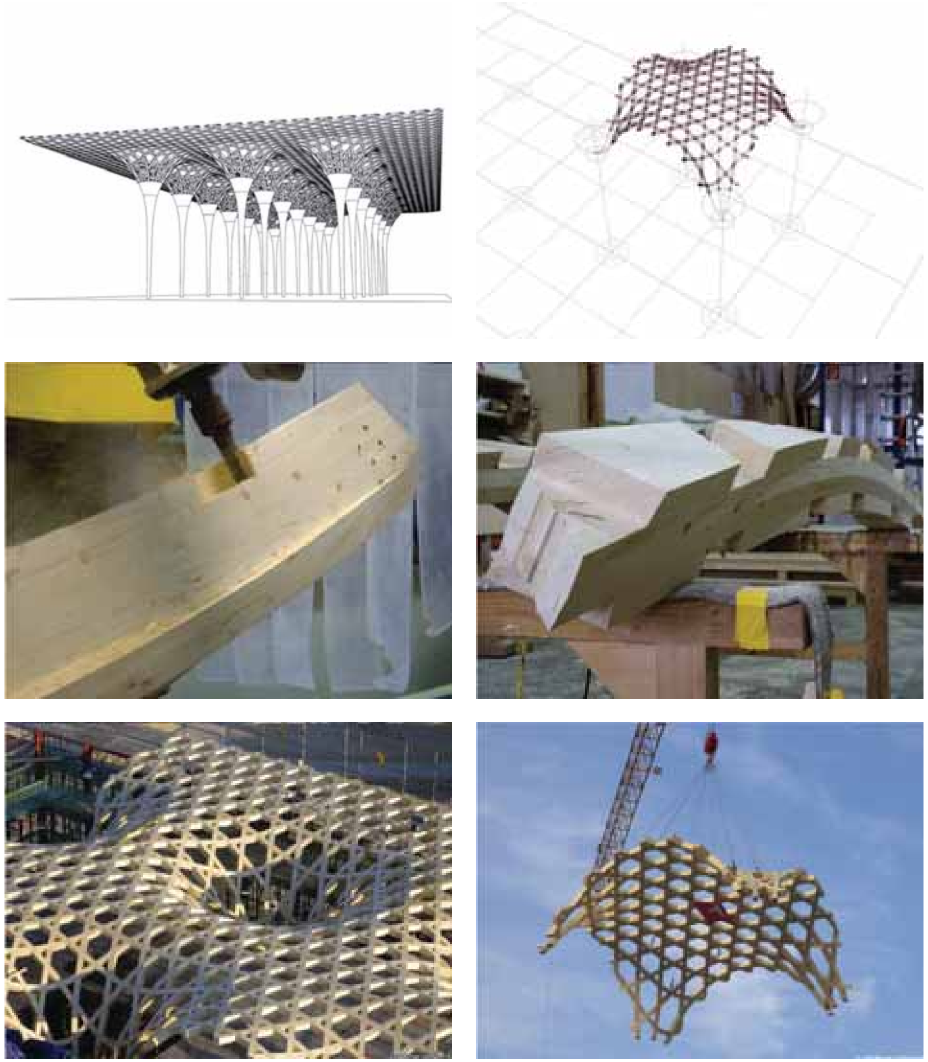


http://theverymany.com

Centre Pompidou Metz by Shigeru Ban
Metz, 2008

http://www.designtoproduction.ch

Haesley Nine Bridges Golf Club House by Shigeru Ban
Yeoju (South Korea), 2008



http://www.designtoproduction.ch

Wood facts

-There are 82% more hardwoods today than 40 years ago.

-Hardwoods come back naturally. Harvesting large, mature trees in a hardwood forest lets enough sunlight reach the forest floor to stimulate new growth.

-Our forest and our trees are renewable natural resources. Wood products come from a resource that grows, matures and is being replanted for future generations.

-Every year, six additional trees are planted for every one that is harvested.

-While trees are renewable, each ton of iron ore, coal and limestone are gone forever.

-Scientists have discovered than when forests become old and overcrowded, trees begin to use more oxygen than they produce. Young, well-managed forest tend to be the most efficient at absorbing carbon dioxide and producing oxygen.

-Wood is recyclable, biodegradable and durable—sometimes lasting for centuries. When it is no longer needed, it can be returned to the earth.

-Trees regenerate naturally through seeding or root sprouting, or are replanted by people.

-`Most softwoods do not sprout from the root so they are most often replanted after harvest.

-More than 80% of the trees planted in 1991 were planted by forest products companies and private timberland owners. The rest were planted by federal and state agencies and individuals.

-Trees, like human beings, have a natural lifespan. Once they reach maturity, which varies depending on the species, growth slows down, decay sets in and they eventually die.

(http://www.bwphdws.com)

-The blackest wood in the world is Ebony {Diospyros crassiflora}.

-The whitest wood in the world is Holly {Ilex opaca}.

-The world's longest solid wood/lumber board {no lamination}, is a piece of Ancient Kauri {Agathis australis}. It is approximately 40 foot in length and has an estimated worth of $100,000.00.

-White Oak {Quercus alba} is the species of wood that is easiest to steam bend. With thin stock {1/8 inch or thinner} you can bend it, into an extremely small {tight} radius.

-The lightest wood in the world or on earth is Southeast Asain Indian Sola Wood {Aeschynomene aspera} Its average weight/density/specific gravity is 0.044

-The heaviest wood in the world or on earth is Australian Bauhinia Red {Lysiphyllum carronii}. Its average weight/density/specific gravity is 1.372

-Bamboo although often tree like, is actually not a species of tree, it is a species of grass.

-The world's largest forest is in northern Russia. It is located between 55 degrees North Latitude and the Arctic Circle {Siberia}. It is a coniferous forest. It covers a total area of 2.7 billion acres.

-One acre of full-grown medium sized trees removes approximately 6 tons of pollution from the air each year.

-The only species of wood that can be used for holding liquids {other than acids} is White Oak {Quercus alba}. This is because the pores are filled with tyloses. This substance does not allow liquids to penetrate it. It is used to make barrels for Whiskey, Sherry and in general for ageing fine wines.

-To build a 2000 square foot house takes approximately 16,000 board foot of lumber.

(http://www.morlanwoodgifts.com)

"Digital working methods, such as CNC machines and associative parametric modeling, have entered the shop floor, but they are not a wholesale replacement for what came before them. Digital fabrication and traditional techniques are compatible and complementary. Even more, they are interrelated and enable us to build a new hybrid toolset.

Knowing the right tool for the job is one hallmark of a skilled craftsman. On the workbench today, we find computer-controlled tools, conventional power tools, and we will always, I believe, find many hand tools. Similarly, with the advent of associative parametric modeling, we have to choose between an advanced computational approach, a drawing-based computer-aided design approach, or hand drawing - moreover, we need to know how to smoothly move between them or combine them as need arises. Work from both *Illumination No.1* and the *Unibodies* series show the fluid interplay of the digital and the manual in custom fabrication.

Having taken hold in the early 1950s, computer-controlled milling machines are by now a very mature technology. They may be relatively new to the architectural design practice, but they are well established broadly in manufacturing. While the technology itself is unlikely to change quickly, how it is applied in bringing buildings to market is still rapidly evolving. The maturity of the CNC technology suggests that we are ready to move beyond examining the means of production, the machines and techniques themselves, to unlock changes in how we conceive of and realize our designs.

Likewise, associative parametric modeling is well rooted in some manufacturing and engineering disciplines, but it has been largely dormant in architectural design. As the computer-aided drafting paradigm is exhausted, software such as *GenerativeComponents* comes to the forefront because of the tremendous creative and practical advantage it offers. To take full advantage of the new software tools requires using computer models as the communication medium. This has ramifications for the legal responsibility of the correctness of the data, such as discussed in the *Folded Water* project, and for the skill set required to work in the design and fabrication disciplines. As a result, the culture of use in these fields is still growing as we exploe the questions surrounding how digital fabrication methods are developed, taught, and applied."

(Kolarevic and Klinger, 2008)

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http://parametricwood2011.wordpress.com
http://www.designtoproduction.ch
http://www.achimmenges.net
http://www.core.form-ula.com
http://transmaterial.net

Metals - Conventional Vs Digital Methods

(http://texturadesign.com)

(http://www.cakitches.com)

(http://www.laserfest.org)

(http://gizmodo.com/389773)

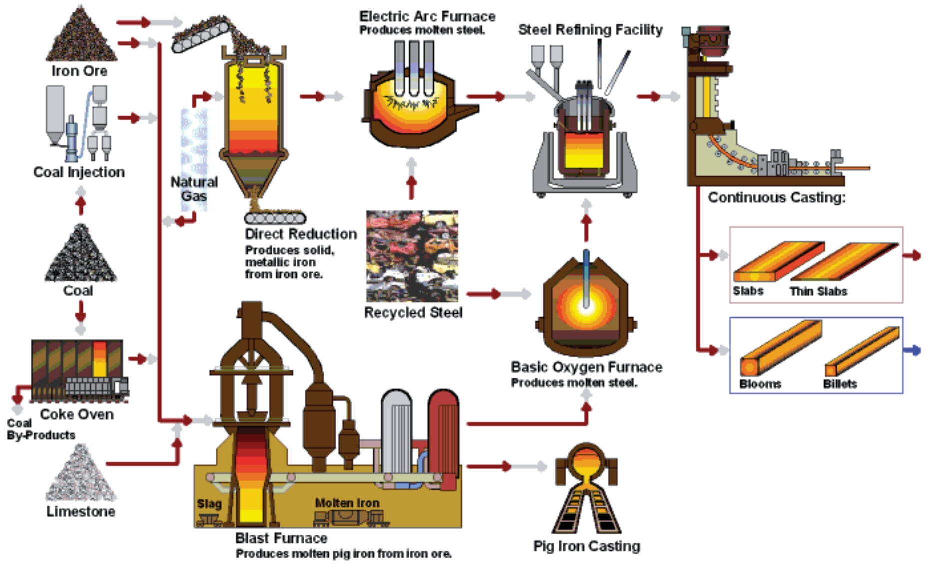
(http://texturadesign.com)

(http://www.hec-showman.co.uk)

Metals History

Process Metallurgy is one of the oldest applied sciences. Its history can be traced back to 6000 BC. Currently there are 86 known metals. From the discovery of the first metals - gold and copper until the end of the 17th century, some 7700 years, only 12 metals were known. The other seven metals, known as the Metals of Antiquity, were the metals upon which civilisation was based. These seven metals were:

(1) Gold (ca) 6000BC
(2) Copper,(ca) 4200BC
(3) Silver,(ca) 4000BC
(4) Lead, (ca) 3500BC
(5) Tin, (ca) 1750BC
(6) Iron,smelted, (ca) 1500BC
(7) Mercury, (ca) 750BC



Metals manufacturing process (http://raunaqsteels.com/iron&steel.html)

Continuous casting
(http://scheererbearing.com)

Melting and pouring the liquid material
(http://www.thefabricator.com)

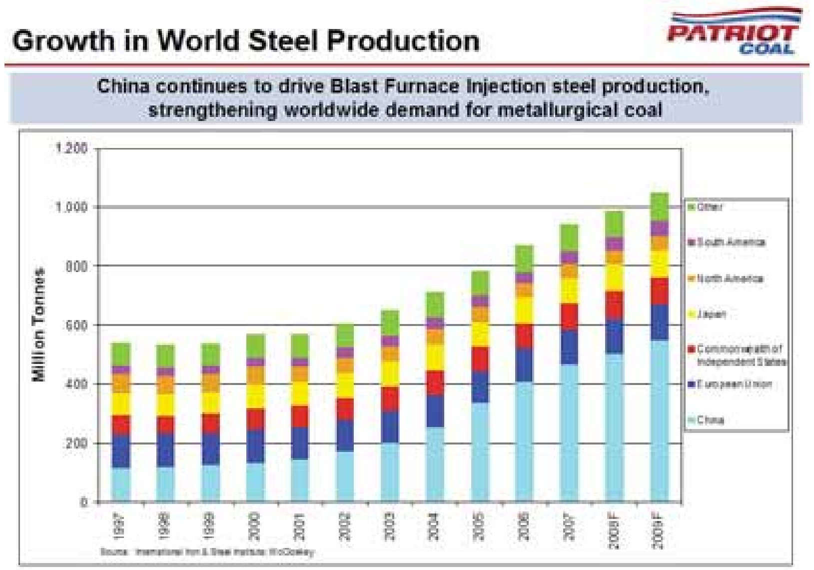
Liquid Steel - The basic material after melting process (http://footage.shutterstock.com)

Metals History

China is the world’s largest steel producer. In 2009, China’s steel industry produced 567 million metric tons of crude steel, which represented 46.3% of the world’s total output.

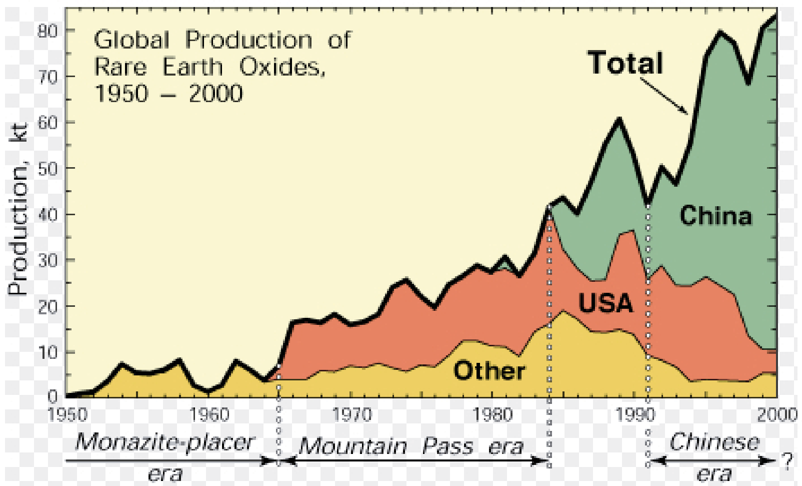
China produces 95% of the world’s rare earth metals, which are critical in the manufacture of many high-tech products ranging from smartphones to smart bombs.

China is also the world’s leading producer of aluminum, antimony, barite, coal, flourspar, graphite, iron and steel, lead, tin, tungsten, and zinc.



China as the leader of worlds steel manufacturer and consumer (http://www.china-mike.com)

Engine parts in different shapes and sizes manufactured fmainly from metals.
Casting in a sand core form. (http://www.tradekorea.com)

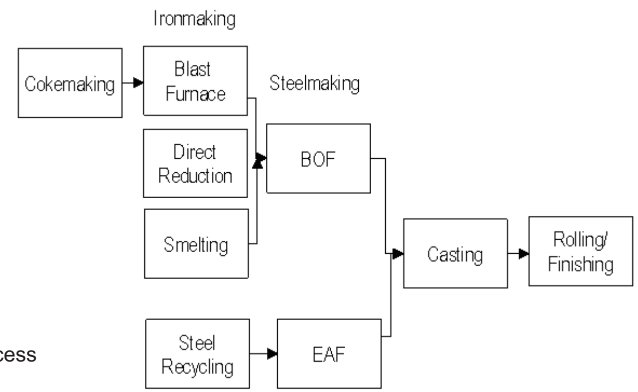


Iron

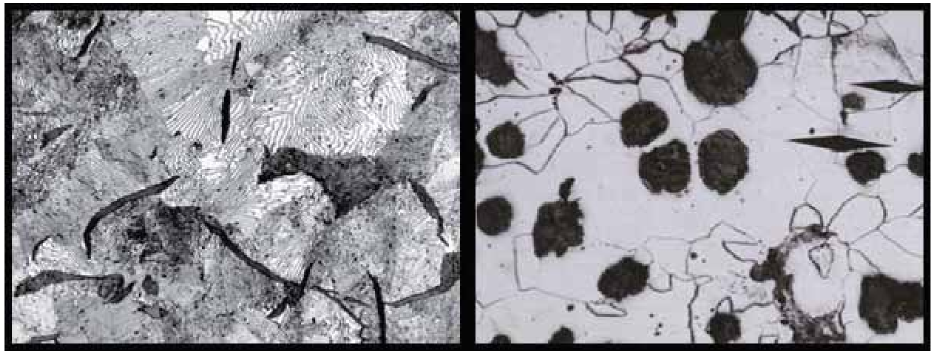
Iron is a chemical element with the symbol Fe (from Latin: ferrum) and atomic number 26. It is a metal in the first transition series. It is the most common element in the whole planet Earth, forming much of Earth's outer and inner core, and it is the fourth most common element in the Earth's crust. It is produced in abundance as a result of fusion in high-mass stars

Iron metal has been used since ancient times, though lower-melting copper alloys were used first in history. Pure iron is soft (softer than aluminum), but is unobtainable by smelting. The material is significantly hardened and strengthened by impurities from the smelting process, such as carbon. A certain proportion of carbon (between 0.2% and 2.1%) produces steel, which may be up to 1000 times harder than pure iron. Crude iron metal is produced in blast furnaces, where ore is reduced by coke to cast iron. Further refinement with oxygen reduces the carbon content to make steel. Steels and low carbon iron alloys with other metals (alloy steels) are by far the most common metals in industrial use, due to their great range of desirable properties.

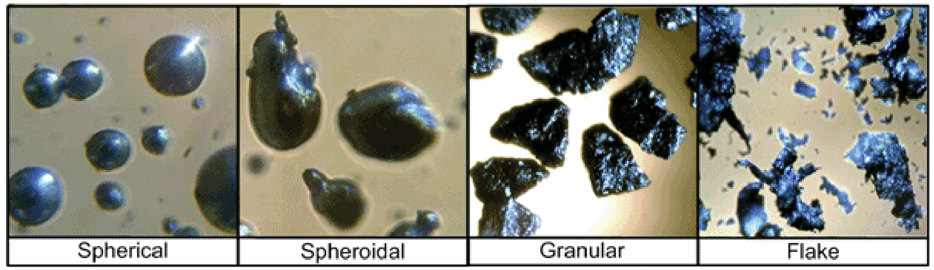
Iron chemical compounds, which include ferrous and ferric compounds, have many uses. Iron oxide mixed with aluminum powder can be ignited to create a thermite reaction, used in welding and purifying ores. It forms binary compounds with the halogens and the chalcogens. Among its organ metallic compounds, ferrocene was the first sandwich compound discovered.
(http://raunaqsteels.com/iron&steel.html)



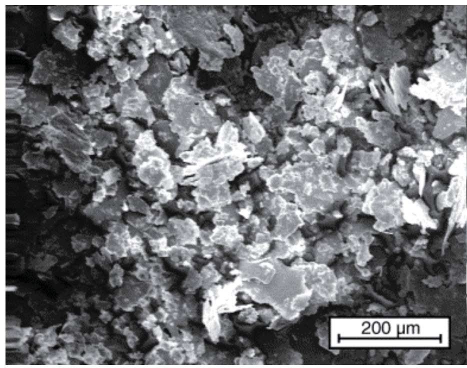
Basic Iron manufacturing process
(http://www.wtec.org)



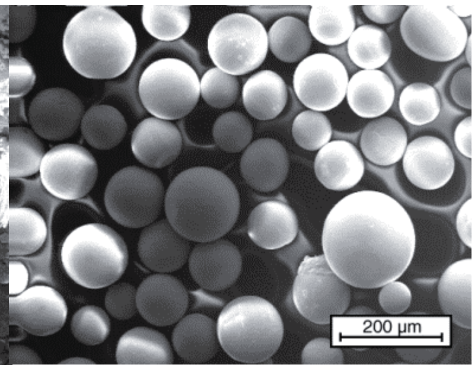
Microscopic structure of typical cast iron (left) stronger sphereical structures within ductile iron (right) (http://www.dartheads.com)



Particle types (http://www.pancai.com)



Atomized, spheroidal aluminum metal powder
(http://www.skylighter.com)



Atomized, spherical titanium metal powder

Steel

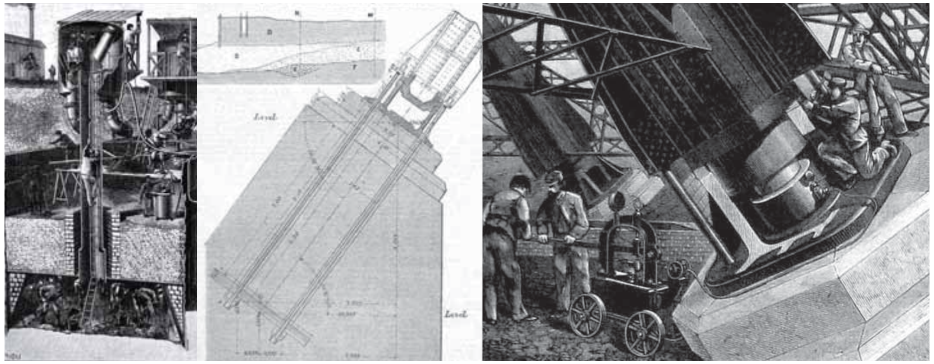
Steel is an alloy that consists mostly of iron and has a carbon content between 0.2% and 2.1% by weight, depending on the grade. Carbon is the most common alloying material for iron, but various other alloying elements are used, such as manganese, chromium, vanadium, and tungsten.[1] Carbon and other elements act as a hardening agent, preventing dislocations in the iron atom crystal lattice from sliding past one another. Varying the amount of alloying elements and the form of their presence in the steel (solute elements, precipitated phase) controls qualities such as the hardness, ductility, and tensile strength of the resulting steel. Steel with increased carbon content can be made harder and stronger than iron, but such steel is also less ductile than iron.

Though steel had been produced by various inefficient methods long before the Renaissance, its use became more common after more-efficient production methods were devised in the 17th century. With the invention of the Bessemer process in the mid-19th century, steel became an inexpensive mass-produced material. Further refinements in the process, such as basic oxygen steelmaking (BOS), lowered the cost of production while increasing the quality of the metal. Today, steel is one of the most common materials in the world, with more than 1.3 billion tons produced annually. It is a major component in buildings, infrastructure, tools, ships, automobiles, machines, appliances, and weapons. Modern steel is generally identified by various grades defined by assorted standards organizations.

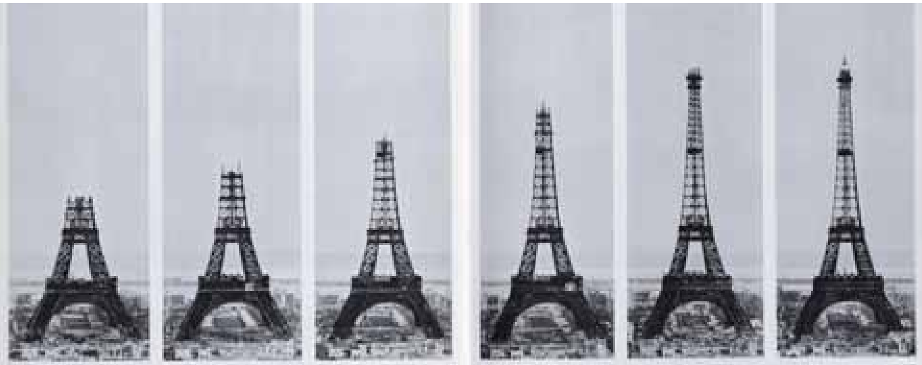
Cost: $20 per ton of steel produced

(http://raunaqsteels.com/iron&steel.html)

(www.dailymail.co.uk) Eleven workmen in New York sit and eat lunch on this beam in 1932



(http://www.cqout.com) Foundation Construction - Alexandre Gustave (1mage 1.1)



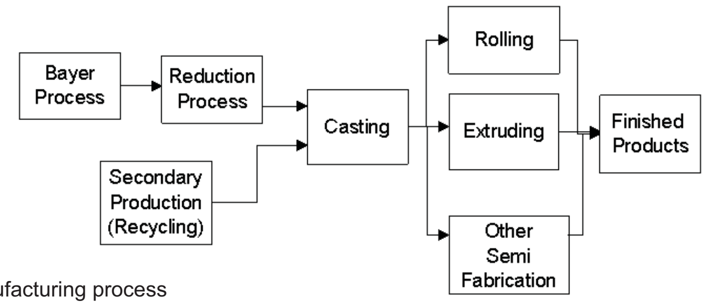
(http://ieii.blogspot.com) 1887-1889 World’s Fair Eiffel Tower steel construction (image 1.2)

Aluminium

Aluminium is the third most abundant element (after oxygen and silicon), and the most abundant metal, in the Earth's crust. It makes up about 8% by weight of the Earth's solid surface. Aluminium metal is too reactive chemically to occur natively. Instead, it is found combined in over 270 different minerals.[4] The chief ore of aluminium is bauxite.
Aluminium is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of passivation. Structural components made from aluminium and its alloys are vital to the aerospace industry and are important in other areas of transportation and structural materials. The most useful compounds of aluminium, at least on a weight basis, are the oxides and sulfates. Aluminium is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. It is nonmagnetic and does not easily ignite.

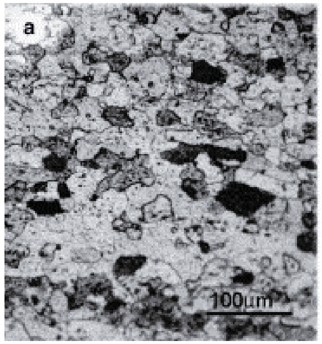
Aluminium Stucco Embossed Coil:
3) Thickness: 0.2 - 3.0mm
4) Width: 500 - 1,500mm
5) Length: to clients' requirements
6) Dimensions can be as per clients' specifications
7) Good plasticity and conductivity
8) Generally used in industrial and construction applications

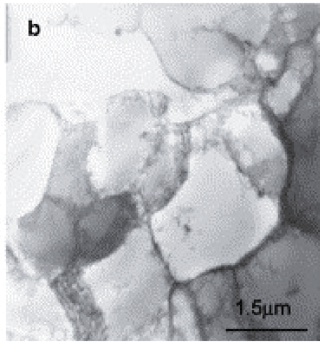
Packing:in export sea-worthy wooden pallet Sheet weight: about 1.5 tons per pallet. Coil weight: about 2.5 tons per coil



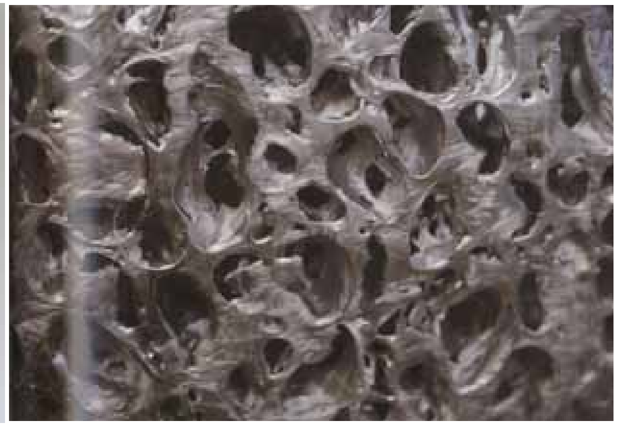
Basic Aluminium manufacturing process
(http://www.wtec.org)

("Manufacturing matterial effects" / Branko Kolarevic) Mike Mckay - Performa 08 Project



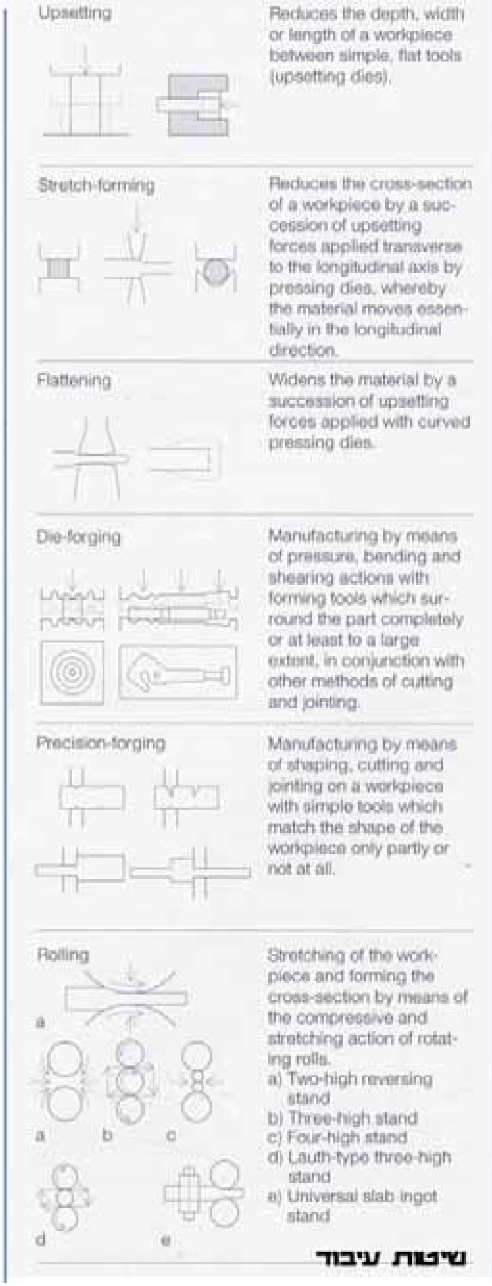


Pressed aluminium embossed coil Particles (500 °C for 4 h) (http://www.sciencedirect.com)



Aluminium casted brick with air spaces made during the hardening process
("Matter" / Gail Peter Borden")

Metal Methods

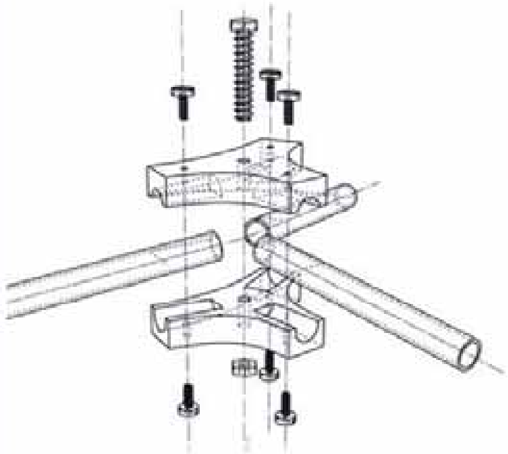


Upsetting	Reduces the depth, width or length of a workpiece between simple, flat tools (upsetting dies).
Stretch-forming	Reduces the cross-section of a workpiece by a succession of upsetting forces applied transverse to the longitudinal axis by pressing dies, whereby the material moves essentially in the longitudinal direction.
Flattening	Widens the material by a succession of upsetting forces applied with curved pressing dies.
Die-forging	Manufacturing by means of pressure, bending and shearing actions with forming tools which surround the part completely or at least to a large extent, in conjunction with other methods of cutting and jointing.
Precision-forging	Manufacturing by means of shaping, cutting and jointing on a workpiece with simple tools which match the shape of the workpiece only partly or not at all.
Rolling	Stretching of the workpiece and forming the cross-section by means of the compressive and stretching action of rotating rolls. a) Two-high reversing stand b) Three-high stand c) Four-high stand d) Lauth-type three-high stand e) Universal slab ingot stand

שיטות עיבוד

שיטות עיבוד

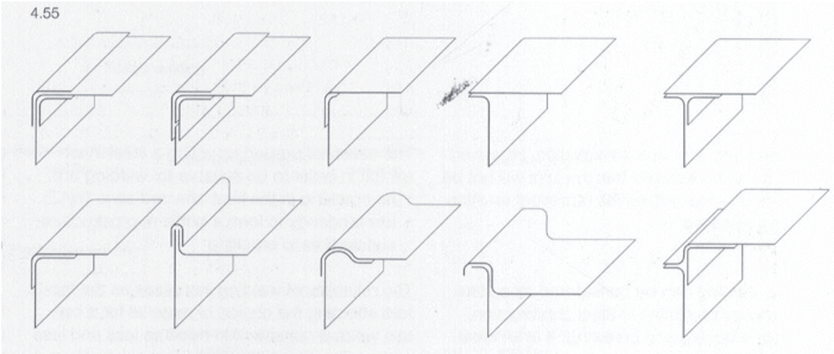
שיטות תעשייתיות
ערגול
ריתוך
עיבוד בקור

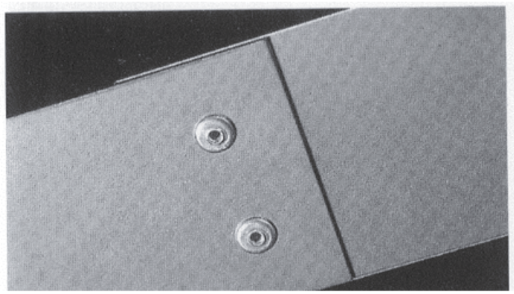


שיטות ממוחשבות
CNC – יצירת אובייקטים ע״י הסרת מסה ועיצוב מונחה מחשב

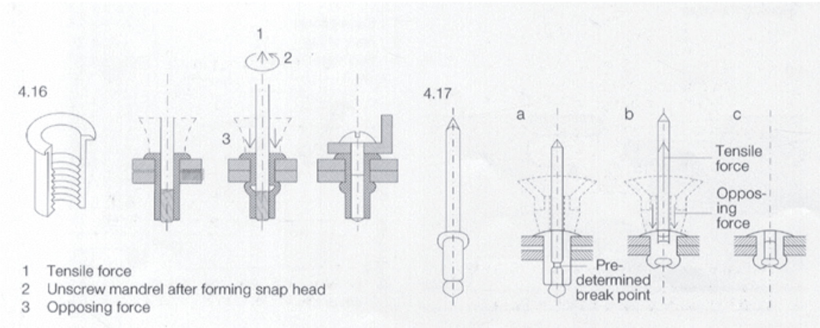
Metal Methods

ריתוך





ניטים – פקק מתרחב בלחץ

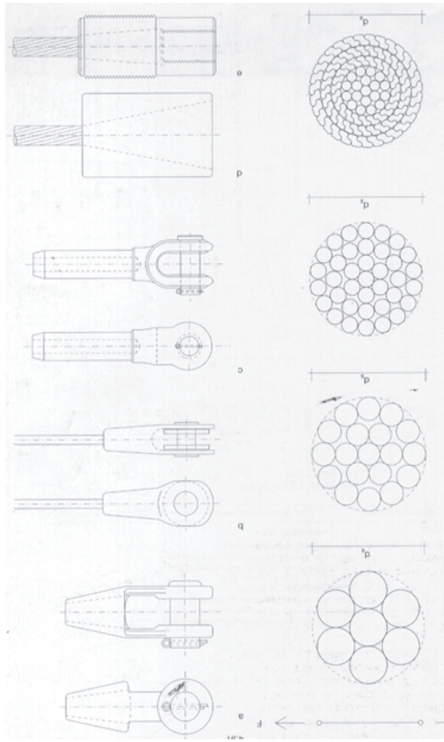


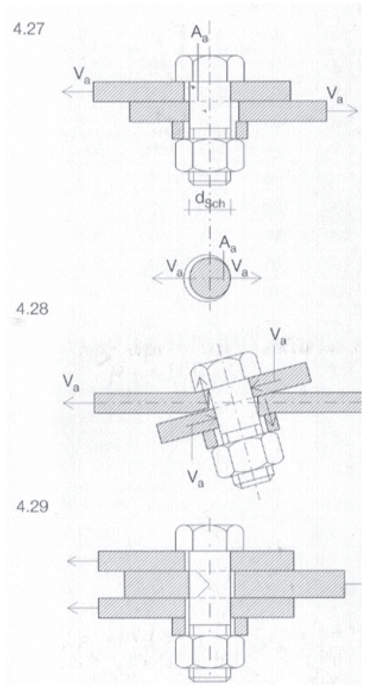
חיבורים

ניטים
ברגים
מסמרים
ריתוך
מיוחדים (MERO)

Connections

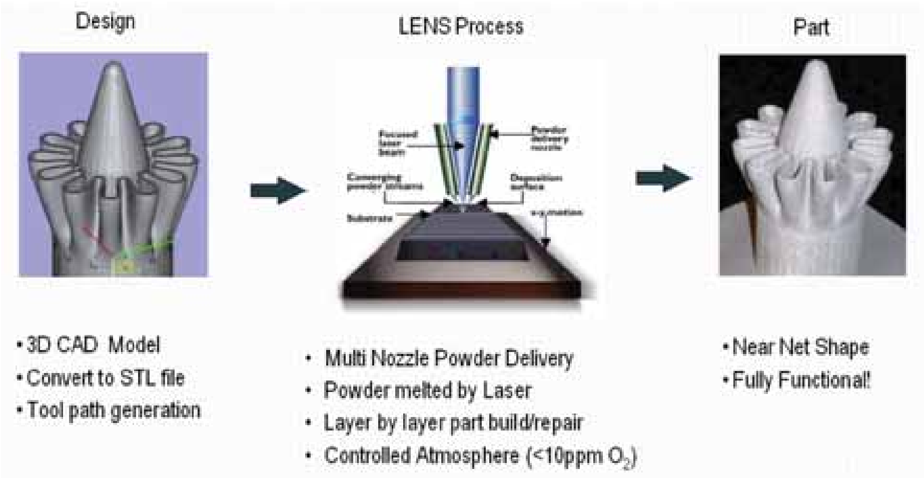
The word 'connection' implies some form of physical joint between two or more elements. How and why separate elements are connected will depend upon the
materials to be connected, the resources available (human labour and mechanical plant) and the manner in which the connection is detailed by the designer.





DDM - Direct Digital Manufacturing

One class of such machines, called Powder Bed machines, builds up a part by spreading a thin layer of powder metal in a bed, and then sintering (melting) select sections before depositing the next layer on top of it. The finished part emerges from a loose volume of powder that is recycled. Part sizes for powder bed machines tend to be limited to one foot
Another approach to building up a part fv om layers of material in a powder bed is to deliver powder by nozzles directly to the point where a focused laser melts the powder, fusing it into a part line-by-line, layer-by-layer. Called Powder Deposition, the technique typically offers larger working envelopes and the ability to either make parts or repair existing parts.in any direction, comments Wohlers. The size of the powder particles determines resolution—think surface finish.



3D Digital comouter based manufacturing (www.optomec.com)

Powder Metallurgy Manufacture

Material Sint D - 11 Annual requirement 60,000 Units
Finished part weight 312 g
Used weight 328 g = 19,680 kg / 60,000 Units
Material loss 16 g = 960 kg / 60,000 Units

Work plan	Machines	Energy kWh / piece	Energy as % of total energy expenditure
Pressing	Powder press 180 t	0.061	2.14
Sintering	Belt Furnace	0.188	6.60
Pressing	Sizing press 360 t	0.066	2.32
Tumbling	Vibratory grinding drum	0.018	0.63
Hardening	Chamber furnace	0.778	27.33
Washing	Washing machine	0.018	0.63
Grinding	Internal round grinder	0.114	4.00
		1.243	43.65

Energy consumption / number of pieces per year 74.6 MWh = 19.4 t fuel oil S = 28,000 SKE

Conventional Manufacture

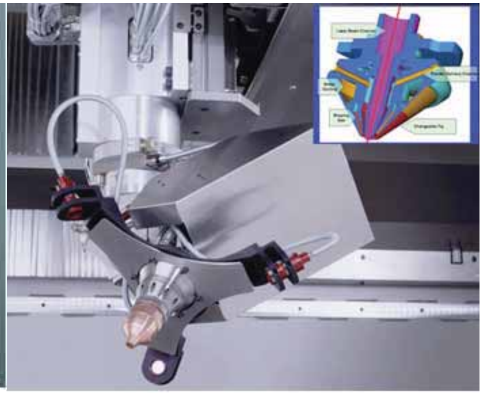
Material 16 Mn Cr 5 Annual requirement 60,000 Units
Finished part weight 300 g
Used weight 560 g = 33,600 kg / 60,000 Units
Material loss 260 g = 15,600 kg / 60,000 Units

Work plan	Machines	Energy kWh / piece	Energy as % of total energy expenditure
Shearing off	Hammer shears	0.011	0.39
Annealing	Annealing furnace	0.040	1.40
Preforging	Drop hammer	0.087	3.05
Finish forging	Forging press	0.298	10.47
Hot deburning	Shears	0.010	0.35
Annealing	Annealing furnace	0.097	3.41
Descaling	Jet unit	0.024	0.84
Sizing	Sizing press	0.164	5.76
Grinding	Single pulley drive-flat grinder	0.200	7.02
Boring	Deep hole boring machine	0.578	20.30
Counter Sinking	Boring machine	0.053	1.86
Broaching	Broaching machine	0.077	2.70
Milling	Milling machine	0.108	3.79
Hardening m/c	Furnace	0.609	21.39
Cleaning	Rotary table radial operator	0.003	0.11
Grinding	Rotary table grinder	0.147	5.16
Grinding	Internal grinder	0.341	11.99
		2.847	100.00

Energy consumption / number of pieces per year 170.8 MWh = 44.5 t fuel oil S = 64,100 SKE

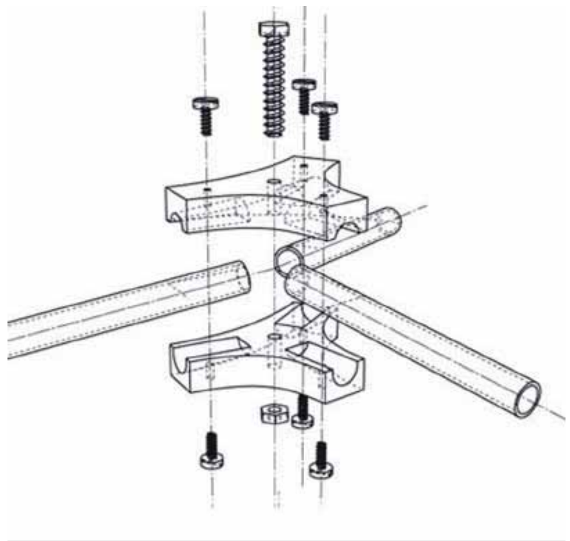
Conventional Vs Powder Digital Manufacture

DDM - Direct Digital Manufacturing

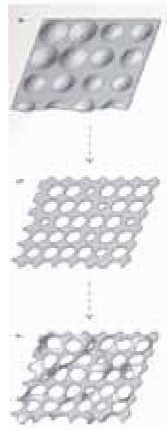



Powder laser head and manufacturing process
(www.Optomec.com)

Laser Stamping by laser beam
(http://www.power-technology.com)







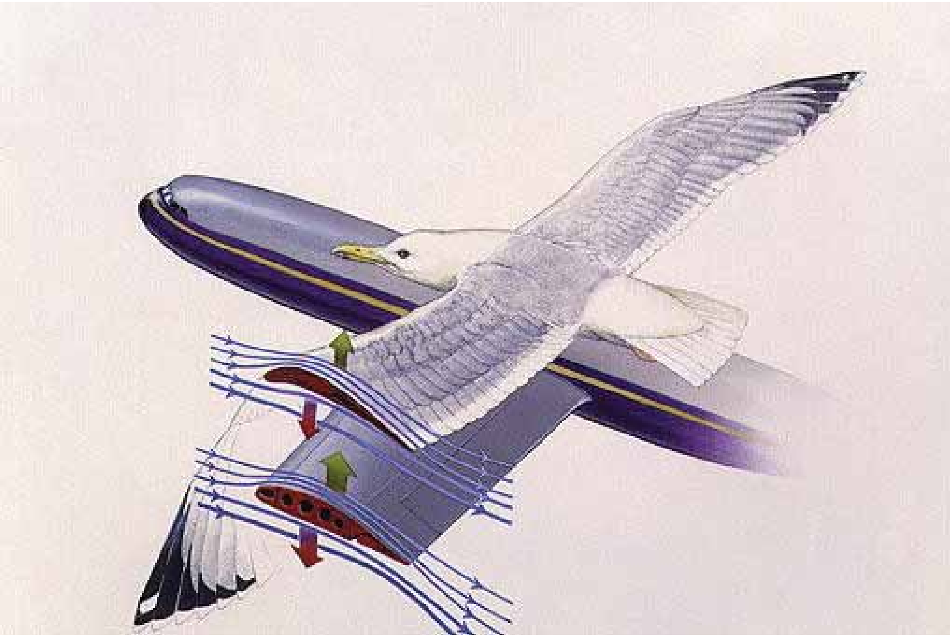
Aluminium Stamping and flexebility
(“Matter” / Gail Peter Borden”)

Planes Manufacturing

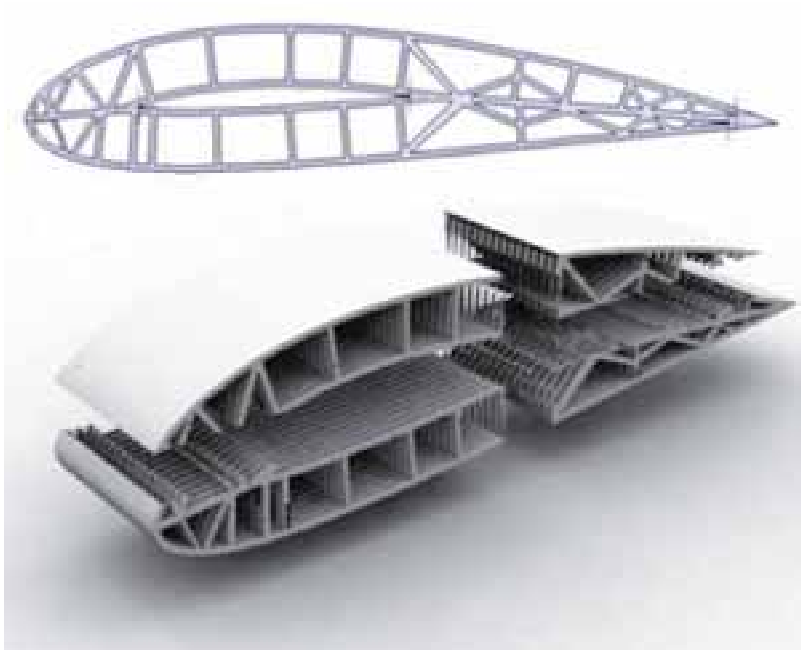
http://www.dvinfo.net

http://aak92.wordpress.com

http://indianapublicmedia.org



Cross section through one barb of a feather (www.sciencedaily.com)

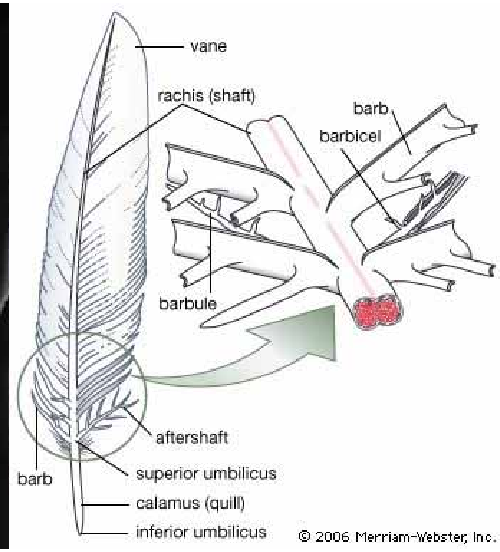


Wing Manufacturing (http://www.me.utexas.edu)

Planes Manufacturing

(http://comenius.susqu.edu)

Micro Bird Feathers (http://blotta.com)

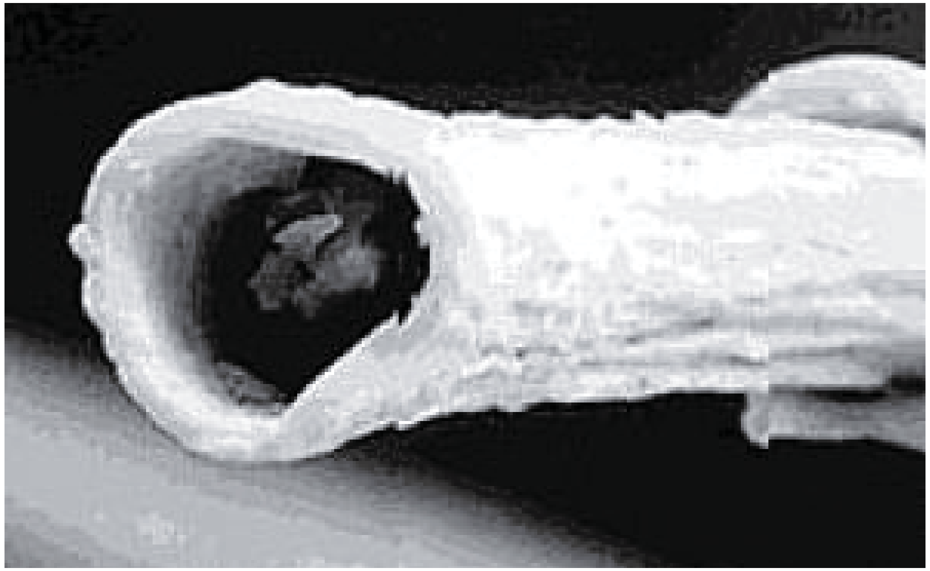


Cross section through one barb of a feather (www.sciencedaily.com)

Feather

Component structure of the outer covering and flight surfaces of all modern birds. Unique to birds, feathers apparently evolved from the scales of birds' reptilian ancestors. Like hair, feathers are made of keratin, a fibrous protein. They are variously specialized for insulation, flight, formation of body contours, display, and sensory reception. Contour feathers form most of the surface of the bird, streamlining it for flight and often waterproofing it. The basal portion may be downy and thus act as insulation. The major contour feathers of the wing (remiges) and tail (rectrices) function in flight. Contour feathers grow in tracts (pterylae) separated by bare areas (apteria) and develop from follicles in the skin. Down feathers have loose-webbed barbs, all rising from the tip of a very short shaft. Their function is insulation, and they may be found in both pterylae and apteria in adult birds. They also constitute the first feather coat of most young birds. Filoplumes are hairlike feathers with a few soft barbs near the tip. They are associated with contour feathers and may be sensory or decorative in function. Bristlelike, vaneless feathers occur around the mouth, eyes, and nostrils of birds. Some bristles function as eyelashes on ground-dwelling birds; bristles over the nostrils may serve as filters.

http://www.britannica.hk

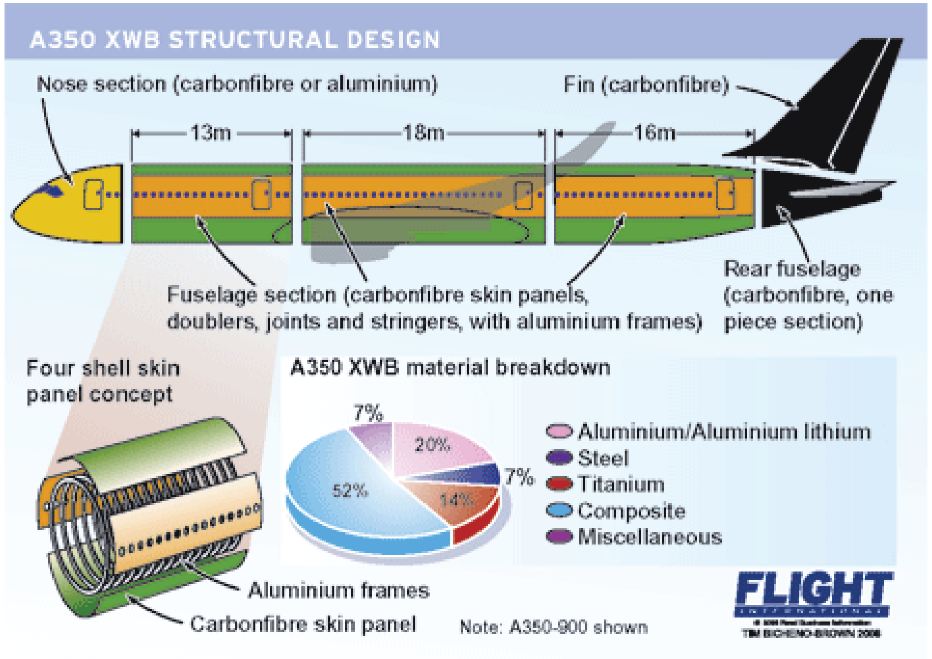


Cross section through one barb of a feather (www.sciencedaily.com)

Planes Manufacturing

Airbus first began studies on a very large 500 seat airliner in the early 1990s. The European manufacturer saw developing a competitor and successor to the Boeing 747 as a strategic play to end Boeing's dominance of the very large airliner market and round out Airbus' product line-up.

Apart from the prime contractors in France, Germany, the United Kingdom and Spain, components for the A380 airframe are also manufactured by industrial partners in Australia, Austria, Belgium, Finland, Italy, Japan, South Korea, Malaysia, Netherlands, Sweden, Switzerland and the United States. A380 final assembly is taking place in Toulouse , France, with interior fitment in Hamburg, Germany. Major A380 assemblies are transported to Toulouse by ship, barge and road.



Basic Aluminium manufacturing process
(http://curiousphotos.blogspot.com)

Bombardier CSeries Fuselage Test Barrel (http://blog.flightstory.net)

measures approximately 23 feet (7 m) long and has a maximum diameter of approximately 12 feet (3.7 m), is made of advanced aluminum alloys. These materials have been selected to provide weight and maintenance advantages for CSeries jetliner operators.

Boeing737airframe (http://varifrank.com/archives/aviation/index.php)

Aluminium Sheets 42X6 m transfered to te CNC machine

After baking the sheets are being expected for quality and moved to assembel line

The sheet is polished according to CAD file and looses 75% of material (from 5 to 1 ton)

10 sheets are being assembled on the wing structure (5 on each side) by perfect match

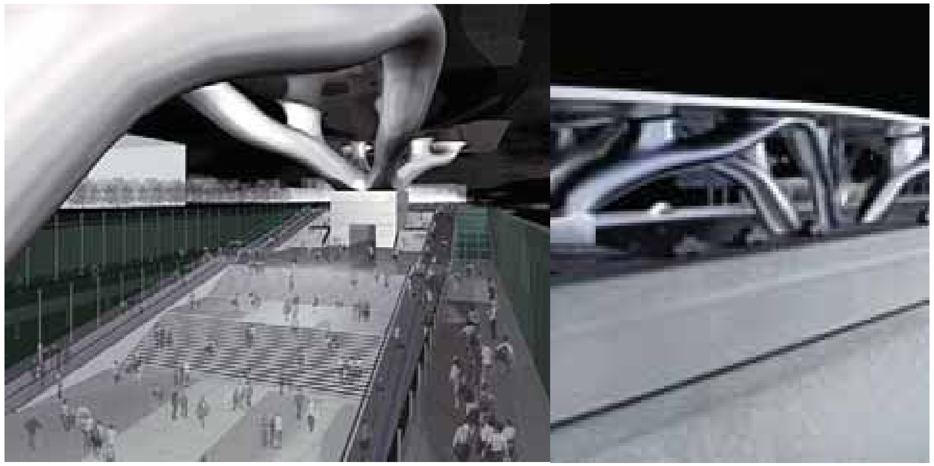
The shaped sheet is rolled withe a nylon in vacum and baked in the oven for 24 H in 180 degrees

Before covering, all the systems are being intalled. the accurency is reached by laser measures

Florence new station - Arata Isozaki, Mutsuro Sasaki
2002

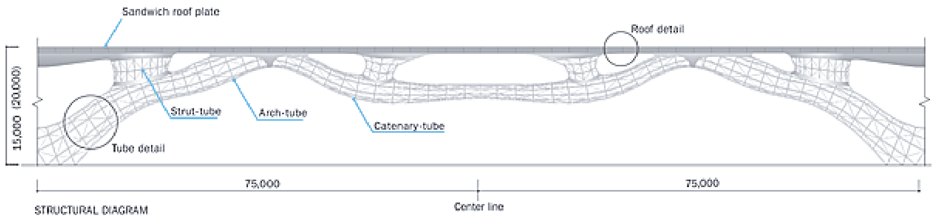
For a competition proposal for a new train station in Florence with the architect Arata Isozaki, Sasaki generated a structure using computer methods rooted in evolutionary biology. The inspiration was based on a Sidra tree which grows in the tropical forests and deals with same structural problems - great span and minimum support in the ground.

The organization of the building consists of stacked flat slabs made of thin steel plates with steel ribs sandwiched between, although the vertical structure is a set of connected tubes forming webbed columns that sinuously flow through the building. He implemented a new shape-analysis approach that he calls Extended Evolutionary Structural Optimization (EESO). he uses “the principles of evolution and self-organization of living creatures, adapted from an engineering standpoint, to generate rational structural shapes within a computer.” The webbed “columns” branch across the station depending on how the structure could be optimized to address stress and deformation loads for the flat roof in an almost sideways version of what he had designed for Sendai Mediatheque.

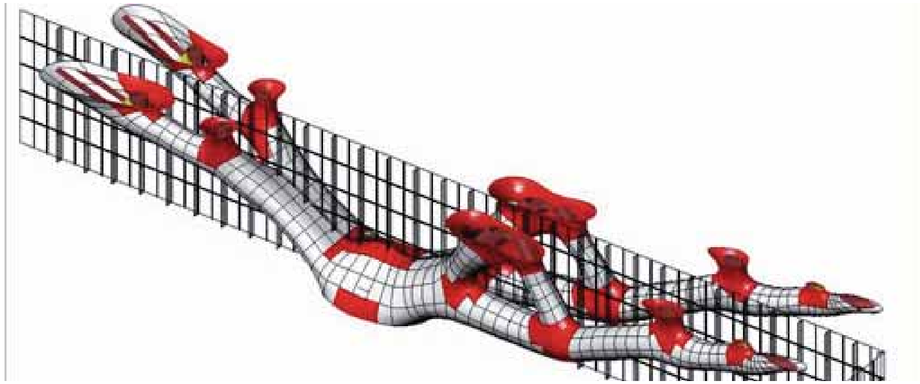


Inner View on the station - Light colomns opening the space (http://www.zero-th.org)

One Module of the structure (Plane base resemblance) (“From Control to Design”)

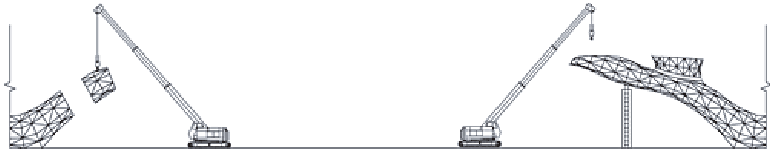


(http://archrecord.construction.com)

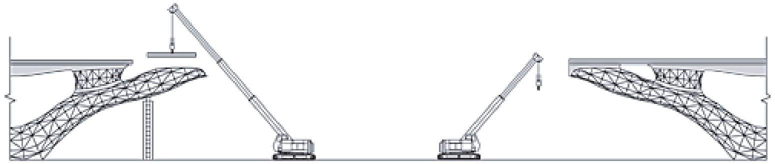


Main canopy support structure - 3 way benned elements (red), while other 75% are only 2 way (http://www.cgarchitect.com)

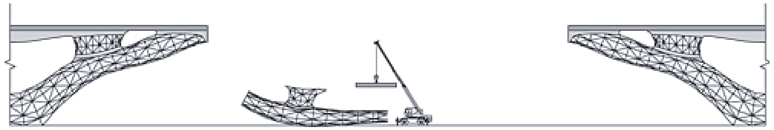
Florence new station - Arata Isozaki, Mutsuro Sasaki



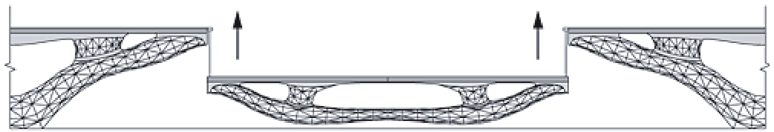
Step 1: Assembly of the Arch-Tube
Assembled units are prefabricated in factory and transported to the site. The sizes of each unit are defined by the size of trailer and other transportation equipments.



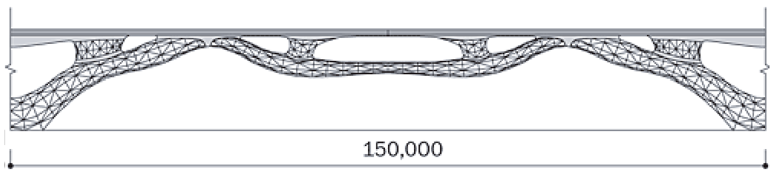
Step 2: Arch-Tube and Sandwich Roof Plate
Canitlevered truss construction. The sandwich roof plates are set on the arch-tube.



Step 3: Catenary-Tube and Sandwich Roof Plate
Center part is preassembly. Catenary-tube and sanwich roof plate are assembed on the ground.

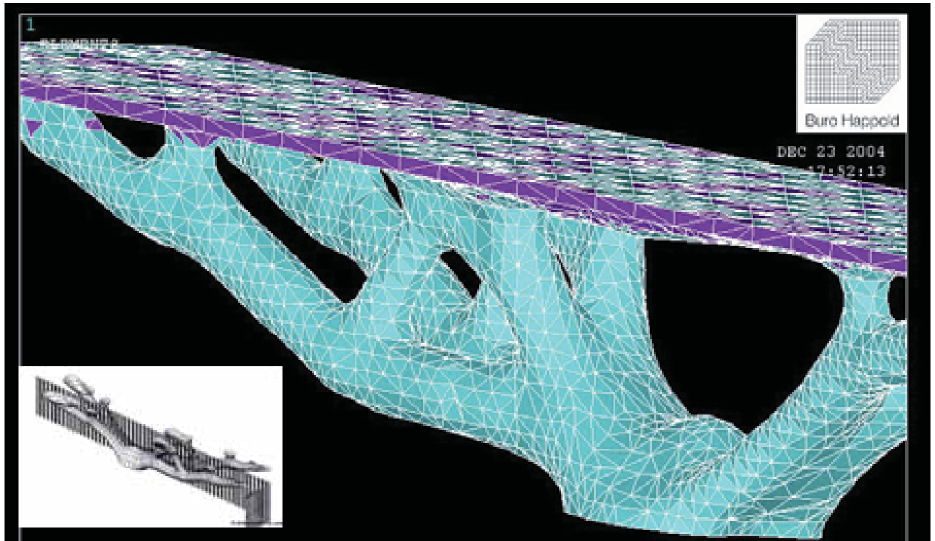


Step 4: Center part is lifted up and connected to both sides.



FEM Analysis

One Module of the structure (Plane base resemblance) ("From Control to Design")



Polygonal inner constructive modules covered with external metal sheets bended accordingly (http://www.beta.iloveqatar.net)

Birds Nest Stadium, Beijing
Herzog & De meuron 2003

In 2001, before Beijing had been awarded the right to host the 2008 Summer Olympics, the city held a bidding process to select the best arena design. Multiple requirements including the ability for post-Olympics use, a retractable roof, and low maintenance costs, were required of each design.[7] The entry list was narrowed to thirteen final designs.[9] Of the final thirteen, Li Xinggang of China Architecture Design and Research Group (CADG), said after he placed the model of the “nest” proposal at the exhibition hall and saw the rival entries he thought to himself, “We will win this.”[7] The model was approved as the top design by a professional panel; however, it was later exhibited for the public. Once again, it was selected as the top design.[7] The “nest scheme” design became official in April 2003.[7]

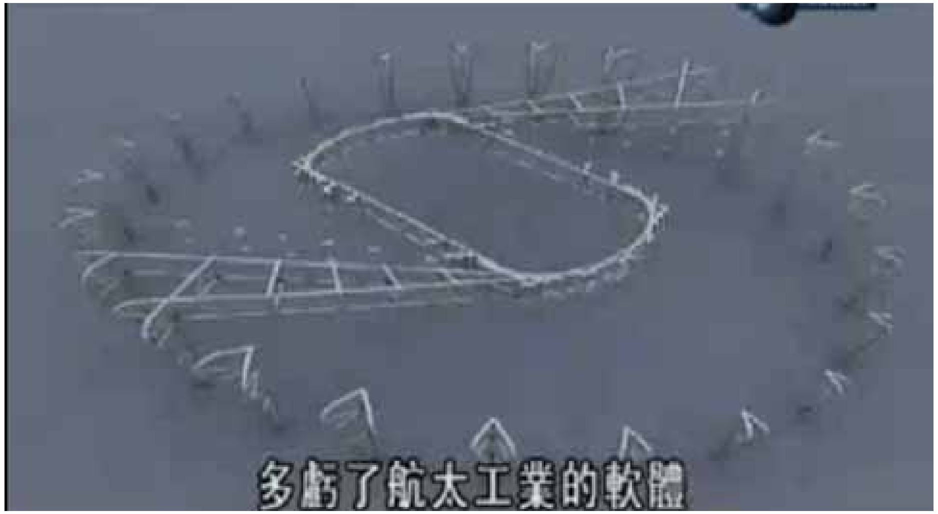
In an attempt to hide steel supports for the retractable roof, required in the bidding process, the team developed the “random-looking additional steel” to blend the supports into the rest of the stadium.[10] Twenty-four trussed columns encase the inner bowl,[12] each one weighing 1,000 tons.[7] Despite random appearance, each half of the stadium is nearly identical.[13] After a collapse of a roof at the Charles de Gaulle International Airport,[7] Beijing reviewed all major projects. It was decided to eliminate the retractable roof, the original inspiration for the “nest” design,[7] as well as 9,000 seats from the design.[13] The removal of the elements helped to bring the project under the reduced construction budget of $290 million, from an original $500 million.[7] With the removal of the retractable roof, the building was lightened, which helped it stand up to seismic activity; however, the upper section of the roof was altered to protect fans from weather.[13] Enerpac was granted the contract to perform the stage lifting and lowering of the stadium roof as part of the construction process.[14] Due to the stadium’s outward appearance, it was nicknamed “The Bird’s Nest”. The phrase was first used by Herzog & de Meuron, though the pair still believes “there should be many ways of perceiving a building.”[10] The use is a compliment Li explained, “In China, a bird’s nest is very expensive, something you eat on special occasions.”[7]

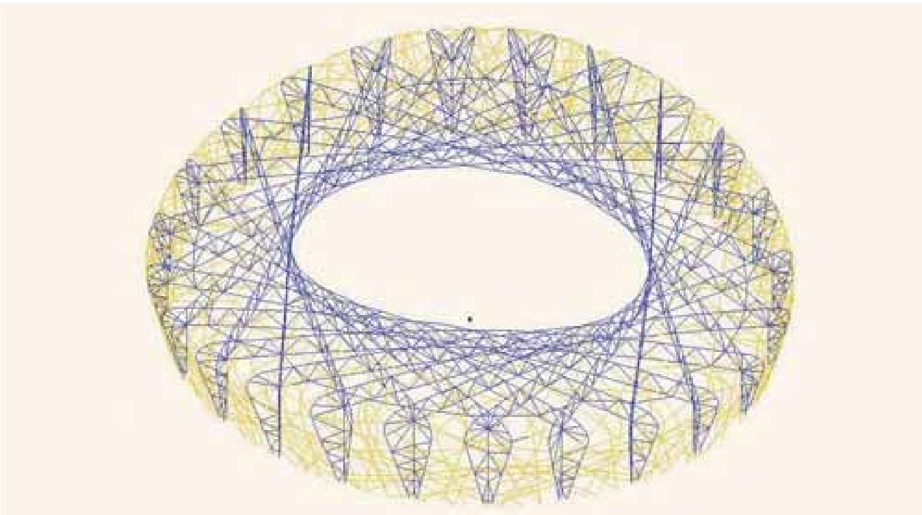
Basic Aluminium manufacturing process
(http://www.wtec.org)

The modules being weld to another (http://news.bbc.co.uk)

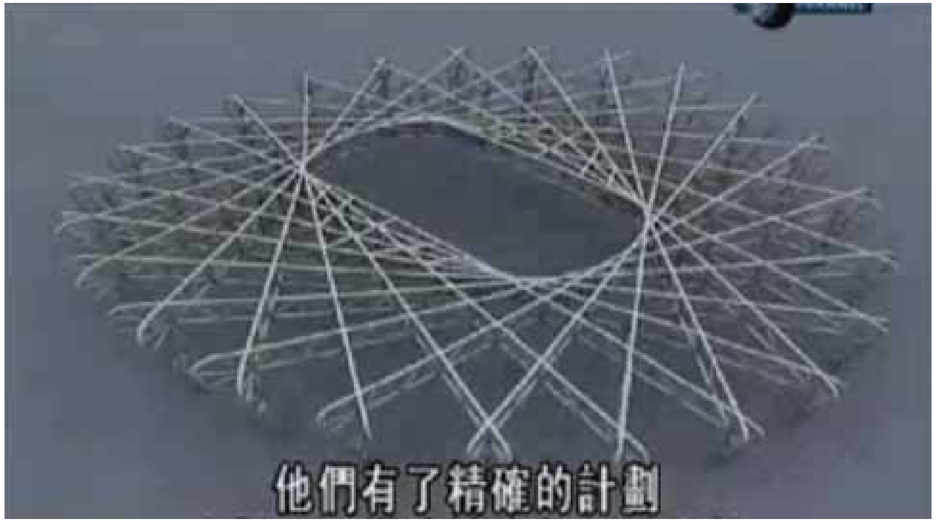
The complete building (http://news.xinhuanet.com)

Birds Nest Stadium, Beijing
Herzog & De meuron 2003





The constructive beams (blue) and the extra beams - seforadic look
(http://www.wtec.org)



Building process - foundation, colomns, beams, etfe
(http://www.youtube.com/watch?v=qrZL7wxp-j4&feature=related)

Ship Manufactering

Shipbuilding and ship repairs, both commercial and military, are referred to as “naval engineering”. The construction of boats is a similar activity called boat building.

The dismantling of ships is called ship breaking. Modern shipbuilding makes considerable use of prefabricated sections. Entire multi-deck segments of the hull or superstructure will be built elsewhere in the yard, transported to the building dock or slipway, then lifted into place. This is known as “block construction”. The most modern shipyards pre-install equipment, pipes, electrical cables, and any other components within the blocks, to minimize the effort needed to assemble or install components deep within the hull once it is welded together. This was first introduced by Alstom Chantiers de l’Atlantique when they built the largest Ocean Liner in the world Cunard’s RMS Queen Mary 2.

Modern metal ribs (http://www.china.org.cn)

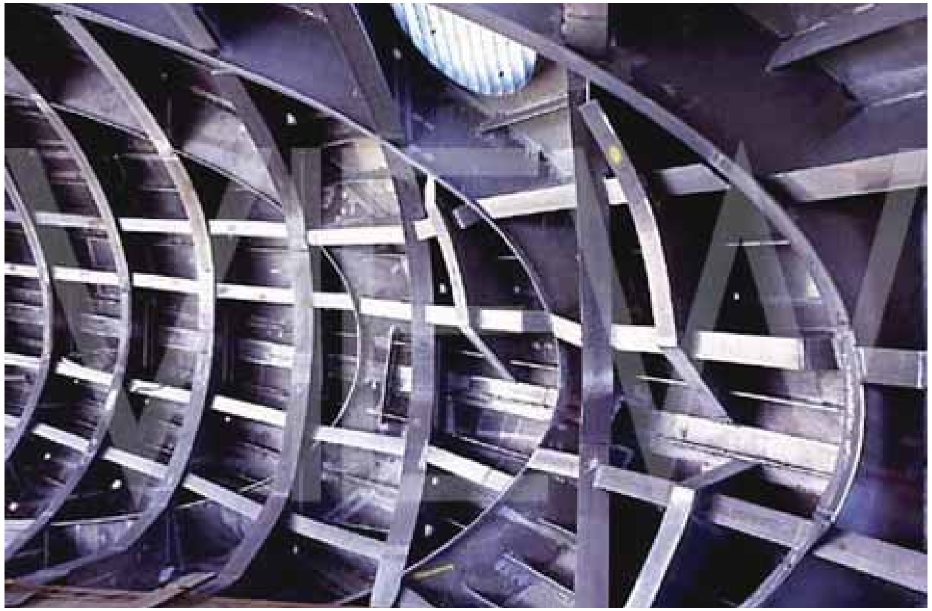
Ships body being assembled out of matal sheets
(www.shutterstock.com)

Conservative wooden constraction (http://olsonfarlow.photoshelter.com)

Nat West Media Centre - Lords Cricket Ground
Future Systems 1998

The objective of the design was to respect and savour the essential nature of Lord’s while bringing to it a building that will herald the coming millennium and provide the most elegant and state-of-the-art media centre in the world.

It’s the first all aluminium semi-monococque building in the world and represents a breakthrough, not just in the creation of a new 3D aesthetic but in its method of construction. This building was built and fitted out not by the construction industry but by a boatyard, using the very latest advances in boat building technology. The aerodynamic contours reflect the sweep of the plan of the Ground with the enclosing skin formed by a smooth, white, seamless shell. The west facing glazing is inclined to avoid any glare or reflections while providing unobstructed views of the game for the world’s media. the design and the realisation of the Lord’s Cricket Ground Media Centre were not the results of parametric processes.



Ribbed construction assembled to a ship structure (http://www.viewpictures.co.uk)

Semi Monocoque aluminium building - constructed in a boatyard
(http://www.mimoa.eu)

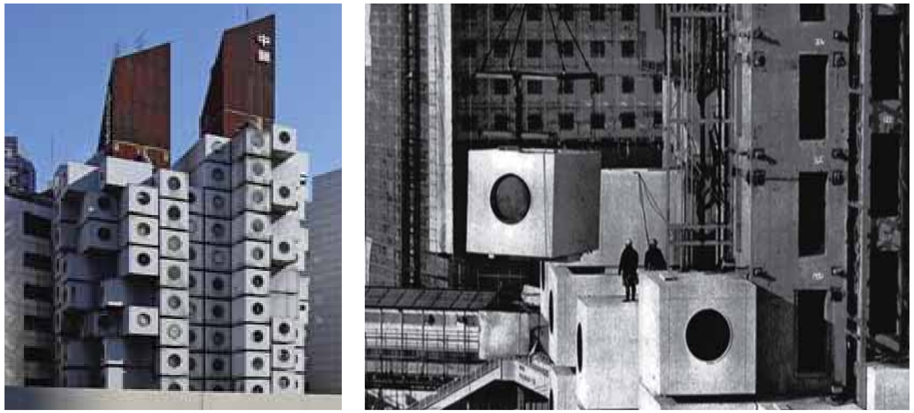
Overal view on the Press “Bubble” rasing above the croud (http://www.mimoa.eu)

Cellular Architecture of the 20 century: Metabolism

Tn the late 1950s a small group of young Japanese architects and designers joined forces under the title of “Metabolism”. Their visions for cities of the future inhabited by a mass society were characterized by large scale, flexible, and expandable structures that evoked the processes of organic growth. In their view, the traditional laws of fixed form and function were obsolete. Metabolism arose in post-World War II Japan, and so much of the work produced by the movement is primarily concerned with housing issues. Metabolist designs relied heavily on advanced technology, and they often consist of adaptable plug-in megastructures.

Nakagin Capsule Tower // Kisho Kurokawa // Tokyo, Japan

The building is actually composed of two interconnected concrete towers, respectively eleven and thirteen floors, which house 140 prefabricated modules (or “capsules”) which are each self-contained units. Each capsule measures 2.3 m × 3.8 m × 2.1 m and functions as a small living or office space. The capsules were fitted with utilities and interior fittings before being shipped to the building site, where they were attached to the concrete towers. Each capsule is attached independently and cantilevered from the shaft, so that any capsule may be removed easily without affecting the others. The capsules are all-welded lightweight steel-truss boxes clad in galvanized, rib-reinforced steel panels. After processing, the panels were coated with rust-preventative paint and finished with a coat of Kenitex glossy spray.



Kisho Kurokawa - Nakagin Capsule Tower, Tokyo, Japan
Source:http://en.wikipedia.org/wiki/Nakagin_Capsule_Tower

Habitat 67 // Moshe Safdie // Montreal, Canada

Habitat 67 comprises 354 identical, prefabricated concrete forms arranged in various combinations, reaching up to 12 stories in height. Together these units create 148 residences of varying sizes and configurations, each formed from between one to eight linked concrete units. The complex originally contained 158 apartments, but several apartments have since been joined to create larger units, reducing the total number. Each unit is connected to at least one private terrace, which can range from approximately 225 to 1,000 square feet (20.9 to 93 m2) in size.
The development was designed to integrate the benefits of suburban homes, namely gardens, fresh air, privacy, and multilevelled environments, with the economics and density of a modern urban apartment buildings.

Moshe Safdie - Habitat 67, Montreal, Canada
Source: http://en.wikipedia.org/wiki/Habitat_67

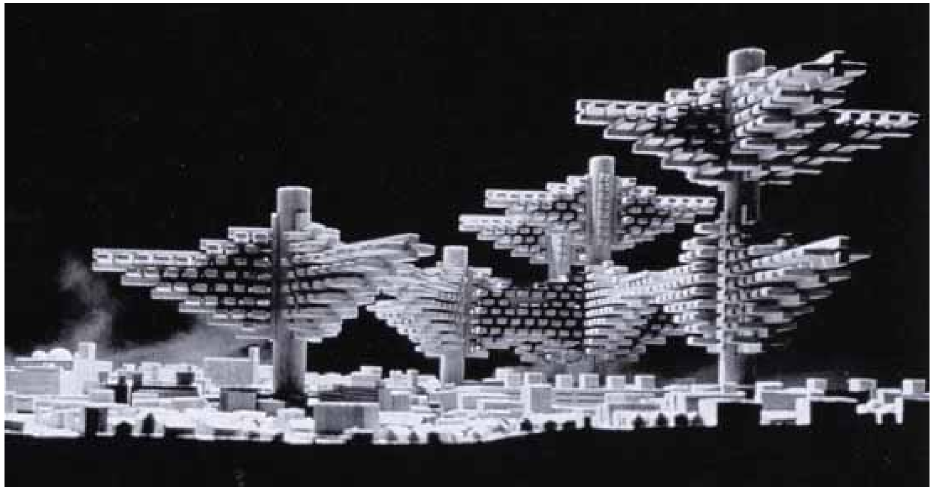
Spatial City // Yona Friedman

The Spatial City (Ville spatiale) is an unrealized theoretical construct inspired by the housing shortage in France during the late 1950s and by Yona Friedman's deep belief that housing plans and structures should allow for the free will of the individual inhabitants. Not wanting to displace the city below, Friedman raised a second city fifteen to twenty meters above the existing one. The framework was to be erected first, and the residences conceived and built by the inhabitants inserted into the voids of the structure. The layout of each level would occupy no more than fifty percent of the overall structure in order to provide air and light to each residence as well as to the city below. The project was designed for construction anywhere, and meant to be adapted to any climate.
The Spatial City is a unit that can be repeated ad infinitum. All of the structural elements connected to the individual user, such as walls, floor slabs, and partitions, are radically mobile, and the architecture deliberately avoids committing itself to any particular style or pattern of use. Versatile and free as Friedman's composition is, however, it is contained by a superior order, on which it relies: the wide grid of pillars and slabs on which it stands. Friedman called this grid the "spatial infrastructure," and designed it for collective use. The user's determination was to play as important a role in it as the architect's: "Mobile architecture looks for techniques which don't impose a preconceived plan. . . . It is the user who makes the project with a potential 'designer's participation.'" The design of Friedman's ideal city is only perfected in its use.

Yona Friedman - Spatial City
Source:http://onfineline.blogspot.com/2010/04/metabolist-movementstudy-case.html

Clusters in the Air // Arata Isozaki

The concept of the clusters was to develop a new way to structure housing around Tokyo. The Cluster are suppose to represent leaves from trees which are the housing units and the core represents the trunk of the tree.



Arata Isozaki - Clusters in the Air, 1962
Source:http://www.aainter3.net/akis/2007/03/clusters_in_the_air_project_19.html

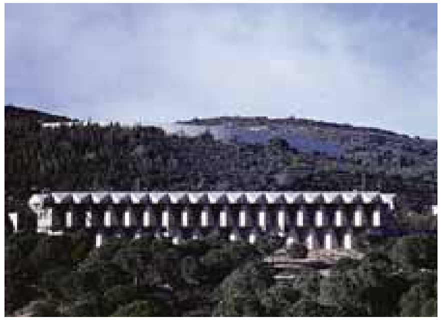
Synagogue of Military Academy // Zvi Hecker // Military Academy Negev Desert, Israel, 1969

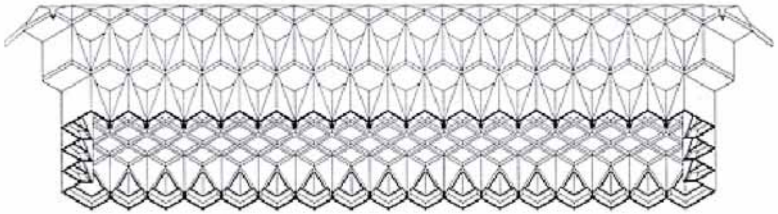
Three types of polyhedral units comprise the structure of the truncated octahedron forming the synagogue. The familiar hexagonal panels are the basic building unit. The triangular spaces between these units are used for stained glass windows at mid-height of the structure. Windows for ventilating are built into suboctahedrons projecting from the building. The synagogue is designed for a utilitarian purpose as well as a spiritual role: It sits atop a cistern that supplies water for nearby housing. In the special desert conditions, the synagogue by its height and wealth of form, stands out very strongly against the montonous background and the surrounding buildings.

Zvi Hecker - Synagogue of Military Academy, Military Academy Negev Desert, Israel, 1969
Source: http://www.zvihecker.com/index_entry.html

Eng. Laboratory Technion Haifa // Zvi Hecker // Technion University, Haifa 1964

The Faculty of mechanical engineering, is composed of several interconnected pavilions two-three story high. They are based horizontally on 45° structural grid of 2,62 m and vertically on exterior bearing walls of concrete folded slab precast elements 4,24 m high, 14 cm thick, triangular in shape, and fill in of narrow jealusie windows between the concrete elements. The Laboratory building here published, has been designed as a proto¬type for the other Faculty buildings: the ground floor serves mainly as an area for heavy mechanical equipment sanitary installation, electrical wiring. The first floor contains several laboratory units and a large crane hall covered by prismatic slab roof and connected to the upper court work through two concrete bridges.

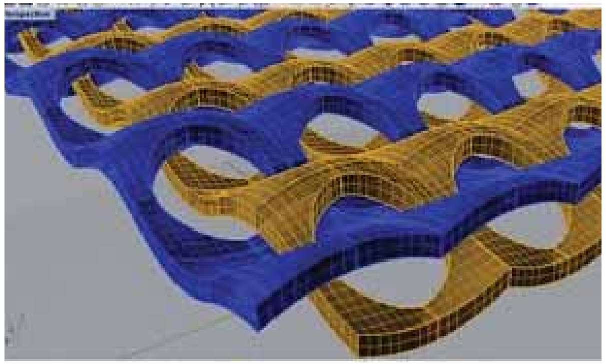




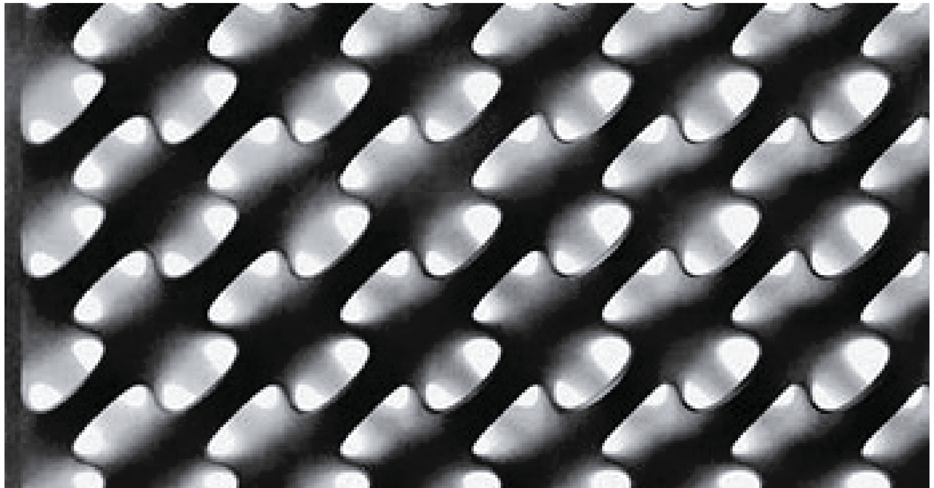
Zvi Hecker - Eng. Laboratory Technion Haifa, Technion University, Haifa 1964
Source: http://www.zvihecker.com/index_entry.html

Installations // Ervin Hauer

Erwin Hauer (b. 1926) is an Austrian-born American sculptor who studied first at Vienna's Academy of Applied Arts and later under Josef Albers at Yale. Hauer was an early proponent of Modular Constructivism and an associate of Norman Carlberg. Like Carlberg, he was especially known for his minimalist, repetitive pieces in the 1950s and 1960s.



Erwin Hauer Church in Liesing, Vienna, Austria, 1951
Source- left: http://www.erwinhauer.com/index.html
Source- Right: http://computecture.blogspot.com/2009/10/practice-1-erwin-hauer.html



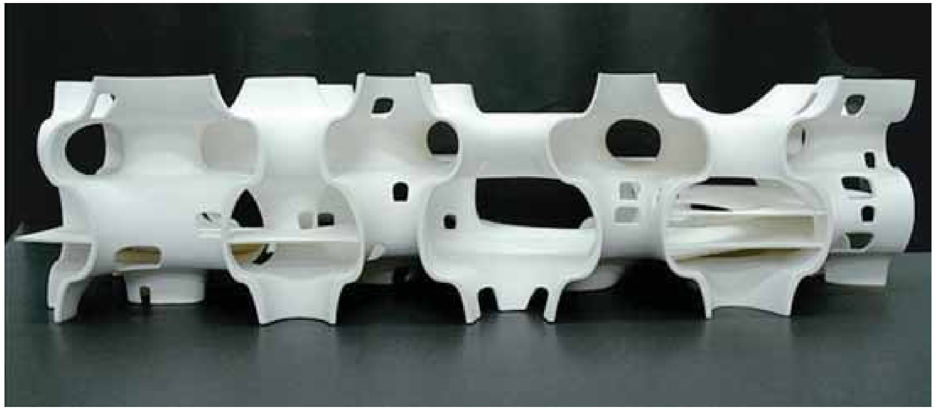
Erwin Hauer Showroom of Knoll Internacional de Mexico, Mexico City (1950)
Source- l http://pytr75.blogspot.com/2010/03/erwin-hauer.html

Erwin Hauer ElieTahari's Manhattan fashion studios, 5th Avenue and 43rd. Street, 1950
Source- lhttp://www.erwinhauer.com/index.html

Metropolitan Opera House \\ Toyo Ito \\ Taichung, Taiwan

מבנה האופרה מורכב ממשטח עקום שפותח מתוך רעיון של של גריד תלת מימדי חופשי של חללים מתמשכים אינסופיים הנקטעים בדפנות של תיבת המעטפת. בנוסף לאיכויות האסטטיות, יש למשטח יש יעילות סטורקטורלית. המשטח תוכנן על פי מודל מתימטי שנקרא Triply Periodic Minimal Surfaces, המורכב מחיבור של מספר אינסופי של צורה catenoid אשר מתפקדת כמשטח מינימאלי אינסופי ולכן בעלת יעילות מבנית הנקראת גבוהה. ניתן למצוא את המודל גם במבנה המולקולרי של חומרים שונים בטבע.
רשת אופקית ואנכית אינסופית של חללים רצופים המפגישה, sound cave איטו קרא למבנה בין אומנויות ואומנים שונים ובין החוץ לפנים. גודל החללים ברשת המקורית עוות ושונה על מנת לענות על דרישות הקונסטרוקציה והפרוגרמה: חלל במת האופרה הגדול, תאטרון קטן, 'הקופסא השחורה'- חלל אינטימי להופעות אקספרימנטליות, סדנאות אומנות, שוק אומנות, מסעדות, חללי שהיה וחניה. מכיוון שהמשטח עוות והוא נושא אלמנטים אחרים בנוסף לעצמו היה צורך בחיזוק קונסטרוטיבי במקומות שונים, לכן המשטח הפך למשטח כפול- עובי הבטון בכל אחד מהמשטחים נשאר זהה, והרווח ביניהם משתנה ומכיל חיזוק מסוגים שונים.
התכנון של המודל הדיגיטאלי נעשה בעזרת ריינו והועבר לתוכנות אופטימיזציה שונות.

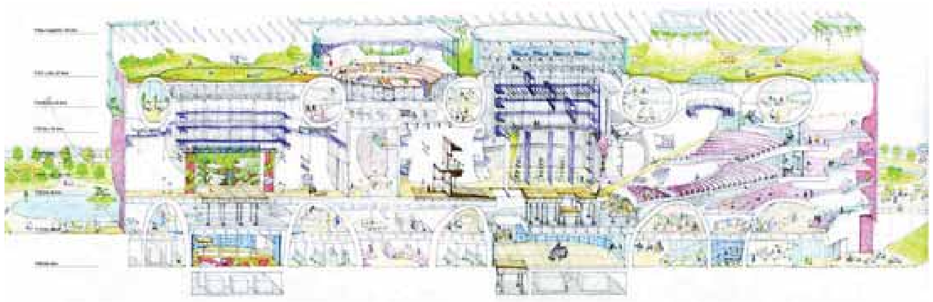
Toyo Ito - Metropolitan Opera House, Taichung, Taiwan
source :http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html



Toyo Ito - Metropolitan Opera House, Taichung, Taiwan
source :http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html

issues of the environment, resources, and energy

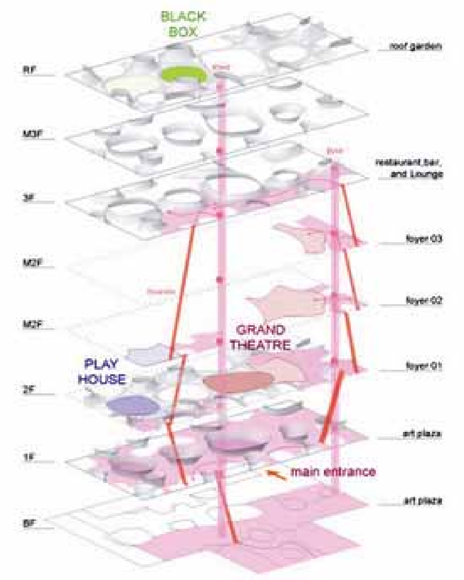
1. recycling of rainwater and sewage: the rain falling on the large roof surface will be collected and filtered for use in irrigation and sprinkling for landscaping plants, etc. sewage from the facility will be processed in a purification tank to approximately 5ppm BOD and 5ppm SS, and then reused as an intermediate water supply for purposes such as toilet flushing.
2. use of eco-materials: the majority of materials used will be recyclable eco-materials. this helps to limit the environmental load and conserve resources, thereby contributing to the reduction of carbon dioxide emissions and prevention of global warming.
3. adjusting the surrounding environment for energy savings

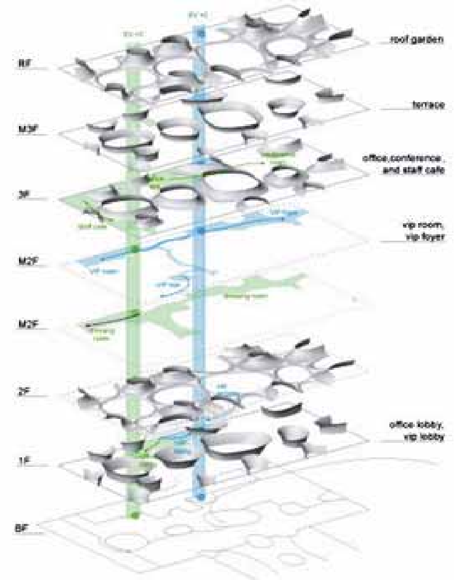


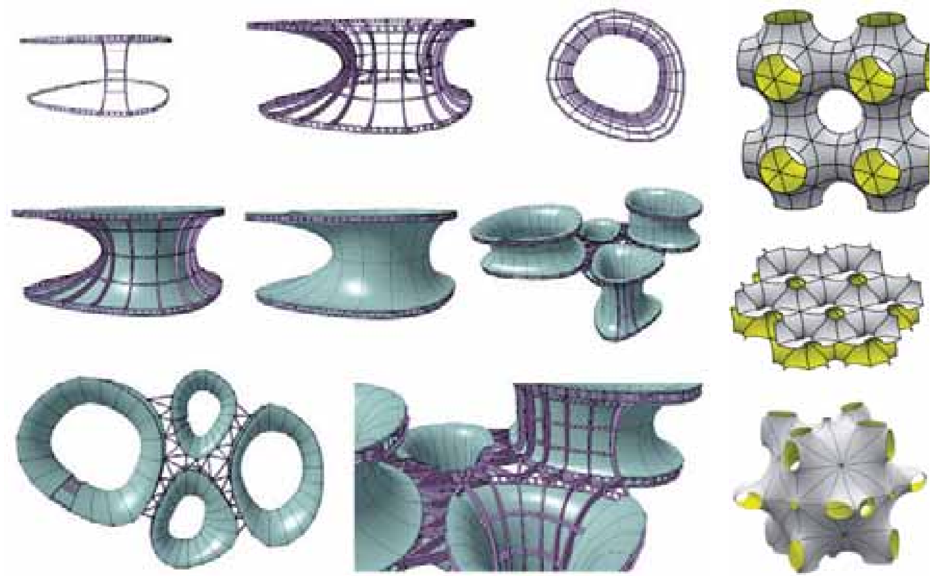
Toyo Ito - Metropolitan Opera House, Taichung, Taiwan
source :http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html

construction process

the structural system is developed together with the construction method to realize the freeform geometry in rational and efficient manner. the freeform concrete surfaces are shotcrete (spray concrete). it is commonly utilized for tunnel construction and suitable for curved surface. it can be shot horizontally or vertically. rather than constructing doubly curved formwork that is expensive and time consuming on site, the temporary structure in the void creates faceted surfaces that best-fit the finished surface. between the temporary steel work,expanded metal mesh is expanded metal mesh spans between the temporary steelwork to act as faceted formwork. 150 mm thick concrete can be shot at one time.the surface layer of 25 mm is shot separately without large aggregate to achievesmooth surface finish. concrete thickness varies between 200 mm at the top floor and 350 mm at the bottom.
the curved wall structure will be formed with 58 curved wall units, creating many complications in building steel bar reinforcements and steel trusses. the construction technique is the first of its kind in the world of architecture and has never been seen before in the taiwanese engineering industry,which meant that many local construction companies failed to show interest in participating in the project. wu chun-shan, president of lee ming construction, said building such a structure containing three-dimensional curved walls was generally thought impossible. ‘but we are making the impossible possible’.







Toyo Ito - Metropolitan Opera House, Taichung, Taiwan
source :http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html

sprayed concrete construction method

typically, an expanded metal mesh is used as a permanent back shutter to which the the reinforcing mesh is affixed. the concrete is sprayed onto the expanded metal and the reinforcement is fully enclosed. the concrete is typically sprayed using one of two methods. with the dry process, the dry constituents of the concrete are mixed in a portable
batching plant and the water is added to the mix at the nozzle. with the wet process, the water is added to the batching plant and premixed with the dry constituents and the wet concrete is sprayed from the nozzle. the benefits of the wet process are that there is greater control over the concrete mix as the concrete is often mixed off site by ready-mix contractors and delivered in lorries. it is common practice to apply the concrete in two layers. the first thick layer is usually applied using the wet process. once sufficiently cured, a second, thin finishing layer is then applied using the dry process.
it is essential that the finished product is cured appropriately to mitigate shrinkage and to ensure that design strength is achieved. spraying concrete is a messy process. some concrete will rebound and some will pass through the expanded metal back shutter. it may be necessary to install temporary protection to avoid polluting the surrounding area.

INVERSABrane \\ KOL/MAC

INVERSAbrane is a project focused on going beyond the current “green” curtain wall standard through strategic linking of advanced geometry, material and structural engineering, digital fabrication technologies and emerging expertise in ecology and biomedia.
INVERSAbrane is exterior membrane and infrastructure. Its performance is based on excess surface which maximizes contact with the environment and creates a unique opportunity for eco-systemic exchanges between building and city. Air, water and light are recycled through it and used as sources of energy. The membrane’s capacity to invert links exterior and interior into a mutually enhancing feedback system with the effect of producing greater safety and comfort for both environments.

KOL/MAC - INVERSABrain
source http://www.kolmacllc.com/tmp/kolmacllc_web.pdf

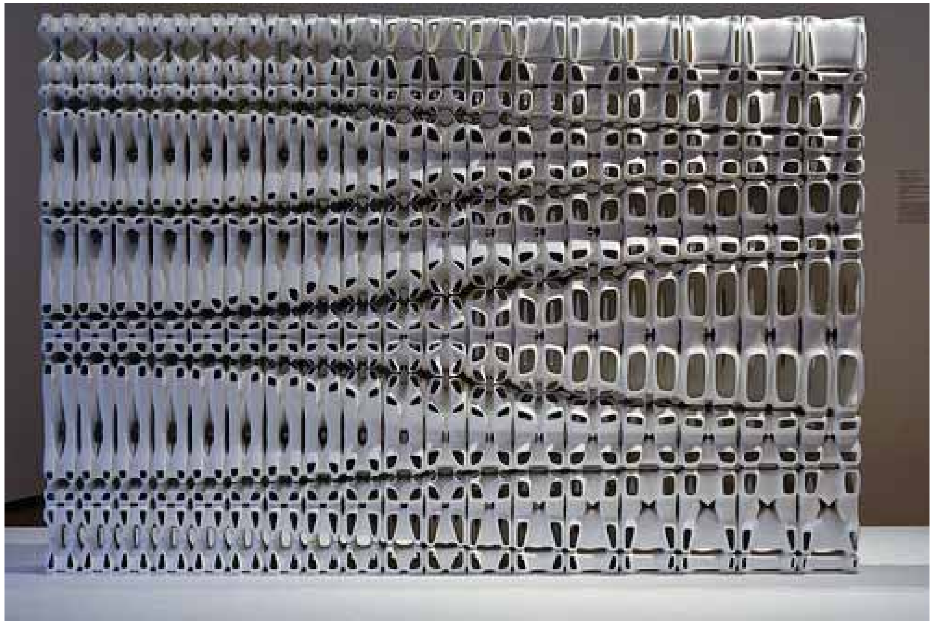
KOL/MAC - INVERSABrain
source http://www.core77.com/gallery/safe-design-takes-on-risk/10.asp

יתרונות:

1. שימוש בקוריאן- חומר עמיד בפני כדורים ופצצות. תלת המימדיות של התא יוצר רב שכבתיות שנותנת הגנה
2. מספר רב של תאים, כאשר לכל תא יש פרפורמנס אחר: ניקוי מים, אוויק, הפיכת אור לאנרגיה
3. תלת המימדיות של התא מאפשרת נפח אחסון ופילטריזציה גדולים
4. קונסטרוקציה קלה המבוססיה על העקרונות הקונסטרוקטיביים של בועות סבון

,Migrating Formations \\ CAP \\ Moma, New York

Commissioned by the Museum of Modern Art for the exhibition “Home Delivery: Fabricating the Modern Dwelling.”
A series of wall cavities vary in size, depth and articulation, and subsequently differ in their ability to transmit light and express the system’s own nonrepetitive, morphing pattern.
The project explores the potential of digital design’s ability to produce building elements en masse, particularly for housing, incorporating ample opportunity for customization without significantly affecting cost.



CAP - Migrating Formations 2008
source http://flickriver.com/photos/scottnorsworthy/2991223494/

יתרונות:

1. קיר קונסטרוקטיבי שנושא את עצמו ללא צורך בעמודים וקורות
2. עי ידי שינוי פרמטרי בקוד ניתן ”להכווין“ את העומסים באופן הרצוי לאורך הקיר
3. מאפשר משחק באור וצל ושימוש בחללים הנוצרים בחזית

The water cube \\ PTW Architects \\ Beijing, China

המבנה מכיל ששת אלפים מקומות ישיבה קבועים ועוד אחד עשר מקומות ישיבה ארעיים נוספים. מעטפת המבנה מורכבת מכ22 אלף תאים המחקים בועות סבון. מחזוריות התאים עוקבת אחר ”מבנה וייר-פלן“, המהווה את הפתרון הטוב ביותר הידוע כיום ל“בעיית קלווין“ (מציאת הפאון המרכיב את מבנה בועות הסבון). את צורת הבועות יצרו קורות מתכת שעליהן סוג של טפלון שקוף למחצה) מלאים באוויר, כך שהמעטפת -ETFE) הונחו כיסי פלסטיק מצמצמת את בזבוז האנרגיה בבנין- הכיסים מבודדים היטב והאנרגיה הסולארית שנאגרת בהם משמשת גם ליצירת ”חממה“ יעילה לחימום החלל הפנימי וגם לחימום הבריכות. מכיוון שכמות מי הגשם לא ניתנת לצפייה מראש, מי הבריכות יעברו תהליך טיהור לשימוש חוזר. בחללו המרכזי הוקמו חמש בריכות, כולל בריכה אחת ענקית שגודלה הוא פי ששה מבריכה אולימפית רגילה. מסביב הוקמה מסעדה בצורה מעוגלת שמתעגלת כבועה טבעית. . משקלם הנמוך של תאי הפלסטיק (כאחוז ממשקל המעטפת אם הייתה בנויה מזכוכית) מבטלת את הצורת בקונסטרוקציה משנית. הקירות חצי שקופים, מה שמאפשר חדירת אור ומצמצם את צריכת האנרגיה של המבנה. גמישות הקונסטרוקציה מתאימה לתנועות הקרקע העלולות להתרחש מתחת למבנה. המתכננים מצפים כי במקרה של רעידות אדמה, המתרחשות מידי פעם באזור זה, המבנה יתנהג כמתוכנן ולא יגרם לו כל נזק.

PTW Architects -The water cube, Beijing, China
source :Burry, J., Burry, M., 2010. The New Mathematics of Architecture. Thames & Hudson.

יתרונות:

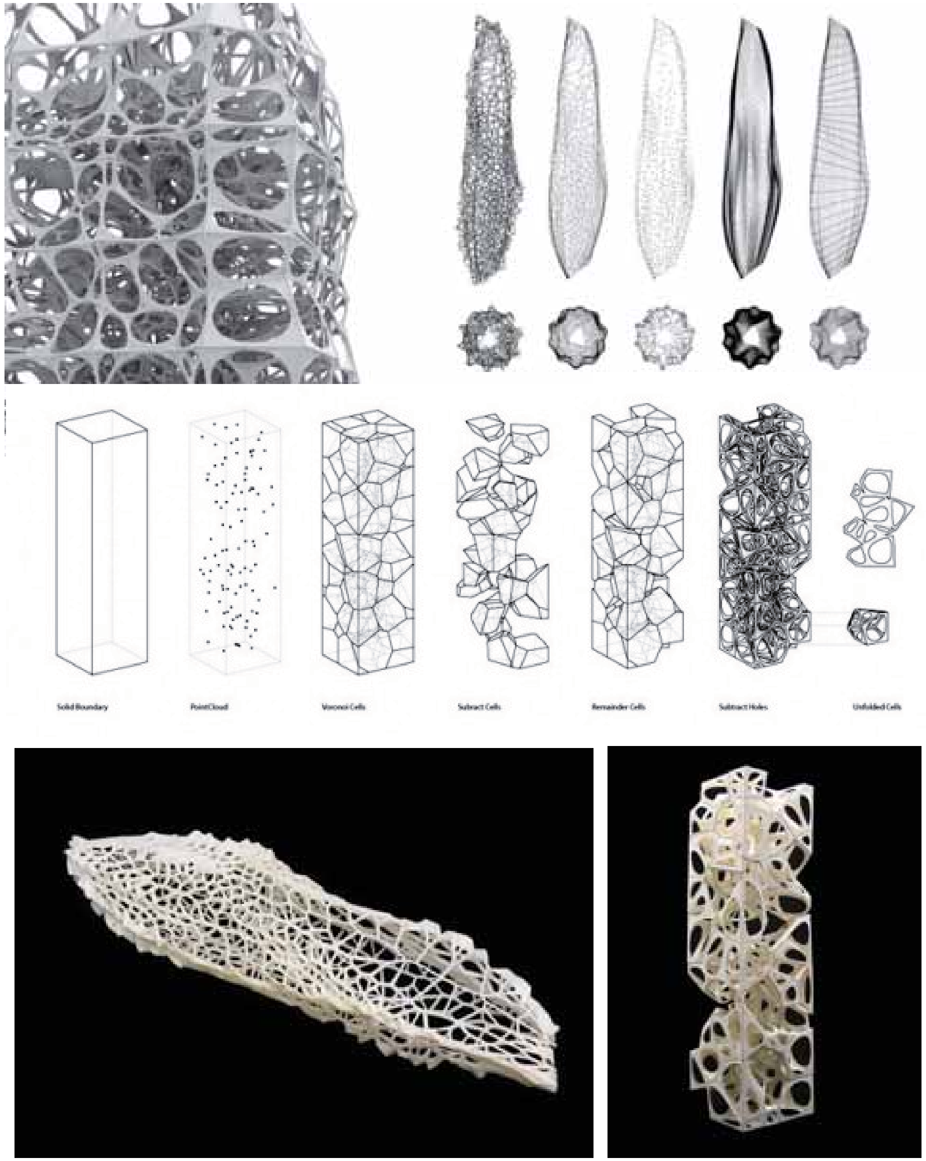
1. קיר קונסטרוקטיבי שנושא את עצמו ללא צורך בעמודים וקורות
2. חיסכון רב בחומר
3. יתרון אקלימי- החללים בתוך הבועות מאפשרים בידוד
4. ניתן להתשמש בחללים אלה באופנים שונים בעתיד

VORONOI MORPHOLOGIES \\ Jelle Feringa of EZCT Architecture and Design Research \\ Columbus, Ohio

Voronoi Morphologies is the latest development in an ongoing area of research into cellular aggregate structures. The voronoi algorithm is used in a wide range of fields including satellite navigation, animal habitat mapping, and urban planning as it can easily adapt to local contingent conditions. Within our research, it is used as a tool to facilitate the translation and materialization of data from particle-simulations and other point-based data into volumetric form. Through this process, it becomes much easier to produce highly differentiated structures that are responsive to local performance criteria.
The project was developed though both 2D and 3D voronoi cellular structures. In both cases, a field of points is used to determine regions of space, or cells, that are closer to a certain point than any other point. As the cells are not constrained by a fixed geometric topology, the cells properties can be tuned in much more specific ways than a tradition rectangular or hexagonal cell arrangement. A custom-designed script was written to connect Rhino with Qhull which did the actual voronoi calculations. The script also digitally unfolds, labels, and prepares the geometry for CNC fabrication.

יתרונות:

1. קיר קונסטרוקטיבי שנושא את עצמו ללא צורך בעמודים וקורות
2. תלת המימדיות של הקיר מאפשר שימוש בחללים הנוצרים בתוך התא,
השינוי בגודל התא מאפשר שימושים שונים ו"מילוי" של חלק מהתאים
3. ניתן לשלוט על ידי שינוי פרמטרי באופן שבו מועברים העומסים דרך הקיר
ולחסוך בחומר רב



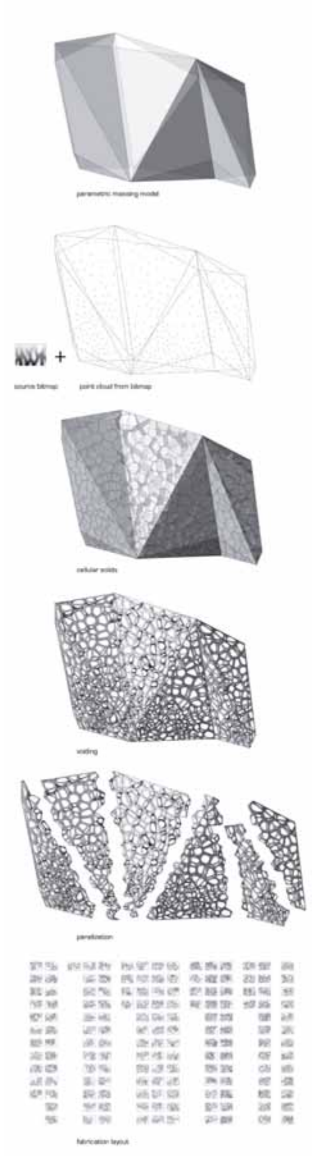
Jelle Feringa of EZCT Architecture and Design Research - VORONOI MORPHOLOGIES, Columbus, Ohio, 2005-6
source : http://matsysdesign.com/tag/digital-fabrication/

C_Wall \\ Banvard Gallery, Knowlton School of Architecture, Ohio State University, Columbus, Ohio

This project is the latest development in an ongoing area of research into cellular aggregate structures that has examined honeycomb and voronoi geometries and their ability to produce interesting structural, thermal, and visual performances. The voronoi algorithm is used in a wide range of fields including satellite navigation, animal habitat mapping, and urban planning as it can easily adapt to local contingent conditions. Within our research, it is used as a tool to facilitate the translation and materialization of data from particle-simulations and other point-based data. Through this operation, points are transformed into volumetric cells which can be unfolded, CNC cut, and reassembled into larger aggregates.

יתרונות:

1. קיר קונסטרוקטיבי שנושא את עצמו ללא צורך בעמודים וקורות
2. ניתן לשלוט על ידי שינוי פרמטרי באופן שבו מועברים העומסים דרך הקיר וכך ניחתן לבנות קירות בעלי גאומטריה תלת מימדית מורכבת בהם העומסים מועברים בצורה לא רגולרית
3. תלת המימדיות של הקיר מאפשר שימוש בחללים הנוצרים בתוך התא, השינוי בגודל התא מאפשר שימושים שונים ו"מילוי" של חלק מהתאים



C_Wall , Banvard Gallery, Knowlton School of Architecture, Ohio State University, Columbus, Ohio
source : http://matsysdesign.com/tag/digital-fabrication/

Monocoque II // Neri Oxman // Museum of Modern Art, NY

Architect and designer Neri Oxman is assistant professor of media arts and sciences at the MIT Media Lab, where she directs the Mediated Matter research group. Her group explores how digital design and fabrication technologies mediate between matter and environment to radically transform the design and construction of objects, buildings, and systems

French for “single shell,” Monocoque stands for a construction technique that supports structural load using an object’s external skin. Contrary to the traditional design of building skins that distinguish between internal structural frameworks and non-bearing skin elements, this approach promotes heterogeneity and differentiation of material properties. The project demonstrates the notion of a structural skin using a Voronoi pattern, the density of which corresponds to multi-scalar loading conditions. The distribution of shear-stress lines and surface pressure is embodied in the allocation and relative thickness of the vein-like elements built into the skin. Its innovative 3D printing technology provides for the ability to print parts and assemblies made of multiple materials within a single build, as well as to create composite materials that present preset combinations of mechanical properties. Photos: Mikey Siegel

יתרונות:

1. מבנה המאפשר שימוש בחומר אחד וסכמה "מונוליטית"- במקום מספר רכיבים קונסטרוקטיביים המבנה בנוי מאלמנט מסוג אחד הנושא את עצמו
2. ניצול מירבי של חומר- אין "מילואה" בלתי קונסטרקטיבית, וכל החומר מקבל את כל התפקידים השונים של מעטפת המבנה

Neri Oxman - Monocoque II, Museum of Modern Art, NY, 2007
source :http://web.media.mit.edu/~neri/site/projects/monocoque2/monocoque2.html

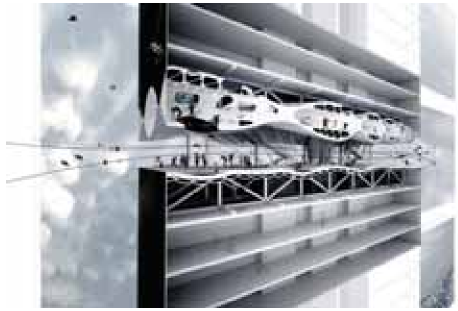
Super Galaxy // FUTURE CITIES LAB // Competition Entry, New York, NY

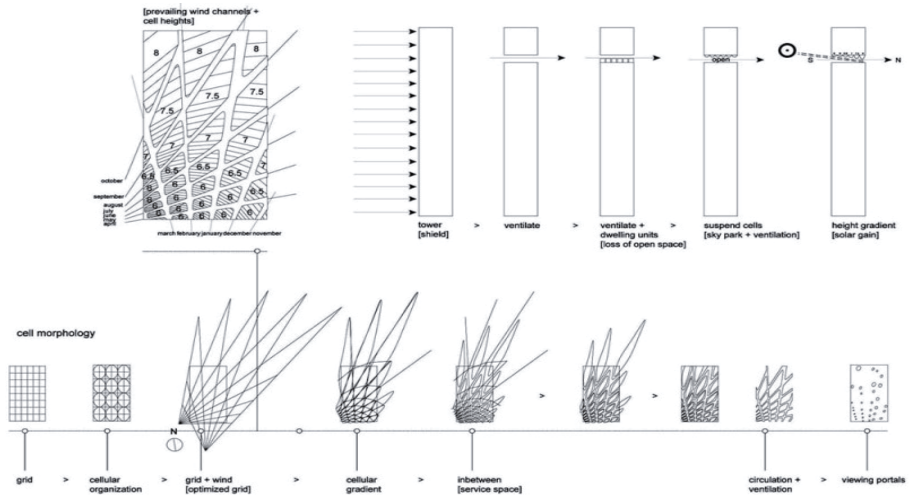
Future Cities Lab is an experimental design and research office based in San Francisco, California and Athens, Greece. Design principals Jason Kelly Johnson and Nataly Gattegno have collaborated on a range of award-winning projects exploring the intersections of design with advanced fabrication technologies, robotics, responsive building systems and public space.

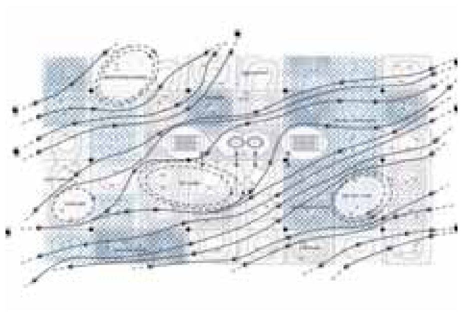
Super Galaxy is an architectural system saturated in atmospheric and electronic phenomena. It is a nomadic enclave in an endless state of spatial and material flux. As it fluctuates between states of varying coherence (solidity, liquidity, and gaseousness), its inner structure maintains an invisible, yet definable pattern. It is a responsive system capable of dynamically interacting with its surroundings on many levels. It is in a constant state of motion as it calibrates and recalibrates relative to both real-time global datasets (weather, pollution, warfare, etc.) and local datasets (desired micro-climates, heat exchange, light and sound).

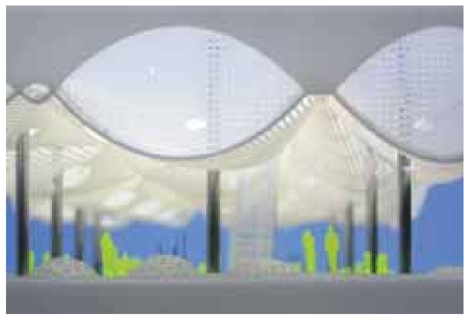
יתרונות:

החלוקה לתאים מאפשרת איזור ושינויים פרוגרמטיים, אסטטים, עיצוביים וביצועיים- לכל תא יש יכולת להשתנות ולהגיב לסביבתו הייחודית ו/או להשתנות ולקבל תפקודים חדשים על ידי המשתמשים









FUTURE CITIES LAB -Super Galaxy, Competition Entry, New York, NY, 2006
source : http://www.future-cities-lab.net/supergalaxy/

Thermaespheres // FUTURE CITIES LAB // Athens, Greece

Future Cities Lab is an experimental design and research office based in San Francisco, California and Athens, Greece. Design principals Jason Kelly Johnson and Nataly Gattegno have collaborated on a range of award-winning projects exploring the intersections of design with advanced fabrication technologies, robotics, responsive building systems and public space.

Public Pavilion

Thermaespheres is a proposal for a public thermal bath and event pavilion facing the sea. It contains three distinct microclimates – the “caldarium” (hot), the “tepidarium” (warm) and the “frigidarium” (cold). These three intersecting domed spaces are surrounded by a light-weight shade canopy that serves as an urban threshold, public promenade, solar energy collector and microclimate generator. The structural system was developed through a series of catenary experiments that describe the structural and microclimatic performance of the canopy.

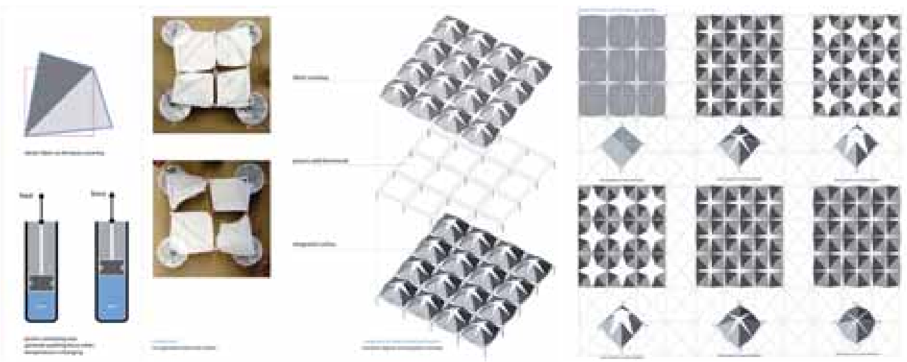
יתרונות:

התאים מגיבים לסכמת הכוחות וסכמה מיקרו-אקלימית של הכיפה והסככה הקלה ומאפשרים אפוטמיזציה של ניצול החומר ושל בקרת האקלים.

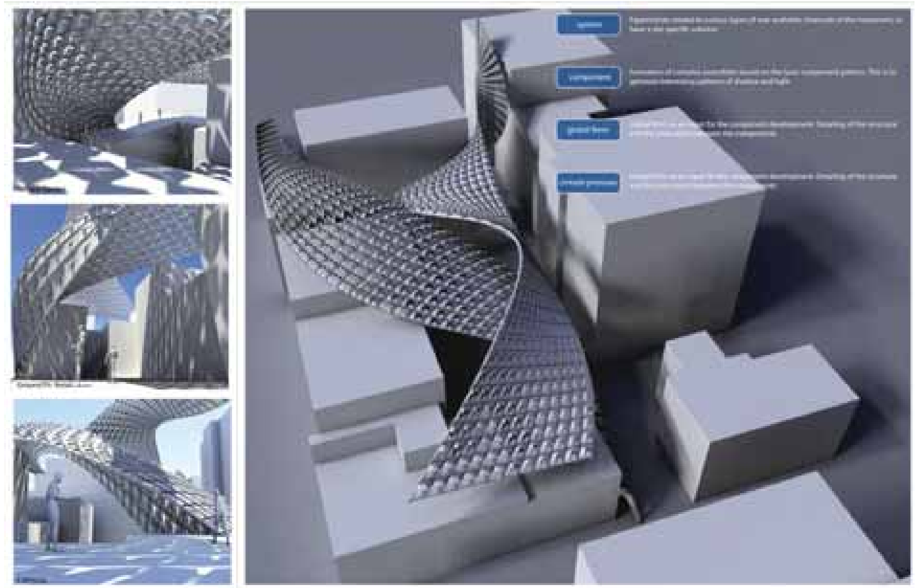
FUTURE CITIES LAB -Thermaespheres, Athens, Greece, 2011
source : http://www.future-cities-lab.net/thermaespheres/

Active Wax System // AA EMTech

Exploring design possibilities of the environment-responsive system was one of the key aspects of the project. Athens, having a hot climate and scorching heat, allowed for temperature variation to be the activator for the system. The system is based on the principle of expansion and contraction of mineral wax with the variation in heat. This principle has been used in auto-vents which are installed in greenhouses to automatically control the airflow based on temperature change. The opener has a metal cylinder containing a mineral wax which expands with heat pushing a piston that opens the vent. As the temperature cools, the wax shrinks and closes the vent. The project incorporates this basic mechanism in developing a component that is responsive to temperature variation. The component closes when the temperature is high and opens up when the temperature decreases. The design parameter of the component is the pivot distance. At the same temperature, but with different pivot distances, variation in the amount of opening and closing can be achieved. The active parameter of the system is the movement of the piston, dependent on temperature variation. Components with the same pivot distance would show a difference in the opening pattern depending on their local temperature variation bringing about a dynamic spatial quality. The radiation pattern determined the placement of functions on the site. These functions act as attractor points for generating global form.

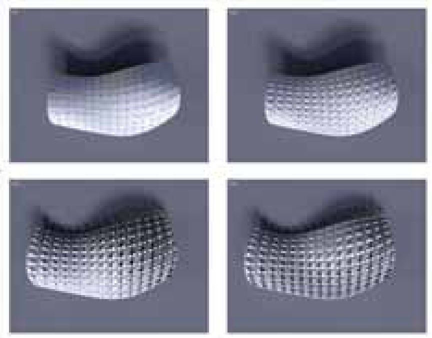


AA EMTech -Active Wax System
source :http://emtech.aaschool.ac.uk/core-studio/core-2/activewax/



יתרונות:

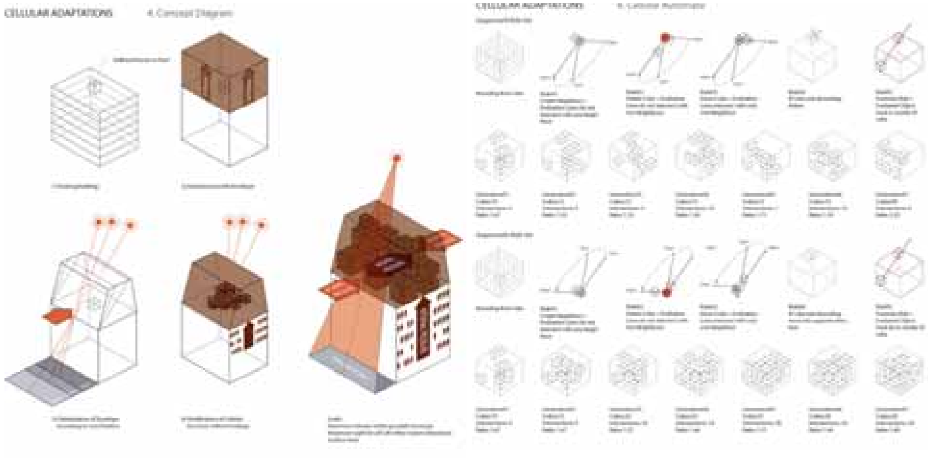
1. התאים מאפשרים יצירת גאומטריה מורכבת של החזית
2. המנגנון שפותח וסוגר את התאים מאפשר התאמה סימולטנית ואטומטית של המבנה לאקלים המשתנה ללא מנגנון חשמלי וחוסכת אנרגיה במיזוג המבנה
3. ניתן להתאים את התאים לאקלימים שונים על ידי שינוי פרמטרי של גודל התאים ושל רדיוס הפתיחה שלהם



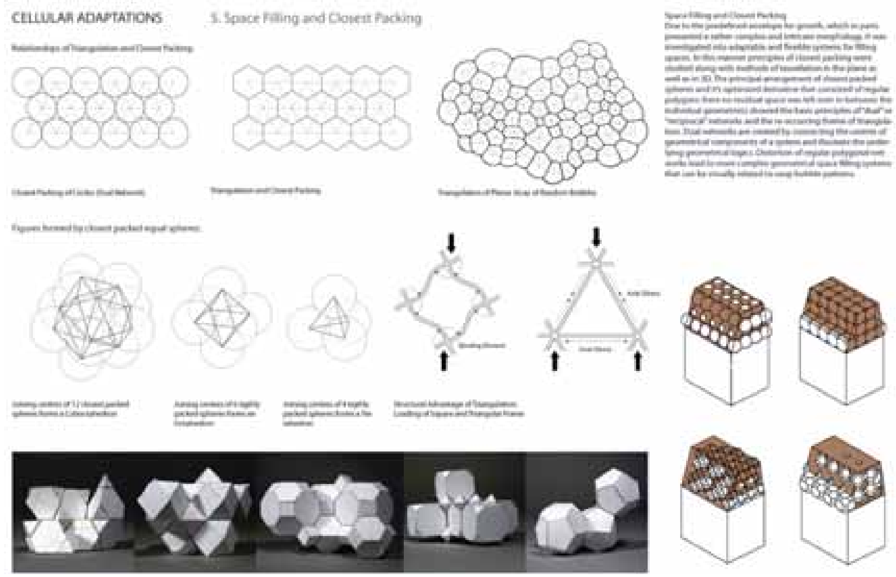
AA EMTech -Active Wax System
source :http://emtech.aaschool.ac.uk/core-studio/core-2/activewax/

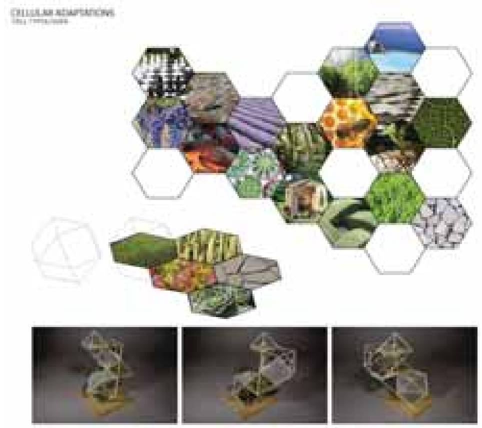
Cellular Adaptations // AA EMTech

Cellular Adaptations proposes an urban intervention in the heart of Athens. It intends to improve the conditions of a given site by creating new “green” spaces on top of existing buildings. It is envisioned that local residents should benefit from these spaces without impairing the existing climatic conditions of the site. In order to achieve this a set of intrinsic rules was established which regulated the size and growth patterns of newly created spaces. In most cases it is assumed that flats have balconies that project into the courtyard which itself is seen as a non-developed urban space, which is mostly used for parking and other non-social activities. Buildings typically have flat roofs that are generally not being used by residents either.



AA EMTech -Active Wax System
source :http://emtech.aaschool.ac.uk/core-studio/core-2/activewax/





יתרונות:

1. התאים מאפשרים יצירת גאומטריה מורכבת של החזית
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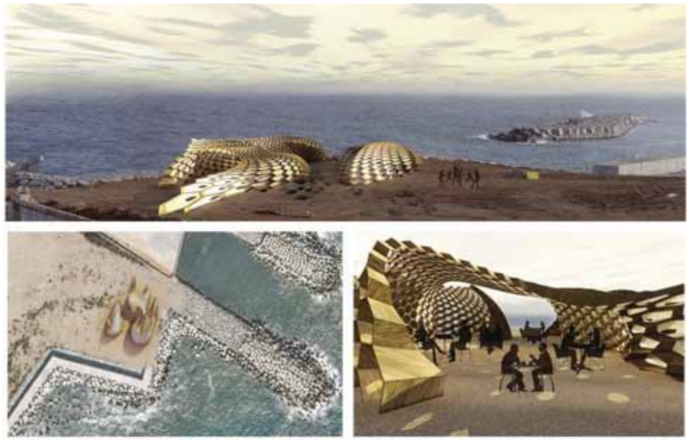
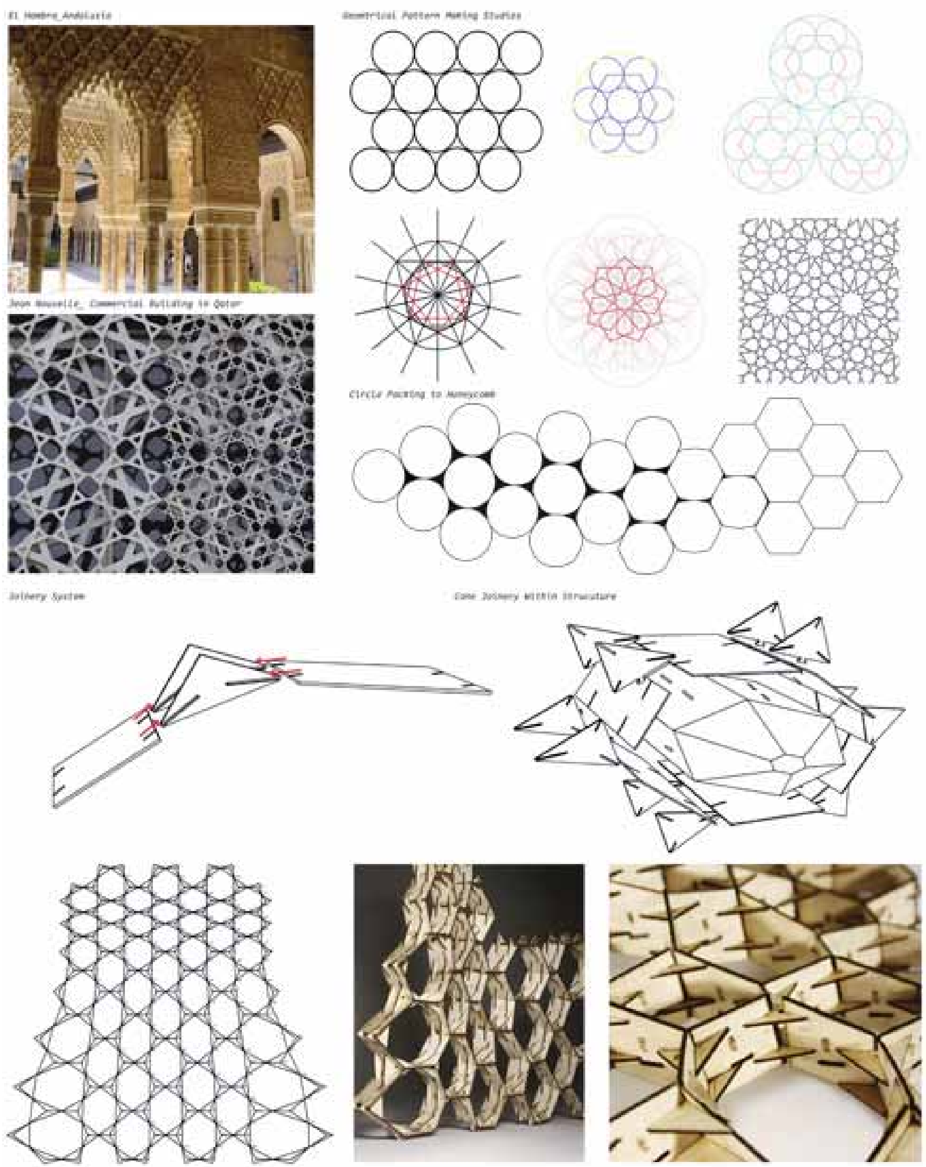
AA EMTech -Active Wax System
source :http://emtech.aaschool.ac.uk/core-studio/core-2/activewax/

Screenwall Pavilion // AA EMTech

The research process was directed towards studying Islamic patterns and their applications in screenwalls. The lattice craftsman began his design using circles in a hexagonal packing order as a guideline; the circle containing within it all other geometries guaranteed infinite possibilities of potential patterns. Connecting the radii and overlapping produced the complex patterns.
In order to maximize the amount of geometries in a given area, the circles have to morph into a more angulated geometry, minimizing the gaps between the packed geometries. The closest relative to the circle is the hexagon, which also allows for more possibilities of fabrication.
We investigated the geometries within the hexagon to generate a system of construction and light modulation. The first solution to stiffen the structure was to triangulate the angles of the hexagons. That could be done by joining the sides of the hexagon, which would be acting at different angles and planes to achieve the global curvature of the wall.
The hexagon is fixed with a cone extruded from the sides of the triangles, acting as the light-modulating tool within the system. The cones within different hierarchies in the wall would have different apertures according to the amount of sunlight hitting the surface. These different variations of the cone would be generated parametrically in order to achieve a gradient of performative differentiation across the pavilion spaces. Our goal was to create shaded spaces into which pleasant light is drawn to achieve a dramatic experience.



AA EMTech -Screenwall Pavilion
source :http://emtech.aaschool.ac.uk/2011/01/22/screenwall-pavilion/



AA EMTech -Screenwall Pavilion
source :http://emtech.aaschool.ac.uk/2011/01/22/screenwall-pavilion/

השראה תאית: קבוצות מחקר מהעולם

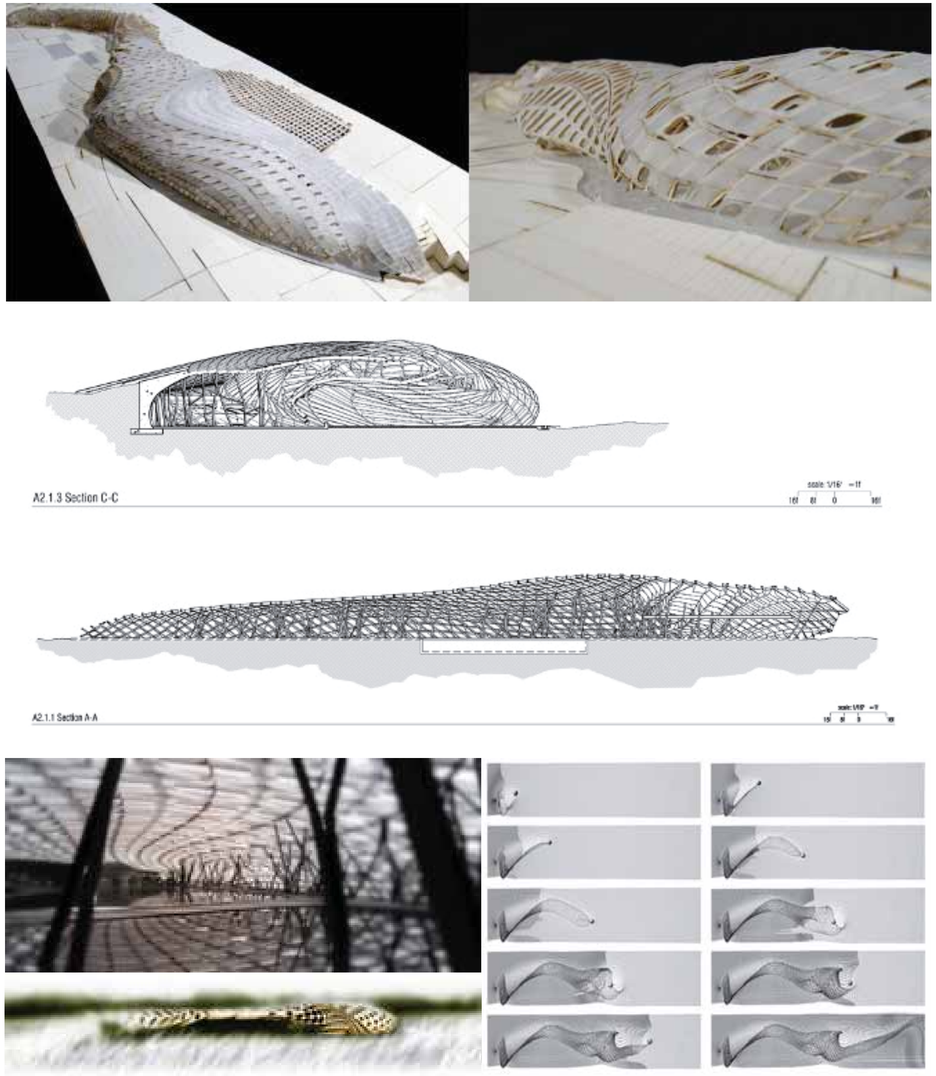
Float // Francis Bitonti (Francis Bitonti Studio) Brian Osborn (bo-th) Severn Clay(lesbetes) // Melbourne, Australia

Float envisions a natatorium for a developing community near Sydney, Australia and includes two Olympic standard competition swimming and diving pools, gym and fitness studios, and a variety of supporting programmatic facilities.

The structure touches down only lightly over a two-inch sheet of water on the other—saturating much of the first floor interior, acting as a thermal moderator, and prompting a series of wood boardwalks to accommodate both egress and accessibility. Clad by a double-membrane fabric façade, the proposal is predominately open-air and utilizes passive mechanics to equalize comfort in the arid Australian climate.

יתרונות:

החלוקה לתאים מאפשרת בניה והרכבה של הגאומטריה המורכבת של המבנה, והחיפוי של ממברנות הבד הדקות הניתנות לפתיחה וסגירה הופכת את המבנה למבנה חצי פתוח שמסוגל להתאים את עצמו לאקלים החם והמשתנה של אוסטרליה.



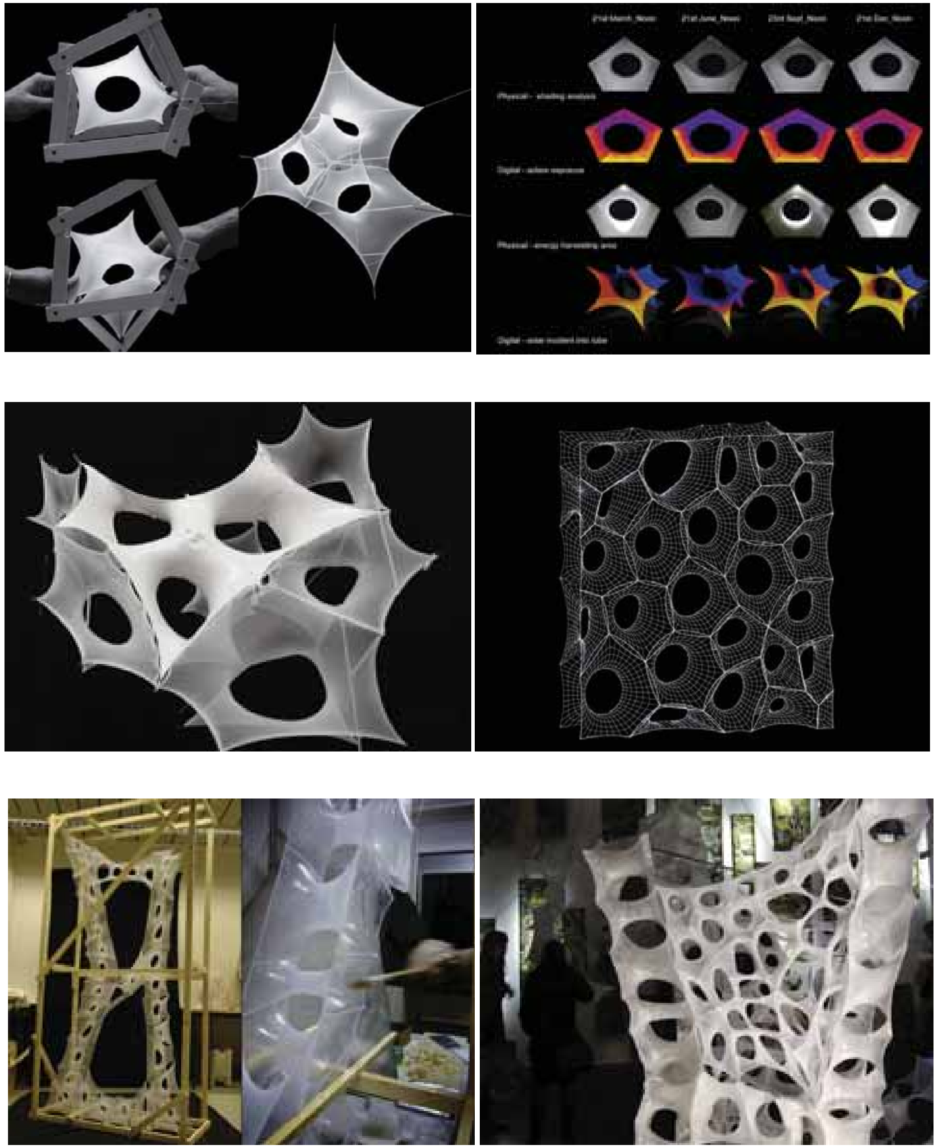
Francis Bitonti (Francis Bitonti Studio) Brian Osborn (bo-th) Severn Clay(lesbetes) - Float, Melbourne, Australia
source : http://francisbitonti.com/FLOAT

Cylindrical Membrane Morphologies // ICD Design Studio
Prof. A. Menges, S. Ahlquist // ICD Stuttgart University

This project pursues the study of a micro tensioned element that is highly flexible in its form and constellation, easily connectible and geometrical aligned but at the same time appears organically and randomly arranged. A system is developed consisting of an easy geometrical principle, which becomes more complex through minor deformation of the single element, and can be materialized as a membrane tensile element or a stiffened fibre-composite cell. Through this process the single element can be highly differentiated by several ways of manipulation and reaction to different parameters, and instrumentalized for particular environmental conditions. At the same time, it can retain control of the overall building concept accommodating larger and more complex structures.

יתרונות:

מבני המתיחה גמישים מאוד בצורתם ובקונסטלציה שלהם, קלים לחיבור ולסידור במרחב ובכך מאפשרים יצירת מבנים בעלי גאומטריה מורכבת. בגלל המתיחה קיימת תלות צורנית בין תא אחד למשנהו מה שמאפשר שינוי פרמטרי סימולטני של כל המבנה באופן פשוט יחסית.

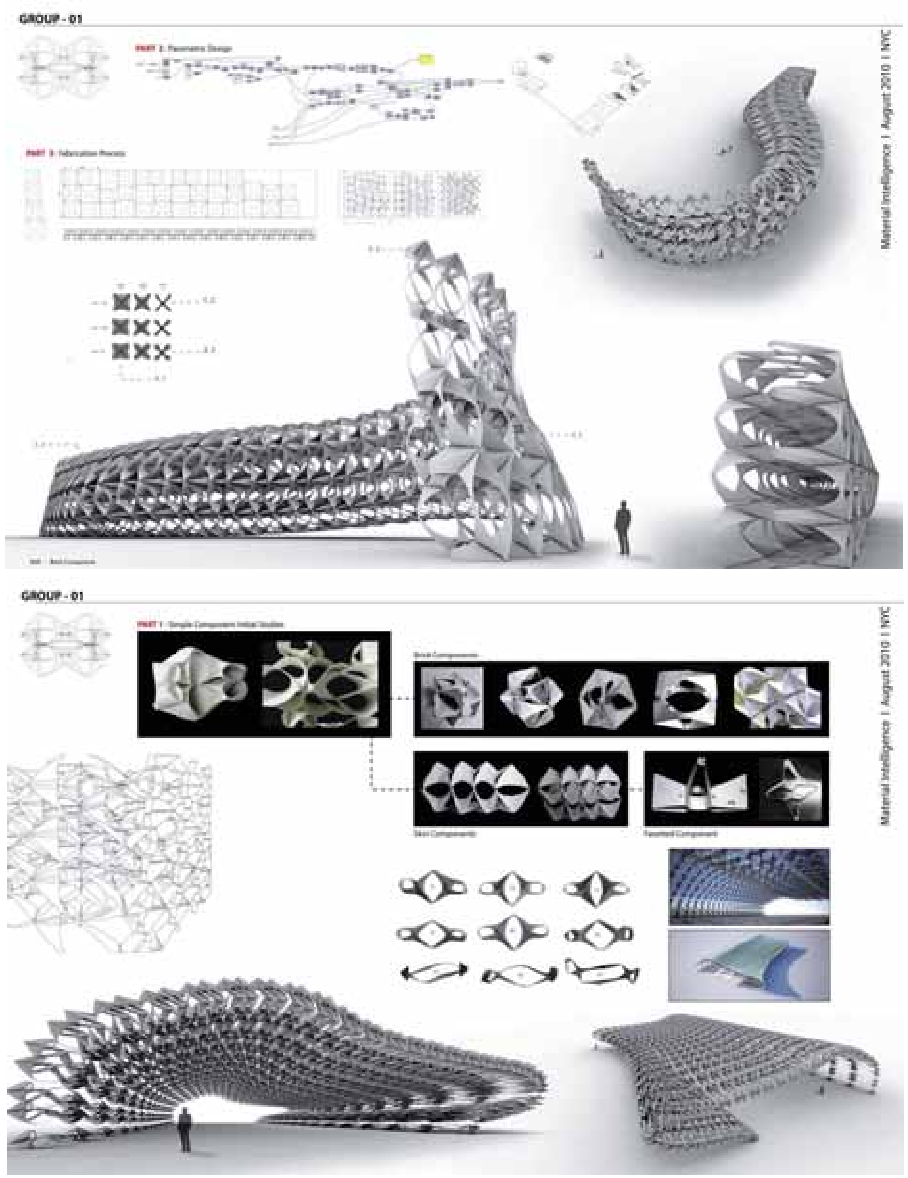


CD Design Studio (Prof. A. Menges, S. Ahlquist) - Cylindrical Membrane Morphologies ,
CD Stuttgart University, 2010
source : http://www.achimmenges.net/?p=4703

השראה תאית: קבוצות מחקר מהעולם

Material Intelligence Workshop

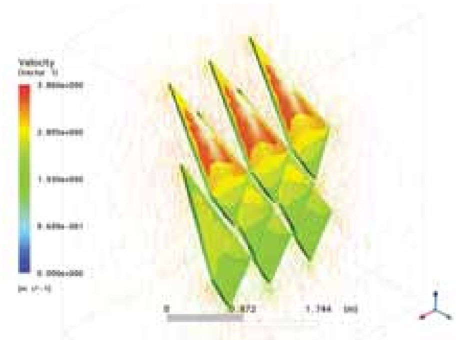
Material Intelligence is a one-week intensive design and prototyping workshop to be held in New York City during the week of August 16-20.
This is the group work that we developed at the Material intelligence workshop. The goal of the project was to explore different parametric features in a system made of differentiated components, as well as including the potential material for design innovation. Through iterative work flows with an emphasis placed on material prototyping, an installation was designed integrating digital parametric design and fabrication. The equipment used included an industrial CNC 3-axis Mill and CNC High-Force Cutter, The primary CAD platform used was Grasshopper for Rhino3D, supported by a suite of associated programs including Rhino Cam, RhinoNest, and Brazil Render.



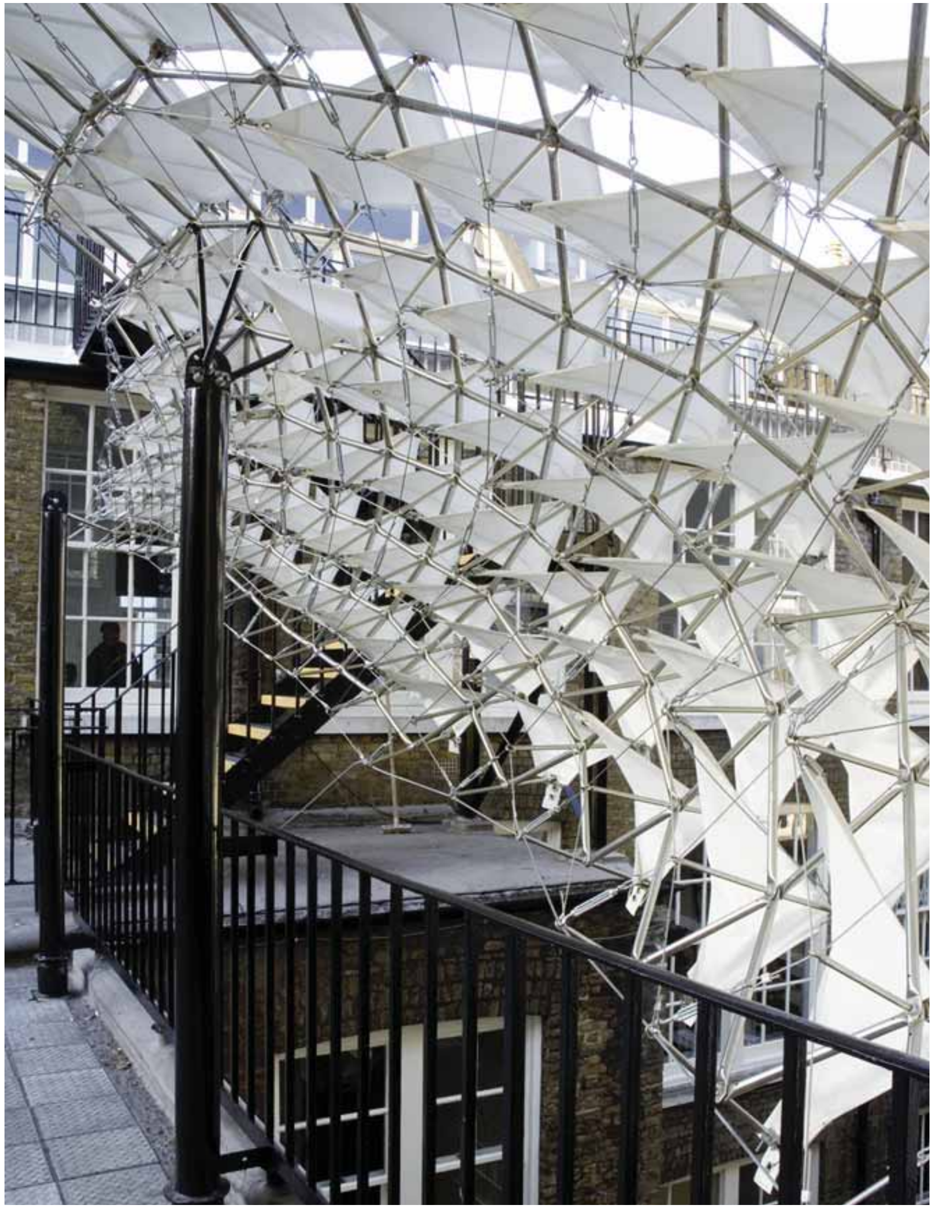
C_Wall , Banvard Gallery, Knowlton School of Architecture, Ohio State University, Columbus, Ohio
source : http://matsysdesign.com/tag/digital-fabrication/

Membrane Canopy // AA EMTech

The AA Membrane canopy was designed by the EmTech Programme 2006/2007. he project was completed for the end-of-year Projects Review at the Architectural Association School of Architecture with the intention to remain for a lifespan of two years, and to function as a canopy for the roof terrace of the School.
The canopy was a highly differentiated cantilevered structure resting on just three points and comprised of fabric membranes and steel members. The individual lengths and bending angles of the steel rods, which are the compressive elements of the canopy, define the global geometry, while the membrane elements act in tension and allow permeability. The overall morphology consisted of 150 membranes and 650 geometrically different steel elements. Parametric modelling, developed using Generative Components software, underlined the entire design process by facilitating a seamless interdisciplinary exchange between the architects and engineers, enhancing the integrity of the design. The associate modelling software enabled a significant level of control over an intensely complex structure through a hierarchical build-up of parametric relationships in tandem with certain control mechanisms. The model was continually updated using interpolated data from the engineering analyses regarding global geometric strategy, local and global population densities, force vector paths and structural depths.



AA EMTech -Membrane Canopy 2007
source :http://emtech.aaschool.ac.uk/2010/10/24/membrane-canopy-2007/

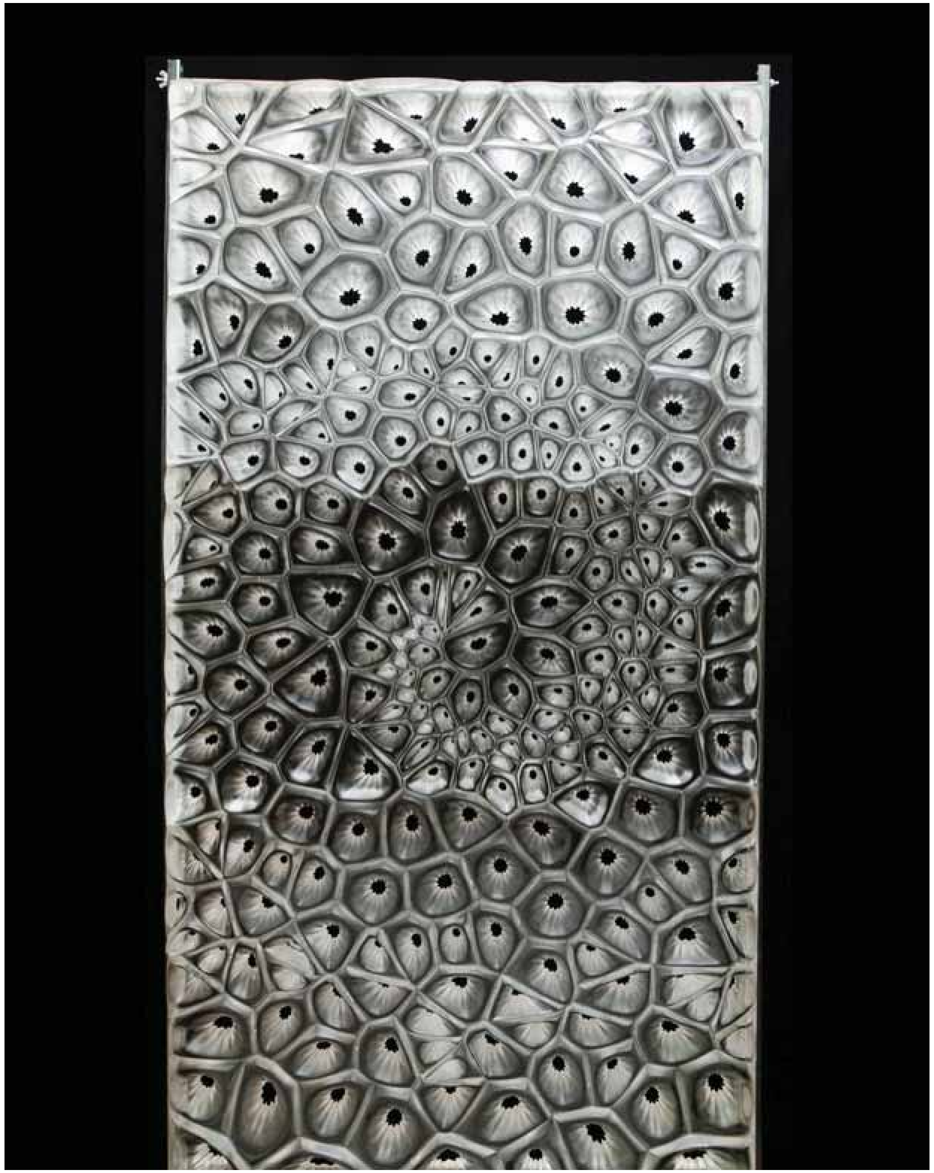


AA EMTech -Membrane Canopy 2007
source :http://emtech.aaschool.ac.uk/2010/10/24/membrane-canopy-2007/

השראה תאית: קבוצות מחקר מהעולם: פבריקציה

Stalasso // Neri Oxman // Museum of Science, Boston

Mineralization processes form many natural structures and introduce metals, such as gold, into a rock. The resulting rock composition is stiffer and stronger. By using the ratio of stiff to soft materials, Stalasso mimics these mineralization processes for design purposes. This leads to construction based on performance requirements. For example, a bed, a table or a building’s ceiling could be tailored to respond to different weights across its surface according to specific requirements and preferences.



Neri Oxman - Stalasso Museum of Science, Boston
source :http://web.media.mit.edu/~neri/site/projects/monocoque2/monocoque2.html

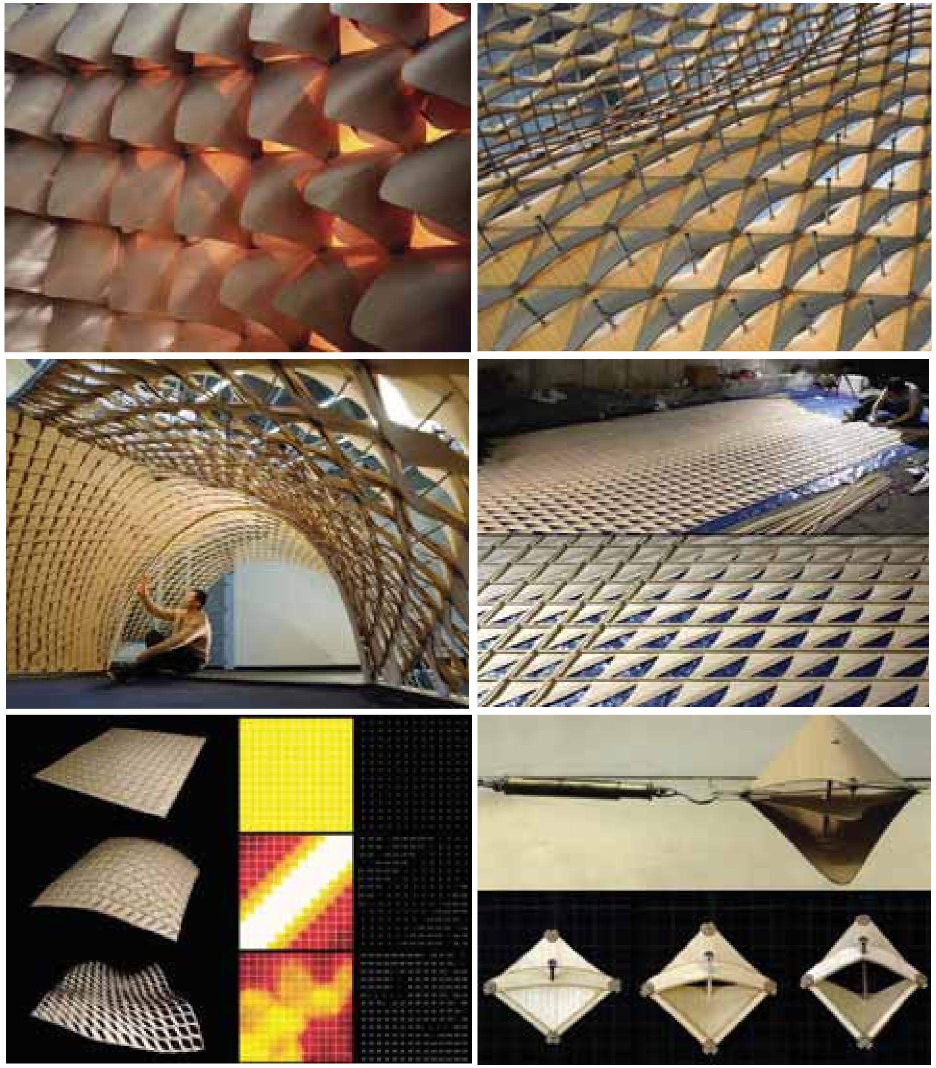
השראה תאית: קבוצות מחקר מהעולם : פבריקציה

Differentiated Wood Lattice Shell // Performative Wood Studio // Harvard University Graduate School of Design

. The first research objective of this project was to extend the range of possible lattice geometries based on the bending behavior of wooden elements with varying cross-sectional dimensions along their length. Thus, a robotic water jet cutting technique was developed, that gradually reduces the cross section of such elements without damage to the perimeter fibres, reducing the risk of splitting during the subsequent bending process. Through the related fabrication variables, each wooden element's stiffness can now be adjusted by locally reducing its structural depth. This differentiation of the cross section allowed building up an entire catalogue of possible bending behavior of the lattice elements, which was computationally established based on a large number of physical tests. This information was embedded in computational design tool for form-finding the lattice shape in relation to the differential bending behavior of its members, which also provides the fabrication data for constructing the initially planar grid.

The second research objective of this project was developing an alternative way of erecting such a flat lattice without the need for additional scaffolding or hoists. A stressed wooden skin was developed, which gradually forces the lattice into its structurally stable, double curved state by the local actuation of each skin element A local actuator element was developed consisting of two skin panels with additional diagonal members and a variable spacer bolt that can adjust the diagonal distance of each respective grid field. Based on detailed studies of the achievable actuation force and related element variables such as size, thickness and fibre orientation, actuator locations and required torque, a computational tool for deriving the related actuation protocol was developed and tested in a full scale prototype.

For the prototype construction, the robotically fabricated members with varying cross-section, together with the laser cut skin elements, are assembled as flat lattice. But once the actuators are adjusted according to the digitally derived protocol the lattice raises into its computationally defined, structurally stable, double curved form. Integrating the critical material characteristics and behavior of wood in the computational design process for both the local stressed skin actuators and the non-uniform bending behavior of elements with locally reduced stiffness allows for a more specific articulation of the lattice geometry. In the resulting structure, the differentiated transparency and articulation of the skin registers the embedded forces, which maintain equilibrium in the very thin, non-uniformly bend lattice



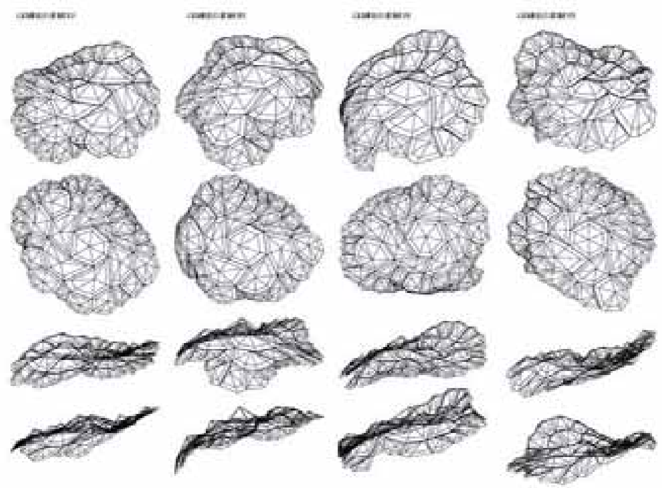
Performative Wood Studio (Visiting Prof. A. Menges) Jian Huang and Minhwan Park - Differentiated Wood Lattice Shell ,Harvard University Graduate School of Design, 2009
source : http://www.achimmenges.net/?p=4339

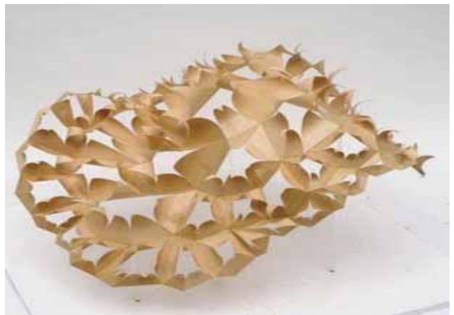
השראה תאית: קבוצות מחקר מהעולם: פבריקציה

Responsive Surface Structure II // Department of Form Generation and Materialisation (Prof. Achim Menges) // HFG Offenbach University of Art and Design, Germany

The second research phase of the Responsive Surface Structure project focused on the development of a more integral system that constitutes both the reactive skin and the load bearing structure within one material system. Through variations in local thickness and fibre direction it is possible to construct the system from wood laminates only. The ordering system of the four to seven sided polygonal elements is algorithmically derived. The computationally evolved surface structure allows for articulating globally doubly curved surfaces with varying densityof elements in response to different structural requirements.

A functional, full scale prototype was constructed and tested. Once exposed to changes in relative humidity the opening and closure of each local component results in different degrees of porosity over time and across the surface, which is both structure and responsive skin. This high level of integration of form, structure and material performance enables a direct response to environmental influences with no need for additional electronic or mechanical control.



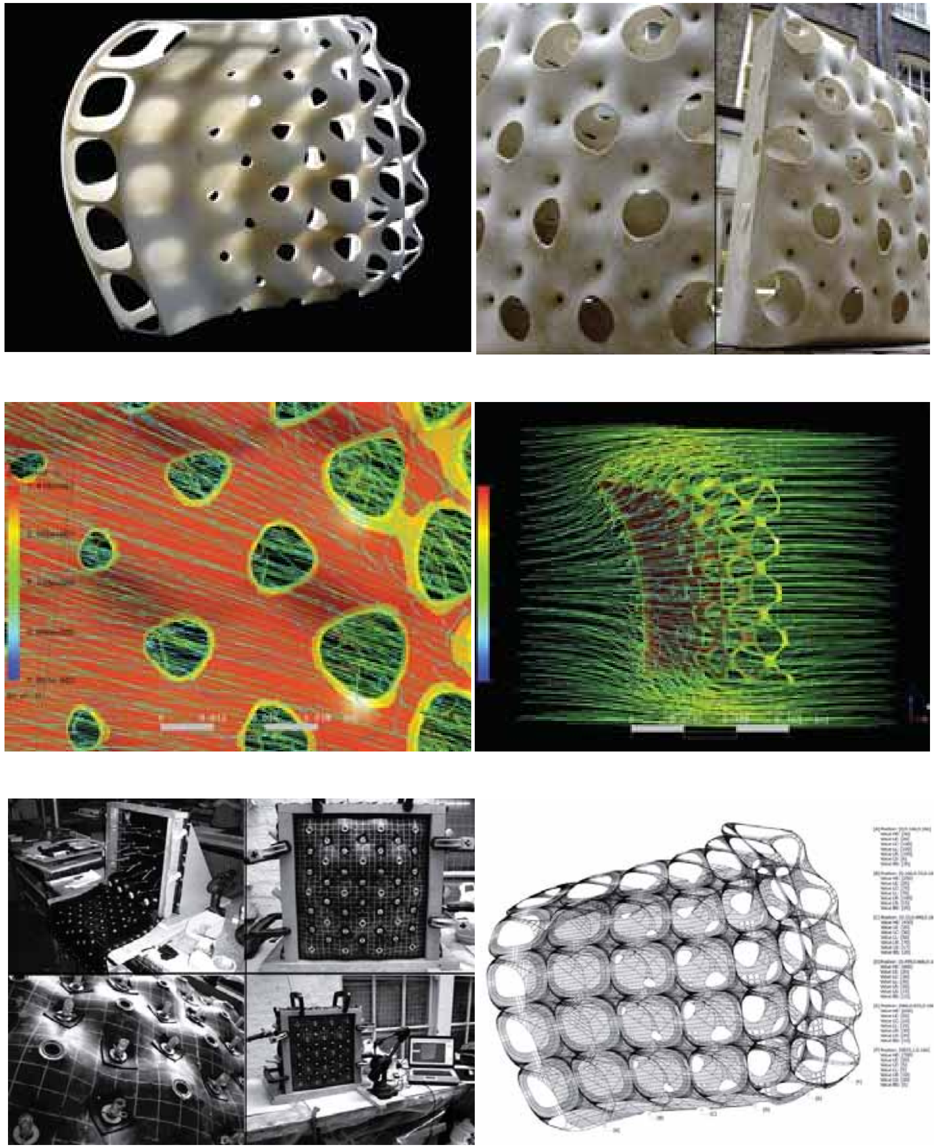


Department of Form Generation and Materialisation (Prof. Achim Menges) - Responsive Surface Structure II ,HFG Offenbach University of Art and Design, Germany 2008
source : http://www.achimmenges.net/?p=4339

השראה תאית: קבוצות מחקר מהעולם: פבריקציה

Porous Cast // AA Diploma Unit (Michael Hensel, Achim Menges)
Gabriel Sanchiz // Architectural Association, London

This research was fostered by an interest in the formation process of diatoms and radiolaria. Diatomes are unicellular or colonial algae. The cell is encased by a characteristic and highly differentiated cell wall, which is impregnated with silica. Radiolaria belong to the order of marine planktonic protozoans and feature a central protoplasm comprising chitinous capsule and siliceous spicules that are perforated by pores. The porous mass of the cell encasements of radiolaria and diatoms delivers an interesting model for differentiated cast walls in architecture that may feature a variety of specific performance capacities. The initial phase of the material system development focused on producing a skeletal framework articulated through the interstitial spaces left between pressurised containers, so-called pneus. A first series of experiments explored ways of casting plaster between air-filled cushions to achieve the typical shape of the mineralised skeletons between pneus that occurs in nature. A list of casting materials that feature different thermal characteristics was established. Physical experiments and digital analysis served to establish the possible range of light and airflow modulation relative to morphological features such as the size and density of pores and other characteristics of the material system. Subsequently a range of manufacturing approaches were tested, resulting in the production of a full-scale prototypical portion of the material system that integrated computer-aided manufacturing processes and pneumatic form-finding as a construction method. A approach finally chosen focused on strategizing a mould that would respond to the casting process and therefore deploy an element of material self-organisation. After several experiments with fabric moulds a rigid frame with an equally rigid back-panel was made. The back-panel supports an inflatable formwork, with pneus placed between two layers of rubber-sheet. The concrete was then cast between the two layers of rubber-sheet to fill the space between the pneus. An acrylic inlay in the frame allowed visual control of the casting process and the proper filling of the space between the pneus. The resulting cast is characterised by double-curvature, controlled porosity, and density and mass of the poured material. It can absorb thermal energy and release it to the airflow enabled by the porosity and the double-curvature can be utilised for thermal exposure or self-shading. Moreover, the artificial dichotomy between mass and lightness are brought into an interesting performative synergy.



AA Diploma Unit 4 (Michael Hensel, Achim Menges) Gabriel Sanchiz) -
Porous Cast , Architectural Association, London, 2005-0
source : http://www.achimmenges.net/?p=4703

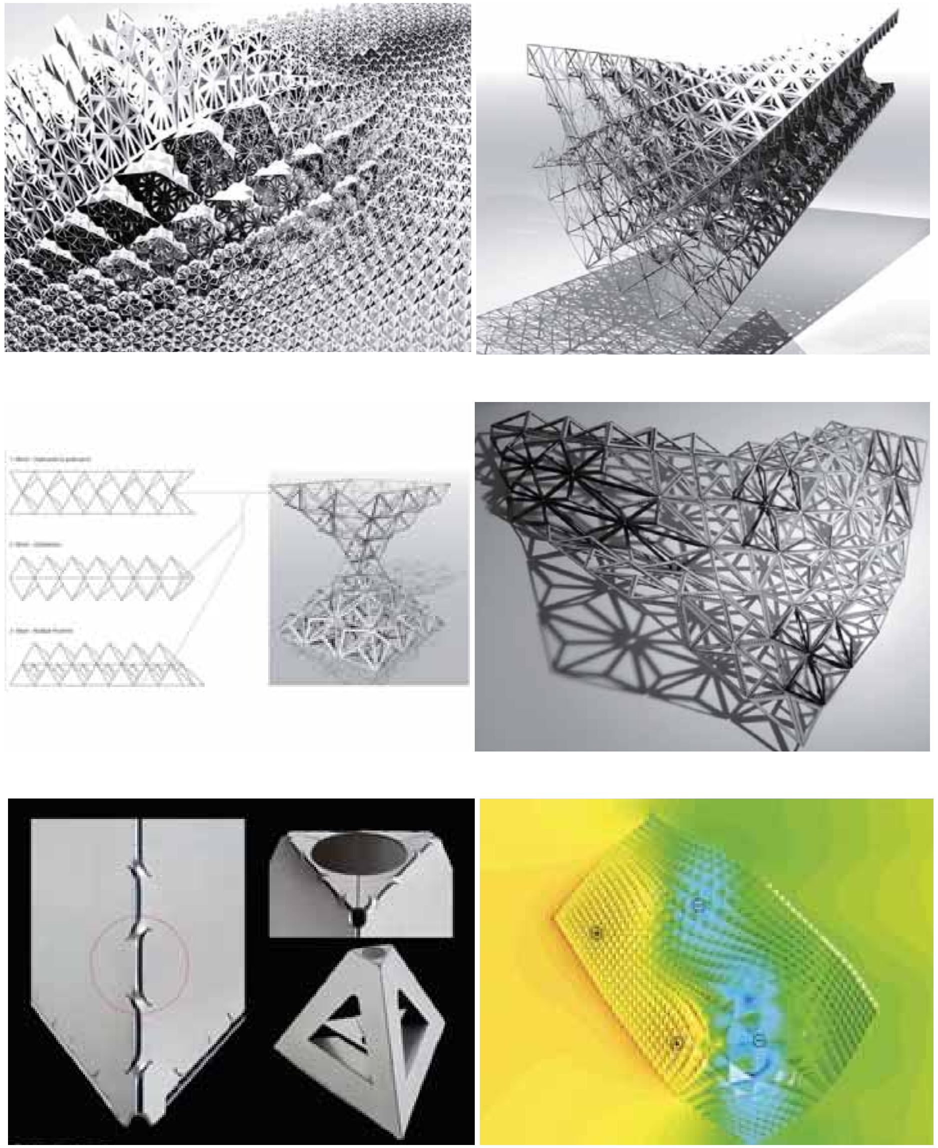
השראה תאית: קבוצות מחקר מהעולם: פבריקציה

Transitional Morphologies // AA Diploma Unit (Michael Hensel, Achim Menges) Dae Song Lee

This project examined strategies and methods to incrementally change an assembly from a vector-active to a surface-active structural system. The transition from space-frame to surface morphology offers a range of performative capacities through related changes of porosity. Finite Element analysis and Computer Fluid Dynamics analysis were used in order to establish the complex interrelation between the morphology of the system and its structural behaviour and environmental modulation. This process began with basic digital studies that simulated airflow around differently articulated single elements, varying the angles of the faces of the tetrahedrons and the size of aperture in each face, as well as the range of sizes within each element. Configurations consisting of a greater number of differentiated elements were then analyzed and the performative capacity of the system was documented and notated in a digital protocol. This directly informed subsequent generations of the system in response to a specific climatic and luminous context.

The investigation of geometric-topological articulation and performative capacity was paralleled by an investigation of manufacturing options. Various approaches to unfolding assemblies into flat-sheet patterns for laser-cutting were examined and tested in a series of scaled physical models. As a specific cutting technique an industrial origami method was chosen that allows the flat sheets to be scored from one side only, while folding is possible in both directions. The associative modelling set-up was developed so that each assembly was automatically unfolded and laid out for laser- or CNC-cutting.

The design was informed by extensive measuring and mapping of thermal, luminous and airflow conditions across a selected test site. Environmental measurements were listed and updated on a data spreadsheet set up to automatically re-interpolate all 20,000 measurement values across the site. This spreadsheet data was linked directly to a map generated within an associative modelling environment. Once the sizes, distribution and orientation of all elements of the material system were established according to the set spatial arrangements, the associative model of the material system could be linked to the mapping set-up. This established an instrumental link and a rigorous feedback between material system and environmental conditions. New environmental conditions can now update the design and, in the same way, the environmental impact of the intervention can be visualised, analysed, evaluated and fed back into the design process



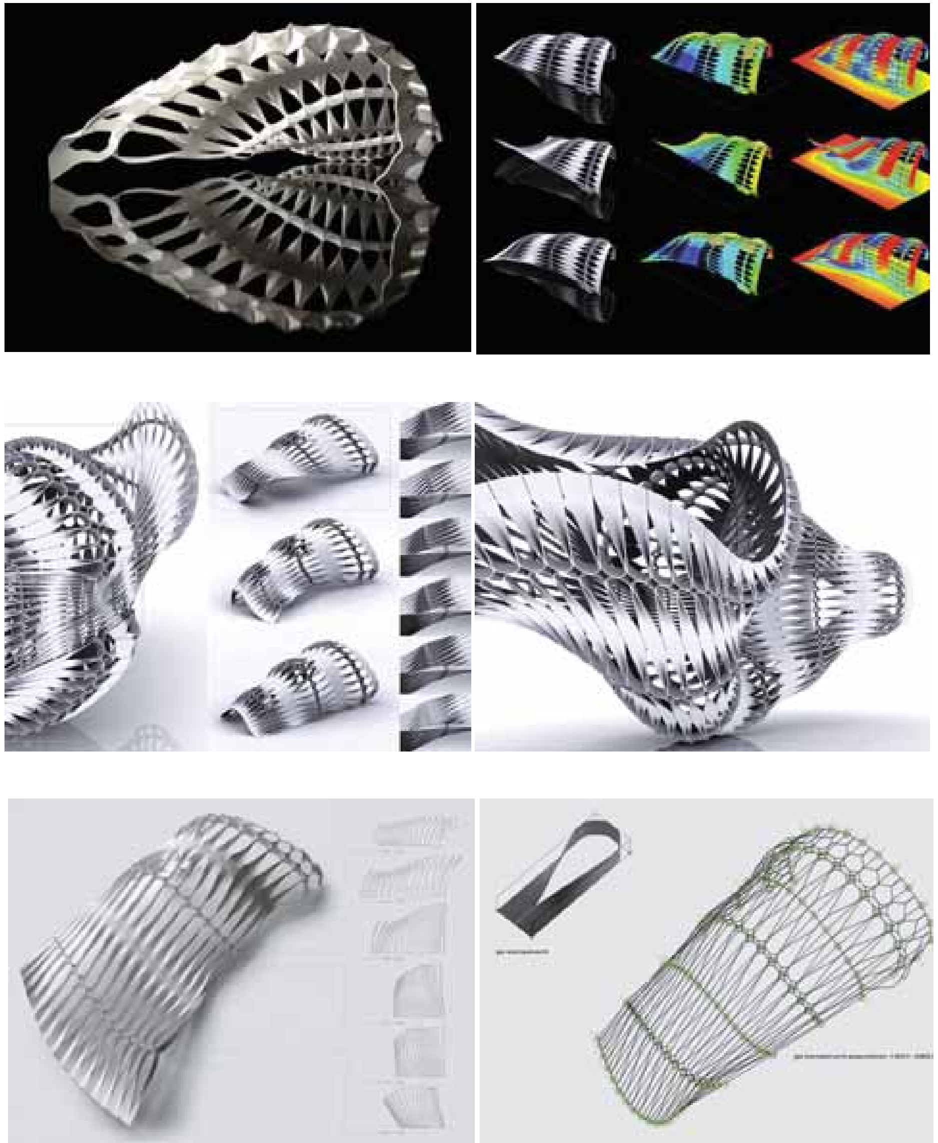
AA Diploma Unit 4 (Michael Hensel, Achim Menges) Gabriel Sanchiz) - Transitional Morphologies, Architectural Association, London, 2005-0
source : http://www.achimmenges.net/?p=4387

השראה תאית: קבוצות מחקר מהעולם: פבריקציה

Morphogenetic Design Experiment III // Paper Strip ExperimentAchim Menges with Andrew Kudless, Ranidia // Leeman, Nikolaos Stathapoulos, Michuan Xu

This Morphogentic design experiment is based on the parametric proliferation of very simple material components, namely twisted and bent paper-strips. In this project a digital component is defined as an open and extendable geometric framework based on the 'logics' of a material system that integrates the possibilities and limits of making and the self-forming tendencies and constraints of the material. Through elaborate physical studies of the behaviour of twisted and bent paper-strips the essential geometric features such as points of curvature, developability of the surface and tangency alignments were captured in a digital component. This component describes the non-metric geometric associations of a single paper-strip as part of a component collective and thereby anticipates the process of assembly and integration into a larger system. In other words, through parametric geometric relationships the digital component ensures that any morphology generated can be materialised as strips cut from sheet material.

A larger system can then be derived through a process of proliferating components into polymorphic populations. For this a variable 'proliferation environment' is defined to provide both the constraints for the accretion of components as well as stimuli/inputs for their individual morphologies. Then an algorithm drives the distribution of the components. The resulting system remains open to 'local' manipulation of individual components, 'regional' manipulation of component collectives and 'global' manipulations of the component system, proliferation environment and distribution algorithm. The parametric associations of and between components, collectives and the overall system allows the rapid implementation of these manipulations, leading to a multitude of self-updating system instances. Situated in a simulated environment of external forces, the system's behavioural tendencies then reveal its performative capacity. For example exposing multiple system instances to digitally simulated light flow enables the registration of interrelations between parametric manipulations and the modulation of light levels upon and beyond the system. Additional digital structural analyses of the same instances reveal the related load-bearing behaviour of the system. These behavioural tendencies of the system interacting with external forces and modulating transmitted



Paper Strip ExperimentAchim Menges with Andrew Kudless, Ranidia Leeman, Nikolaos Stathapoulos, Michuan Xu -Morphogenetic Design Experiment III
source : http://www.achimmenges.net/?p=4387

MOZAMBIQUE

Mozambique is a cellular structure, made of 2 separated systems.
The first one is the skin of the building, which is a completely
otonomous creature, which is hang between each 2 frames of the building.
it creates energy using the sun light,
collects rain water, and creates a comfortable micro-climate
with the double-layer skin, which is able to switch
co oling-heating modes according to the weather.
The second system is the constructive skeleton, made of 3D cells
which contain buildings servises and define buildings space between them.
The cells can blow up in each direction and create an endless range of combination possibilities

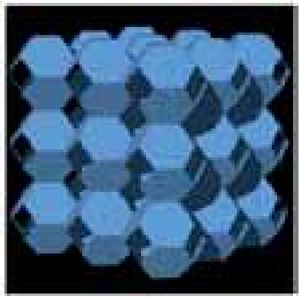
RESEARCH

Infinite Polyhedron (Polyhedral Sponges)

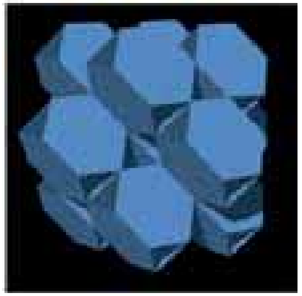
In geometry, an infinite skew polyhedron is an extension of the idea of a polyhedron, consisting of regular polygon faces with nonplanar vertex figures, allowing the figure to extend indefinitely without folding round to form a closed surface.

Regular infinite polyhedra

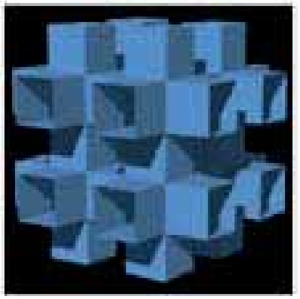
Consists of identical polyhedrons, involves infinetly to each direction (x,y,z). There are only 3 regular infinite polyheda:



{6,4|4}



{6,6|3}



{4,6|4}

Semi-Regular infinite polyhedra

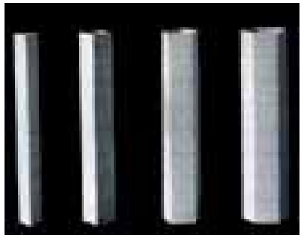
There are many other semiregular (vertex-transitive) infinite skew polyhedra. Wachmann, Burt and Kleinmann (1974) discovered many examples but it is not known whether their list is complete.

There are 3 groups of semi-regular infinite polyhedra:

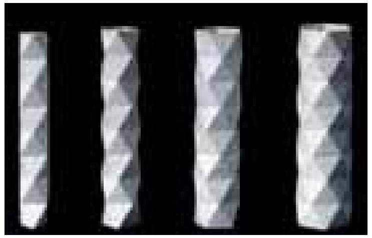
- One direction copy (Cylindrical polyhedra)
- Two direction copy (One layer polihedra)
- Tree direction copy (Multi layer and multi direction)

One Direction Copy // Cylindrical Polyhedra

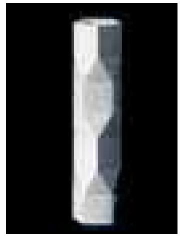
6 types of cylindrical polyhedra:



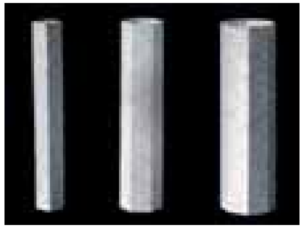
1 Prismatic rings.



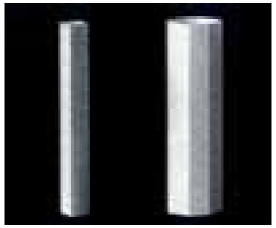
2 Anti-prismatic rings.



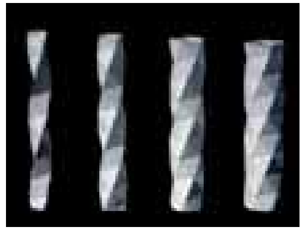
3 Prismatic and anti-prismatic rings, alternately.



4 Regular triangles strips.



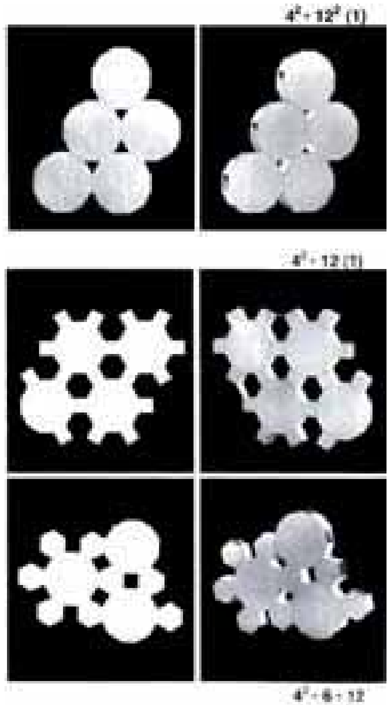
5 Regular triangles and squares alternately, strips.

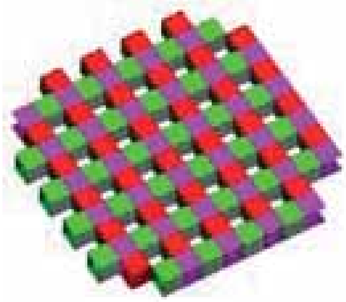


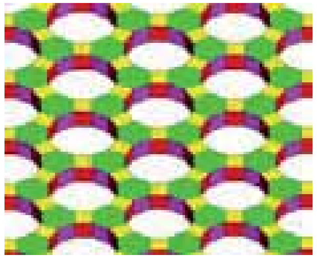
6 Spiralic strips of regular triangles.

Arata Isozaki, Art Tower Mito (Mito, Japan, 1990)

Two Directions Copy // One Layer Polyhedra





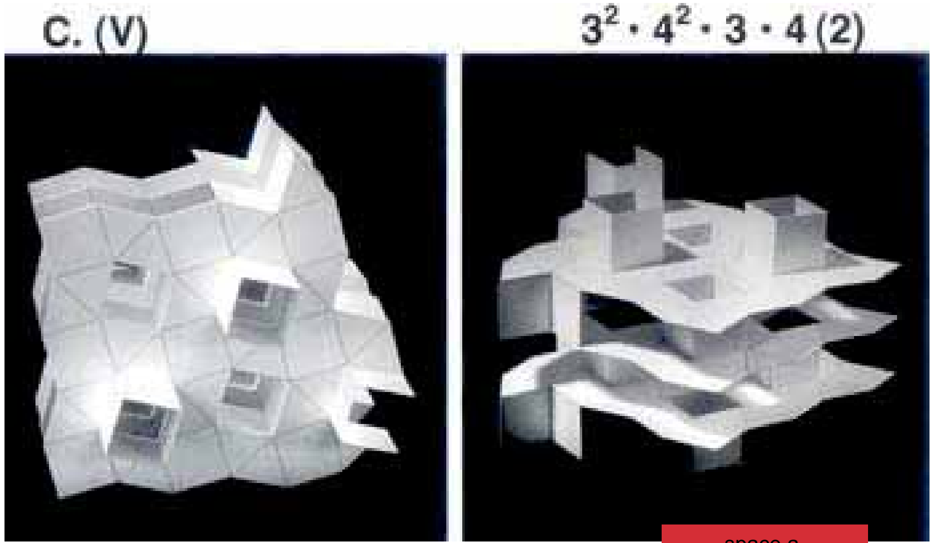


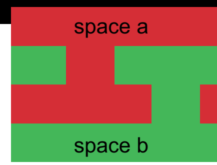
Geometric facade (Osaka, Japan)

שיכון שטיח, שכונה ה',באר שבע

Three Directions Copy // Multi Layer Polyhedra

A combination of tiling and prismatic and anti-prismatic rings.





Three Directions Copy (Multi Direction Polyhedra)

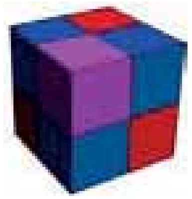
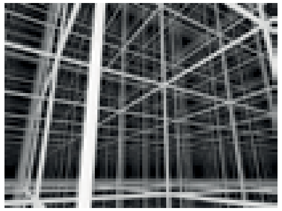
Multi direction polyhedra is a way of packing the space with polyhedrons. There are 2 ways to do that:

1. packing the space without gaps.
2. packing the space with gaps

Packing the space without gaps // Honeycombs

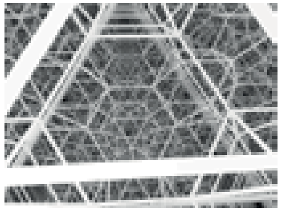
A honeycomb having all cells identical within its symmetries is said to be cell-transitive or isochoric. A cell of such a honeycomb is said to be a space-filling polyhedron. Known examples:

Cube

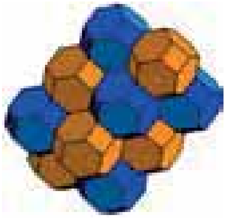
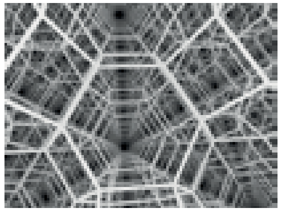




Rhombic Dodecahedron





Truncated Octahedron

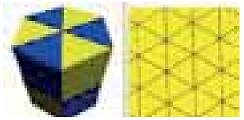
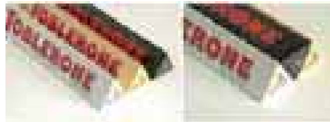

Micro Dweling, N55

Prismatic Polyhedrons

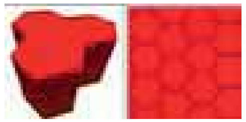
cubic



hexagonal

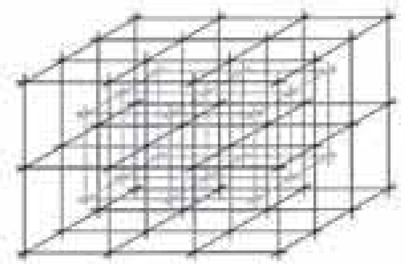



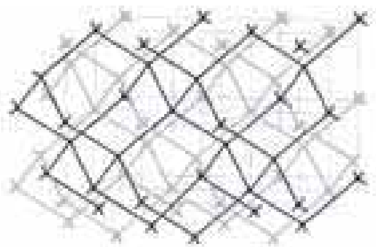
trianglural

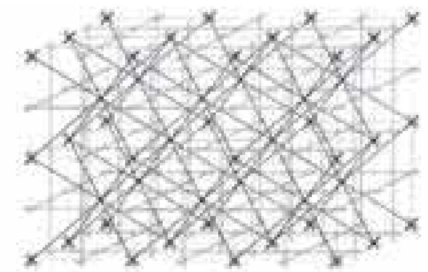


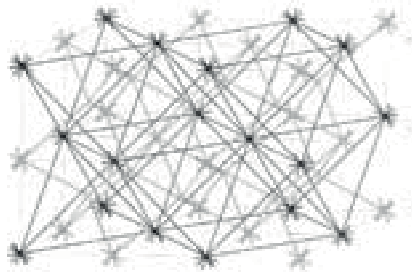
Packing the space with gaps

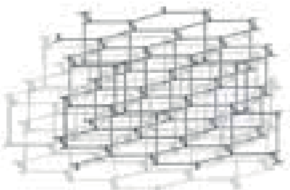
There are 7 pairs of nets that fit most of the infinite polyhedrons:

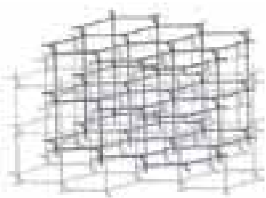

C (cubic)

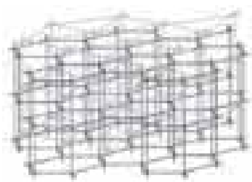

D (diamond)


CC (cube centered)

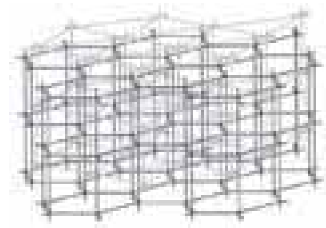

OT (octahedra tetrahedra)


G (grafit)

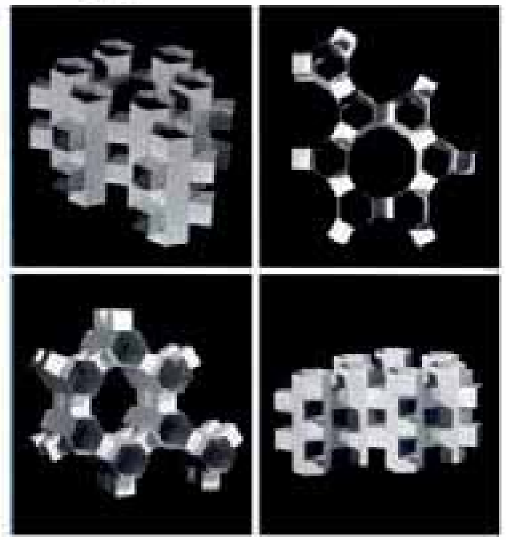

TP (trihedra petrahedra)


PO (prismatic)

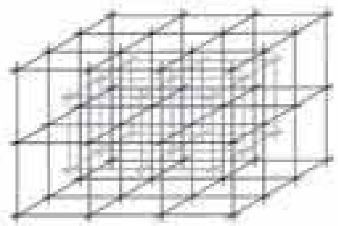
PO (prismatic)



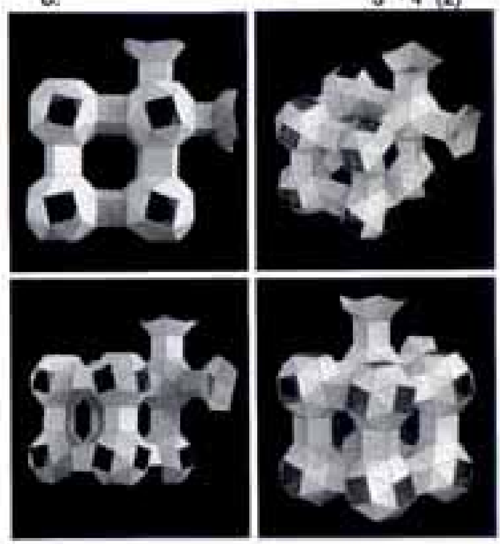
4^5 (7)

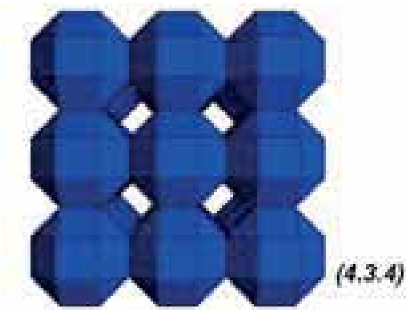


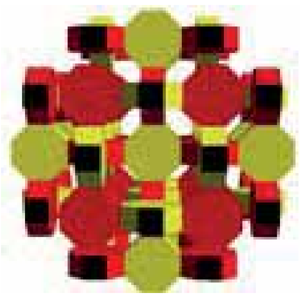
C (cubic)

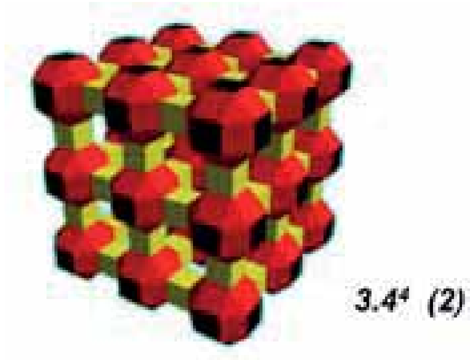


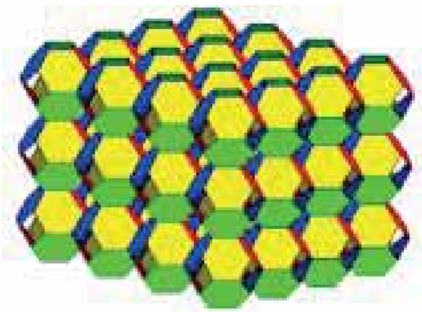
C. $3^4 \cdot 4^2$ (2)

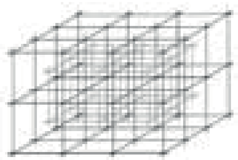


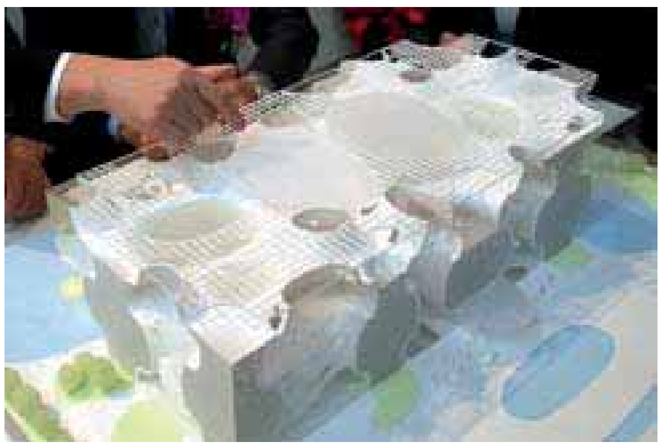








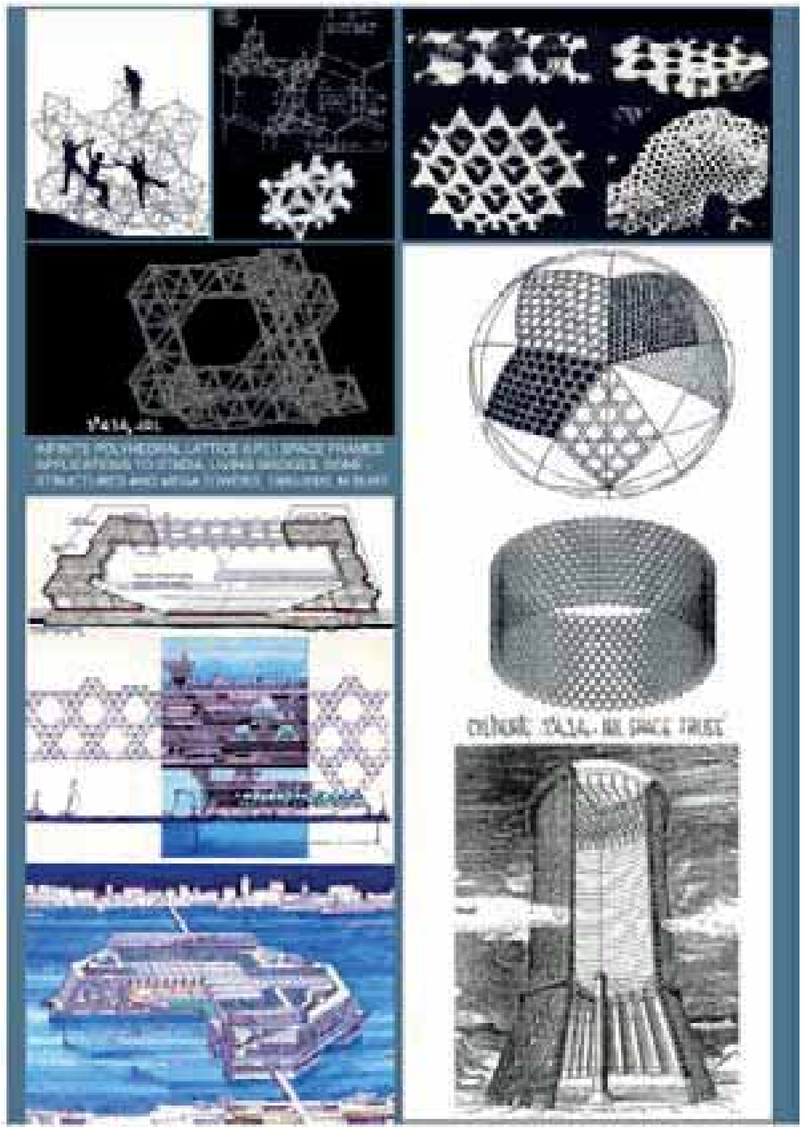




Toyo Ito museum

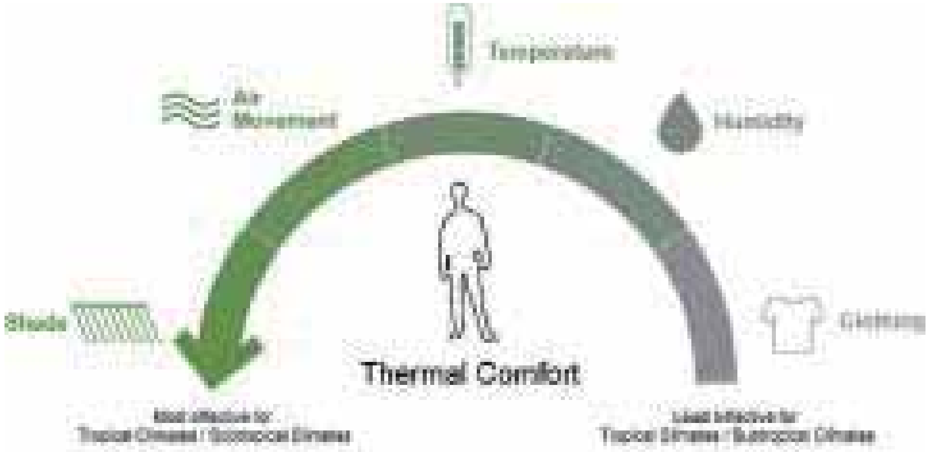
PERIODIC SPONGE SURFACES AND UNIFORM SPONGE POLYHEDRA IN NATURE AND IN THE REALM OF THE THEORETICALLY IMAGINABLE.

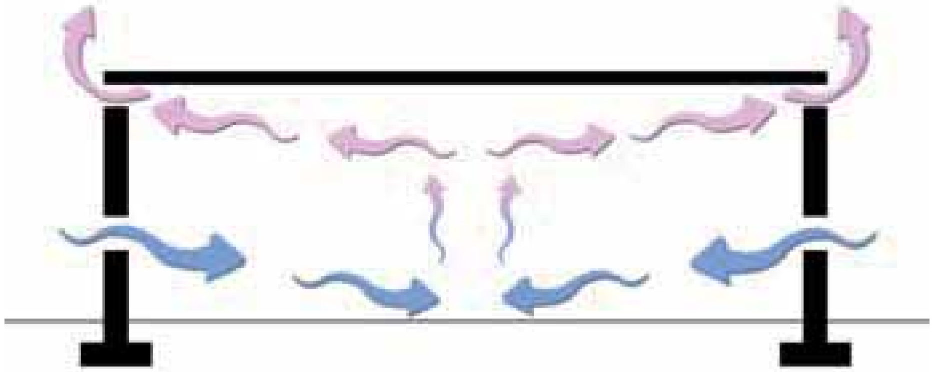
Michael Burt



MOZAMBIQUE A

Micro Climate

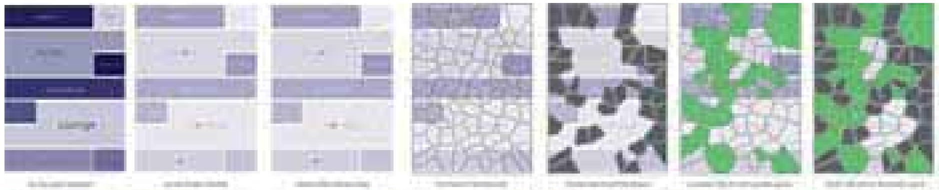




hot and cold air scheme

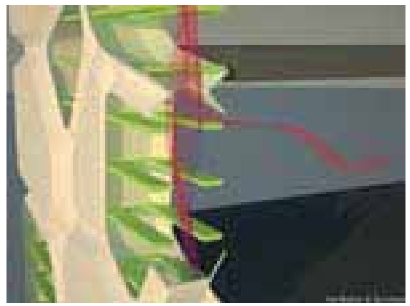
Material

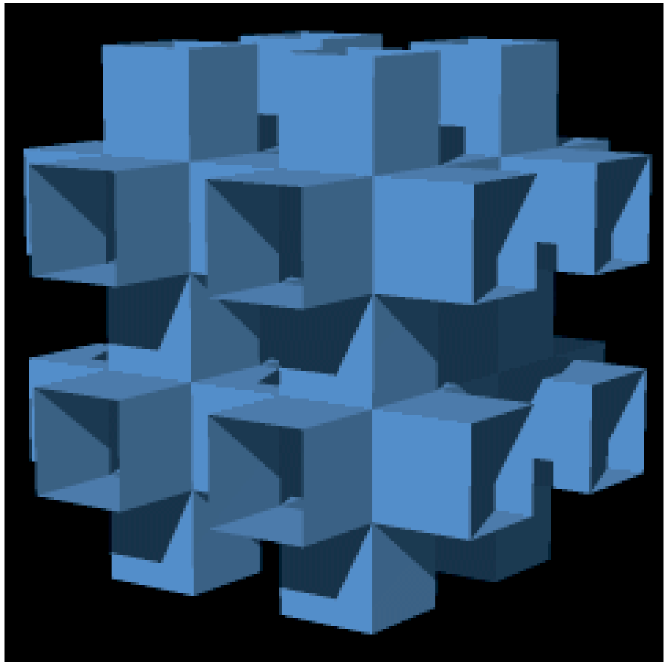
Reinforst transperent plastic

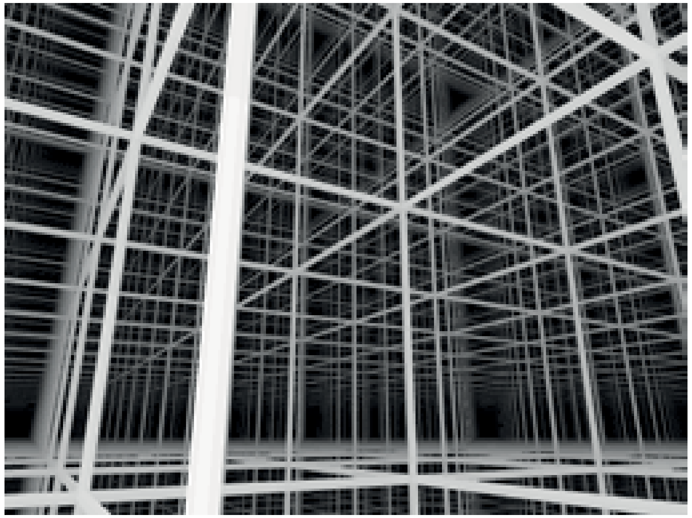


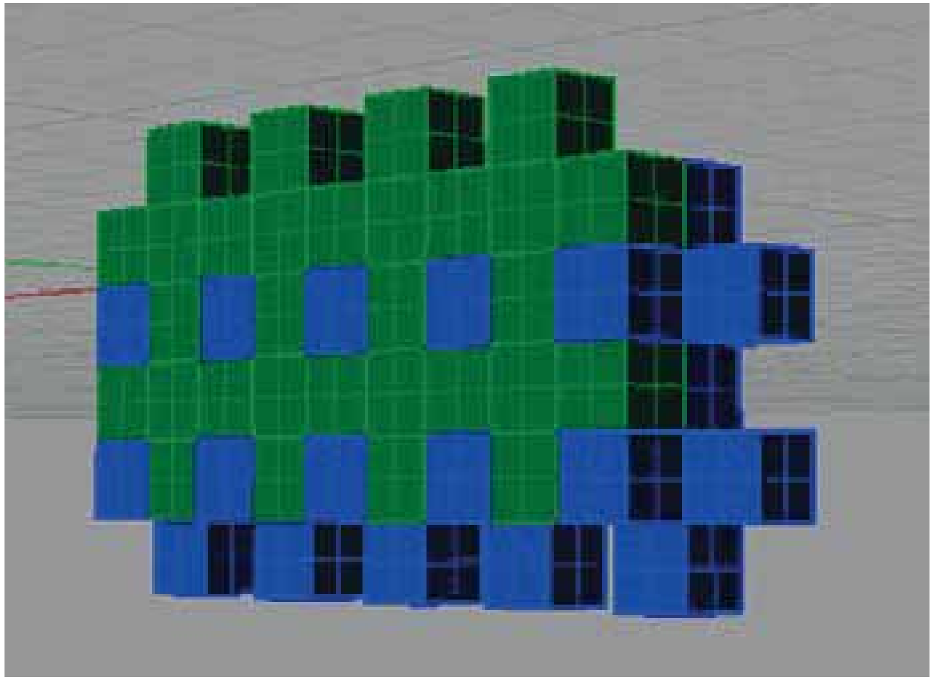
Breathing Facade

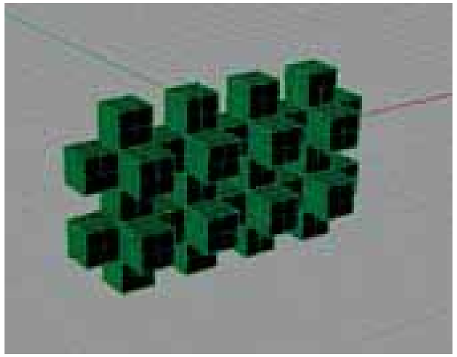
Aadm SHEK
parametric design assingnment

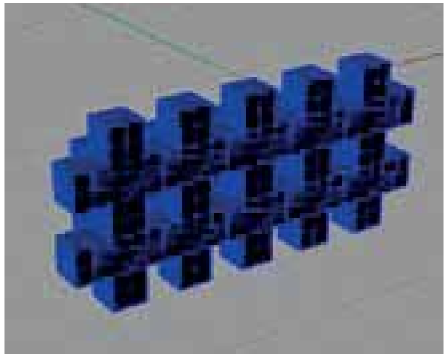








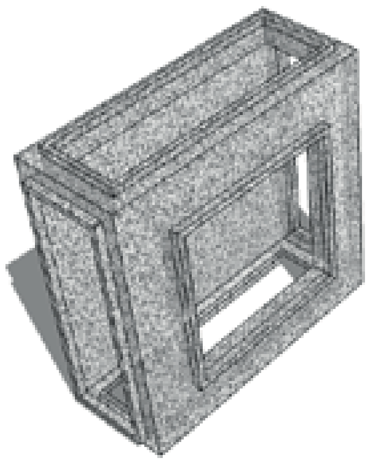




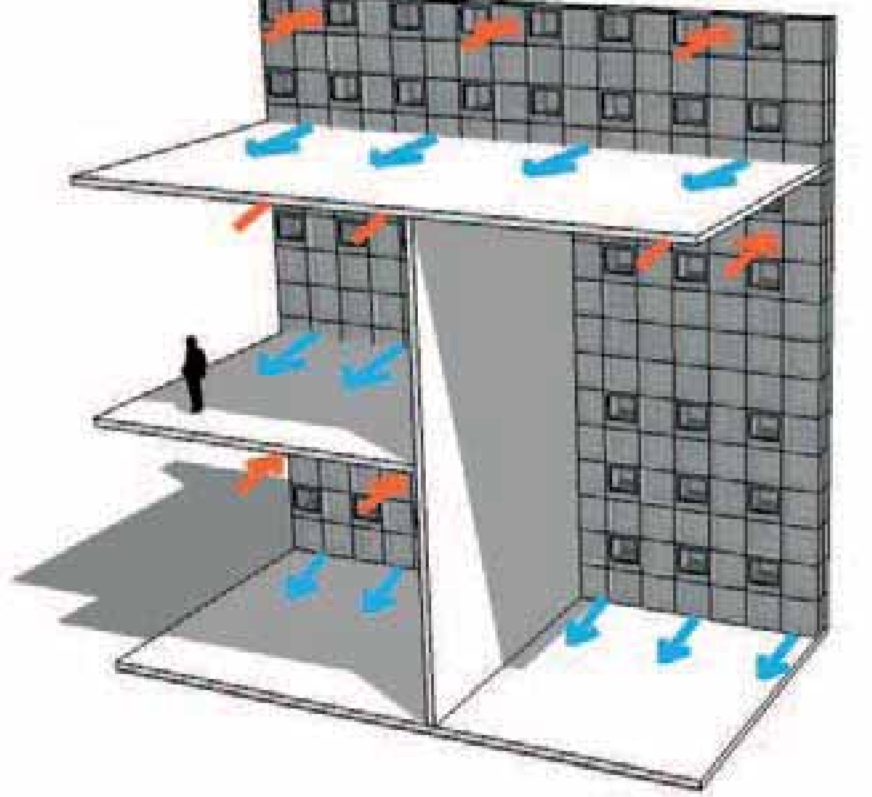
infinite polyhedra

two-layered polyhedra

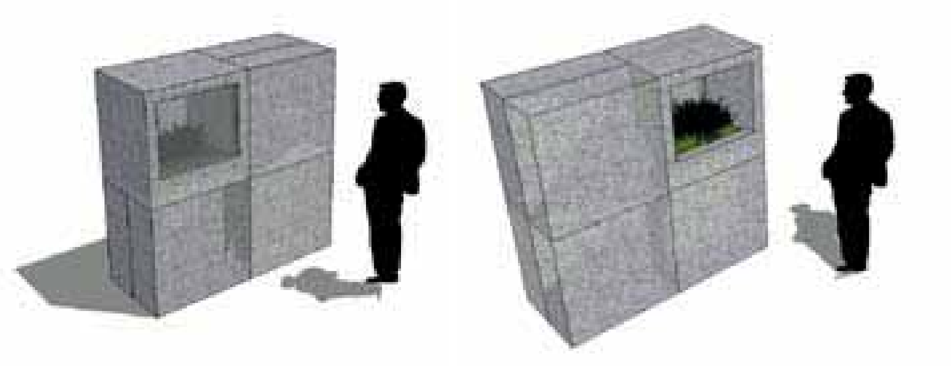
basic cell

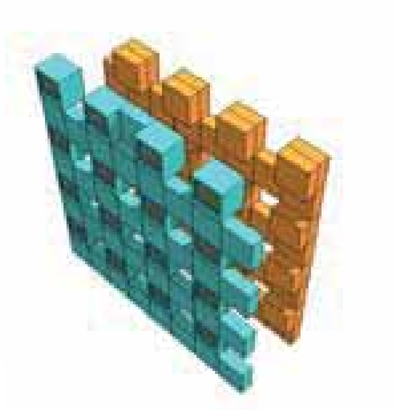


air movement

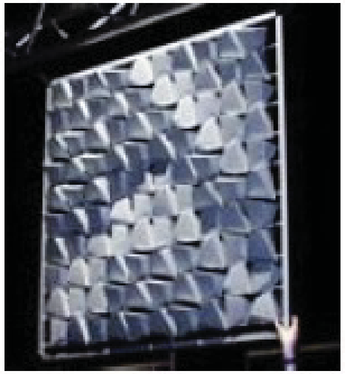


basic block



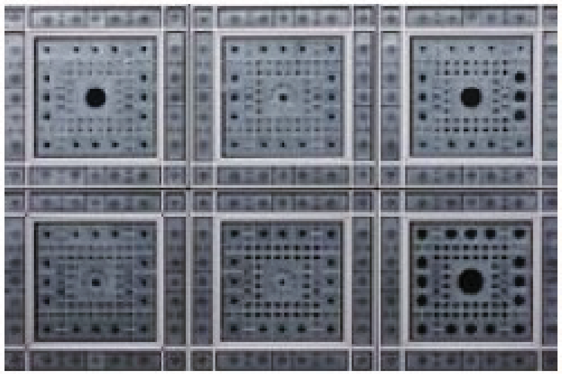


Kinetic Facade



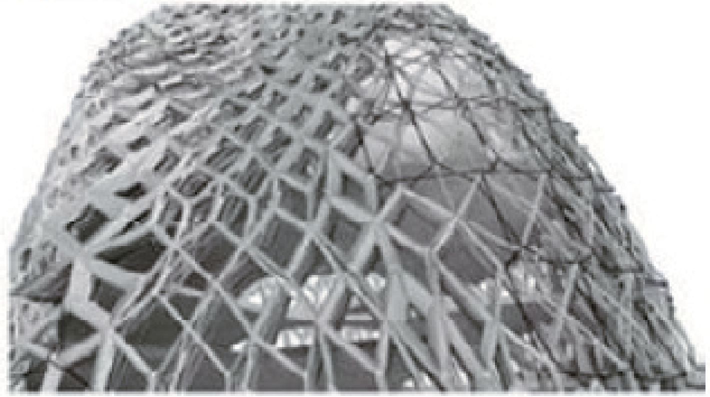
Dynamic Architectural Facade by Flare

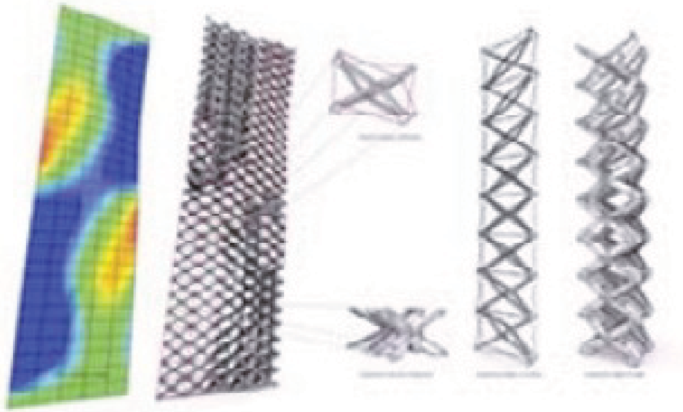
Flare turns the building facade into a penetrable kinetic membrane, breaking the convention of a buildings surface as a static skin. Computer controlled pneumatic cylinders allow for light and shadow plays across the surface.This is the font you use for body text, This is the font you use for body text, This is the font you use for body text, This is the font you use for title - use the paragraph style.



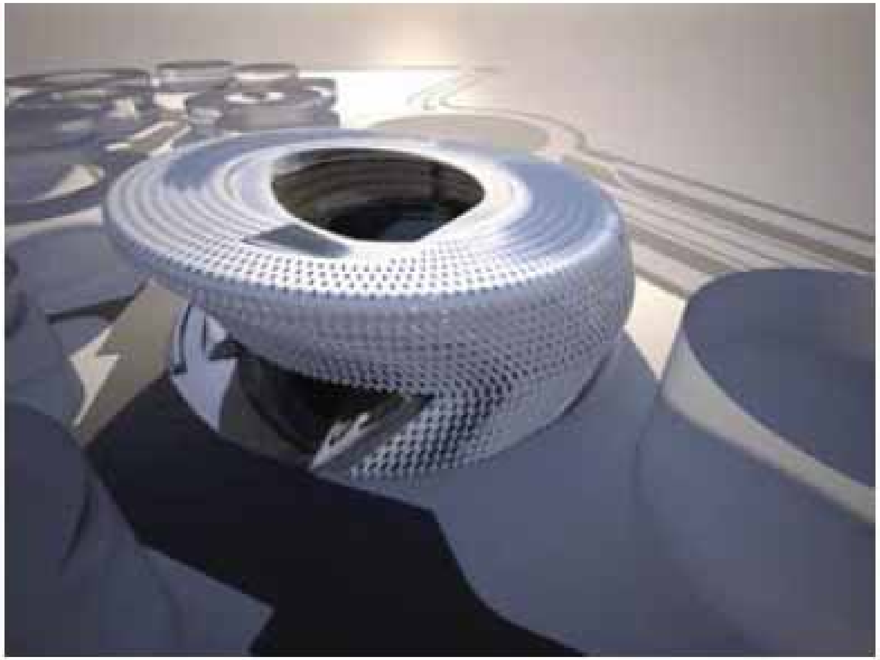
The Arab Institute (Institut du Monde Arab) designed by Jean Nouvel was completed in 1980. The main architectural feature of this building is the active sun-shade irises that cover the south facade of the building; each square you can see in this image is a collection of different sized metallic irises which close automatically to regulate the heating effect of sunlight hitting the building.

Parametric Pattern





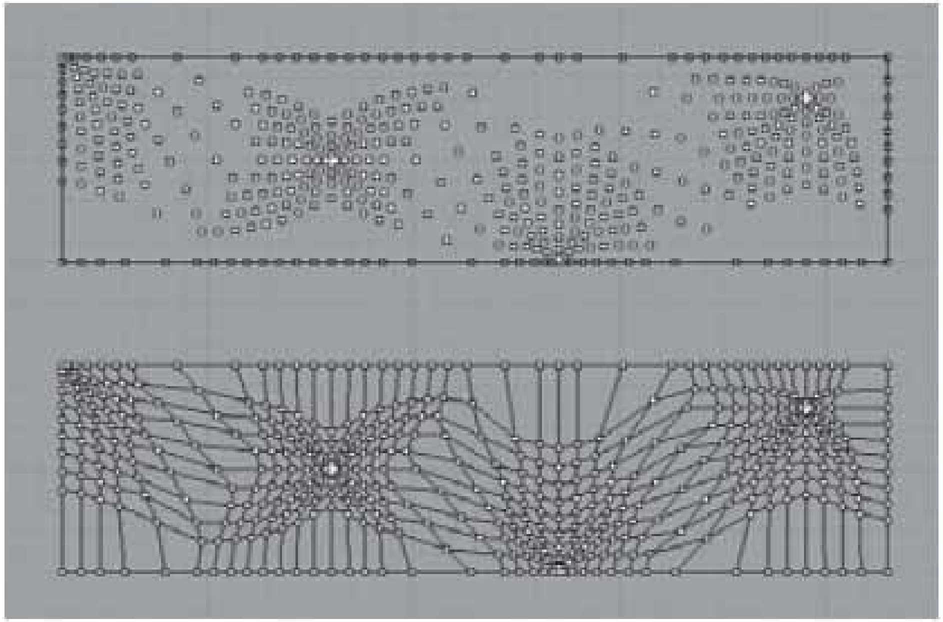
The patterning participates within a cascade of sub-system correlation: The façade pattern articulation correlates with the structural system which in turn correlates with both exterior shape and the shape dependent interior voiding. The result is a deep relationality that serves orientation. Huang Yung-Chieh, Hang Jin & Wen-Kai Li, Parametric Urbanism, AADRL, tutored by Patrik Schumacher and Christos Passas

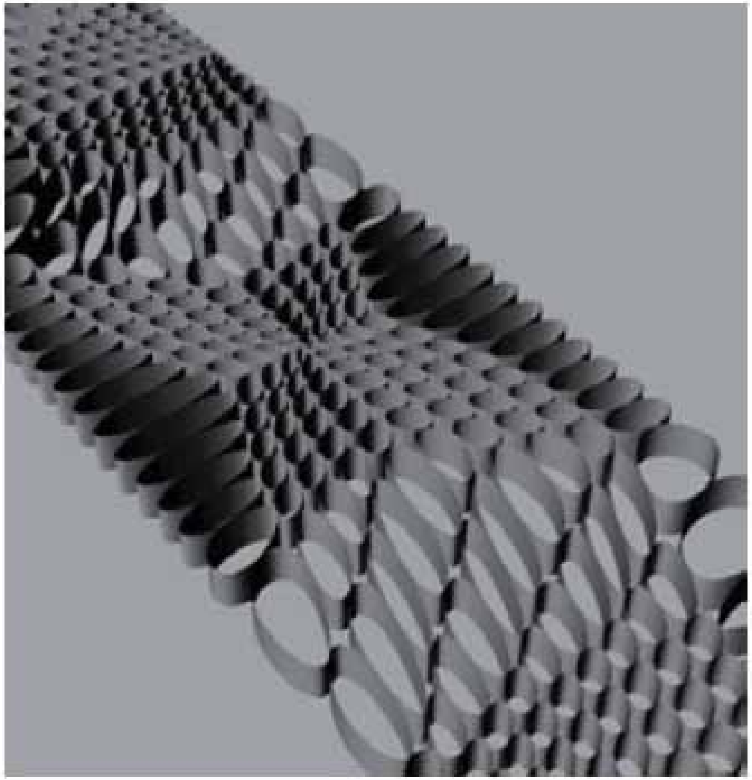


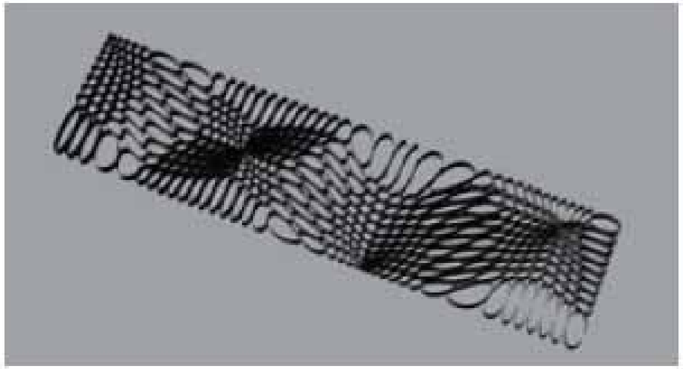
Zaha Hadid Architects, Civil Courts – Madrid, 2007, Accentuating Environmentally Adaptive Façade

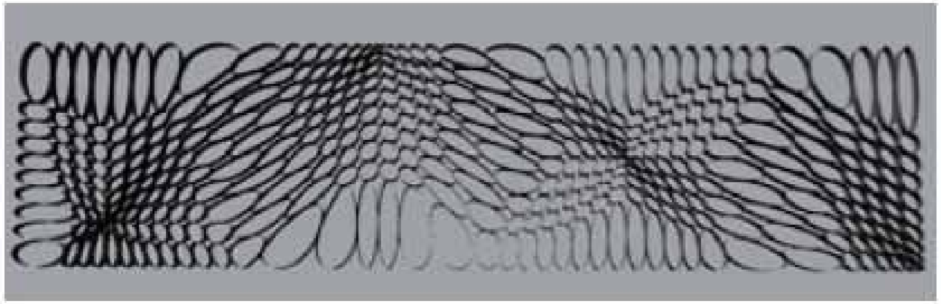
Variable light/shadow effects. Parametric Figuration Project, Elias Hermann & Milly Niku, Masterclass Zaha Hadid,
tutored by Patrik Schumacher, University of Applied Arts, Vienna 2007

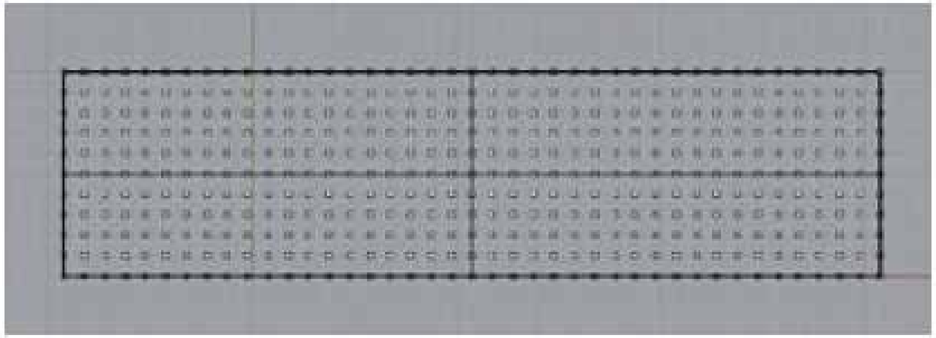
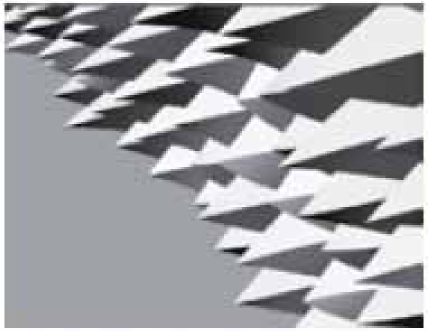
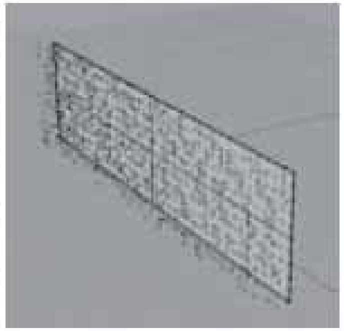
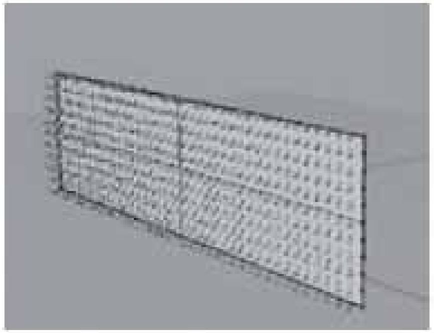
First Try

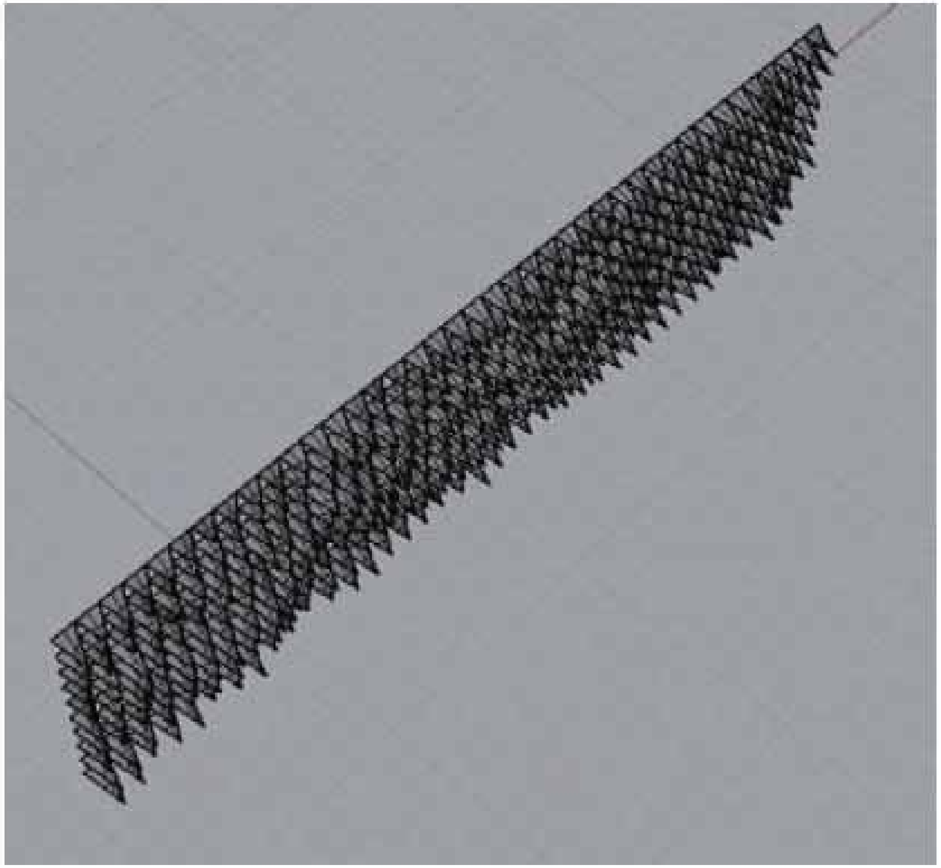
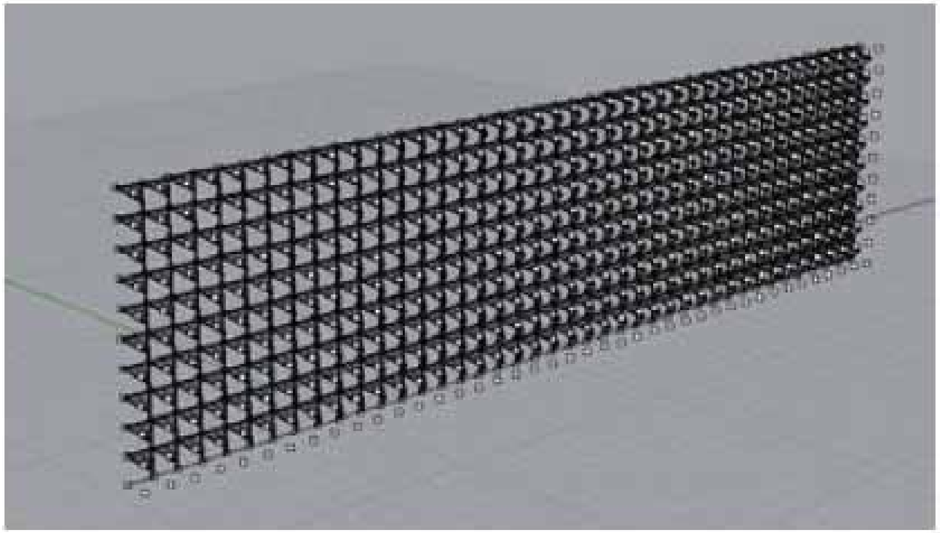




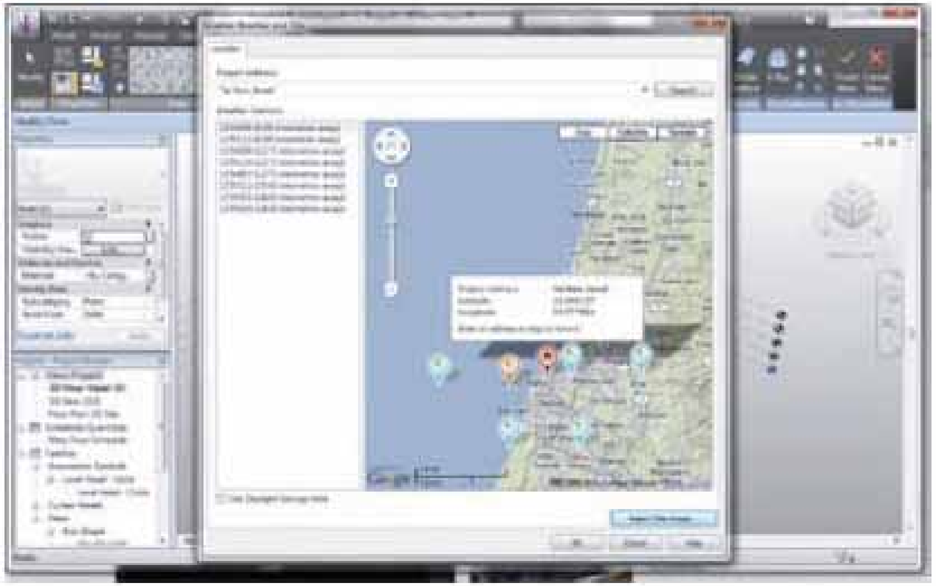


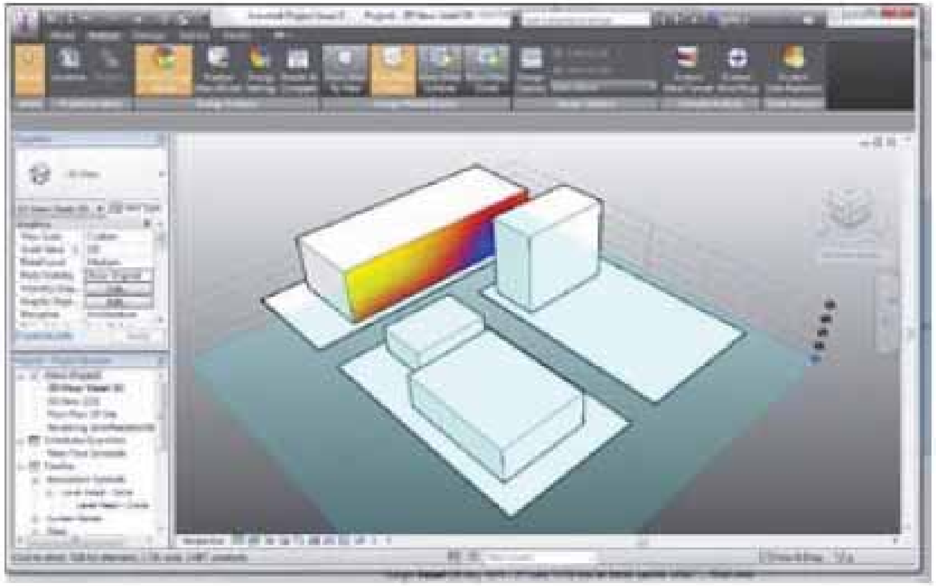


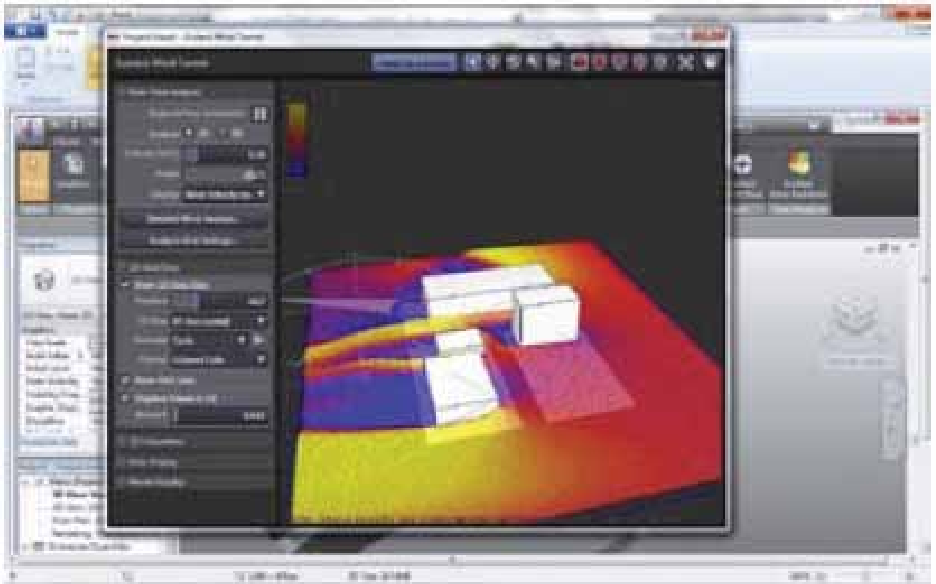





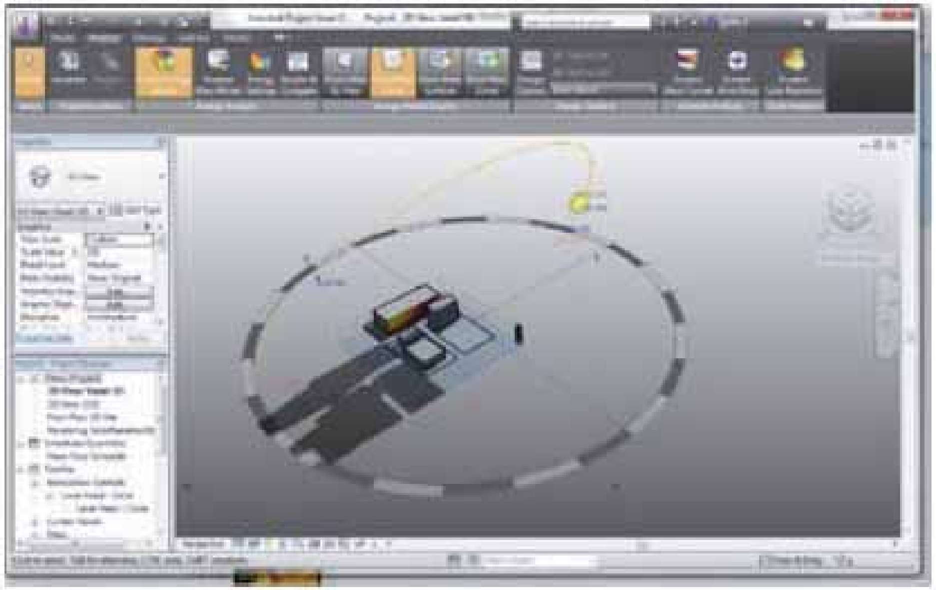



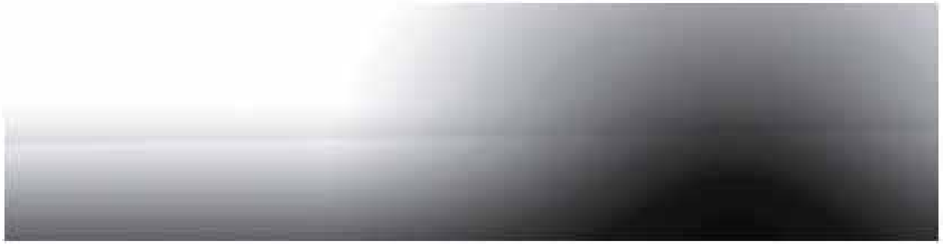
Vasari

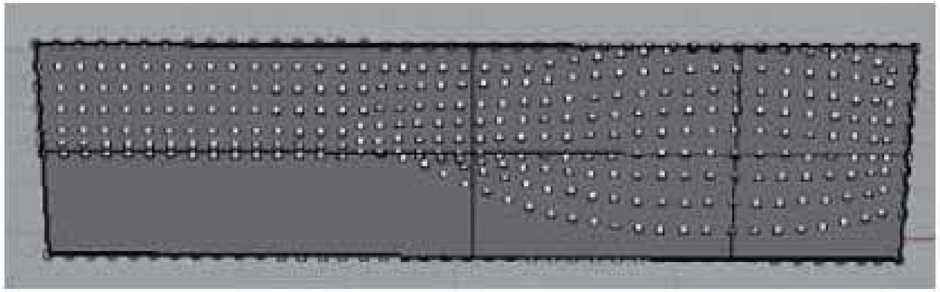


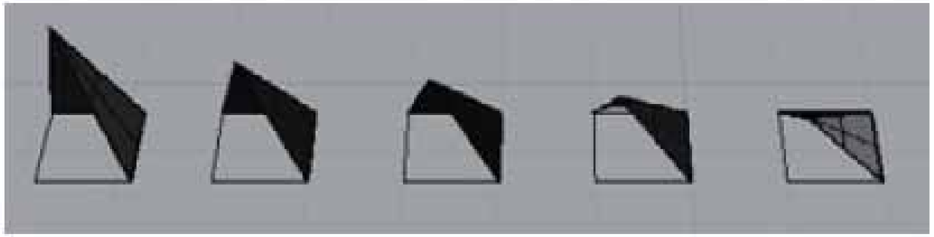


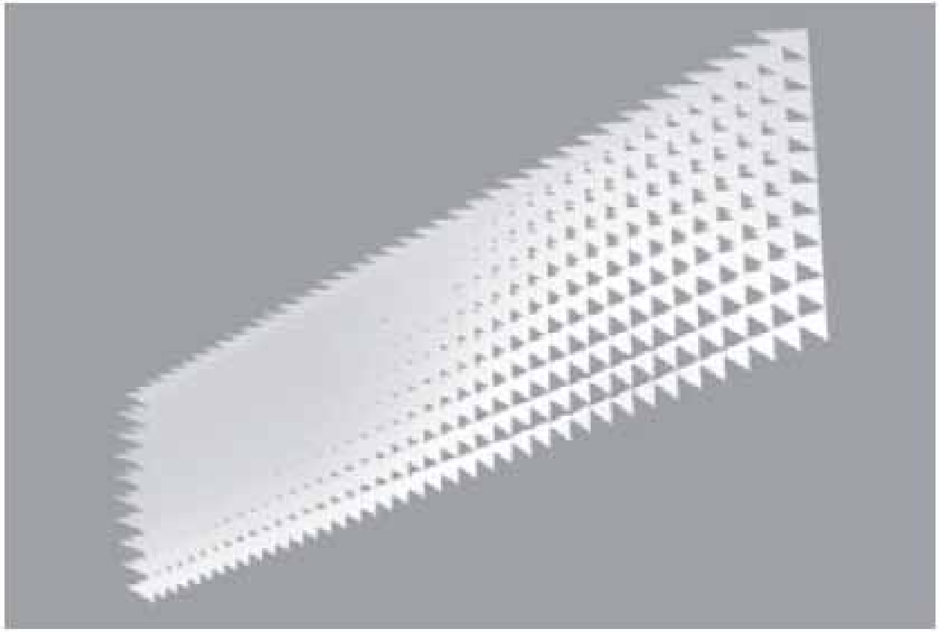


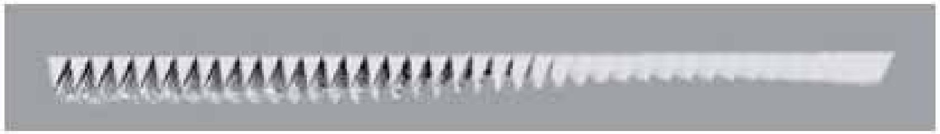


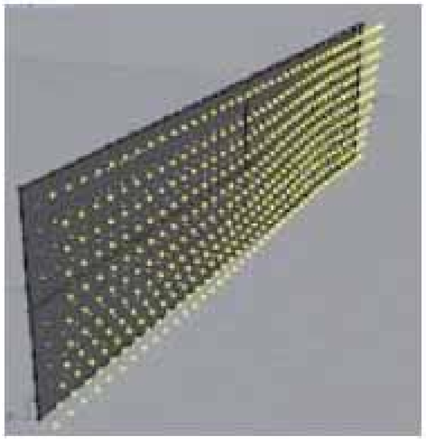


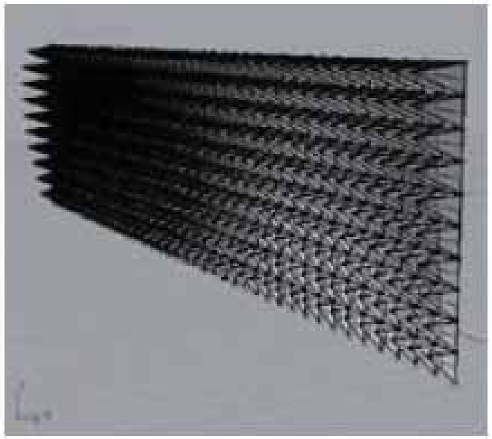


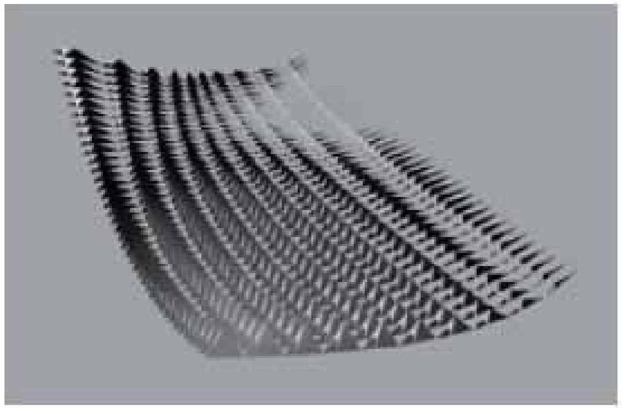






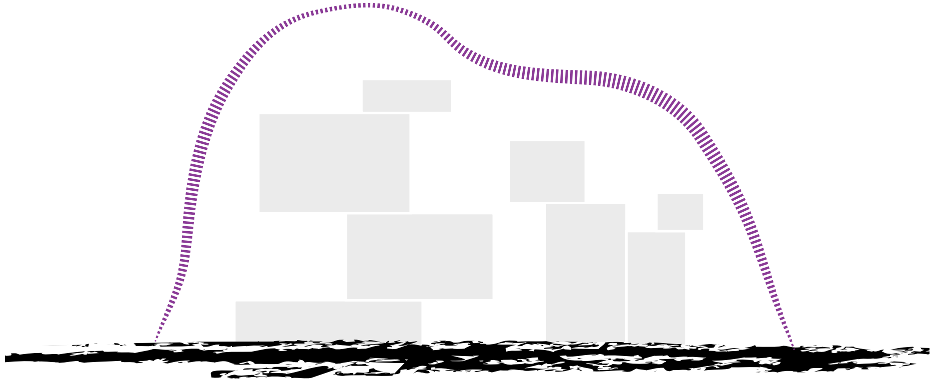




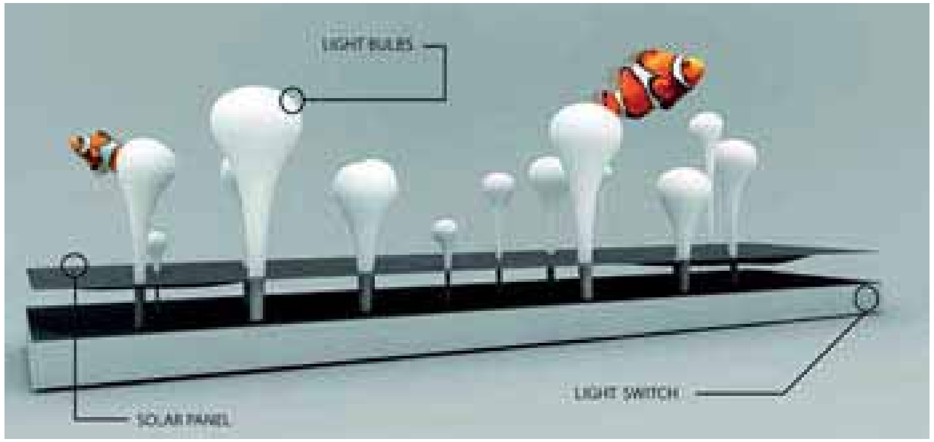


המעטפת

המעטפת מתפקדת כגוף חופשי ועצמאי, ללא תלות בנפחים הפנימיים, ותשתיות חיצוניות.
המעטפת יוצרת מיקרו אקלים נוח, ובעצם סוגרת בתוכה חלל ביניים חוץ-פנים.
המעטפת כולה מורכבת מתאים המכילים בתוכם פונקציות שונות.



כל התאים מתפקדים כקולטי אנרגיה סולרית ושימוש בה במעטפת כמערכת תאורה המקרינה פנימה והחוצה בשעות החושך. דוגמא למערכת כזאת קיימת:



Drawing from the shapes of endangered coral species, Serbian designer Marko Vuckovic designed a series of innovative lighting system that creates an energetic aquatic environment very within your house. Called “Coral Lamp”, the system is comprised of a square shaped base-unit that holds a series of coral shaped light bulbs of varying heights. Each bulb is powered by the solar energy harvested by the solar panels located at the top exterior of the base. Therefore, the lamp needs to be placed by the window at daytime in order to make it illuminate throughout the night.

www.markovuckovic.com

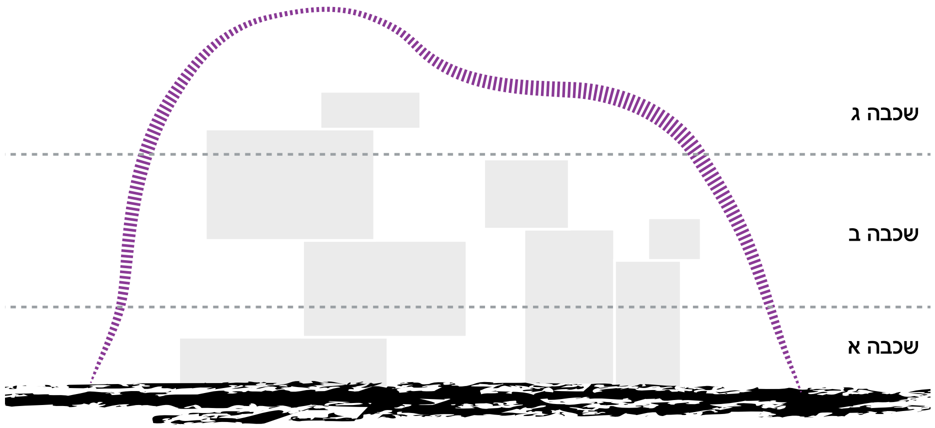
המעטפת

התאים
צורת התאים מבוססת על כוורת, תאים משושיים משתנים בגודלם ובעומקם- המכילים בתוכם טכנולוגיות שונות.

Be it their biomimetic form, their integral strength, or the their beautiful visual texture, lately we can't get enough of hexagonal honeycomb structures. The latest to catch our eye is the stunning Sinosteel International Plaza by Beijing-based MAD architects. More than just a striking façade, the building's hexagonal curtain is based upon climate modeling and serves to regulate the structure's temperature and daylight by varying the size of each cell's window.

www.inhabitat.com

תפקוד המעטפת מתחלק ל 3 חלקים, כל חלק בעל תפקיד אחר במערכת:



שכבה א - INHALING
השכבה העבה ביותר והפתוחה ביותר לאור.
מכילה פונקציה של החדרת אוויר פנימה תוך ניקוי האויר דרך צמחיה, בנוסף לכך כל תא מכיל טכנולוגיה של יצור מי השקיה עבור הצמחיה מאידוי אויר.

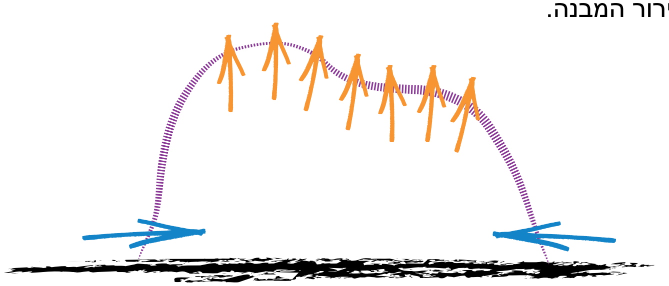
'Dew Drop' is an innovative plant watering device. Once the device is placed in the pot's soil and plugged into a power supply, it starts condensing water vapor in surrounding air and as a result, small water drops are formed on the surface of leaf-shaped portion and fulfill the watering needs of the plants within the same pot. Jacky wu.
www.yankodesign.com

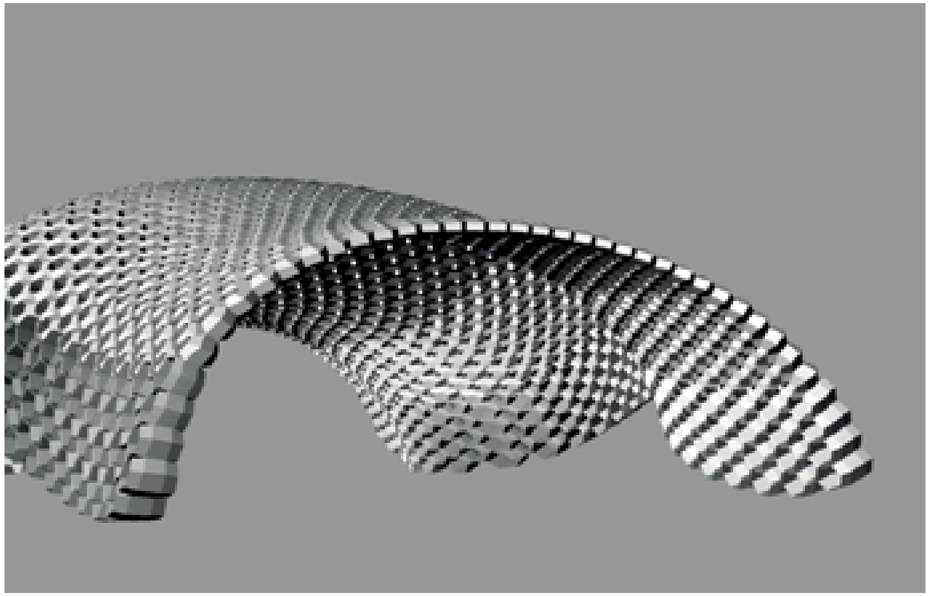
This air-purifier is capable of removing toxic compounds from polluted air by using certain plants like Gerbera that has the ability of absorbing toxic compounds, as polluted air passes through the glass pot. Mathieu Lehanneur.

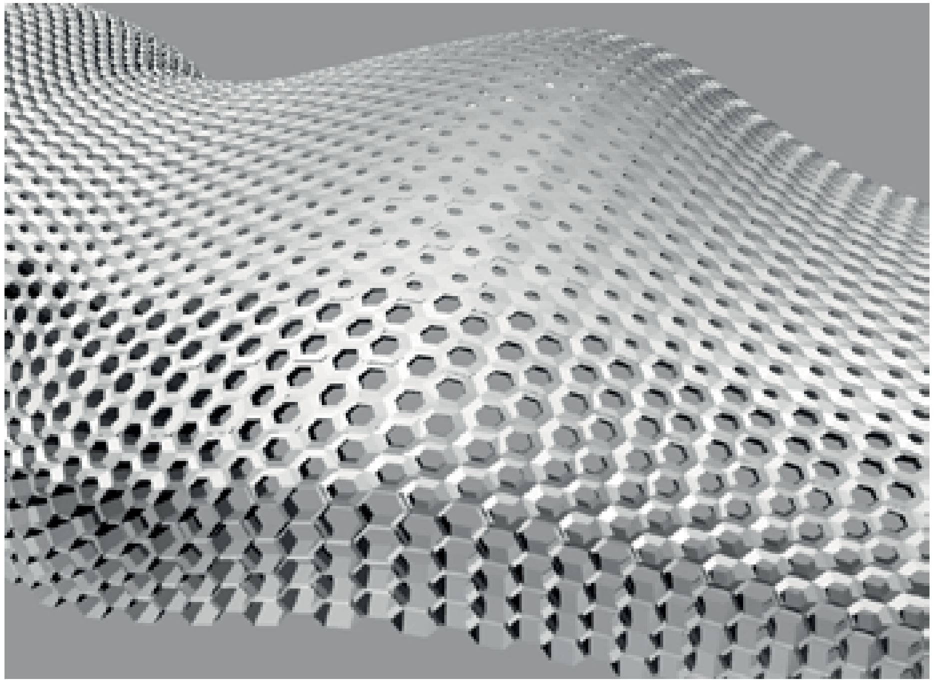
www.mathieulehanneur.fr

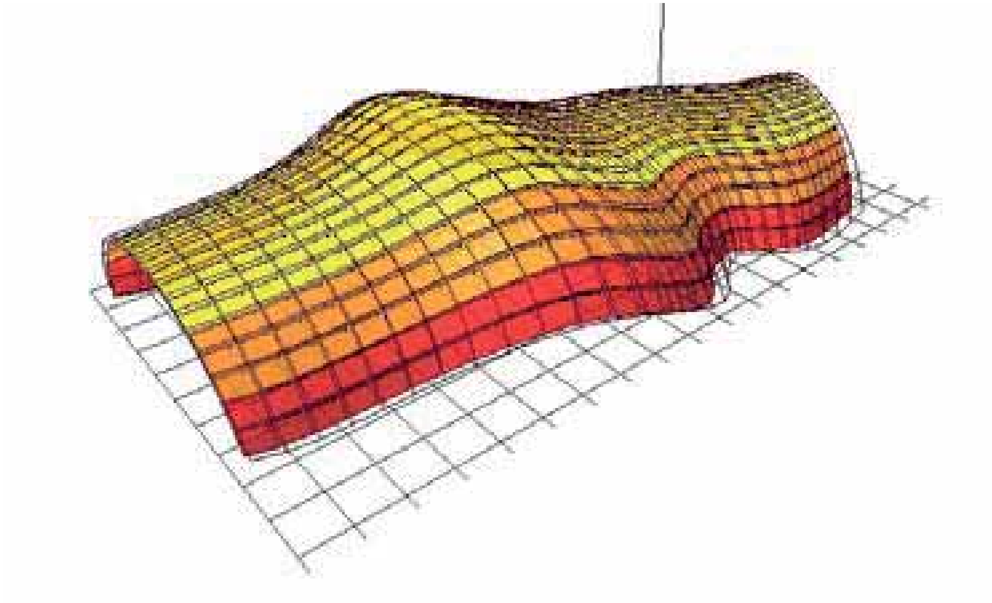
שכבה ב - COLLECTING
תאים בגודל בינוני, ופתיחות בינונית.
מכילה פונקציה של איסוף מי גשמים ואגירתם, תוך ניקויים והשמשתם למי שתיה בברזיות ת בתחתית המעטפת בפנים ובחוץ.

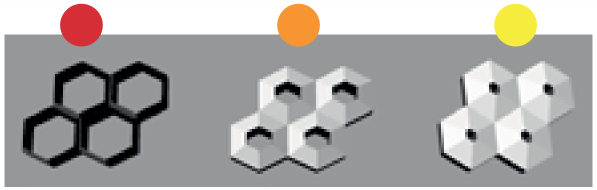
שכבה ג - EXHALING
התאים הקטנים והגורים ביותר.
התאים מתפקדים כפולטי אוויר חם העולה למעלה וכך מאפשרים יחד עם השכבה הראשונה, זרימת אוויר וקירור המבנה.

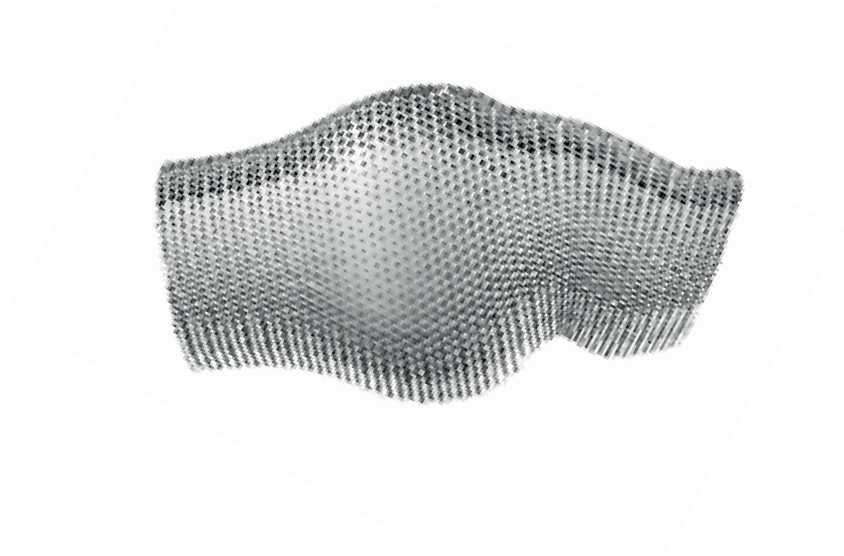












המבנה

עקרון המבנה מבוסס על מגדל הטבעות.

2 מערכות שונות יוצרות את סך המבנה:
הגזע: המערכת הקונסטרוקטיבית, והעורק הראשי במבנה, אשר מעבירה בתוכה את הפונקציות האנכיות המקשרות בבנין (מערכת תנועה, תשתיות).
התאים: על גבי הגזע מולבשים תאים שונים ליצירת המבנה הכולל. כל תא הוא קונסטרוקטיבי בפני עצמו ונתלה על הגזע בצורה זיזית. התא הבודד הוא אוטונומי ואמור לתמוך בעצמו בלבד- מה שמאפשר לו להיות קל וגמיש.

דוגמאות למבנים המתייחסים בצורה דומה להיבט הקונסטרוקטיבי והצורני:

The Nakagin Capsule Hotel Tower in Shimbashi was the first of its kind in the world; a wholly modular building comprised of a concrete stack with latch-points for pre-fabricated one-piece rooms to bolt on to, with a built-in life cycle for obsolescence and upgrade.
http://www.michaeljohngrist.com

“This diverse program has different needs for phasing, positioning and size,”say the architects. “To facilitate this all elements are designed as rings. By pushing these rings outwards, every part of the program receives a terrace for outdoor life.” Gwanggyo Power Centre, MVRDV.

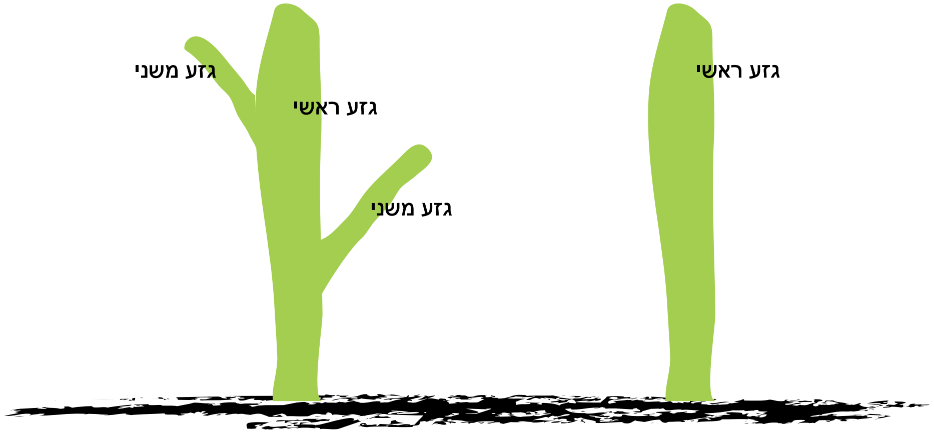
www.dezeen.com

תפיסת החלל

Pyjama Garden Medical Center Extension, Veldhoven, The Netherlands. MVRDV)www.mvrdv.nl(

המבנה

הגזע
הגזע משמש כעמוד השדרה של המבנה כולו, הוא הלב הקונסטרוקטיבי והמכיל של הפונקציות האנכיות במבנה: מערכת תנועה ותשתיות, החדרים הרטובים יושבים בתוכו גם כן.



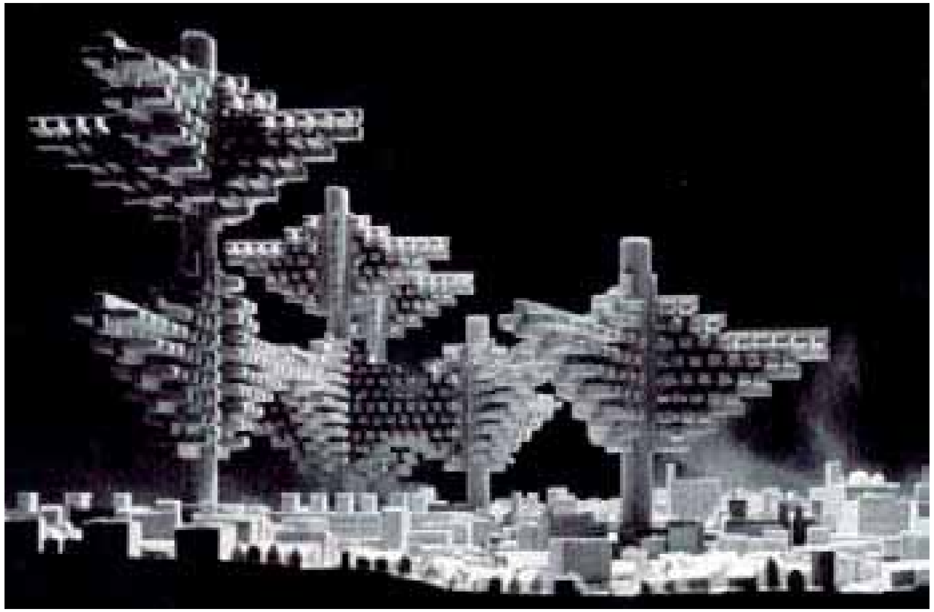
גזע משני
אלכסוני
מערכת תנועה משנית-מדרגות בלבד
תשתיות מצומצמות

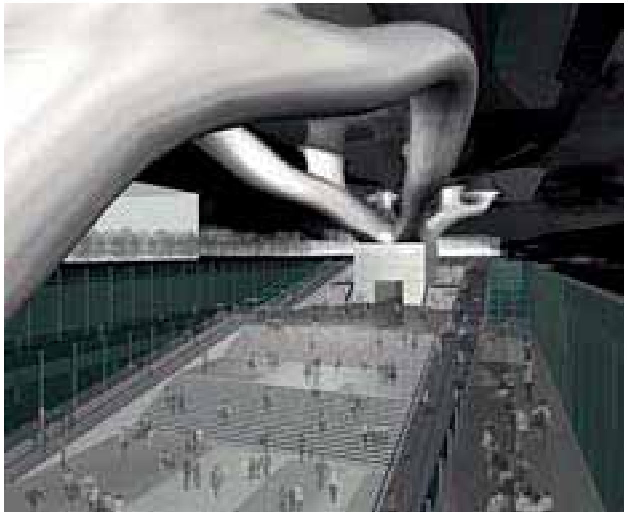
גזע משני יכול להחזיק תא אחד בלבד המתרכב בצורה שונה

גזע ראשי
אנכי
מערכת תנועה ראשית
רשתיות

גזע ראשי מחזיק מספר רב של תאים המתרכבים בהשחלה

עקרון קונסטרוקטיבי


The Vertical, the Dense; Trajectories for Tokyo in the 21st century

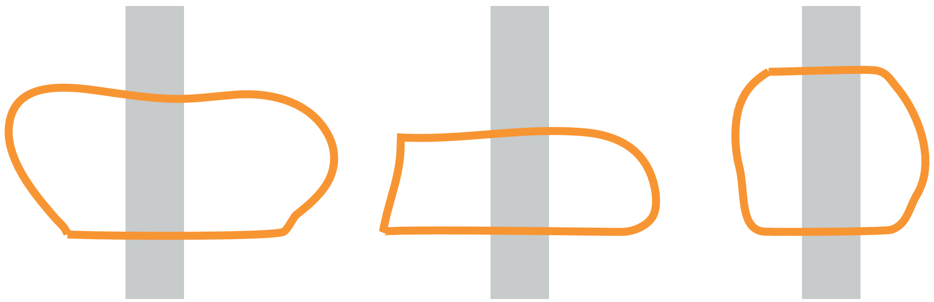

Rendering courtesy Arata Isozaki and Associates
The webbed “columns” branch across the station depending on how the structure could be optimized to address stress and deformation loads for the flat roof in an almost sideways version of what he had designed for Sendai Mediatheque.

המבנה

התא

כל תא הוא גוף קונסטרוקטיבי בפני עצמו, והוא בנוי כ FREFABRICATED או MONOKOK.
העובדה שכל תא תומך אך ורק בעצמו מאפשר לו להיות קל וגמיש.

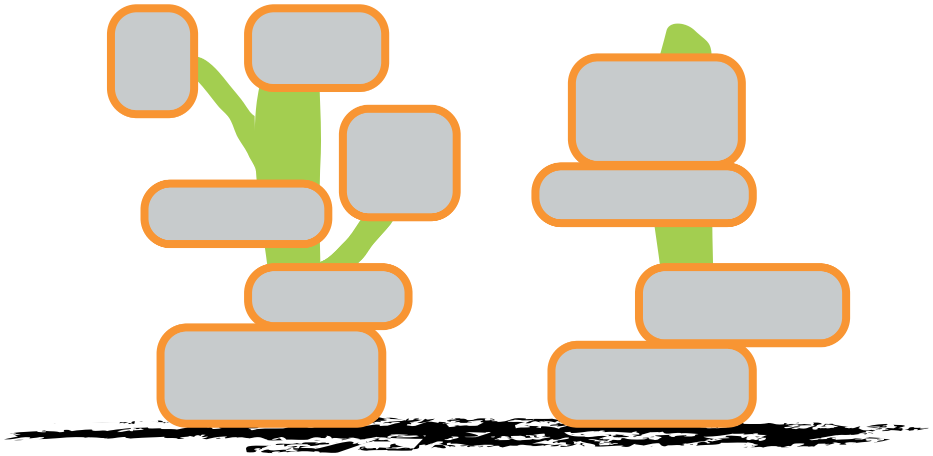
התאים משתנים ביניהם בחתך

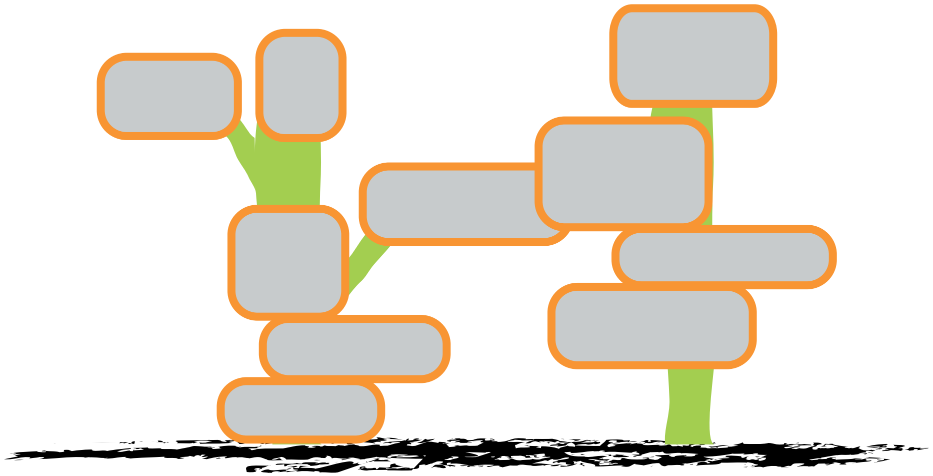


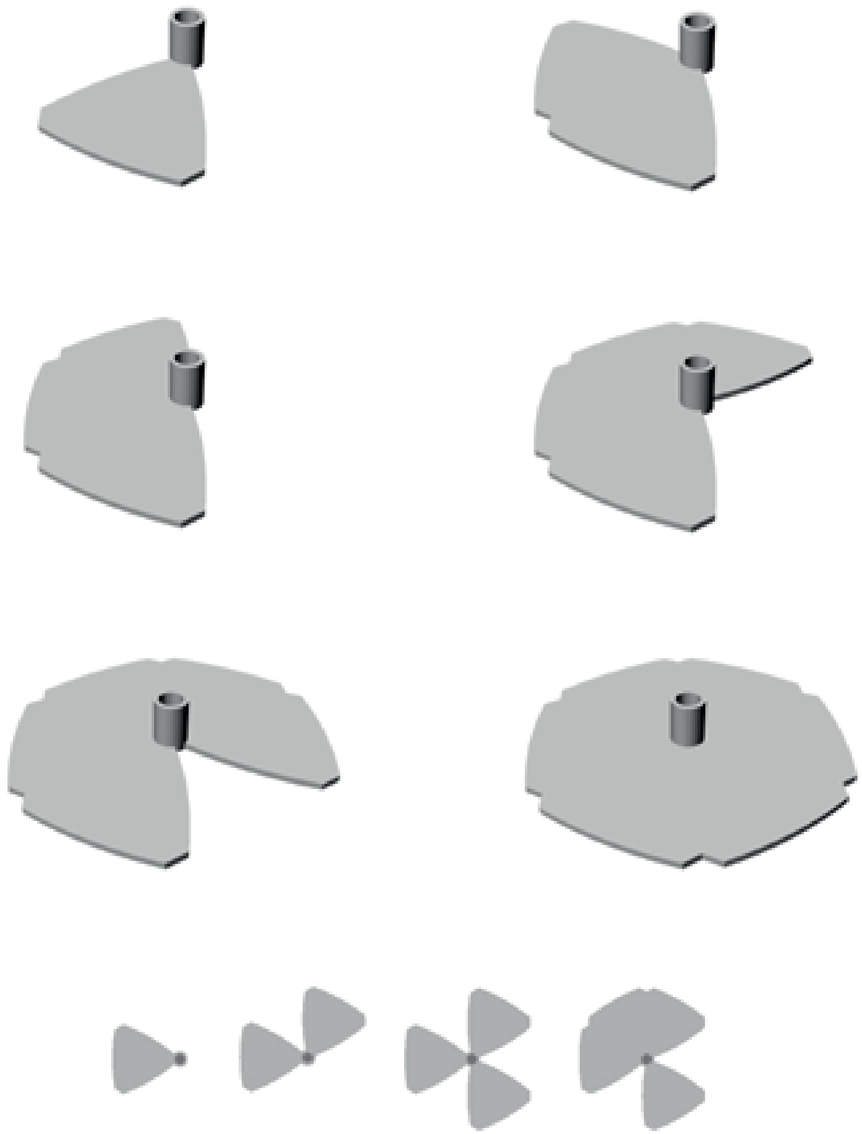
התאים משתנים ביניהם בתוכנית

מערכת מודולרית

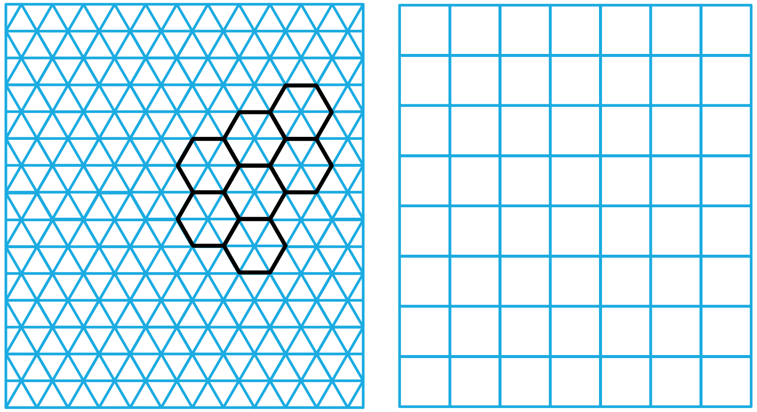
פיתוח מספר מצומצם של תאים מאפשר מגוון של צורות הרכבה ושילובים בתלת מימד.
מגוון חללים פנימיים הנוצרים מנגיעה של שני תאים.
ומגוון חללים חיצוניים בין התאים לגזע ולמעטפת.

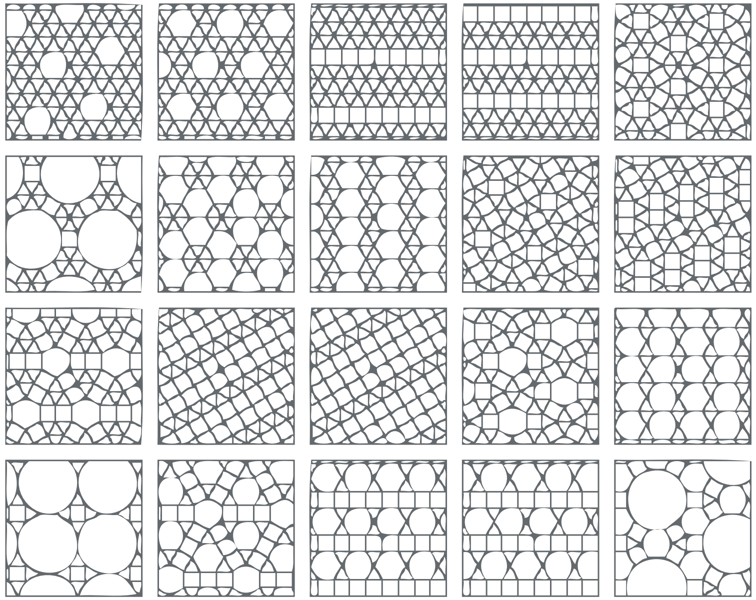




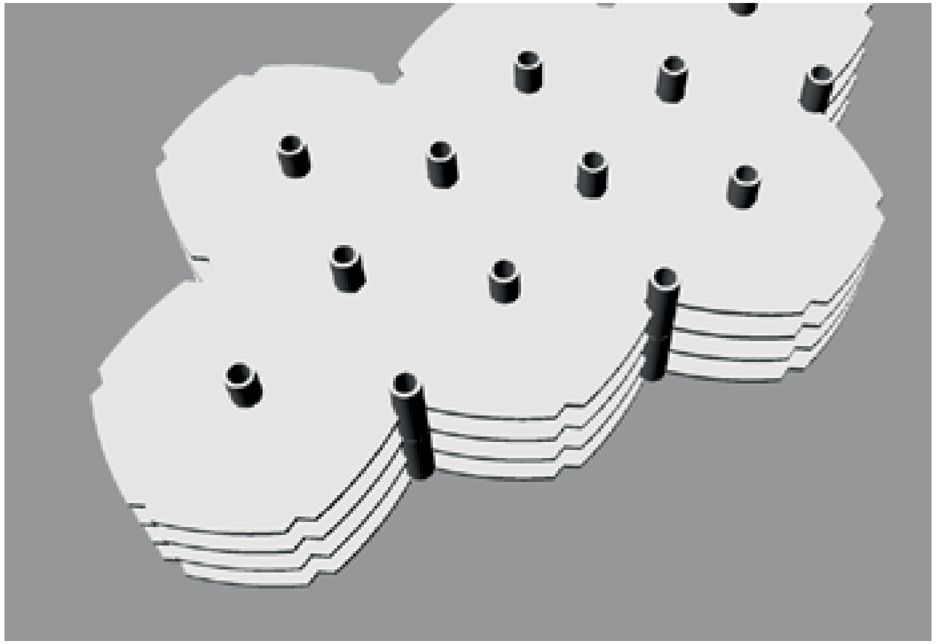


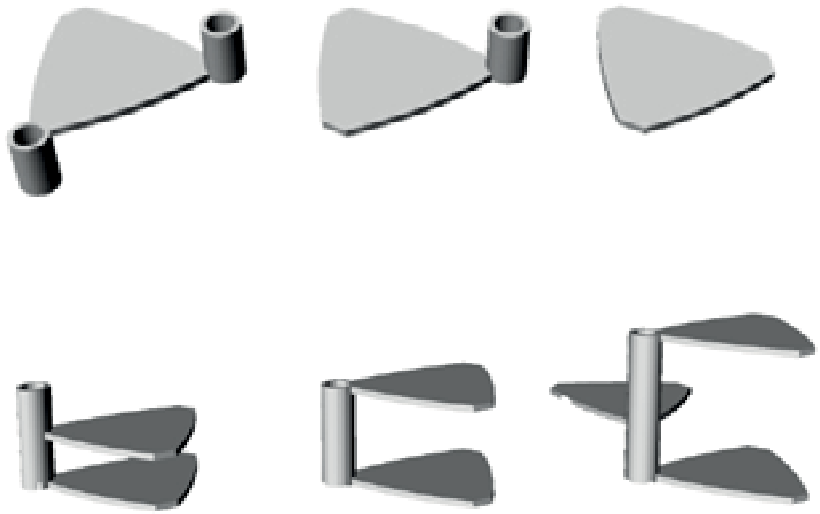
infinite tessellation

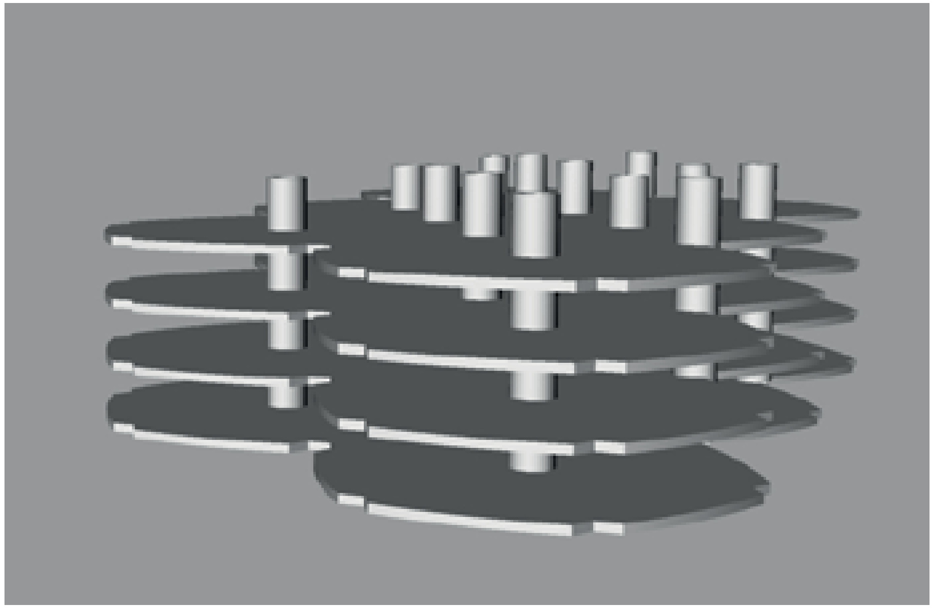


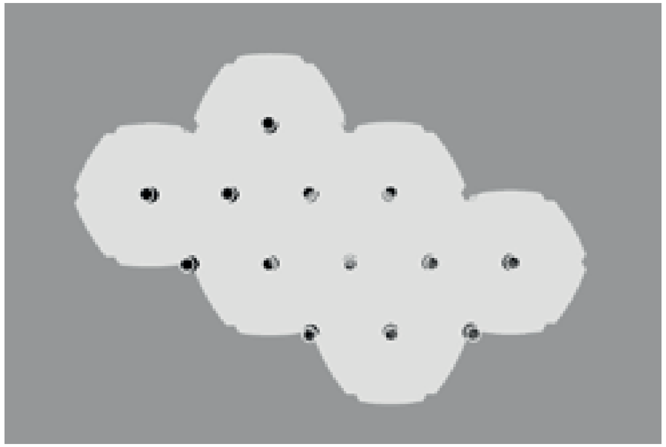


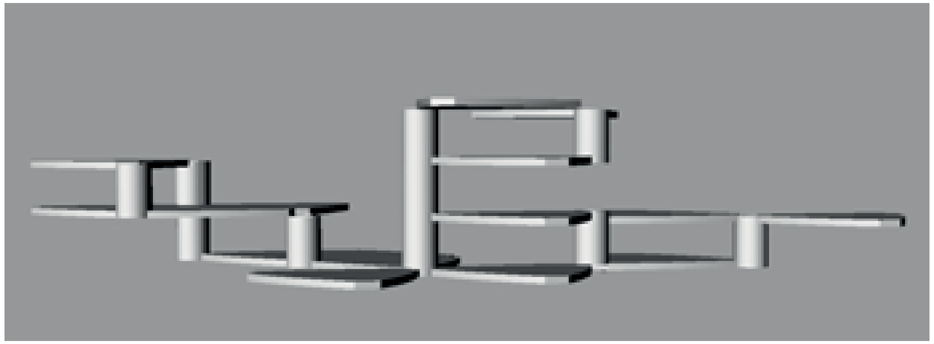
* non-regular tessellation

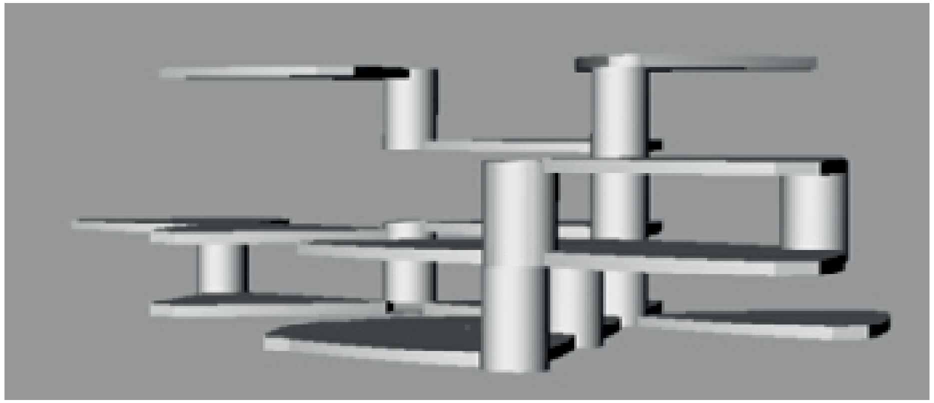


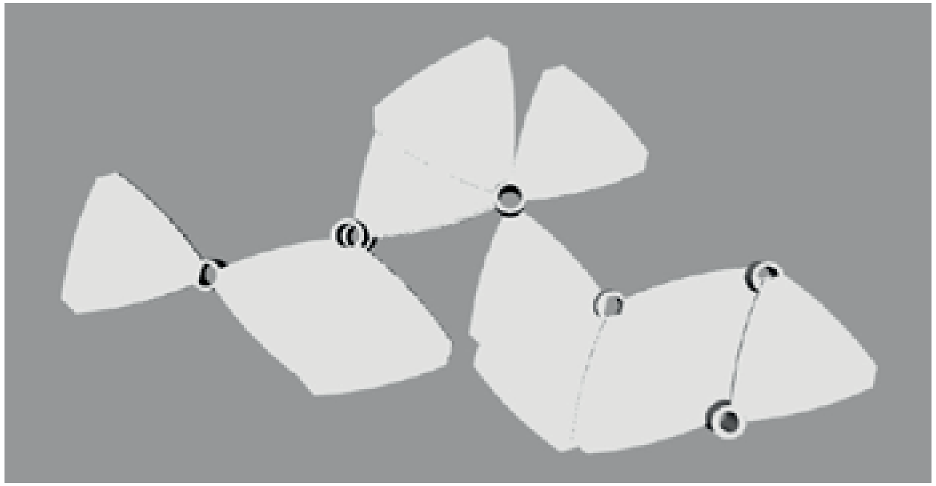


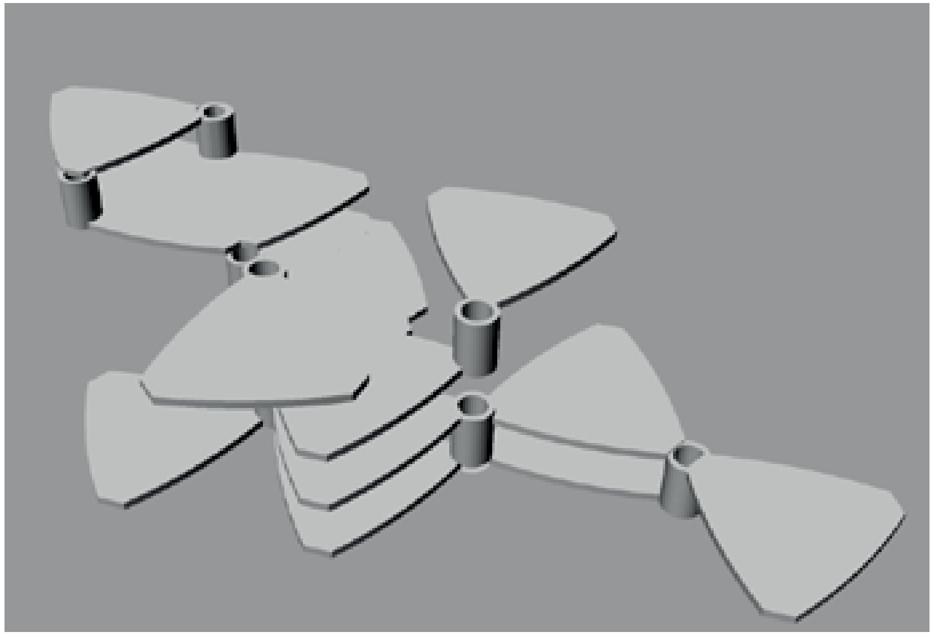


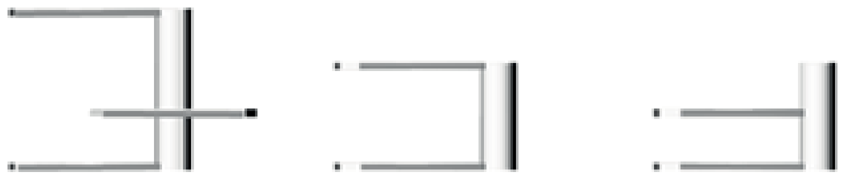


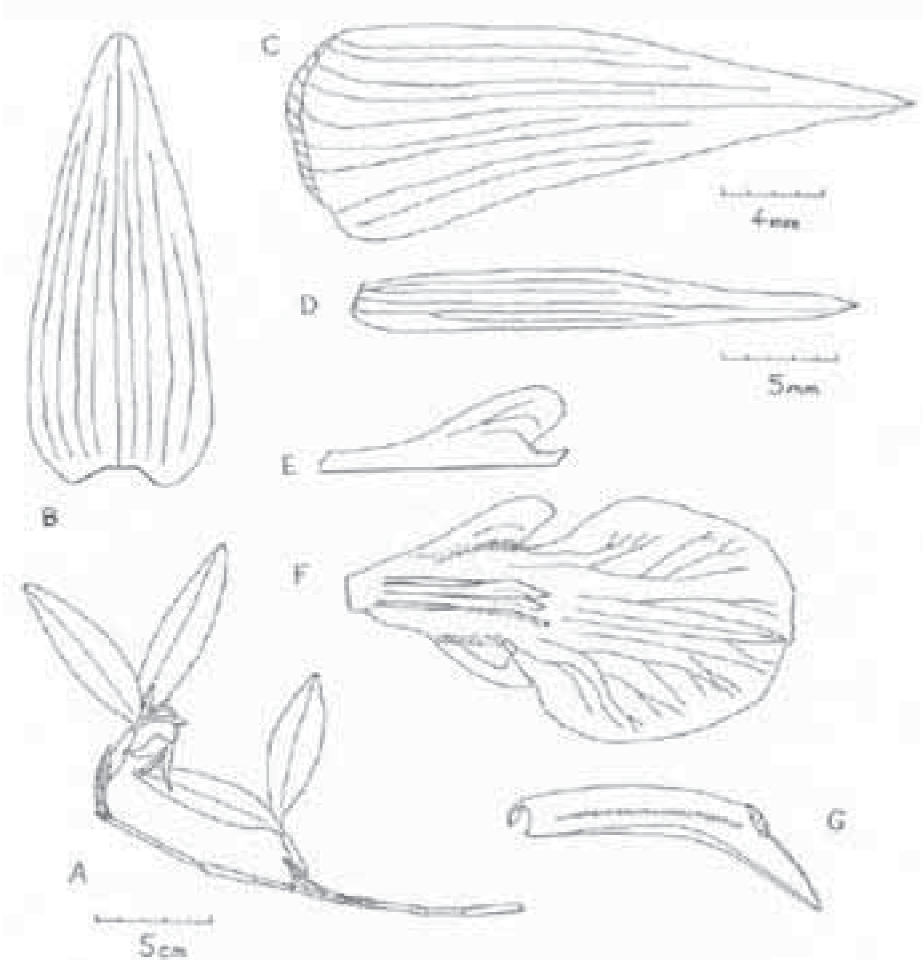


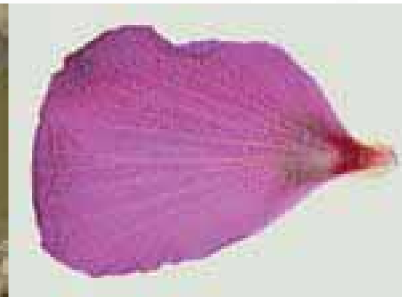


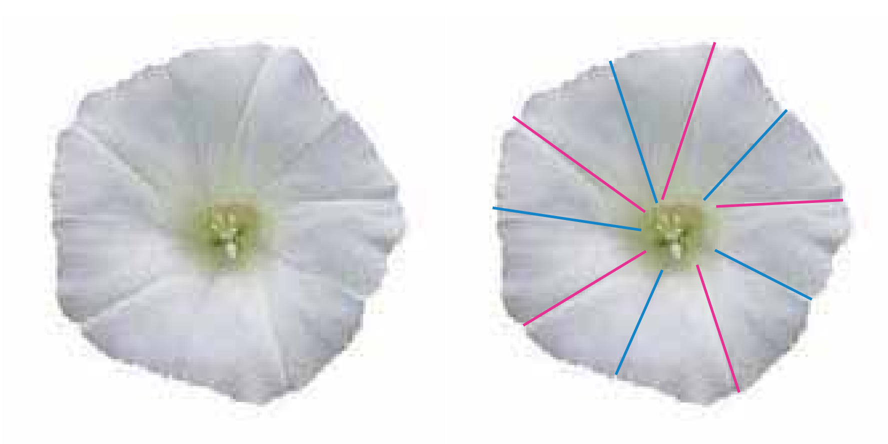


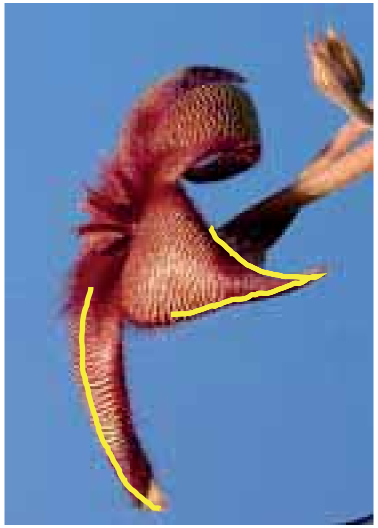


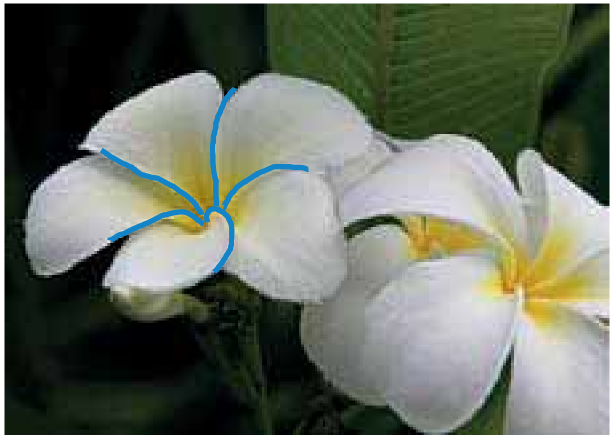


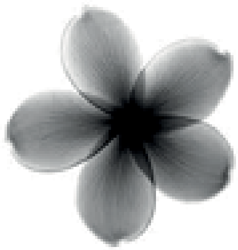

C
4mm
D
5mm
E
B
F
G
A
5cm

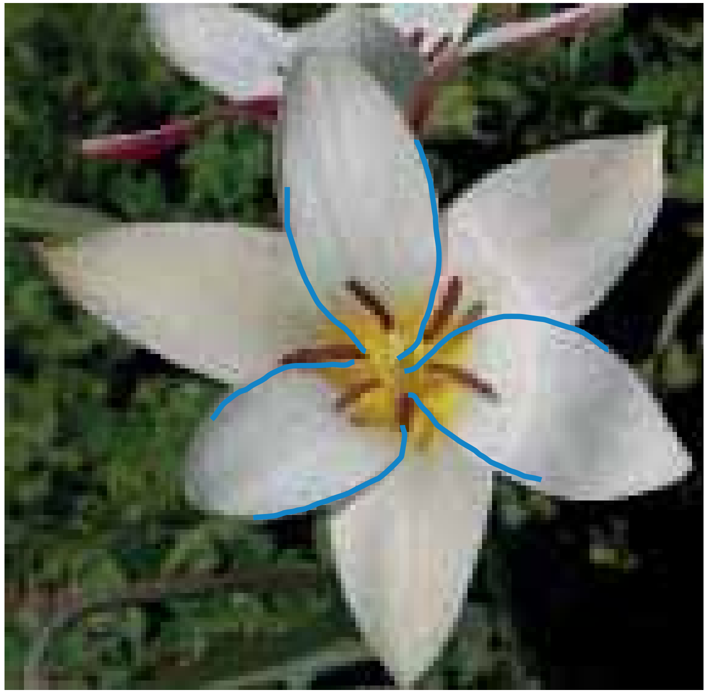


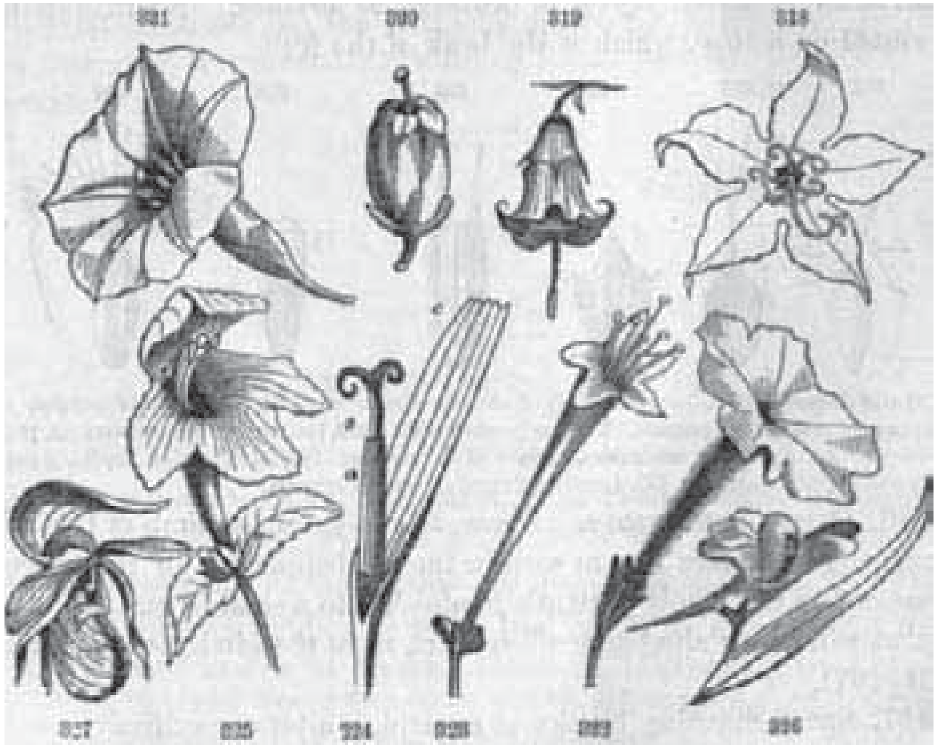


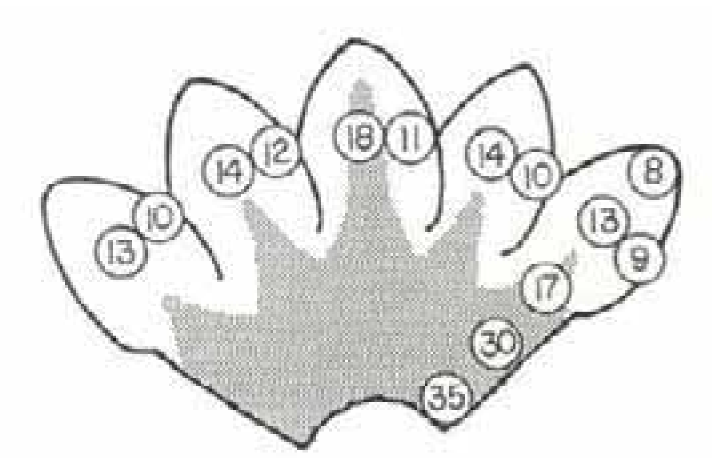




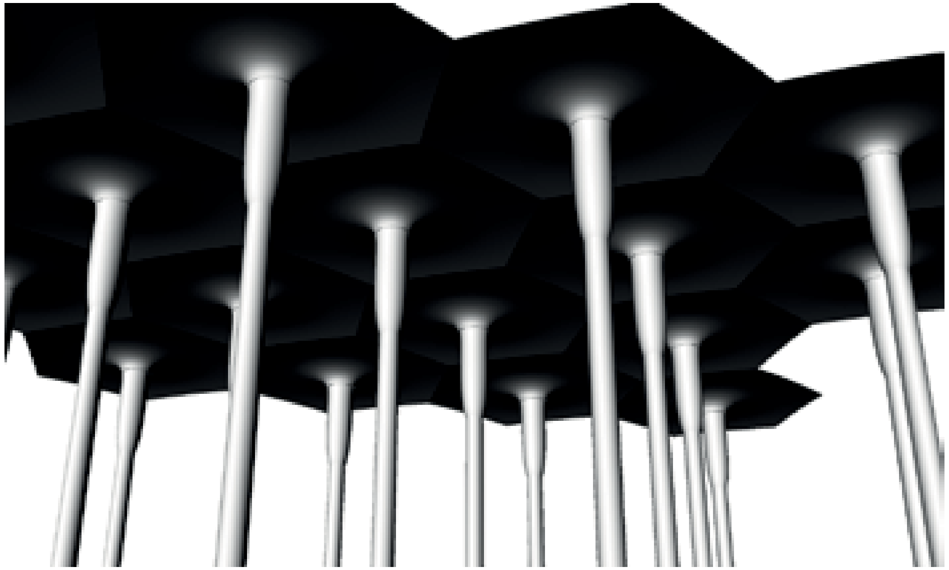


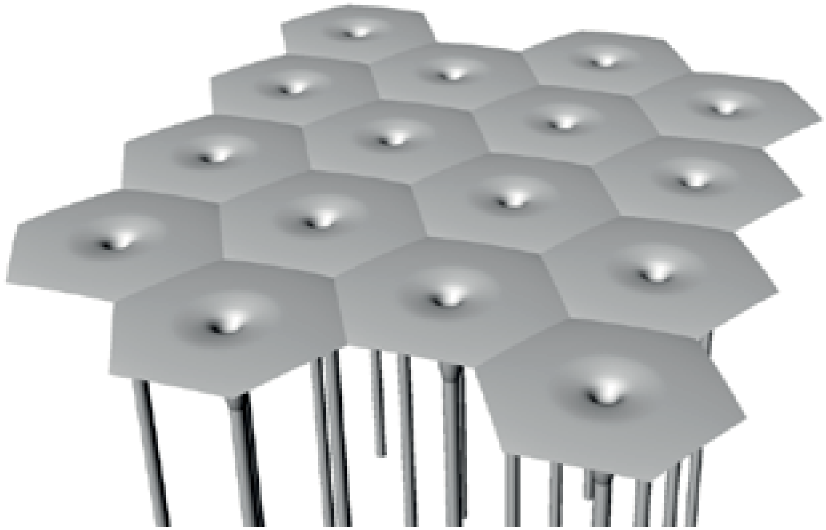


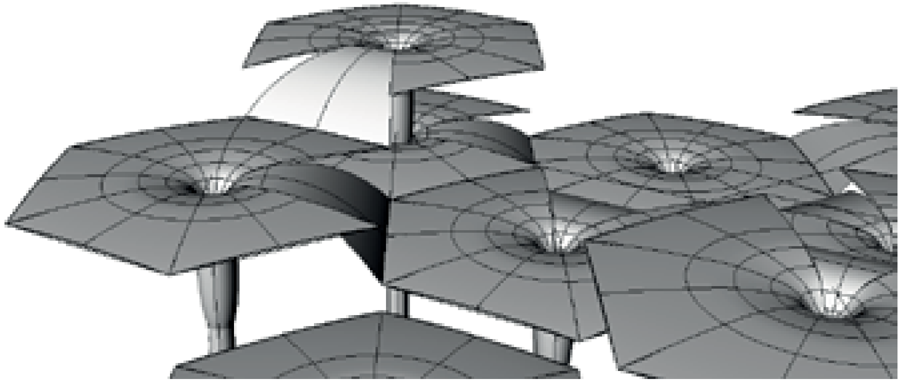


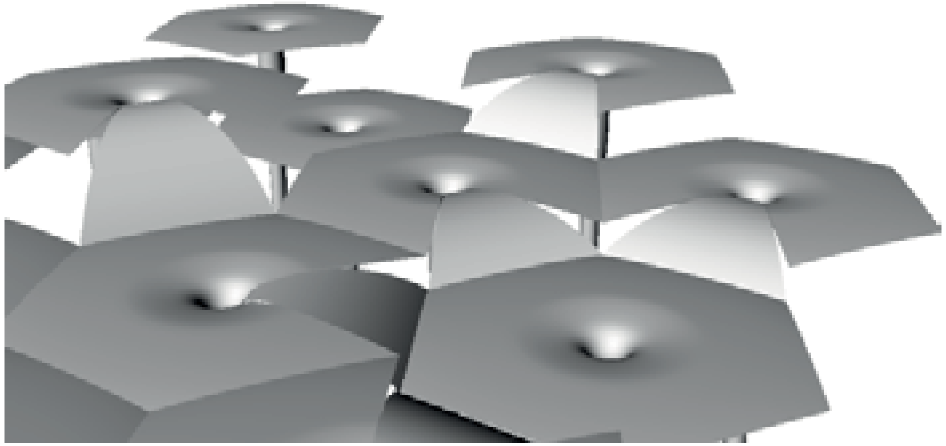


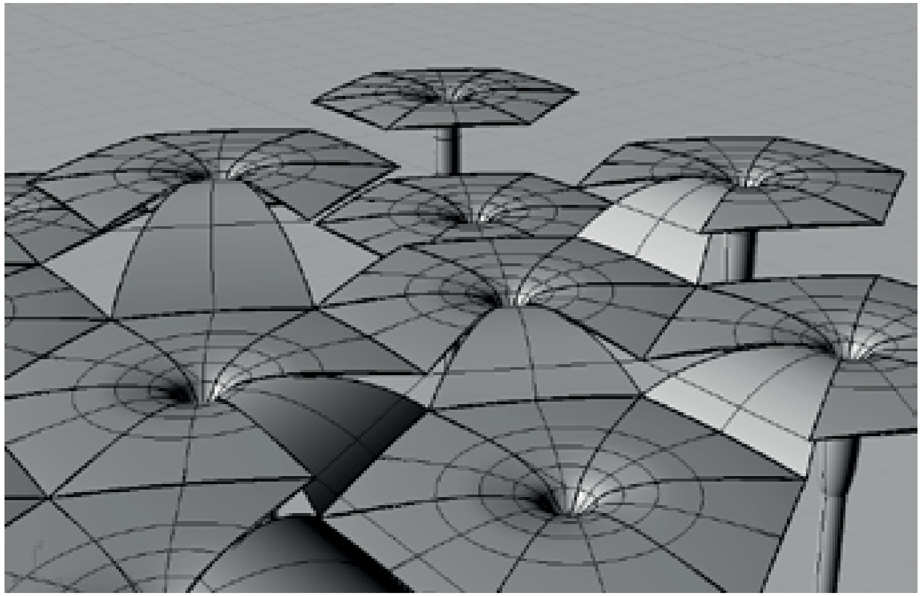
10 mil = 0.25 mm











MOZAMBIQUE PROGRAM

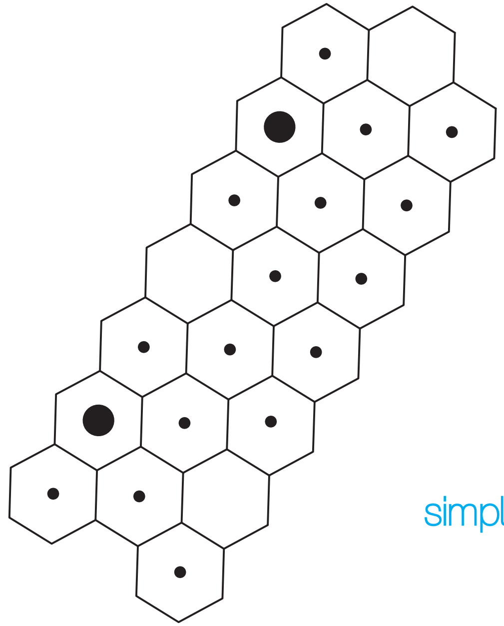
1000 m LOBY
- exhibition
- dining 100 m
- shopping 400 m
- luli 60 m

THEATRE 350 m

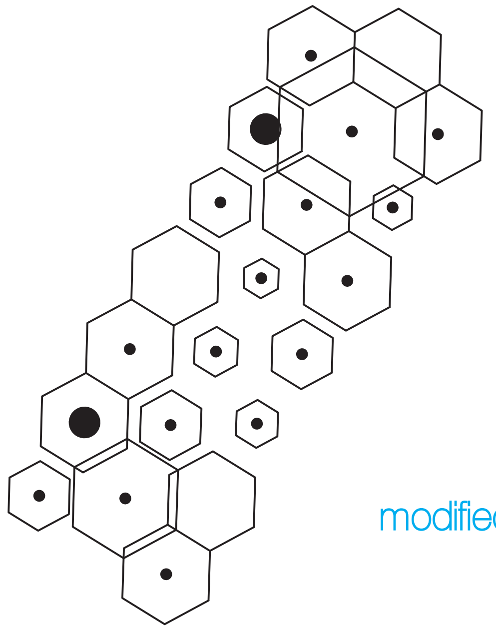
EDUCATION
- S study groups 9m * 5
- M classes 24m * 3
- L lecture hall 60 m

500 m LIBRARY
- reading
- audio
- video

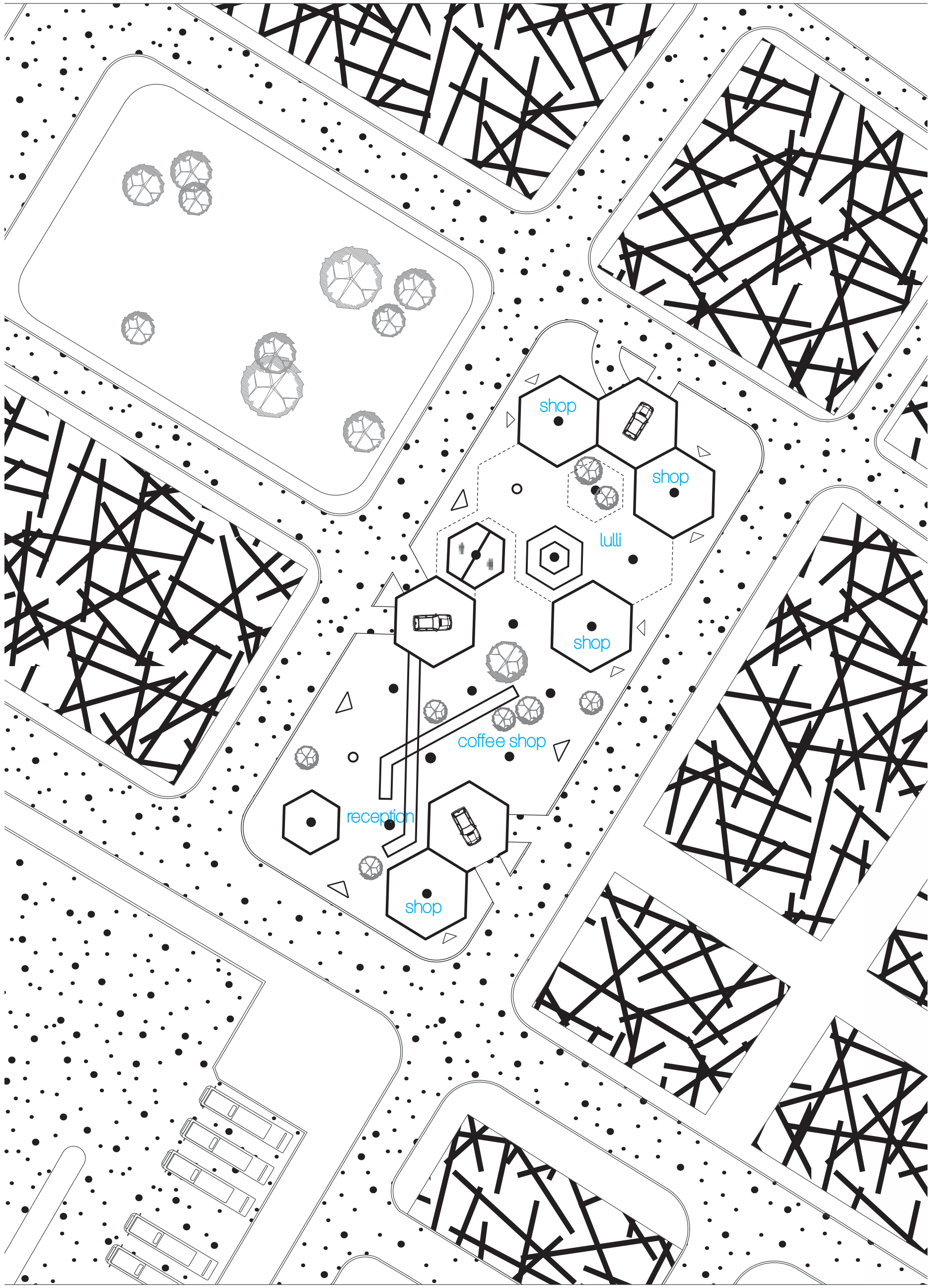
SERVICE
- offices
- toilets
- storing
- parking

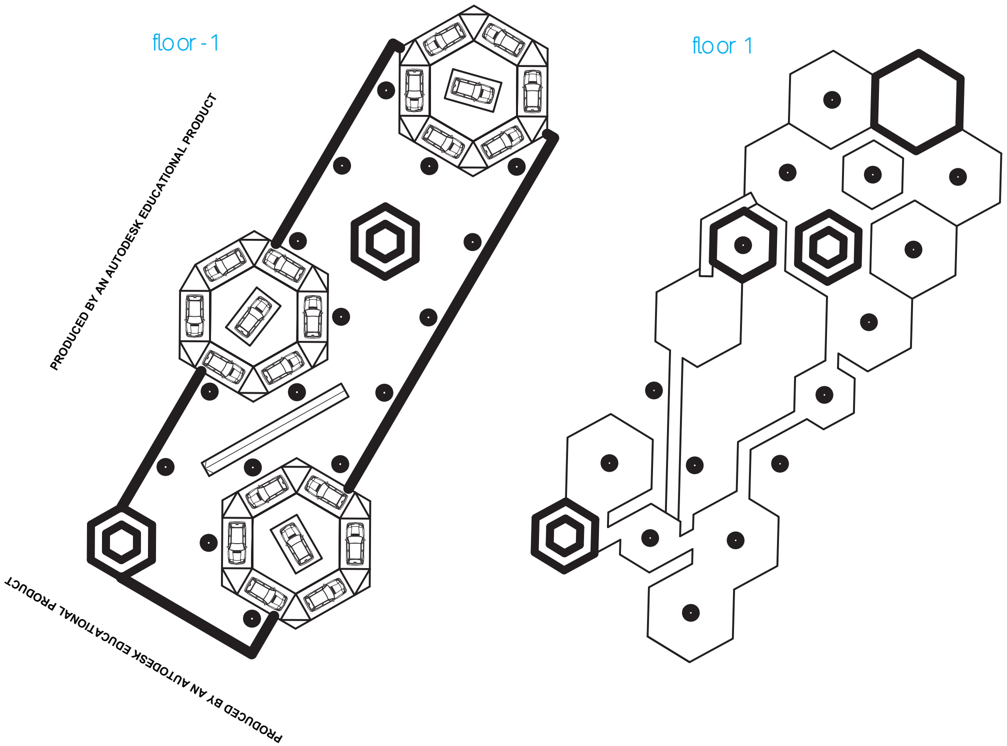


simple grid

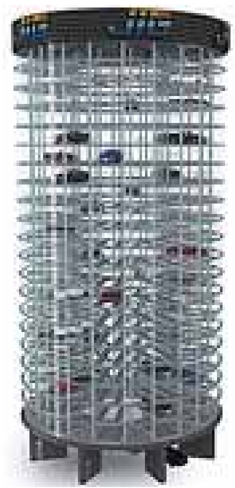


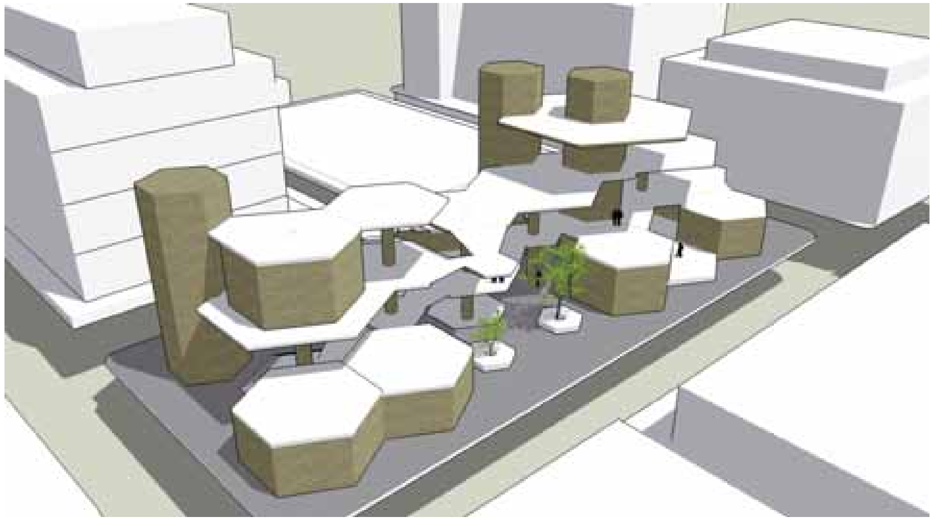
modified grid

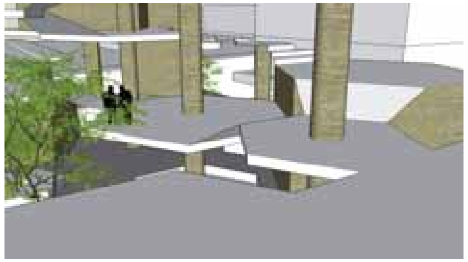


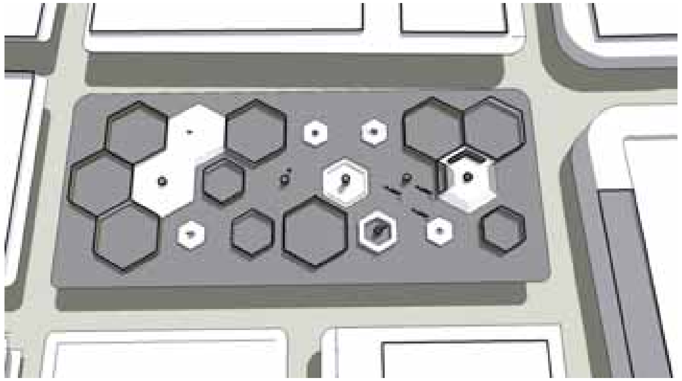


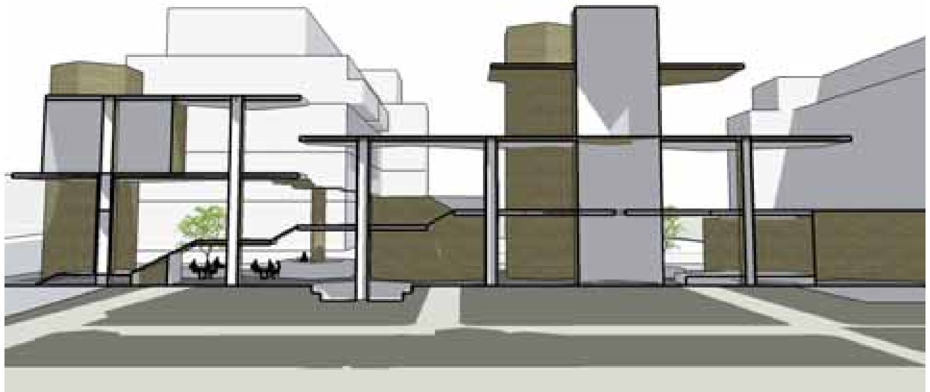
parking system

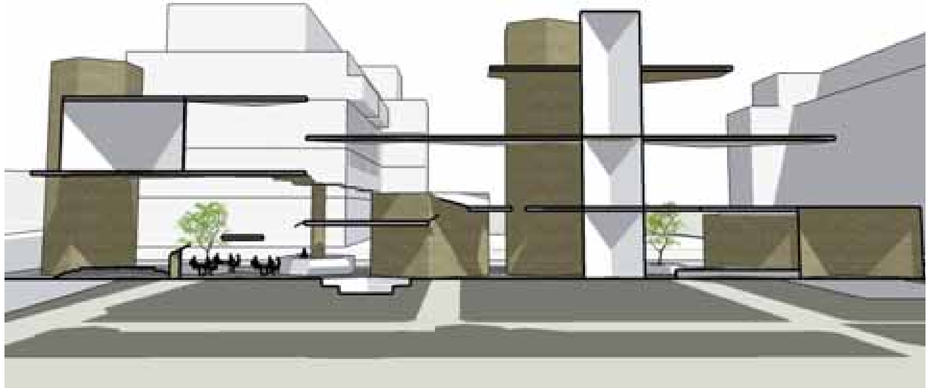


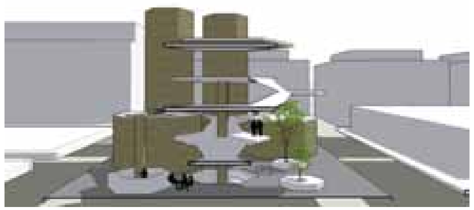






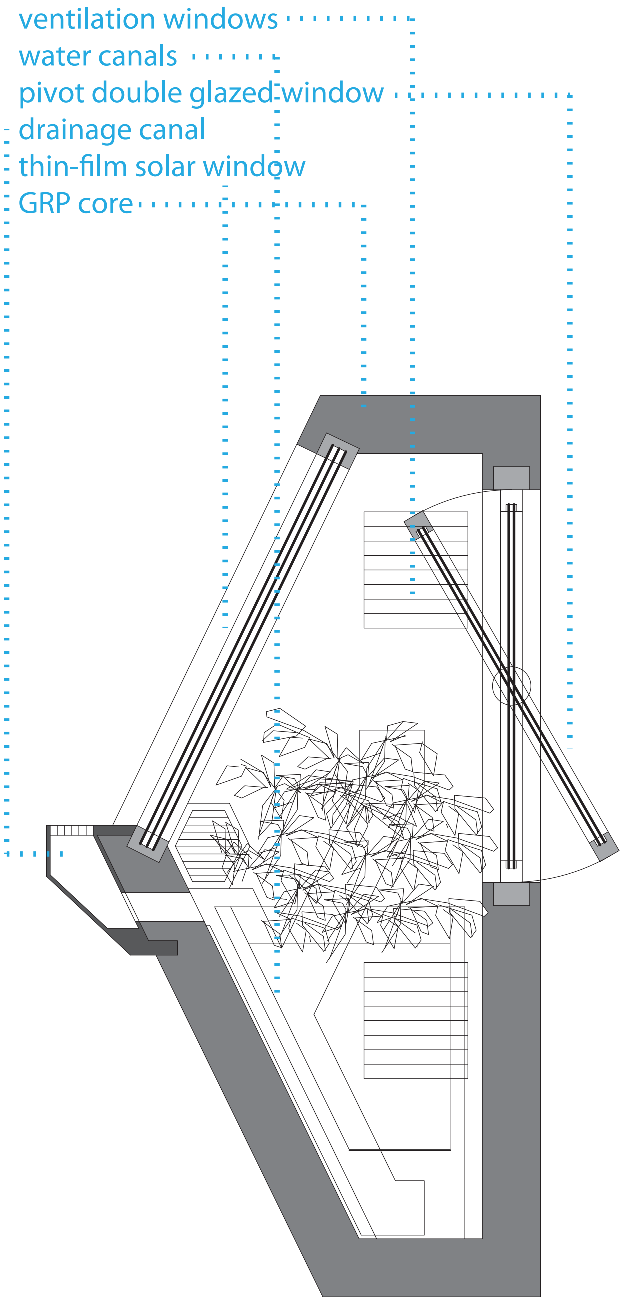


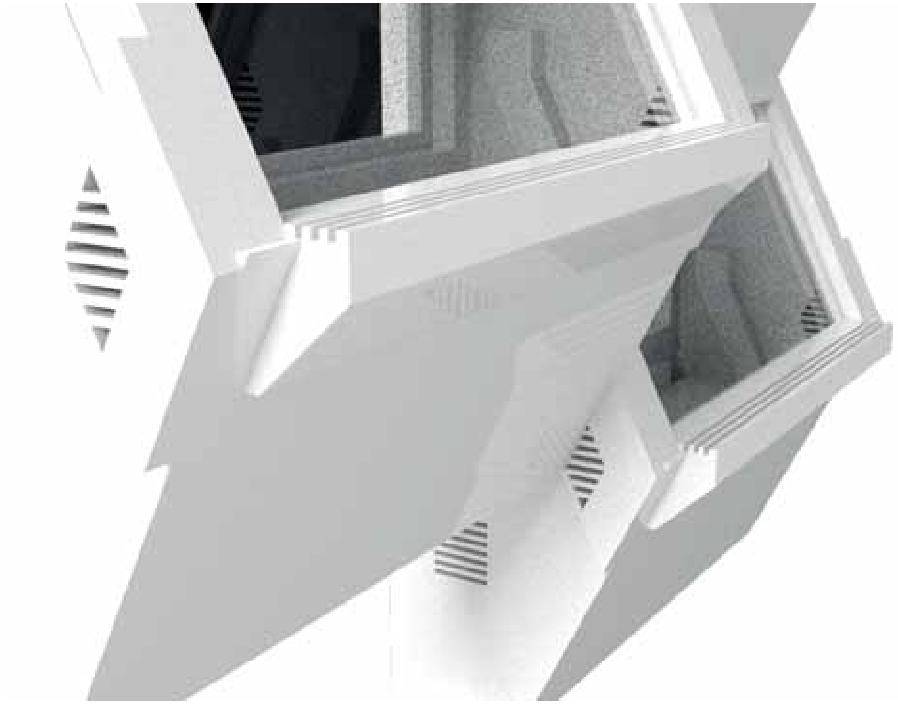




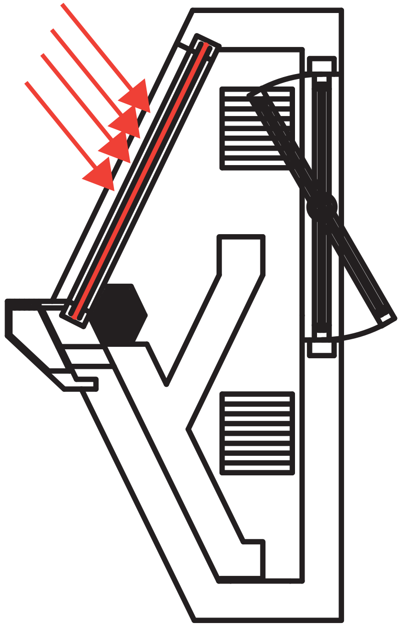
MOZAMBIQUE B

Facade cell

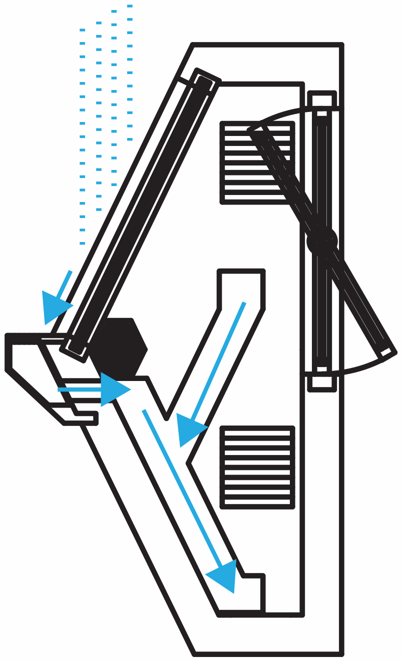

ventilation windows
water canals
pivot double glazed window
drainage canal
thin-film solar window
GRP core



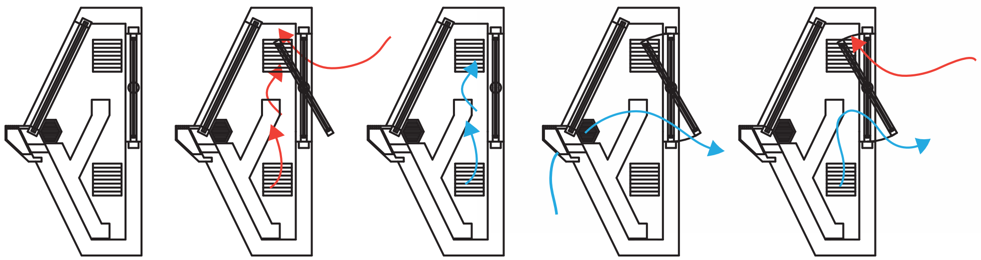
SUN ::: solar enegy absorption



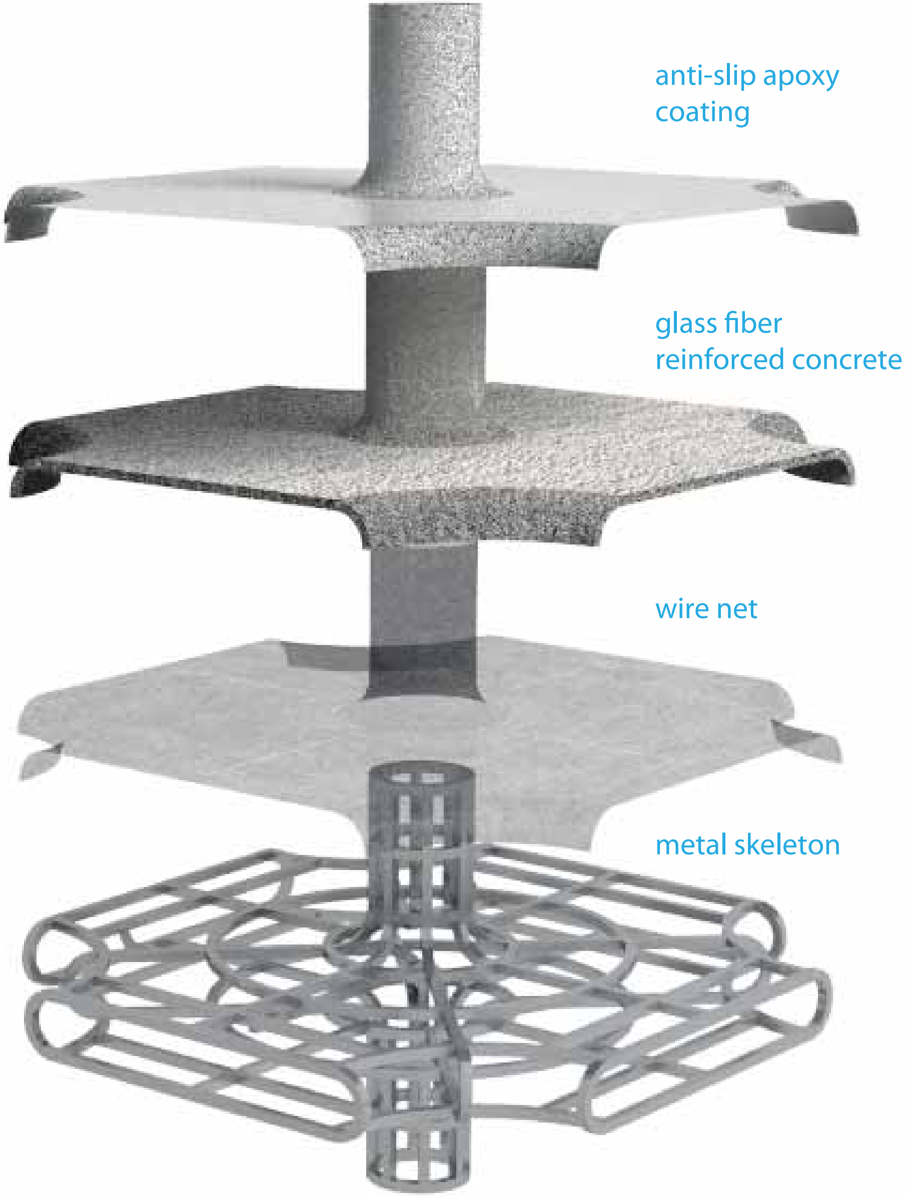
WATER ::: rain collector

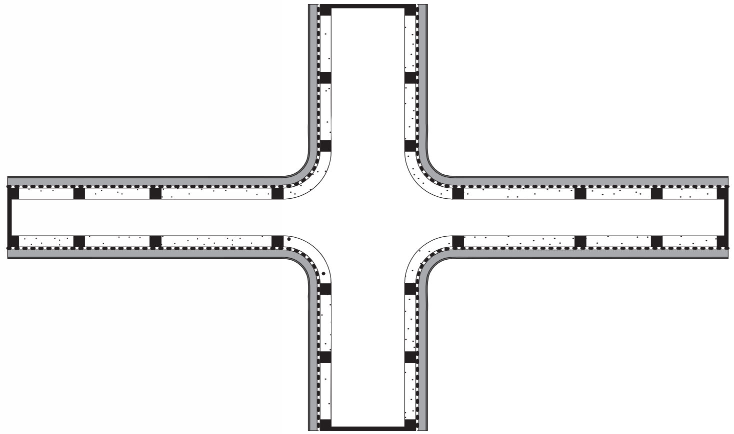


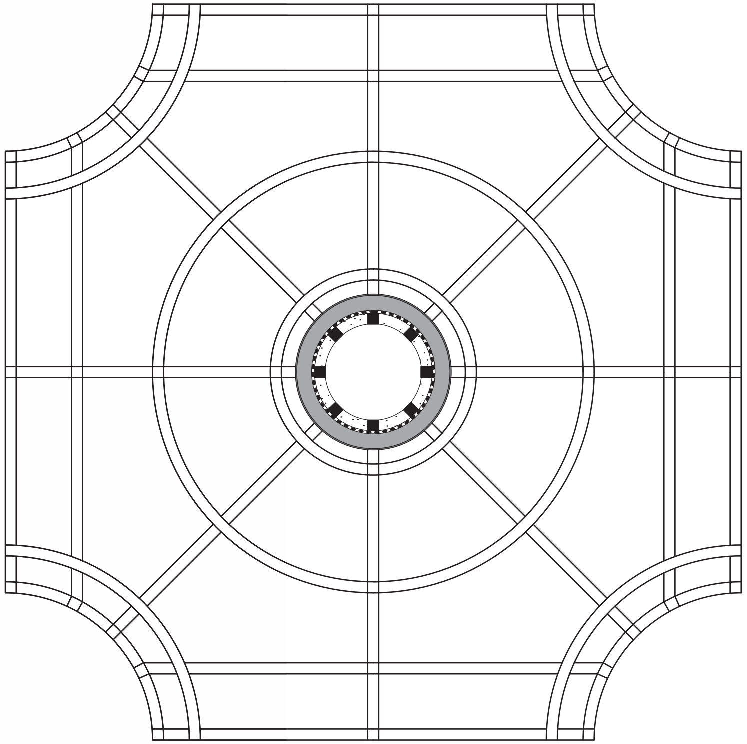
AIR ::: various ventilation modes

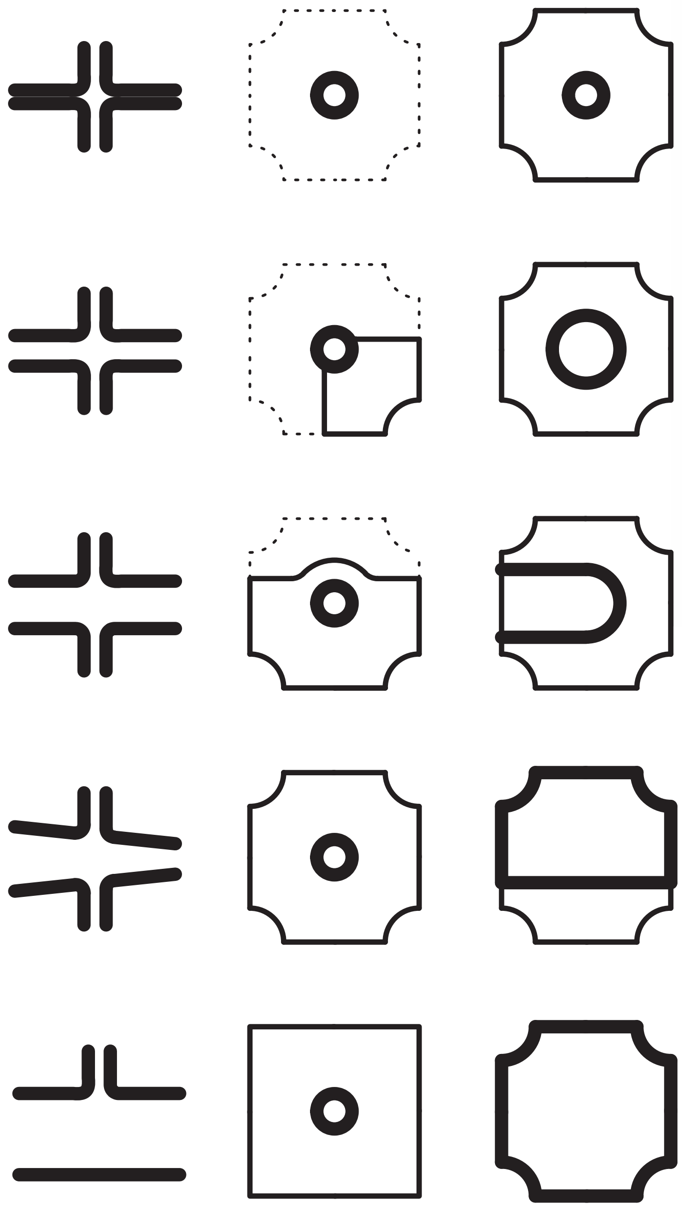


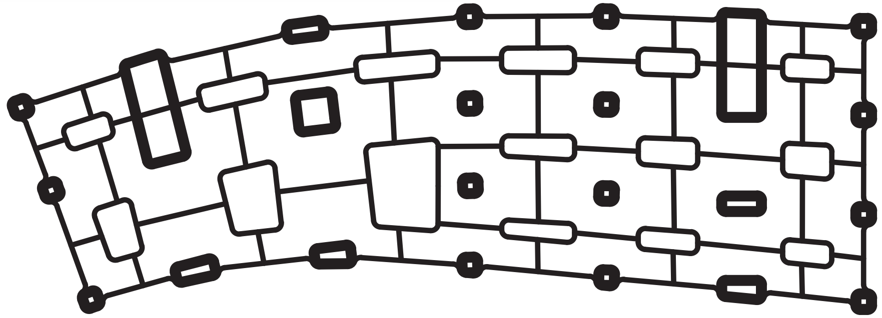
Structure cell

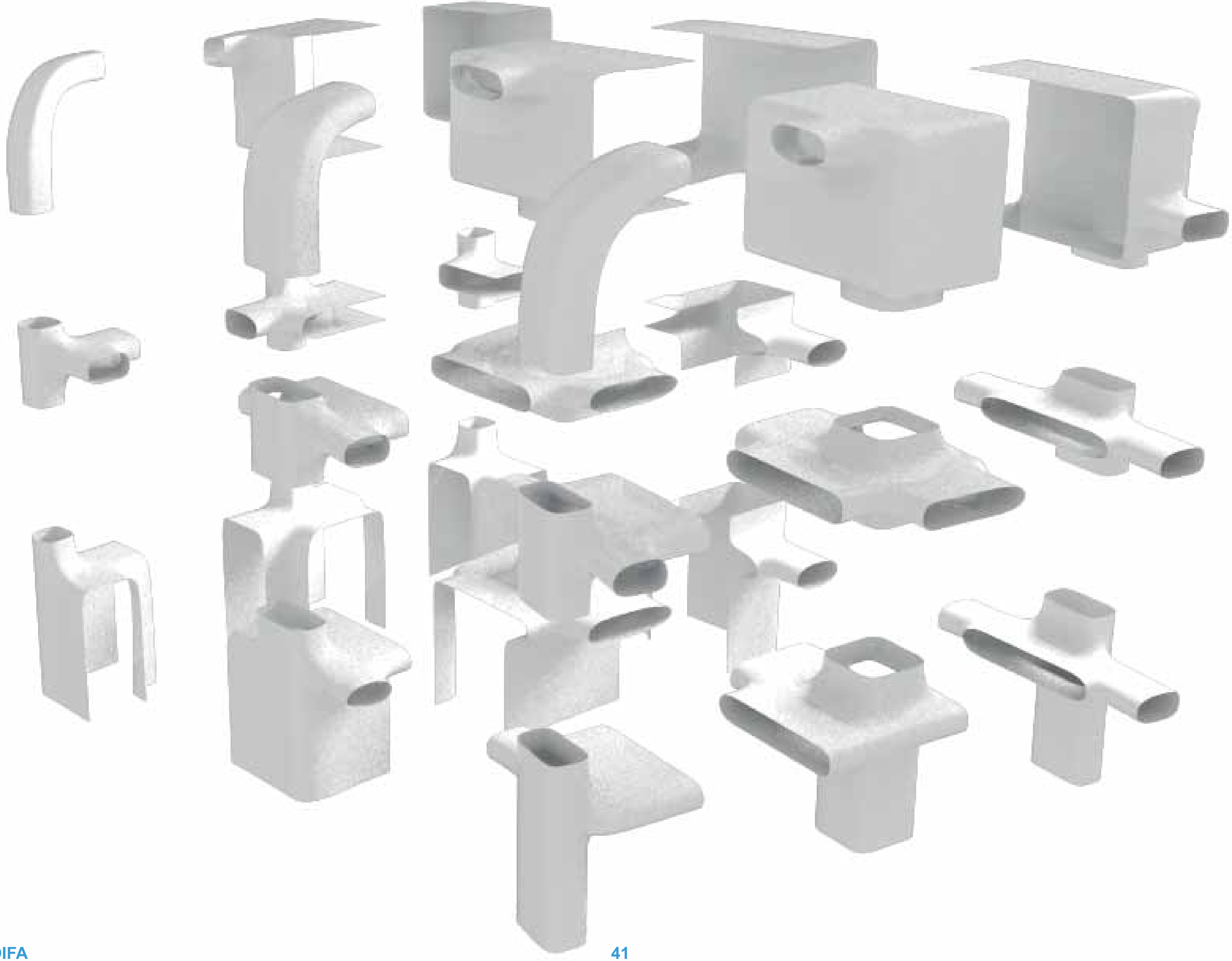


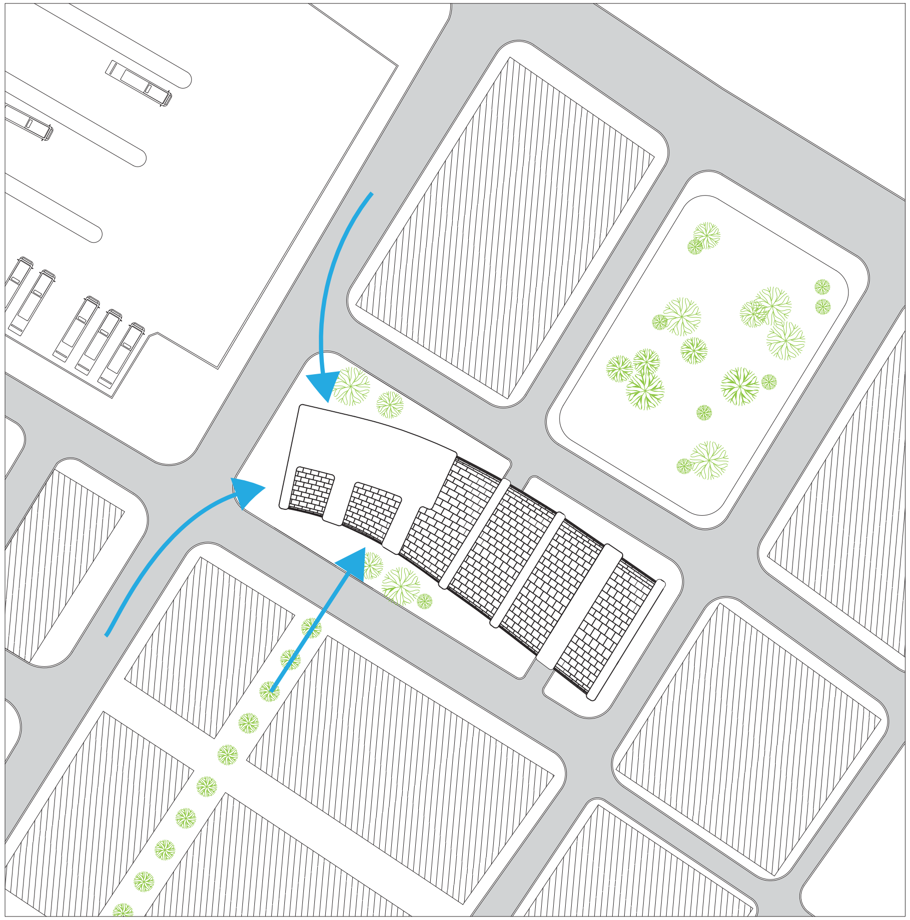




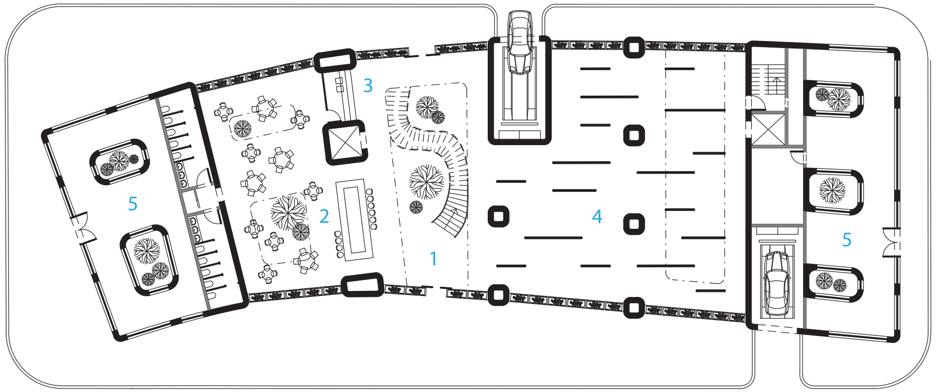






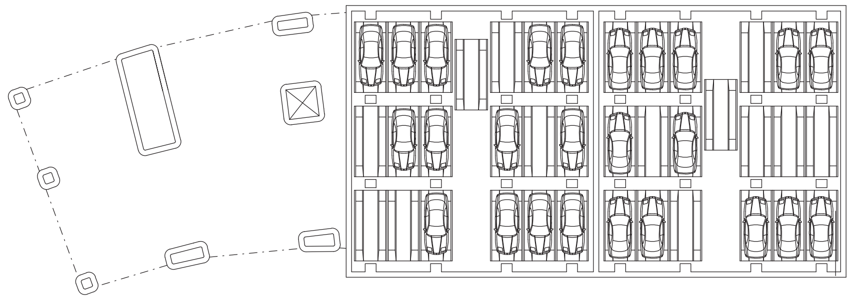


floor 0

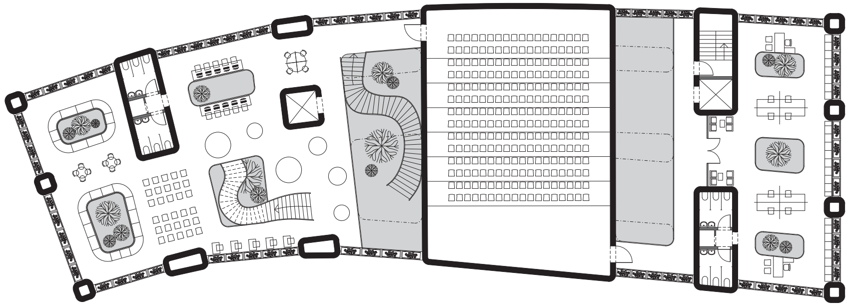


1 lobby
2 coffee shop
3 reception
4 gallery
5 shop

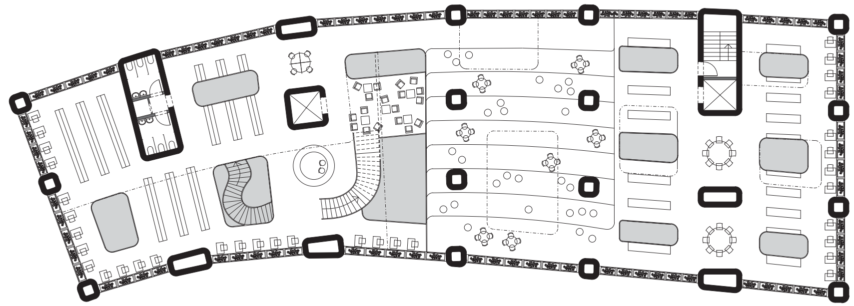
floor -1



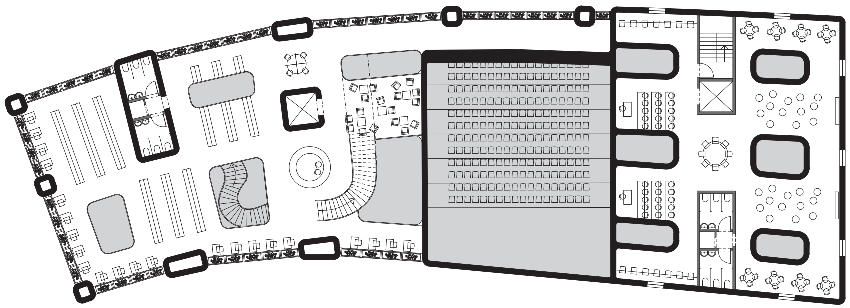
parking



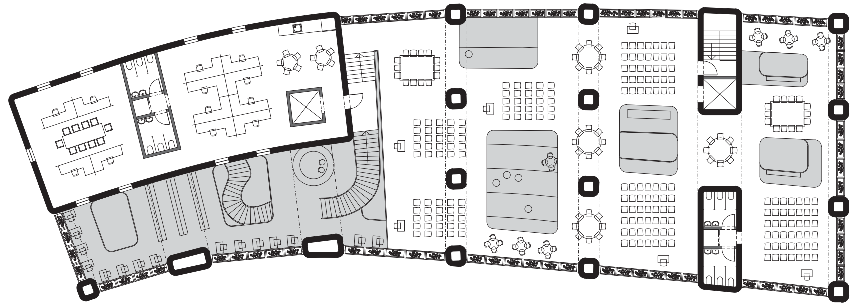
1 multimedia
2 hall
3 offices



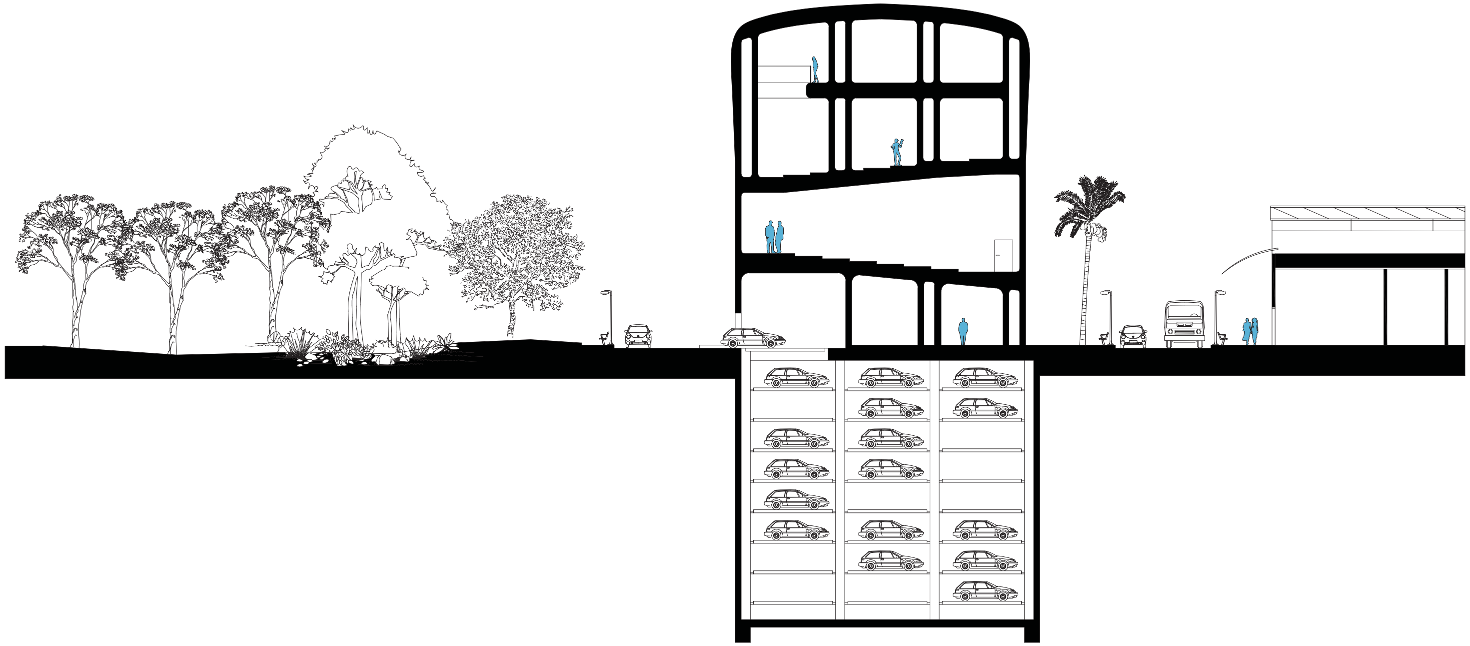
library

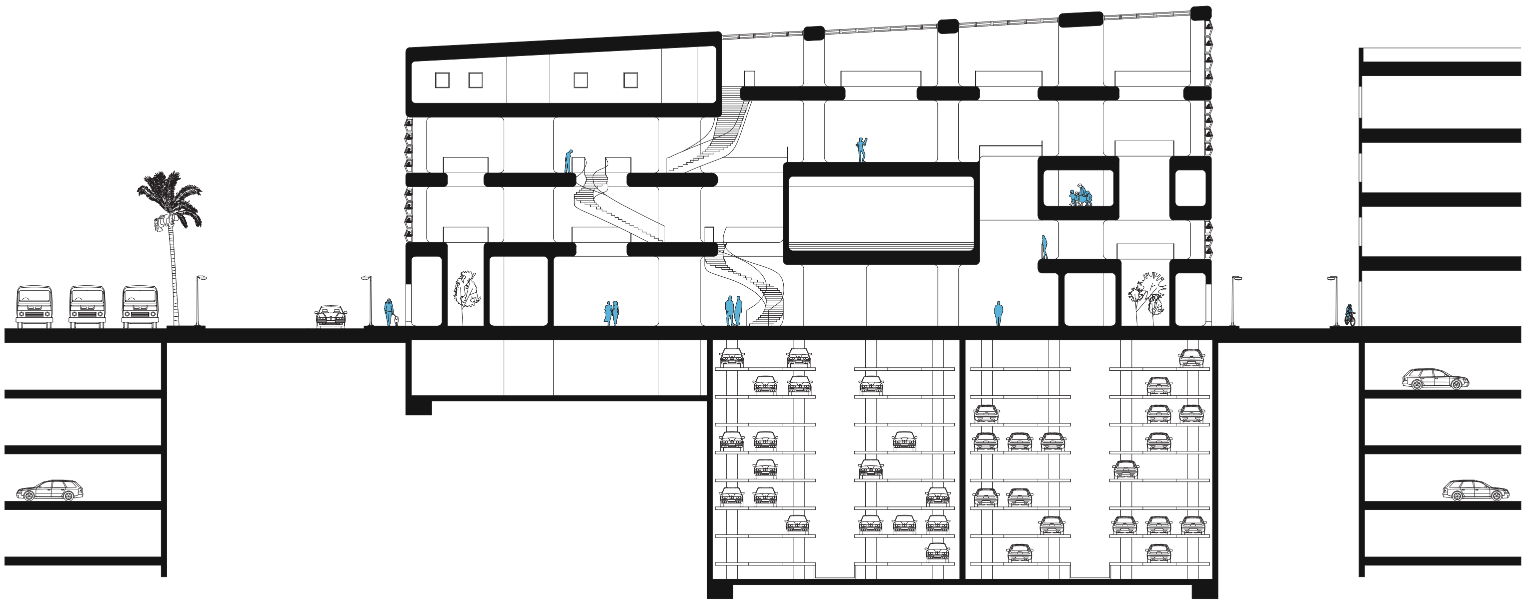


1 library
2 kinder garden



1 teachers room
2 learning hall





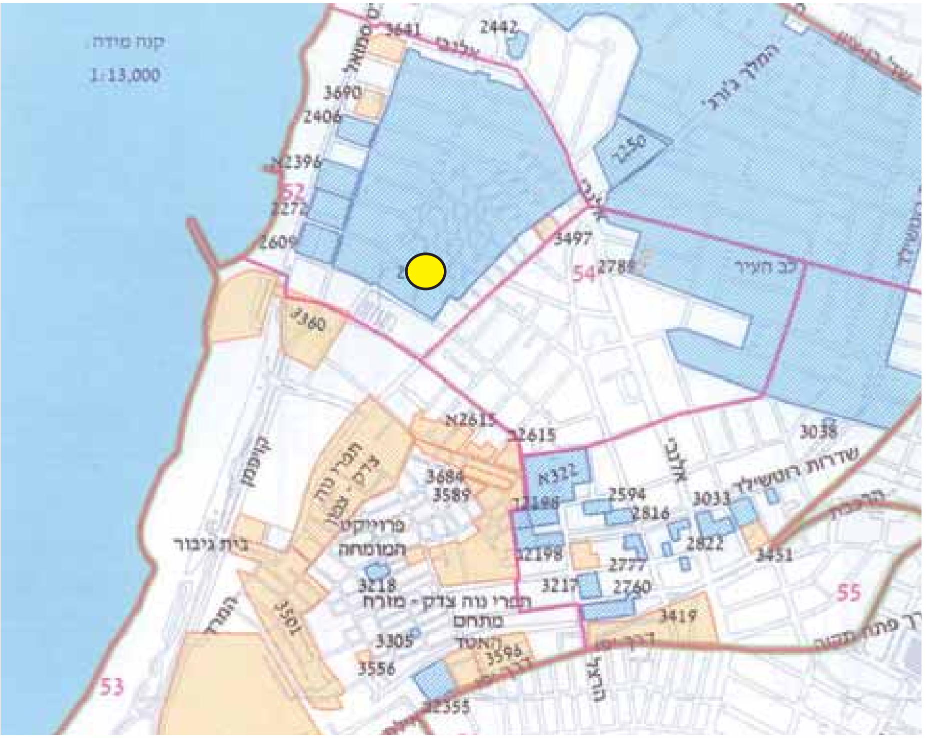
Water Element
Anat Blaistain

בהנחיית דר. יאשה גרובמן
סטודיו מבנים תאיים
פקולטה לארכיטקטורה ובינוי ערים, טכניון, אביב 2012

יריית הפתיחה // כוונות ראשוניות

המגרש ממוקם בדרום תל אביב באיזור כרם התימנים ושוק הכרמל. קרבתו של המגרש לים והפרוגרמה הכללית העתידית של האיזור בו הוא ממוקם (שוק אוכל, איזור מסעדות ומקום ציבורי ושוקק חיים באופן כללי) הובילה לחיפוש של אלמנטים חוויתיים, מרעננים, "חיים" ונכונים מבחינה אקלימית, ולכן התכנון החל מחיפוש של תאים המתמודדים עם מים (איסוף, מחזור, שימוש לנוי ולקירור וצמחיה (קירות ירוקים).

תצ"א ותמונות מאיזור שוק הכרמל הממוקם בסמוך לפרויקט
מקורות: אקסלרוד גרובמן אדריכלים



יריית הפתיחה // כוונות ראשוניות

ל"קירות ירוקים", עם צמחייה ירוקה או צבעונית יש יתרונות מרובים:

1. קירות ירוקים "פעילים" משמשים כפילטר ביולוגי, ומטהרים את האוויר במבנה שלם: אוויר, שמכיל דו תחמוצת הפחמן ורעלנים מוזרם על הצמחים, אשר קולטים אותם (טיהור האוויר מתבצע דרך קליטה של הרעלנים על-ידי בקטריות בשורשי הצמחים) ומשחררים לחלל חמצן. האוויר הנקי מוזרם דרך מערכת מיזוג לחדרי הבניין. שיפור איכות האוויר חשוב במיוחד במבנים סגורים, הסובלים מתופעת "הבית החולה", בהם האוורור אינו יעיל ובחלל המבנה מצטברות מולקולות רעילות, הנפלטות מהמבנה והריהוט.
2. צמחי הקירות משפרים את רמת הלחות ומקררים את סביבתם.
3. צמחים על-גבי קירות חיצוניים הם מבודדים יעילים, וחוסכים בצריכת אנרגיה בתוך המבנה.
4. משטחים אנכיים תורמים להגדלת השטח הירוק, שמייצר חמצן לסביבה בתהליך הפוטוסינתיזה, מבלי ל"בזבז שטח".
5. אמצעי למחזור מים - השקיית הצמחים במים אפורים מאפשרת ניצולם דרך פירוק החומר האורגני על-ידי חיידקים וקליטת מינרלים במערכת השורשים, ובכך גם מקטינה את זיהום מי תהום וחוסכת במים.
6.קירות ירוקים מוסיפים צבע ויופי לסביבה.


source: http://www.bvd.co.il

מחזור מים אפורים וטיהור בעזרת צמחים:

טיהור מי ביוב בעזרת צמחי מים מתקיים בטבע, וגם באופן מלאכותי, במקומות שונים בעולם בהצלחה רבה. עקרון הפעולה של השיטה מתבסס על תכונתם הייחודית של צמחי המים לקלוט חמצן באוויר ולהעביר אותו לשורשיהם. בסביבה רווית החמצן של השורשים מתפתחים מיקרואורגניזמים שונים (כ 10,000 מינים שונים , חיידקים, אנזימים ופטריות, ספציפיים לצמח ולסביבת הביוב שבה הוא גדל) בעלי יכולת פירוק וספיחה מדהימים של רעלים וגורמים פתוגנים.



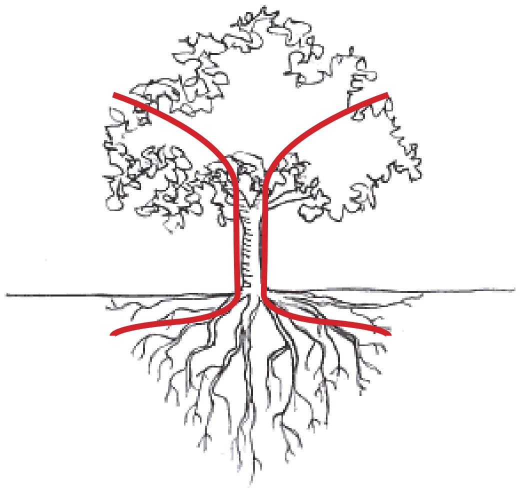
בבנין "אמפא" בתל אביב ניתן לראות שימו בבריכות נוי המטהרות מים אפורים של מספר מבני ציבור
מקורות: איילה מים

תהליך עיצוב התא // מקורות ההשראה

פרחים כמודל טבעי לניקוז ואגירת מים
עלי הכותרת הרחבים מהווים נקזים יעילים- יחסית למשקלם ולעוביים הנמוך הם מצליחים לנקז מים משטח גדול ביחס לפרח. השיפוי של עלי הכותרת יעיל הן מבחינה קונסטרוקטיבית והן לצורכי אגירת מים.

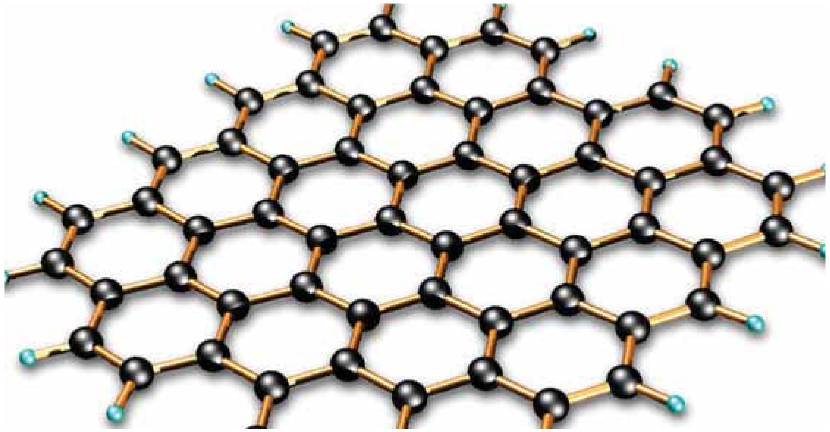
http://www.tiuli.com/flower_info.asp?flower_id=79

העץ כמודל קונסטרוקטיבי
מבנה העץ מאפשר לרכז עומסים המתפרסים על פני שטח גדול באיזור העלווה (תקרת העץ) אל עמוד אחד דק יחסית. הסיבה היא צורת ה"משפך"- המפחיתה מומנטים באופן משמעותי ויוצרת רוחב ממוצע גדול יותר. גם החיבור לאיזור השורשים הרחב מקבל את צורת המשפך האופייני, על מנת להפחית מומנטים וכוחות גזירה.



http://www.sustland.umn.edu/implement/planting.html

חלת דבש כמודל תאי קונסטרוקטיבי יעיל
חלת הדבש בנויה ממעין קירות תמך נושאים, כאשר השיפוע של המשושים יעיל מבחינה קונסטרוטיבית (יוצר משולשי כוחות המעבירים את העומסים בצורה אופטימלית) ויוצר ריצוף תאי יעיל מבחינת יחס שטח אחסון לשטח קירות בנויים.

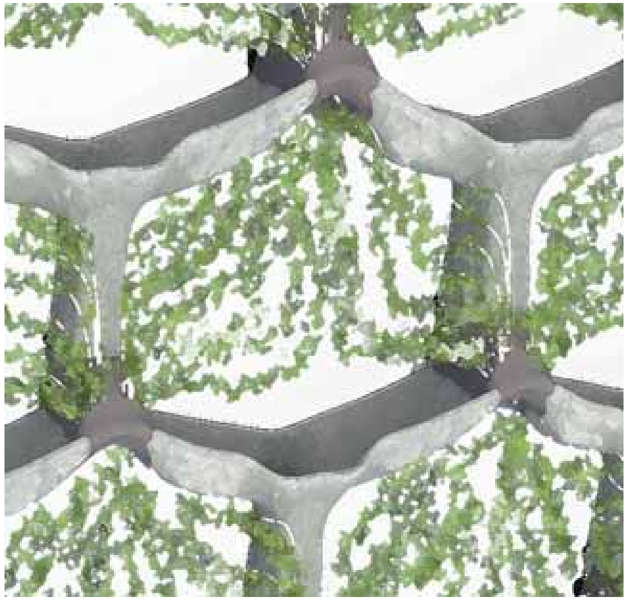


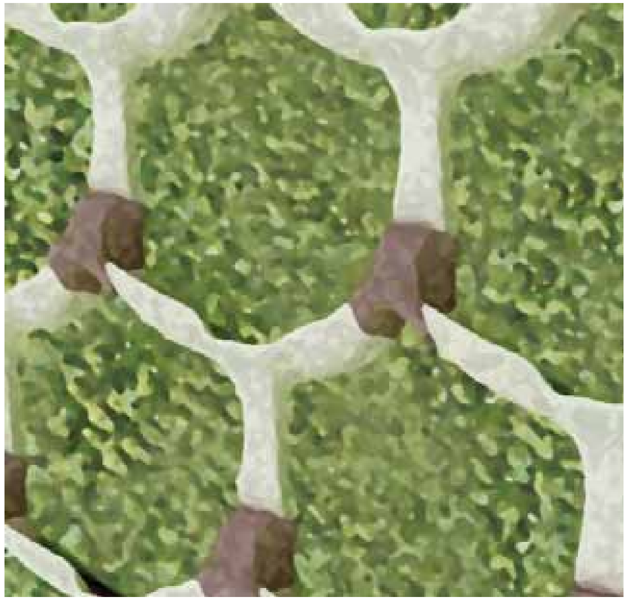
http://www.androidguys.com/2010/08/19/rumour-iteration-android-honeycomb/honey-comb/

תהליך עיצוב תא החזית // רעיונות ראשוניים

תאי החזית כללו שני סוגי תאים: תאי חלונות (כמטר על מטר וחצי) ותאי מרפסות שניתן לשהות בהם (כ3 מטר על 4 מטר).

התאים מוצללים ע"י צמחיה, כאשר טכנולוגית הגידול וסוגי הצמחים קובעים את מידת אטימות התא ומידת ההצללה הרצויה:
התא האטום נוצר ע"י קיר ירוק המסנן את האוויר ומקרר את הבנין, ותא המאפשר חדירת אור נוצר ע"י מטפסים נשירים עונתיים במידת צפיפות משתנה המאפשרים לשמש החורף לחדור אל הבניין.

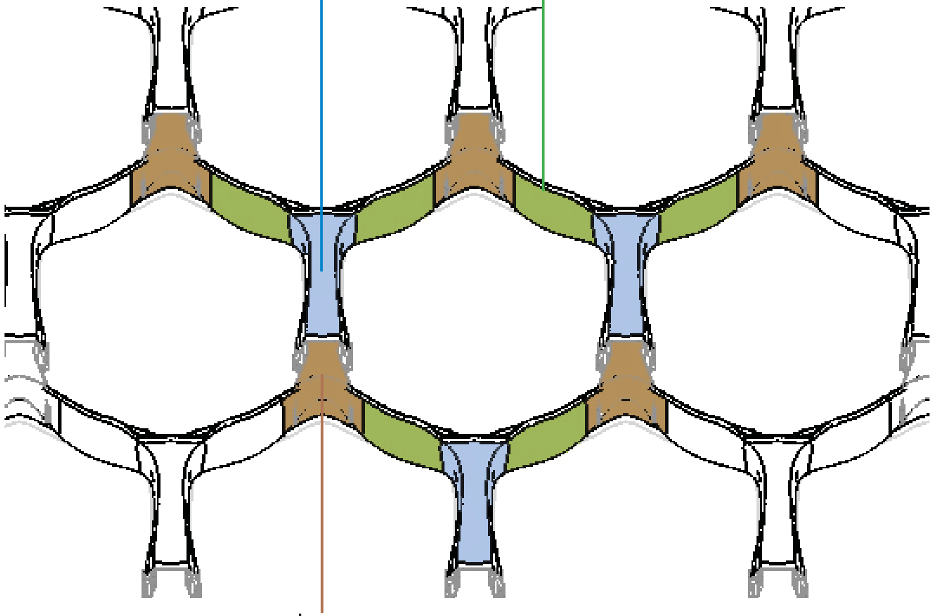




תהליך עיצוב תא החזית // רעיונות ראשוניים

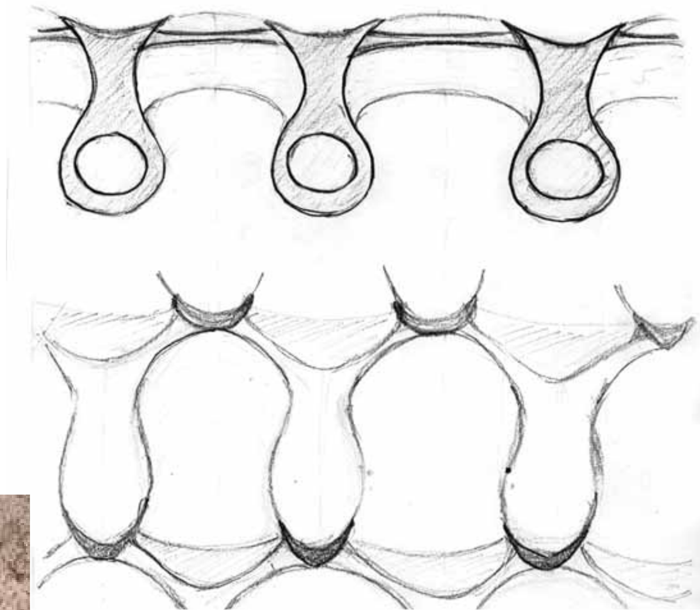
הפרפורמנס של התא:

1. עיכוב הניקוז של מי הגשמים ואגירה של חלק מהם
2. גידול צמחיה לצורכי סינון אוויר
3. גידול צמחיה למטרת קירור הבנין בקיץ
3. הצללה יעילה של פתחים
4. בידוד תרמי



חתך אופייני: צלעות קירור

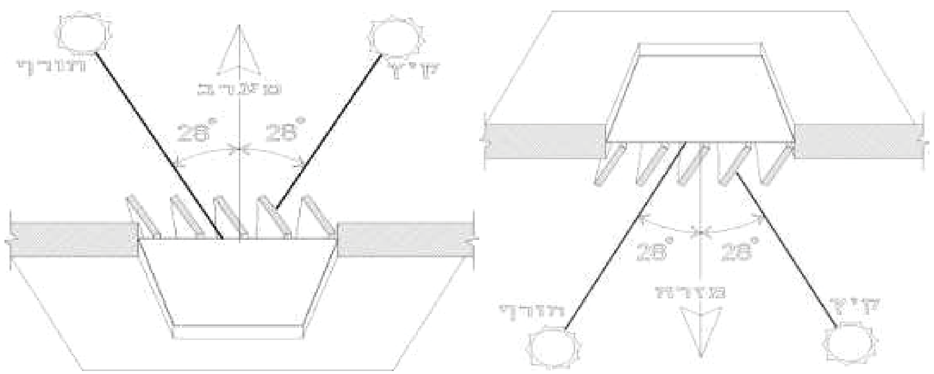
בדומה לצלעות המאפיינות את הקקטוס, מאגרי המים מתפקדים כצלעות קירור שמטרתן ליצור תאים המוגנים מפני רוחות ומוצללים היטב ובכך ליצור מיקרו אקלים נוח בתוך התאים.



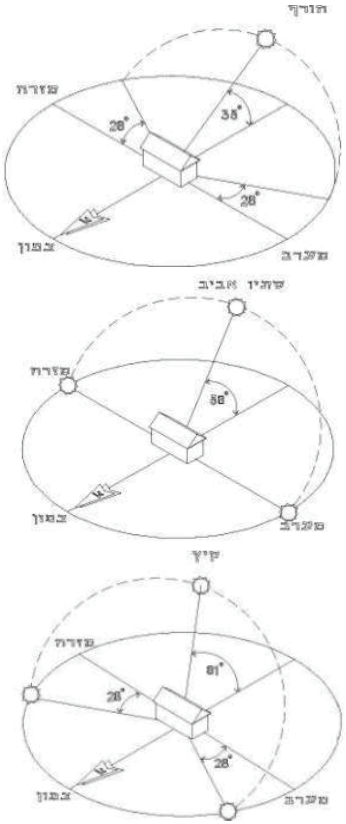
הקקטוס כמקור השראה

A common architectural design strategy to moderate thermal gains is to reduce the ratio of building envelope to interior space. Conversely, barrel cacti integrate a layered system consisting of self-shading spines, a high surface area to circumference ratio, and liquid thermal mass to flourish during the high diurnal temperature swings and seasonal variations of the Sonoran region. Deep relief ribs, the undulated outer surface, are a distinguishing characteristic of barrel cacti, fig. 1, and contribute to the thermal performance of the system. Cacti ribs can increase the surface area up to 80% compared to a smooth cylinder of the same stem radius and shades greater than 60% of the cacti surface [2]. Ribs also serve as a high mass radiator, thermal collector and self-shading mechanism. Shaded surfaces reduce the absorbed shortwave solar radiation resulting in a slower warming period throughout the day. Convective heat transfer rate from the cacti to the environment is also reduced, figures 2 – 4. Deep ribs reduce wind speeds generating an insulating air layer over the entire surface [2]. While the

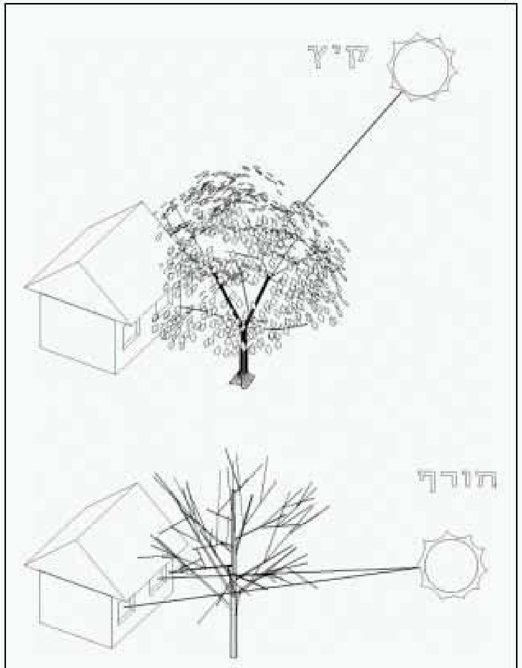
מחקר לקראת עיצוב התא // הצללה



source: http://www.adira.co.il/



source: http://www.adira.co.il/



הצללה קיצית על ידי צמחייה נשירה
תרשים 19

הצללה אופקית מעל החלון

הצללה זו יעילה בחזית הפונה לכיוון דרום (גם בסטייה קלה של עד 15°). יתרונה בכך שהיא מאפשרת כניסת אור, אך מונעת כניסת קרינה בעונת הקיץ, זאת על ידי התחשבות בזווית השמש המשתנה בין עונות השנה (בקיץ השמש בזווית גבוהה בחורף בזווית נמוכה). חשוב ליצור חריץ בחיבור שבין אלמנט ההצללה האופקי לקיר המבנה

הוספת אלמנט הצללה אנכי בנוי

בעונת הקיץ, פתחים הפונים למזרח חשופים לקרינה חזקה בבוקר ופתחים הפונים לכיוון מערב חשופים לקרינה חזקה בערב. היות שבשעות אלה השמש נמוכה, לא ניתן לחסום קרינה זו על ידי הצללה אופקית, אלא על ידי אלמנטים אנכיים בנויים. אלמנט הצללה אופקי אטום, מונע את אוורור המבנה בשעות אחר הצהריים ומהווה פתרון בעל יעילות חלקית.

הצללה אופקית חזית מזרחית

אלמנט הצללה אנכי בנוי אך לא אטום, פותר בעיה זו ומהווה פתרון יעיל להצללה צידית. יתרונו בעונת הקיץ הוא, בהכנסת אור ללא קרינה ואפשרות אוורור. בעונת החורף הוא מאפשר לנצל אנרגיה סולרית חורפית. חסרונו הוא בחוסר גמישותו, חיסרון של כל האלמנטים הבנויים.

סבכה (רושן)

אלמנט בנייה מסורתי המאפשר כניסת רוח ואור, ועם זאת יוצר הצללה החוסמת קרינה ישירה ובוהק. אלמנט זה מתאים לאקלים חם ולח. לרוב הסבכה בנויה עץ רך, אשר סופג לחות ומאפשר כניסת אוויר יבש לחלל.

משרבייה

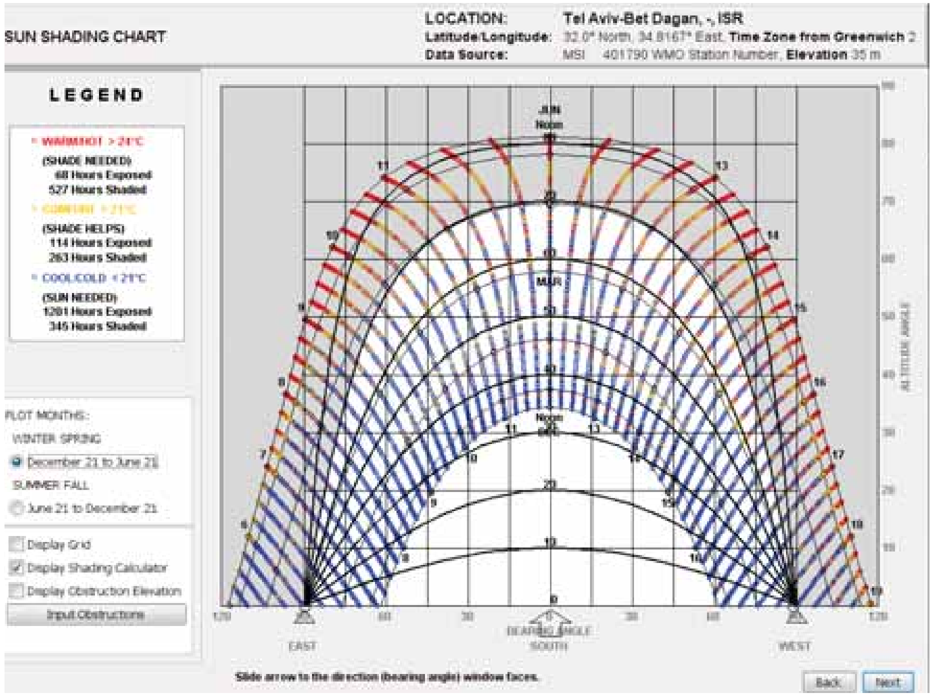
גם המשרבייה היא אלמנט בנייה מסורתי. במקור אלמנט זה היה בנוי עץ קשה, אך כיום ניתן למצוא משרביות ממגוון חומרים. צורת פעולתה דומה לזו של הסבכה, אך היא מתאימה לאקלים יבש. בעבר היו מניחים בגומחות כלי חרס ובהן מי שתייה, כך שהמים היו מתקררים ומוסיפים לחות לחלל.

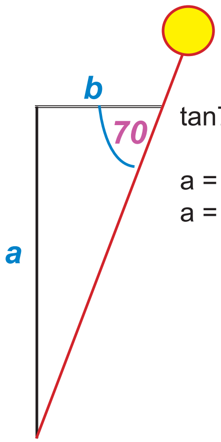
הצללה של צמחייה

צמחייה יכולה להוות אלמנט הצללה מעולה וזאת על ידי שימוש בעצים נשירים. בעונת החורף, כאשר העצים נמצאים במצב של שלכת, קרני שמש מגיעות לחלונות הדרומיים, ואילו בעונת הקיץ, כאשר העצים נמצאים במצב של פריחה, נעצרות הקרניים בעצים.

מחקר לקראת עיצוב התא // הצללה

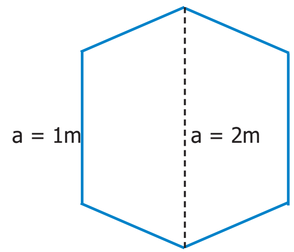
חישוב הצללה אופטימלית- חורף



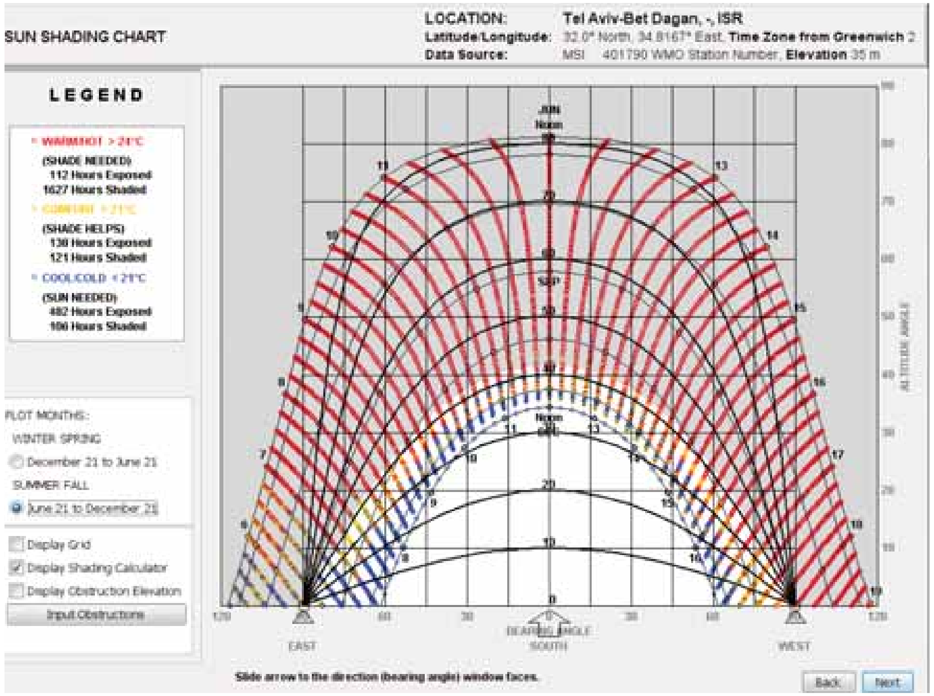


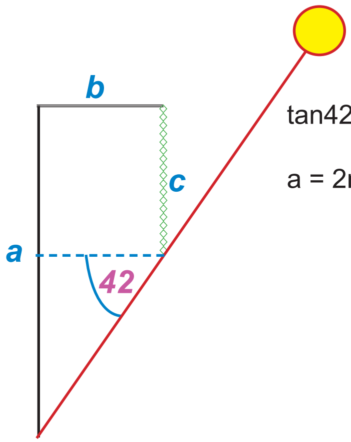
tan70 = a/b = 2.74

a = 2m -> b = 0.72m
a = 1m -> b=0.36m



חישוב הצללה אופטימלית- קיץ





tan42 = (a-c)/b = 0.9

a = 2m, b = 0.72m -> c = 1.35m

Modular Trellis Panel System

The building block of this modular system is a rigid, light weight, three-dimensional panel made from a powder coated galvanized and welded steel wire that supports plants with both a face grid and a panel depth. This system is designed to hold a green facade off the wall surface so that plant materials do not attach to the building, provides a “captive” growing environment for the plant with multiple supports for the tendrils, and helps to maintain the integrity of a building membrane. Panels can be stacked and joined to cover large areas, or formed to create shapes and curves, are made from recycledcontent steel and are recyclable. Because the panels are rigid, they can span between structures and can also be used for freestanding green walls.

Cable and Wire-Rope Net Systems

The cable and wire-rope net systems use either cables and/or a wire-net. Cables are employed on green facades that are designed to support faster growing climbing plants with denser foliage. Wire-nets are often used to support slower growing plants that need the added support these systems provide at closer intervals. They are more flexible and provide a greater degree of design applications than cables. Both systems use high tensile steel cables, anchors and supplementary equipment. Various sizes and patterns can be accommodated as flexible vertical and horizontal wire-ropes are connected through cross clamps.

Source: greenscreen®

מחקר לקראת עיצוב התא // קירות ירוקים

Biofiltration

An ‘active’ living wall is intended to be integrated into a building’s infrastructure and designed to biofilter indoor air and provide thermal regulation. It is a hydroponic system fed by nutrient rich water which is re-circulated from a manifold, located at the top of the wall, and collected in a gutter at the bottom of the fabric wall system. Plant roots are sandwiched between two layers of synthetic fabric that support microbes and a dense root mass. These root microbes remove airborne volatile organic compounds (VOCs), while foliage absorbs carbon monoxide and dioxide. The plants’ natural processes produce cool fresh air that is drawn through the system by a fan and then distributed throughout the building. A variation of this concept could be applied to green facade systems as well, and there is potential to apply a hybrid of systems at a large scale.

מחקר לקראת עיצוב התא // צמחים מטפסים נשירים

חסכוניים במים

סולנום מטפס

שם בוטני)בלטינית(SOLANUM
SEAFORTHIANUM , אורך חיים: רב שנתי, אופי
עלוה: נשיר, קצב צימוח: מהיר, דרישות השקיה:
בינונית , עמידות בקור: בינונית, עמיד, עמידות
במליחות: בינונית, דרישות אור: שמש, עונת
פריחה: אביב, קיץ

אברון גדול פרחים

שם בוטני (בלטינית): CRYPTOSTEGIA
GRANDIFLORA, צורת חיים: מטפס נכרך
אורך חיים: רב שנתי, אופי עלוה: נשיר, קצב
צימוח: מהיר, דרישות השקיה: בינונית, עמידות
בקור: בינונית, עמידות במליחות: עמיד, דרישות
אור: צל חלקי, שמש, עונת פריחה: סתיו, קיץ

http://mgonline.com/articles/vines.aspx

ארכובית בוכרית

אורך חיים: רב שנתי, אופי עלוה: נשיר, קצב
צימוח: מהיר, דרישות השקיה: בינונית, עמידות
בקור: עמיד, עמידות במליחות: עמיד, בינונית
דרישות אור: צל חלקי, שמש, עונת פריחה: אביב,
סתיו, קיץ

אפונה ריחנית

שם בוטני (בלטינית): LATHYRUS ODORATUS,
תיאור: עשבוני, אורך חיים: עונתי, קצב צימוח:
מהיר, דרישות השקיה: בינונית, עמידות בקור:
בינונית, עמידות במליחות: רגיש, דרישות אור:
שמש, עונת פריחה: אביב

http://www.thompson-morgan.com/flowers/flower-plants/sweet-pea-plants/sweet-pea-snoopea/p89631TM

מחקר לקראת עיצוב התא // מחזור מים

מחזור מי מזגנים- בדיקת כמויות

מי מזגנים ידועים באיכותם המעולה. מים אלו ניתנים לאגירה ומשם להפנייתם לשימושים נוספים. מי מזגנים הם מים חסרי מינרלים ולכן בבואנו להשקות גינות עם מים אלו עלינו להוסיף דישון לגינה. בממוצע, מזגן ביתי במישור החוף בחודשי הקיץ יכול לייצר ב10 שעות עבודה בין 30-50 ליטרים מידי יום. בבנייני משרדים ובמקומות בהם יש יותר ממזגן אחד או שפועלים שעות רבות במהלך חודשי הקיץ, כמות המים היומית יכולה להסתכם במאות ליטרים ולהגיע לעשרות אלפי ליטרים במגדלי משרדים וכדומה.

שלהי קיץ 2009 כשעומס חום כבד ולחות מעיקה ירדו על גוש דן מחד והפרסומות בטלביזיה על המחסור במים הדהדו בראשו מאידך החליט מנהל ייצור בבית דפוס גדול לקחת את העניינים לידיים. הוא בדק ומצא כי בבית הדפוס מערכת מיזוג מרכזית המייצרת ביום קיץ לח כ 1000 ליטר מי עיבוי בשעה. אם ימחזר את מי המזגנים בית הדפוס אמור לחסוך כ 4000 קוב בשנה, חסכון שיוביל גם לחסכון כספי של מעל 20,000 ₪ בשנה.

מחזור מי גשמים- בדיקת כמויות

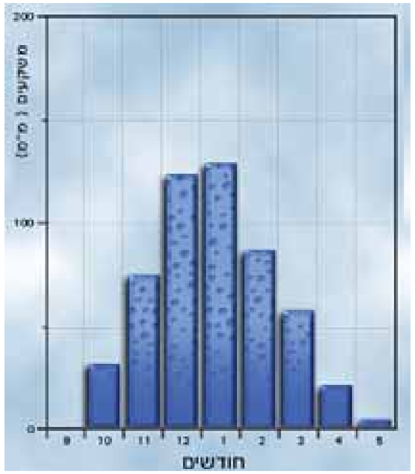
ממוצע גשמים בתל אביב- 550 מ"מ בשנה = 0.55m

גודל הגג: $25mX65m = 1625m^2$

$1625mX0.55m = 893m^3$

צמח טרופי = 1,200 מ"ק מים לשנה, לדונם.

צמח חסכני = 250 מ"ק מים לשנה, לדונם.



http://lib.cet.ac.il/pages/item.asp?item=8747&kwd=2290

<u>טבלת תצרוכת מים בגינה פרטית וגינת בית משותף</u>

ליטרים / למ"ר ביום

האזור	קיץ דשא ועצי פרי	פרחים וירקות	שיחים ועצי נוי	אביב וסתיו דשא	פרחים וירקות	שיחים
רצועת החוף	3.0	4.5	1.5	2.0	3.0	1.0
מישור החוף והשפלה	3.5	5.0	1.5	2.5	3.0	1.0
אזור ההר	4.0	6.0	2.0	3.0	4.5	1.5
הנגב והעמקים החמים	4.5	6.5	2.0	3.0	4.5	1.5
הערבה ואילת	7.0	11.0	3.5	5.0	8.0	2.5

השטח המחושב להשקיית עצים הוא שטח היטל נוף העץ (גם אם העץ מושקה במקומות נקודתיים מצומצמים), עצי פרי הניצבים בגן בשטח מושקה אחר, יקבלו תוספת יחסית.

מרווחי השקיה מומלצים (ימים)

סוג הקרקע	דשא	פרחים	שיחים ועצים
קלה	3 - 7	3 - 5	15 - 20
בינונית קלה	10 - 15	7 - 15	20 - 30

לדוגמא:

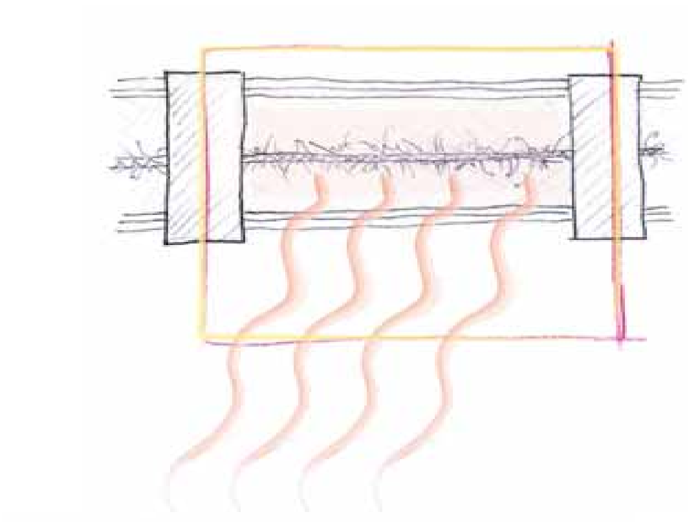
בגינה ביתית במישור החוף באדמה קלה יש 100 מ"ר דשא,
פרחים בשטח של 25 מ"ר,
צמחי כיסוי ושיחים בשטח כולל של 50 מ"ר.

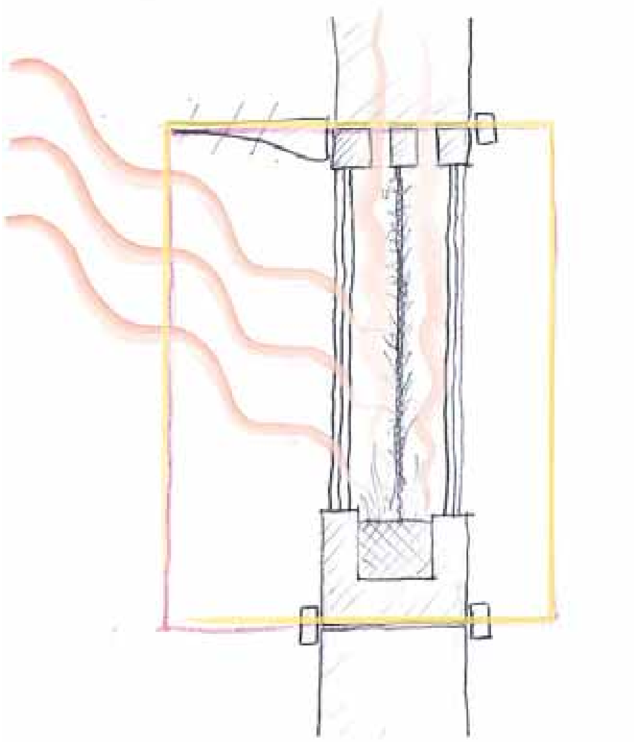
בקיץ:

דשא - משקים אחת לשבוע - בכמות כוללת של **2450** ליטר.
החישוב: 7 (ימים) * 100 (מ"ר) * 3.5 (ליטר למ"ר ליום).

פרחים - משקים כל 4 ימים - בכמות כוללת של **500** ליטר.
החישוב: 4 (ימים) * 25(מ"ר) * 5.0 (ליטר למ"ר ליום).

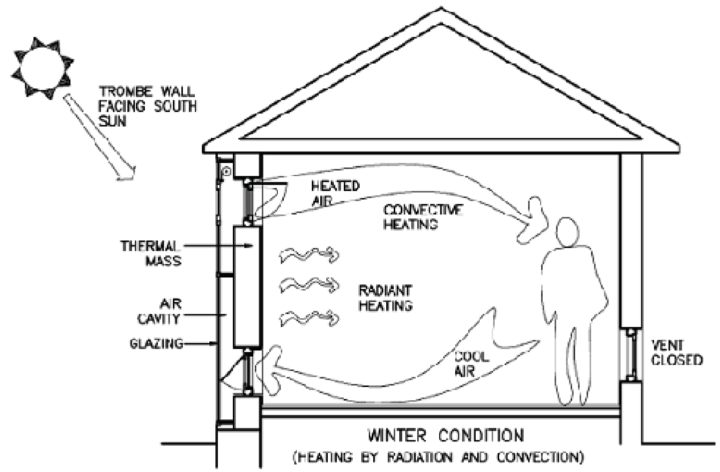
שיחים - משקים כל 20 ימים - בכמות כוללת של **1500** ליטר.
החישוב: 20 (ימים) * 50 (מ"ר) * 1.5 (ליטר למ"ר ליום).

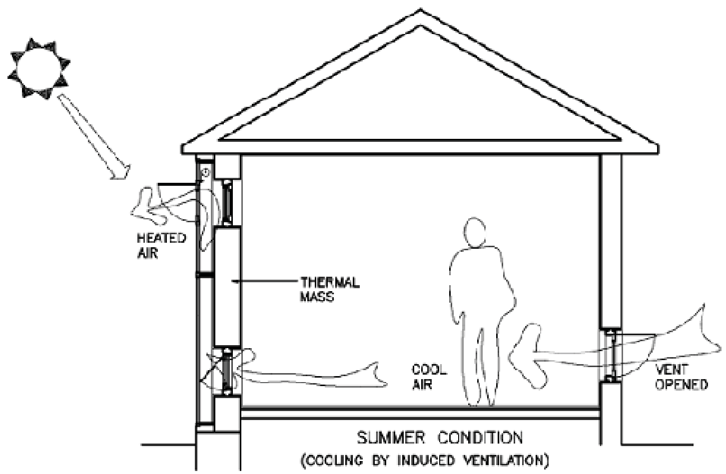




תהליך עיצוב התא // עיקרון הפעולה של תא החזית

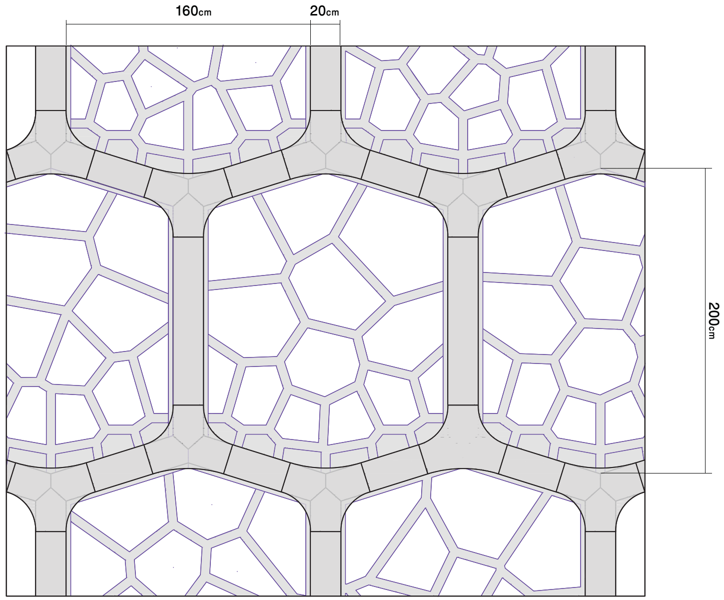
בגלל התדירות הנמוכה והכמות המועטה יחסית של מי גשמים שיכולים להאגר על החזית, נזנח רעיון אגירת המים וסינונם בחזית.
התא החדש משתמש בעיקרון קיר טרומב. קרינת השמש מחממת אוויר הכלוא בתוך חלון כפול שבתא, וכשהוא מתחמם הוא עולה למעלה ועובר בתוך רשת העמודים החלולים של התאים. האוויר החמם יוצא דרך פתחים באיזורים העליונים שבחללים, כך שהוא יוצר ונטילציה של אוויר בטמפרטורה המותאמת לעונה בשנה.



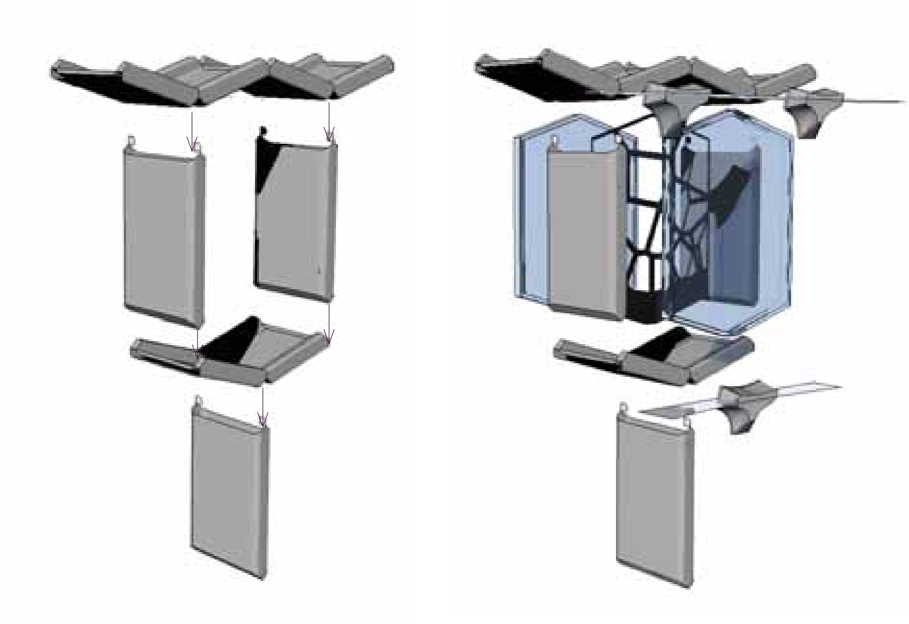


מבנה התא // תהליך הבניה

עמודים הפלדה החלולים מורכבים ממודולים חזרתיים המיוצרים באקטרוזיה, כאשר המודול האופקי מורכב משני חלקים המרותכים זה לזה במפעל, והמודול האופקי מגיע בשני גדלים- גודל של חלון (2 מ') וגודל של מרפסת (4 מ').
עמודים הפלדה מרותכים זה לזה באתר הבניה. לאחר מכן מולבש החלון הכפול (מיוצר גם כן בשני גדלים קבועים- חלון ומרפסת) ושבכת ההצללה, העשויה פח מחורר המאפשר לצמחים המטפסים להתפס על גביו.
לבסוף מרכיבים פאנל המכסה את החיבורים המרותכים המעניק לתא את מראה המשפך האופייני לבניין כולו. בפאנל יש אפשרות לחבר לוחות פח מחורר בגודל המשתנה בין תא לתא ע"פ מיקומו והפונקציה שנמצאת מאחוריו.



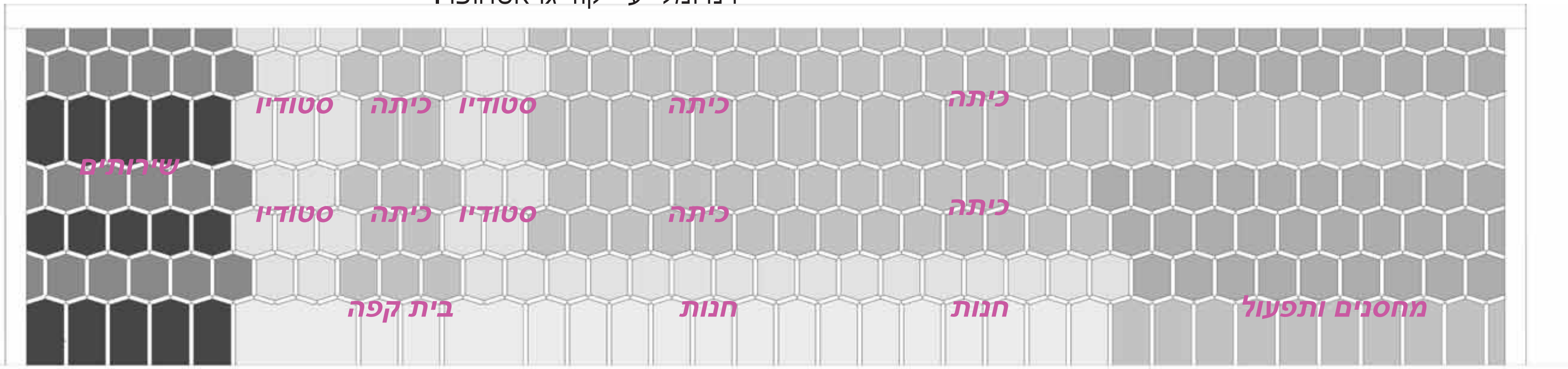
הדמיה של החזית

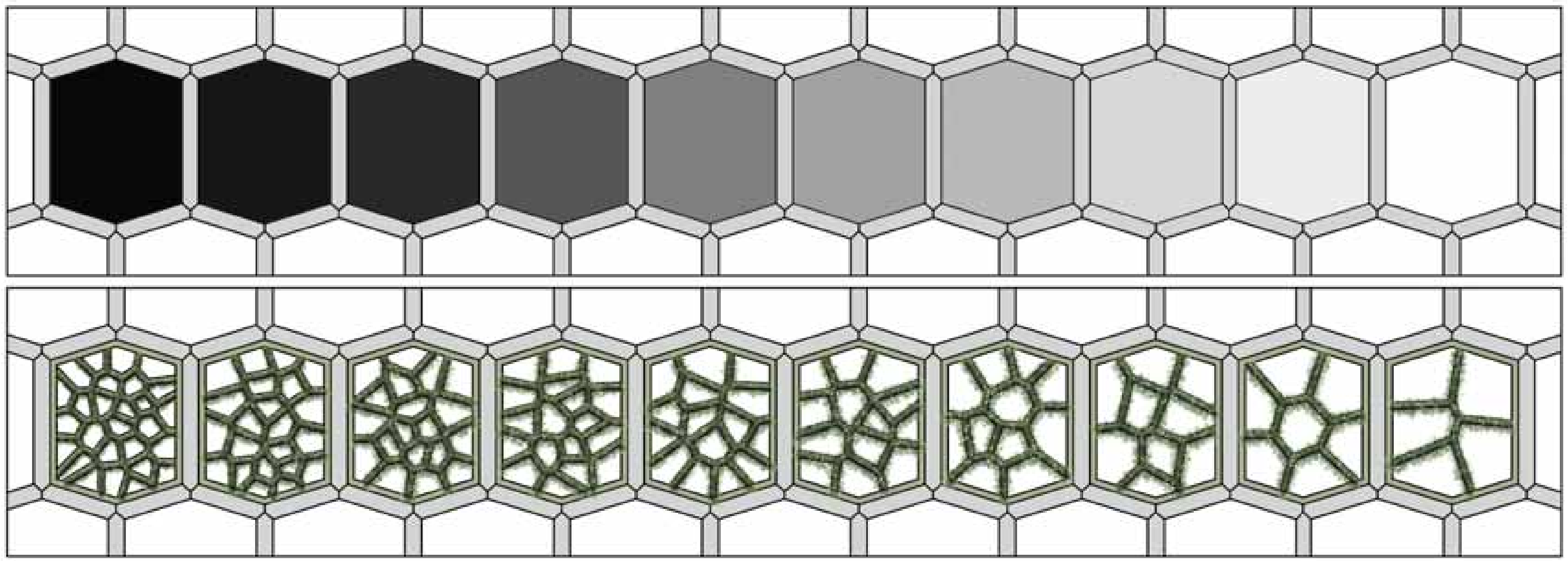


מבנה התא // עיקרון ההצללה

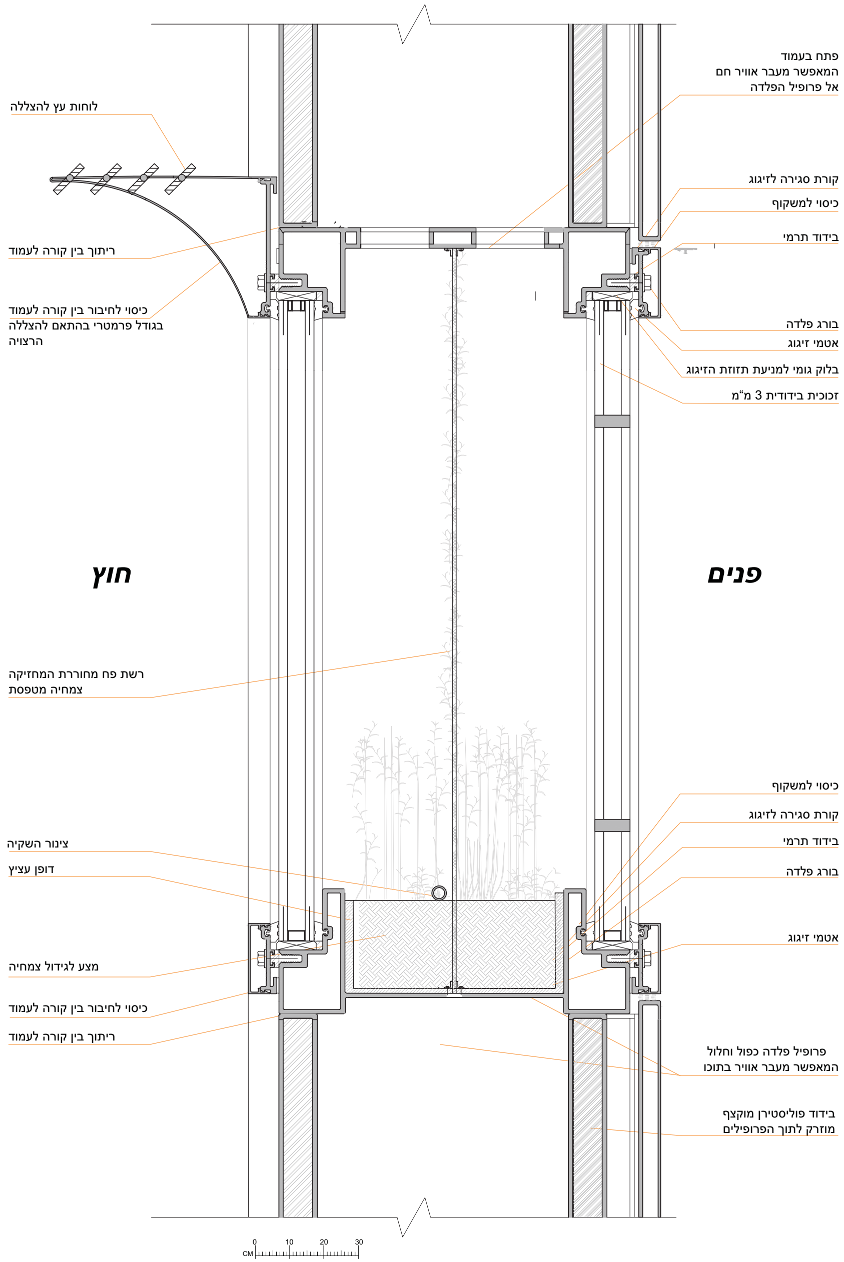
תאי החזית ממופים ע"י סקאלה הנעה בין 1 ל10, כאשר 1=לבן=הכי מעט הצללה, 10=שחור=הכי הרבה הצללה. המיפוי נובע ממיקום התא בחזית ביחס לשמש ע"פ עקרונות אקלימיים, וע"פ הפונקציה הפרוגרמטית הנמצאת מאחורי התא (לפי הצללה על פי שעות פעילות וגם מידת האטימות של חזית הפונקציה). לכל שלב בסקאלת הצבעים מואמת פונקצית וורונוי, כאשר ככל שהצבע כהה יותר- מספר הנקודות עליו מתבסס הוורונוי גדול יותר, וגם נוצרת רשת צפופה יותר המספקת הצללה רבה יותר. הנקודות מפוזרות בתא באופן רנדומלי ע"י קוד גראסהופר.

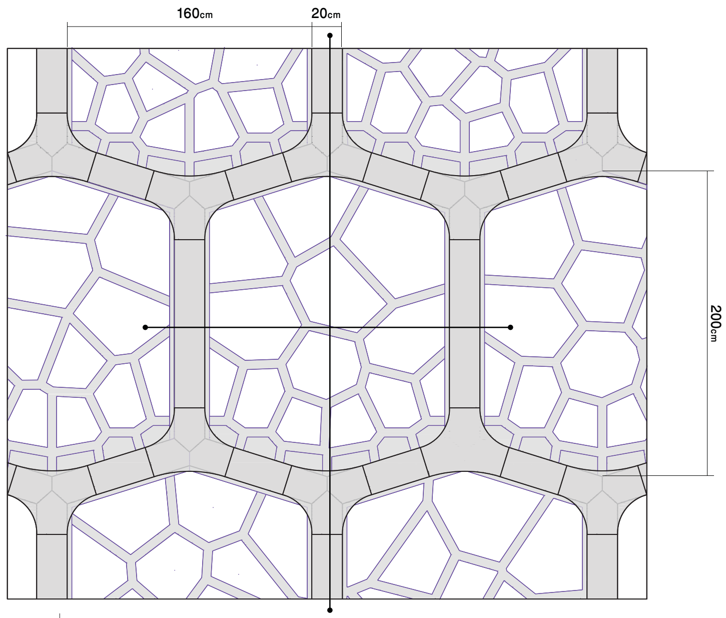
חזית דרום- מזרחית: סכמת מידת הצללה ע"פ פרוגרמה

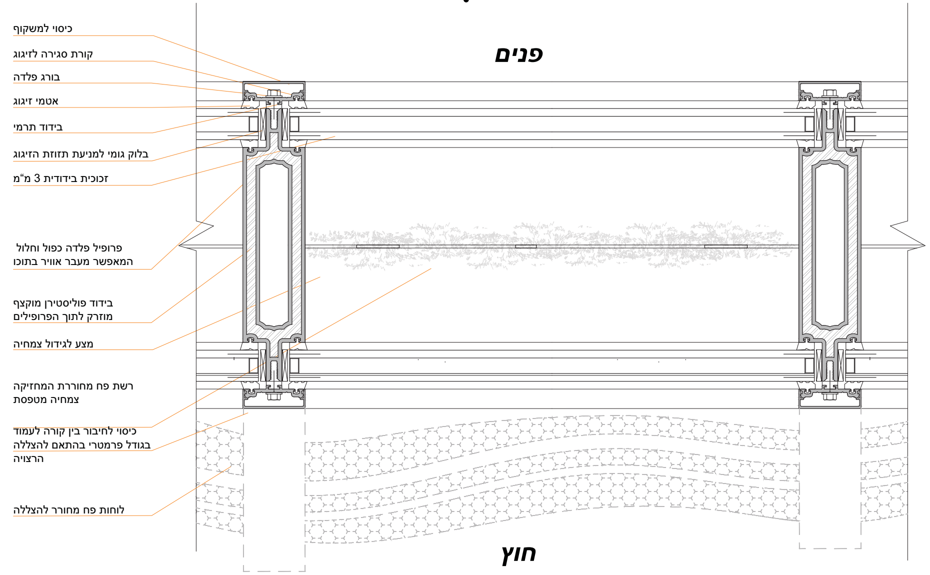




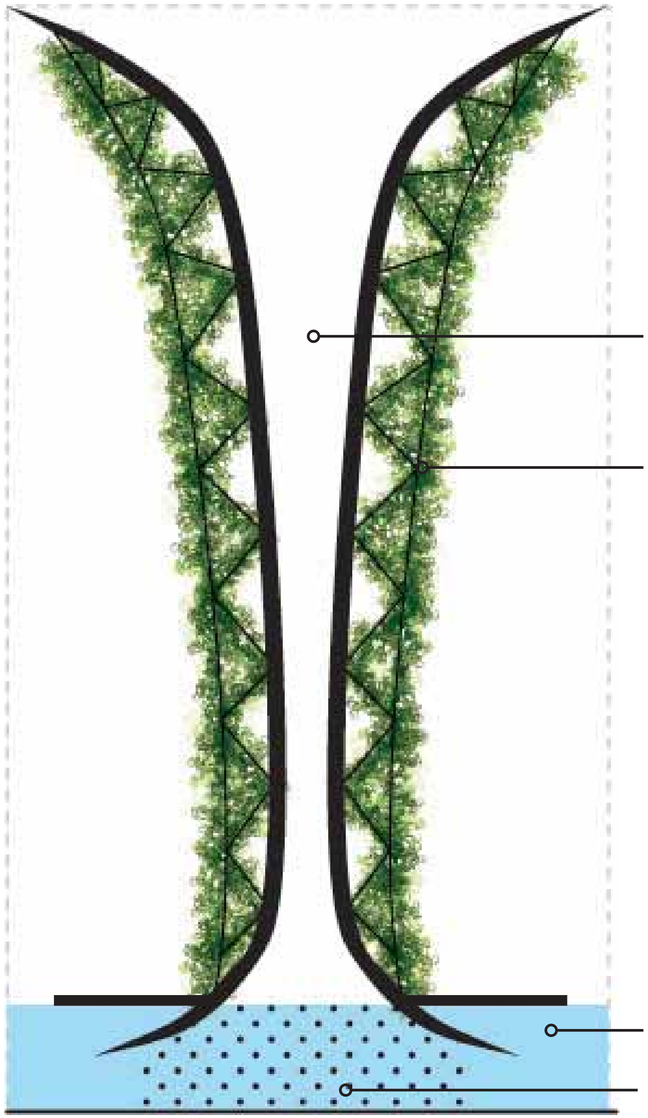
מבנה התא // פרטים



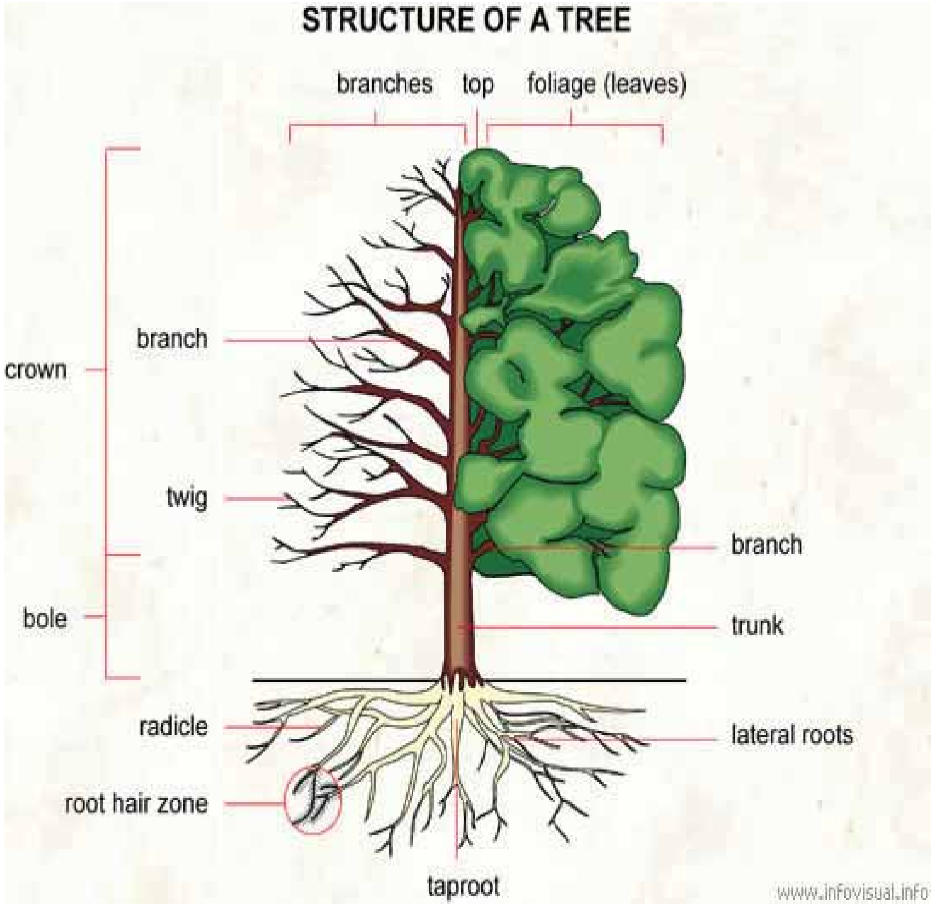




תהליך עיצוב תא הבנין // רעיונות ראשוניים

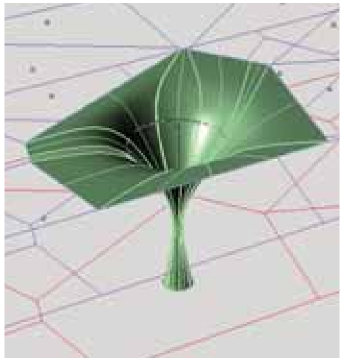
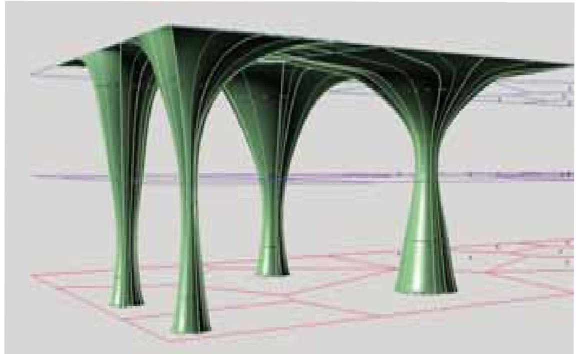
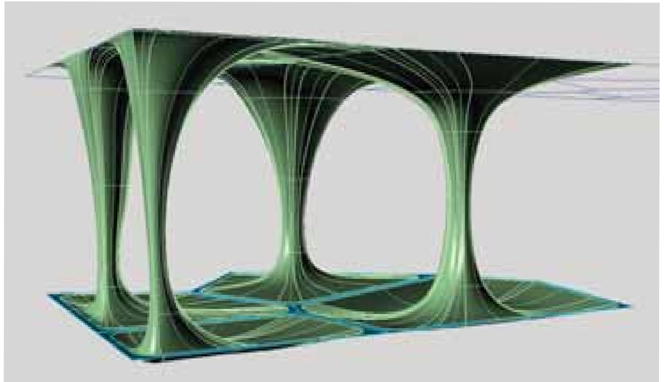
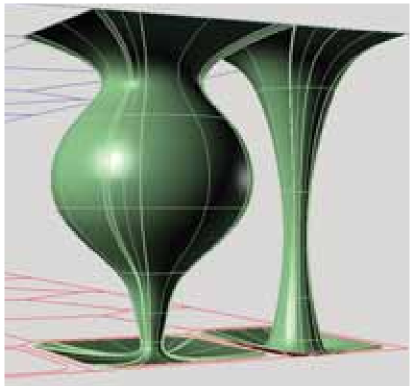
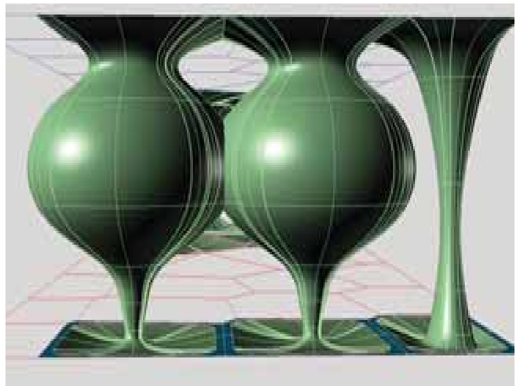
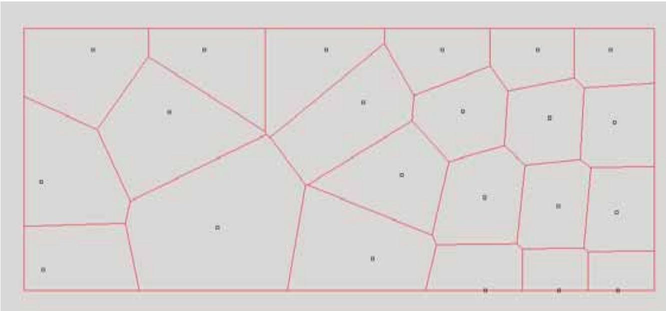
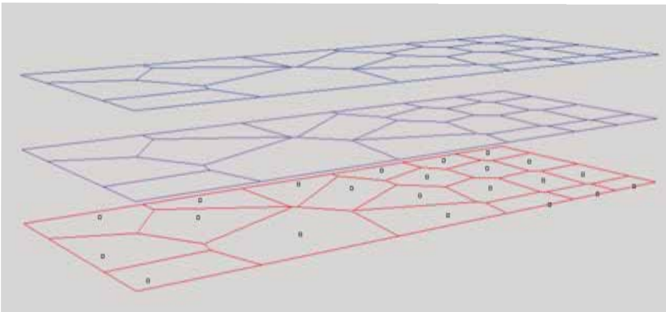
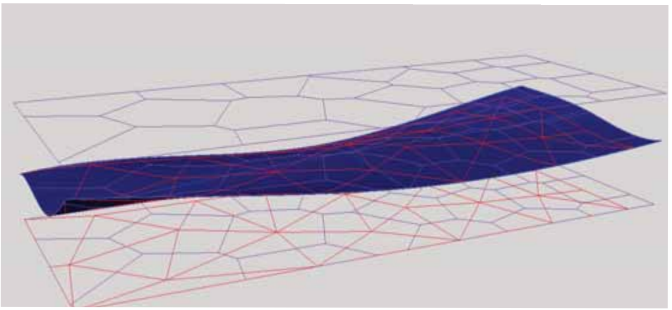


הרעיון הראשונה של תא הבנין השתמש במבנה הקונסטרוקטיבי של העץ (כזה דק המשמש כעמוד, התרחבות רדיאלית בעלווה והתרחבות באיזור השורשים), וביכולות השימוש במי התהום (ע"י יניקה של שורשי הצמח) לצורך השקיה של צמחים חיים.

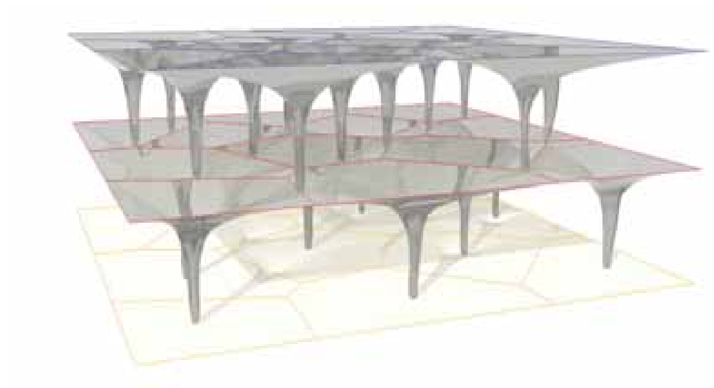
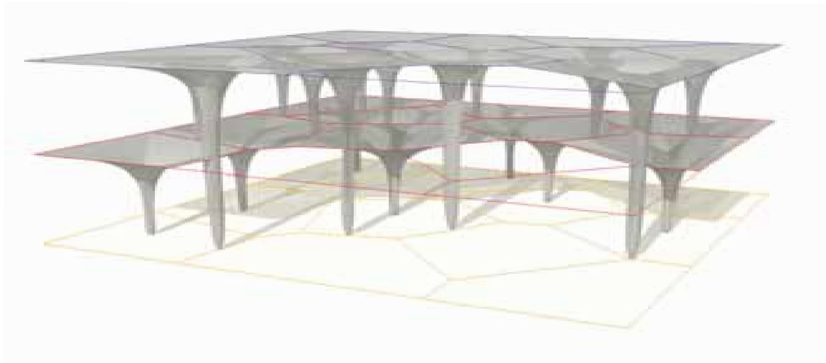
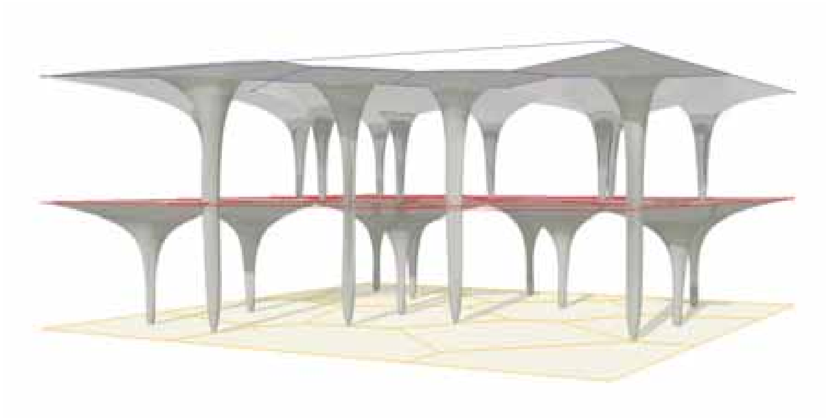


תהליך עיצוב תא הבנין // רעיונות ראשוניים

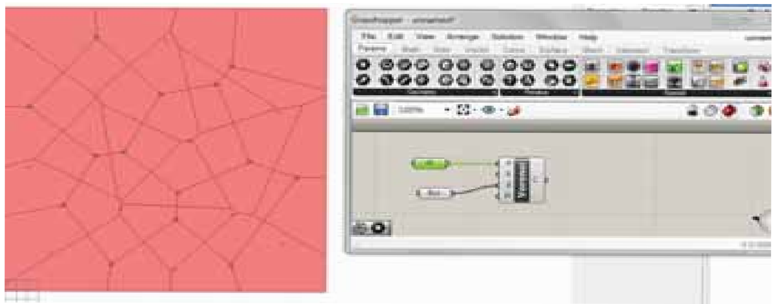
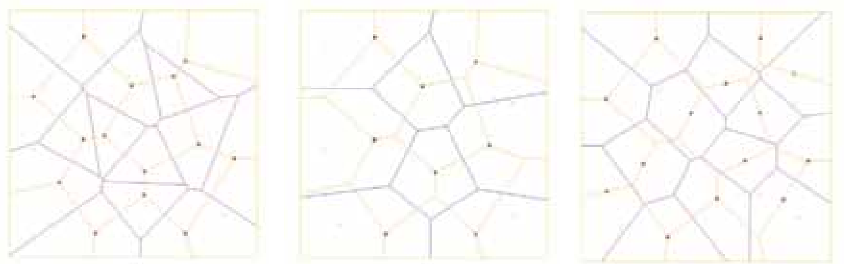
הגרסא הראשונה נבנתה על גבי רשת וורונוי, שנקבעה ע"פ חלוקה פרוגרמטית והוכפלה לפי מספר המפלסים בבניין. ה"משפך" נוצר ע"י פעולת "לופט" בין תא וורונוי אחד לאחר, כאשר הרוחב המשתנה של המשפך נקבע באופן פרמטרי בהתאם לגודל תא הוורונוי (מטעמים קונסטרוקטיביים, רוחב עמוד בהתאם לגודל תקרה).
בהמשך היה ניסיון לבדוק התרחבות של התאים הבסיסיים ושימוש בחללים שנוצרו בתוכם כחללים בבניין.

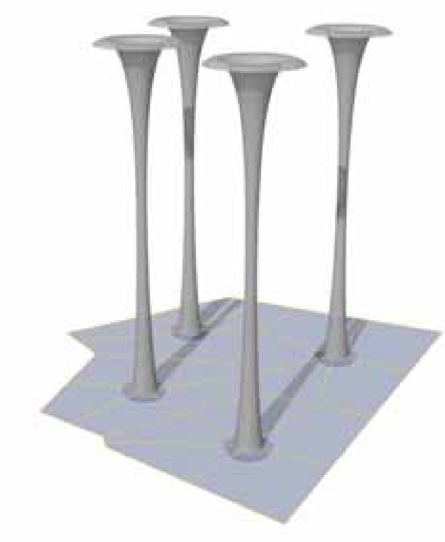
תהליך עיצוב תא הבנין // רעיונות ראשוניים

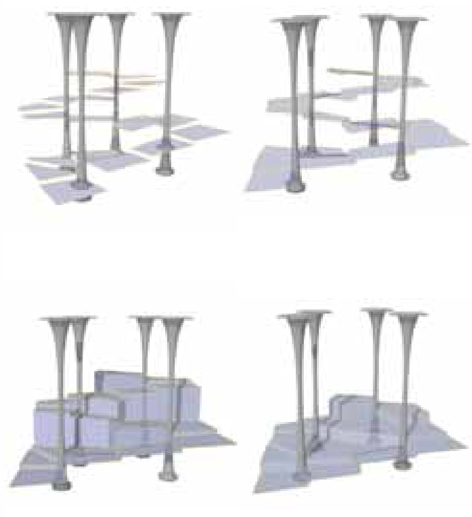




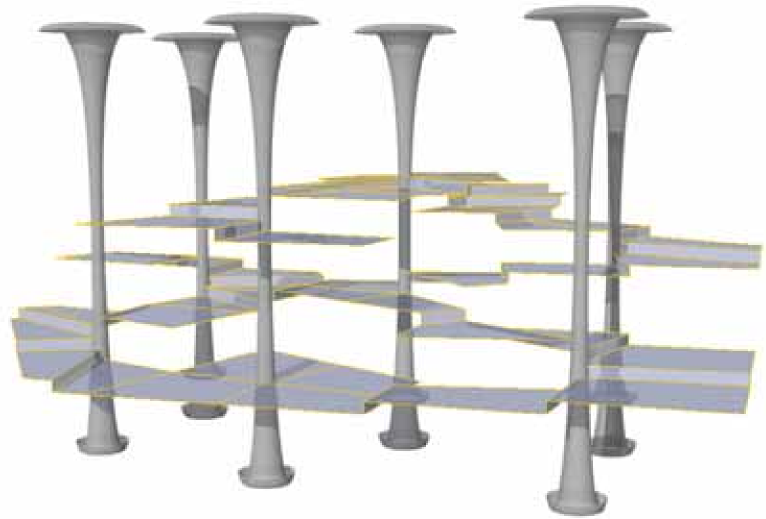
הגרסא השניה בדקא אפשרות של תא המגדיר חלל בן מפלס אחד, כאשר בין מפלס למפלס יש הסתה של רשת הוורונוי עליה נבנה התא. בהתאם לכך נערכה בדיקה של מגוון אפשרויות לעריכה של רשת הדלנוי (הרשת הדואלית לוורונוי) על מנת שתתאים יותר להגדרה של חללים למבנה ציבור.

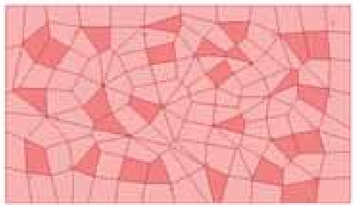
תהליך עיצוב תא הבנין // רעיונות ראשוניים

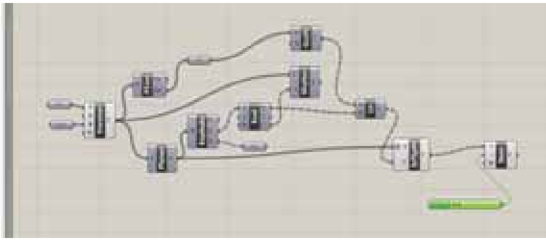


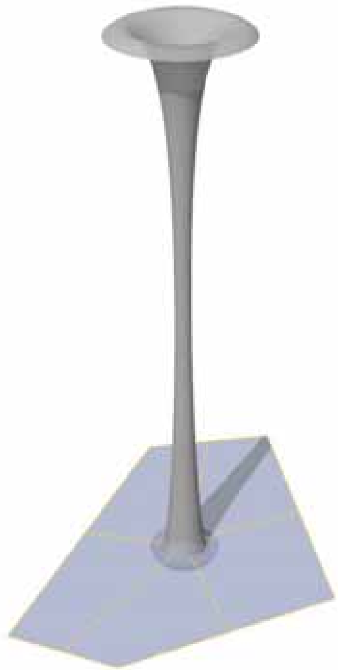


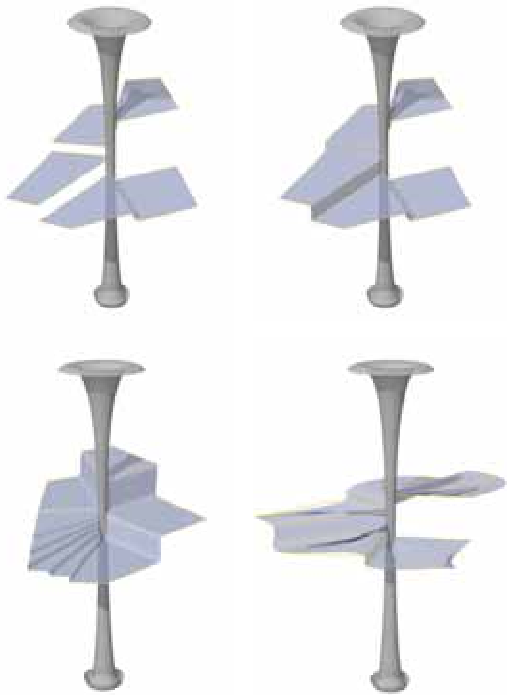


גרסא נוספת בדקה אפשרות של הגדרת התא ע"י תא וורונוי המחולק לתת מפלסים ע"י קווי הדלנוי שבתוכו. במרכז תא הוורונוי נמצא עמוד המשפך. צירוף של כמה תאים שכאלה יצר אפשרות למשטחים מדורגים שונים עם ספקטרום רחב מאוד של חללים שיכולים להווצר באופן שכזה.









תהליך עיצוב תא הבנין // קונספט

		kn/m^2	2.5	[illegible]		[illegible] m^2	[illegible] m	[illegible]
		1.5 kn/m^2		[illegible]		172.048	10	
	25*0.40=	10 kn/m^2		[illegible]				
		1.5 kn/m^2		[illegible] 10 [illegible]				
lo=	17.32051							
[illegible]	15.9		kn/m^2					
Fd=	22.2		kn/m^2					
k11=0.85								
k12=25								
k13=1.07	[illegible]							
O.k	[illegible]			0.760759064				

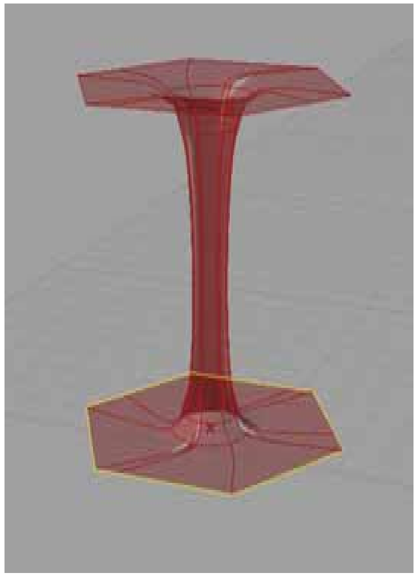
עמודים מעיכה

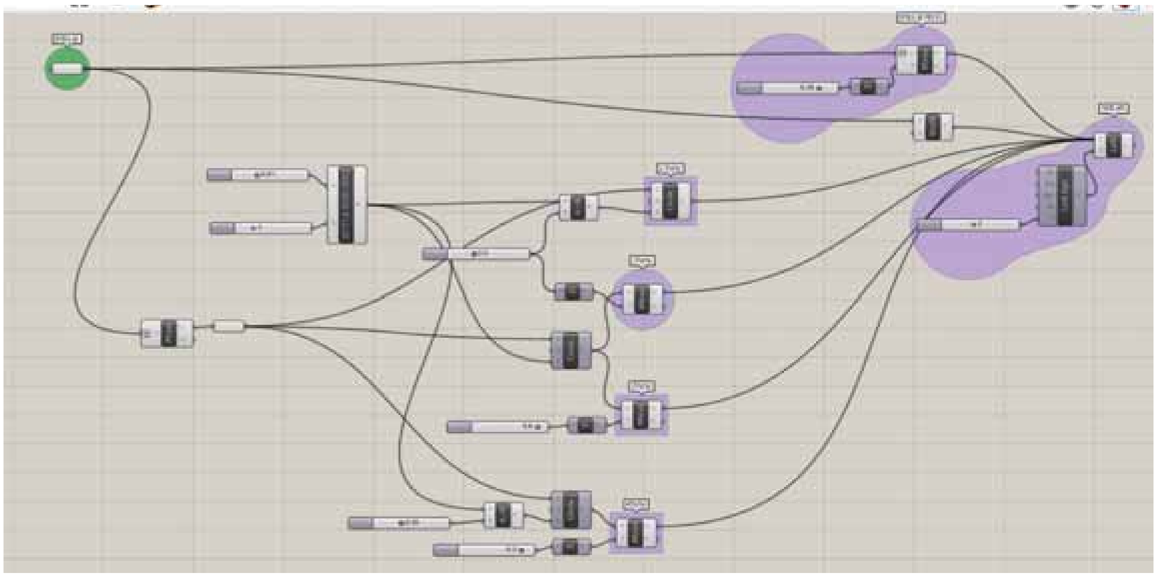
מאמץ לדריכה מותר	מאמץ לדריכה	כה"כ kn	kn	מסר 3.5 kn קומה	מ"ע kn	שטח		רדיוס
22100	85252.6	2678.29		2666.744	8.25	0.031416		0.1
22100	21588.3	2712.87		2666.686	32.99	0.125664		0.2
22100	3762.8	2955.32		2666.686	206.17	0.785398		0.5
22100	2725.4	3082.32		2666.686	296.88	1.130973		0.6
22100	2099.8	3232.41		2666.686	404.09	1.53938		0.7
22100	1693.8	3405.59		2666.686	527.79	2.010619		0.8
22100	1415.4	3601.86		2666.686	667.98	2.54469		0.9

סבה קומה

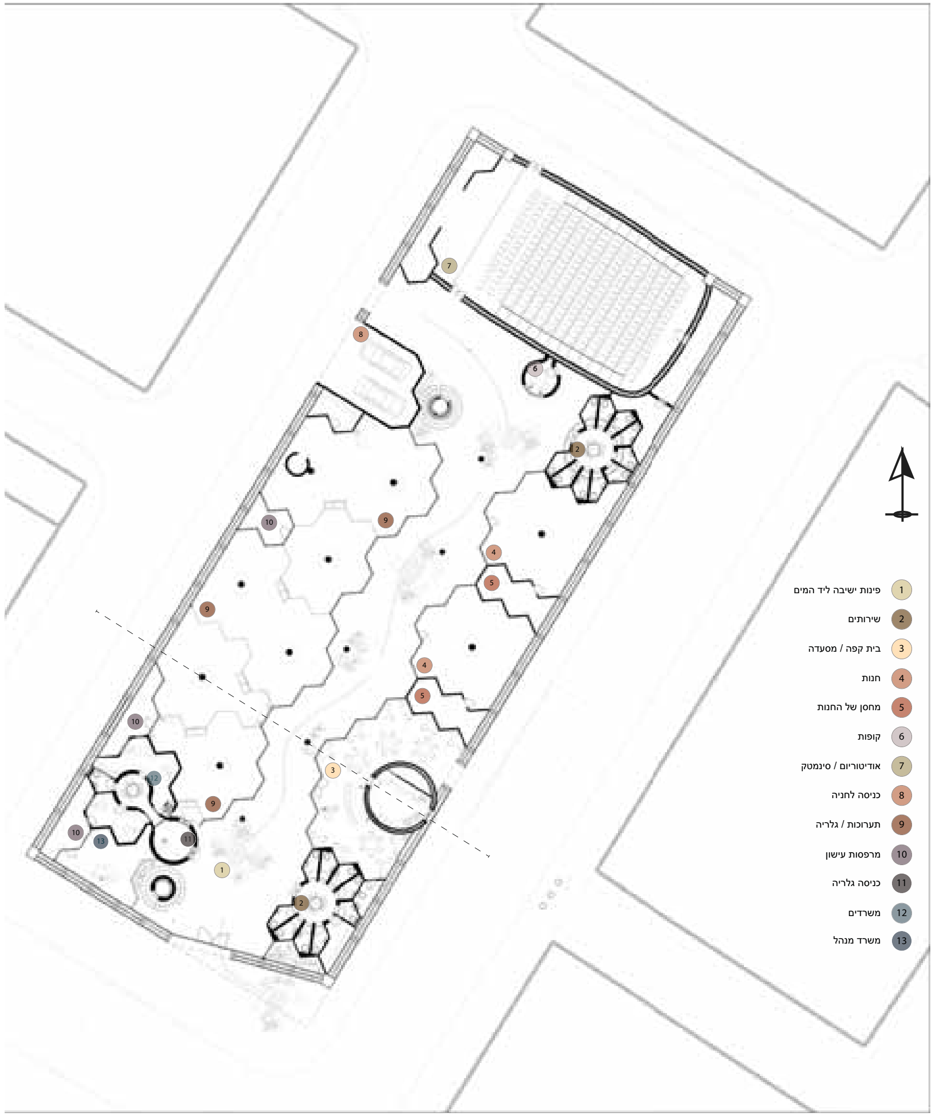
עמודים קריסה

le	K	L	i	I	A	lx	רדיוס	
6.8	0.85	8.00	0.050	7.85398E-05	0.031416		0.1	
6.8	0.85	8.00	0.175	0.0117865881	0.384845		0.35	
6.8	0.85	8.00	0.200	0.0201061193	0.502655		0.4	
6.8	0.85	8.00	0.300	0.1017876002	1.130973		0.6	
6.8	0.85	8.00	0.350	0.1885740099	1.53938		0.7	
6.8	0.85	8.00	0.400	0.3216990088	2.010619		0.8	
6.8	0.85	8.00	0.450	0.515299735	2.54469		0.9	

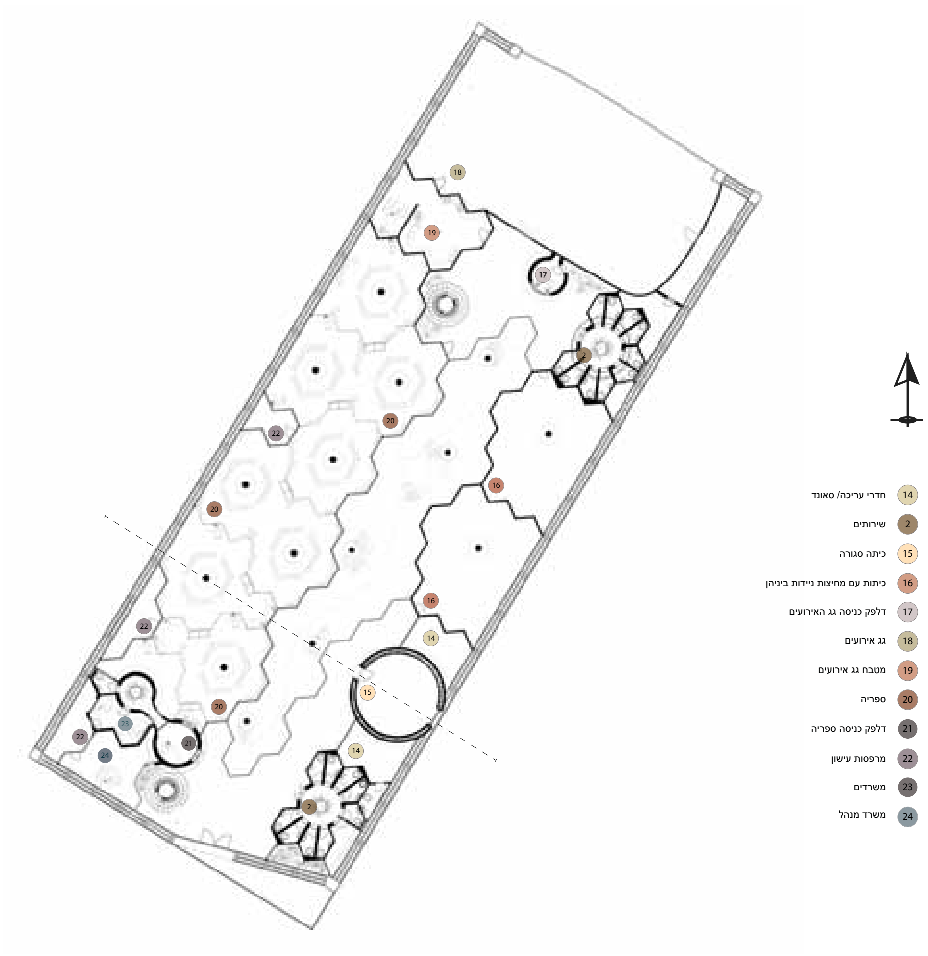


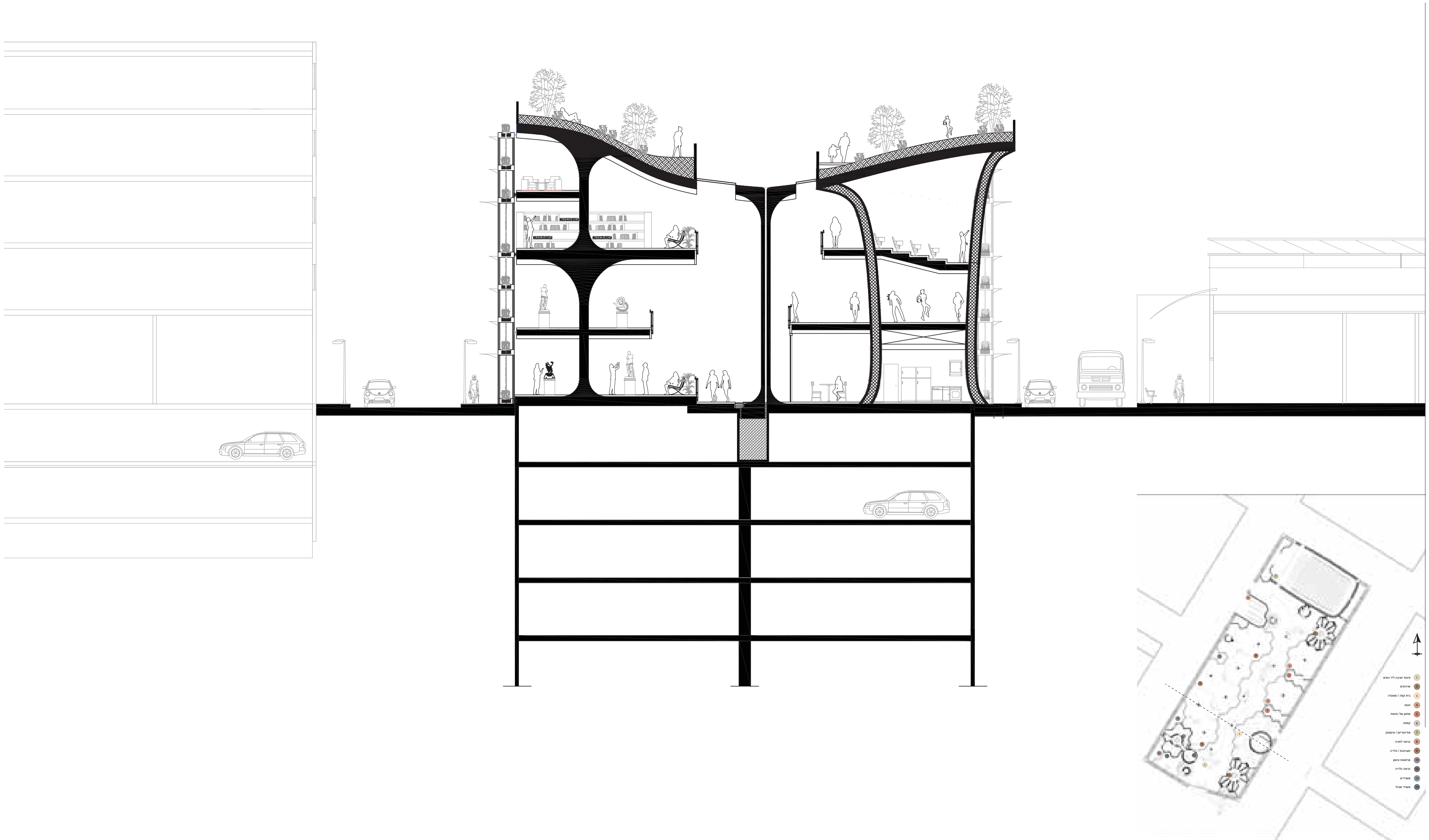


תוכנית מפלס קרקע



תוכנית מפלס 3





פרקטליות תאית

סטודיו תמטי בנושא מבנה ציבור תאי

מגיש: איתי בליישטיין
מנחה: דוקטור יאשה גרובמן

הקדמה: מהוא מבנה תאי?

הנושא התאי באדריכלות אינו נושא חדש. שורשיו נמצאים ברעיון הלבנה: יחידה חזרתית ובעלת יכולות שונות ששוכללו עם השנים- התאמה למגוון ביצועים כגון הובלה ונשיא בידי אדם, עמידות, בידוד, יתכנות כלכלית, השתלבות במקבץ ברמה המורפולוגית גיאומטרית, חלוקה, ביצועים קונסטרוקטיבים, הופעה אסטטית, ווירטואזיות באופן ההצבה ועוד .

הרעיון ממשיך ובא לידי ביטוי במערכות ריצוף, בפסיפסים, באדריכלות מתועשת העושה שימוש במודולים, ובכלל נראה כי הראיון התאי מושרש עמוק אל חוקי הטבע .

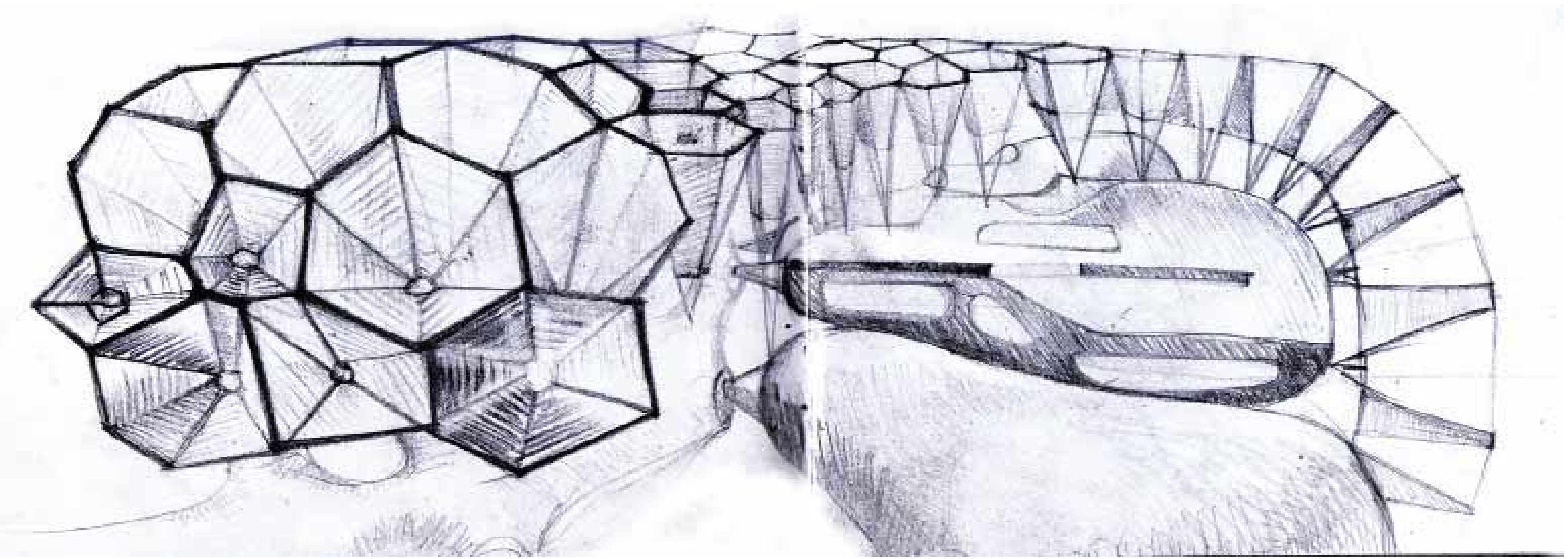
בתחילתו של התהליך המחקרי נשאלנו: מהו מבנה תאי?
תשובתי הפרטית בתחילת הסמסטר הייתה כי כל מבנה הוא תאי, שכן הוא עשוי לבנים, אלמנטים, מערכות ריצוף, חדרים ויחידות .

בסוף תהליך מחקרי זה, אני מוצא עצמי מנסה לענות על השאלה שוב ומגלה שהתשובה השתנתה.

המערכת התאית אינה רק עשויה מחלקים חזרתיים אשר נערמו, הוצבו וסודרו כדי לייצר חלל.
מערכת בניין תאית חייבת לייצג מודל מורכב, חי וזורם של תהליכים המתקימים בשתי רמות- מיקרו ומאקרו .
מבנה תאי- כברקמה החיה- מתקיים על שדה כוחות שמנוקד בחבורת ישויות המקימות קבוצה. הישויות משתפות פעולה כדי לשרוד והן מתמחות ביעילותן וביכולת שלהן להתפתח אל מול התנאים הדינאמיים הקיימים סביבן.

ברמה הפרטית, המיקרוקוסמוס, מתקיימים תהליכים פנימיים המשרתים את המוטיבציה של התא.

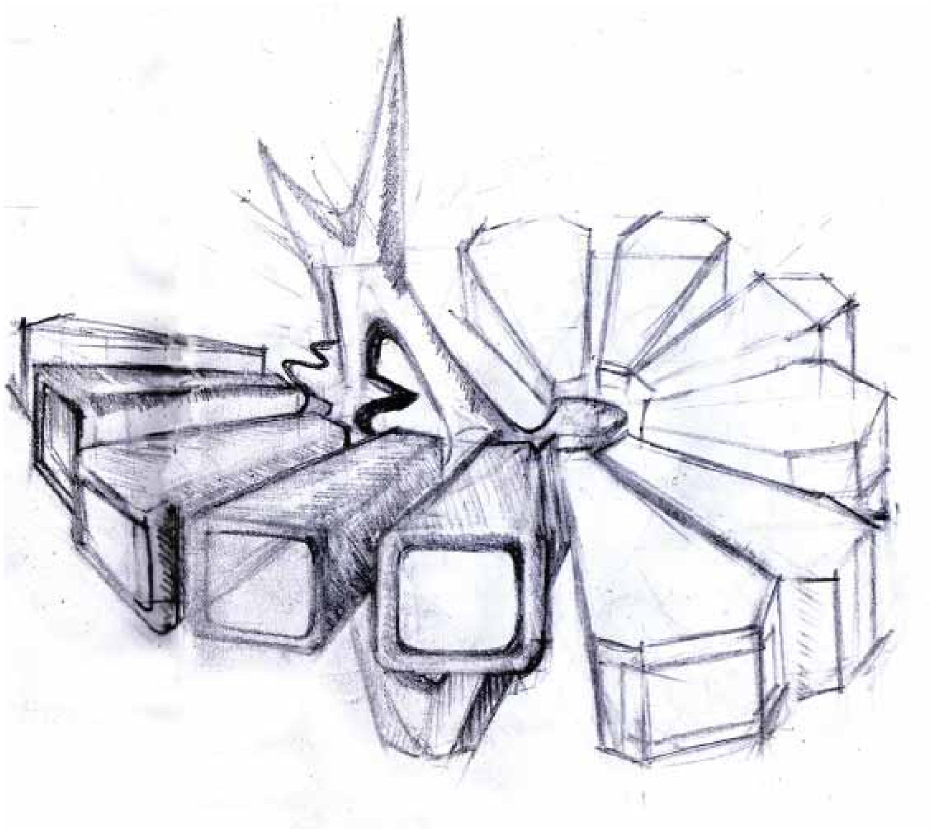
ברמת המאקרו , יחסי הגומלין הבין תאיים מספקים איכות חדשה של תפקודים, הודות למנגנון מלכד היודע לשכלל את הזהות העליונה של סך כל התאים ולהגיב לסביבה כאירגון אם אסטרטגיה ומטרה משותפת.



החיפוש אחרי ההופעה המורפולוגית של בניין תאי:

אחת השאלות שענינו אותי במהלך הסמסטר הייתה שאלת הסטרוקטורה התאית: האם הסטרוקטורה של הבניין נובעת מצבירה של יחידות בעלות נפח, או שמה מדובר בניסיון לייצר מערכת חללים ע"י משטח מתפתל אחד?
מקורות הדילמה נעוצים בזהות הכפולה של הבנין התאי. מצד אחד יש לו זהות כוללת הנובעת מהכותרת הפרוגרמטית שלו, לדוגמא "מרכז הספורט"- כלומר זיקוק של סך החלקים לכדי שם אחד המכיל את כלל המאפינים הפנימיים.
מצד שני יש לבנין התאי היבט של מצבור או קבוצה כלומר מערכת שנוצרה מריבוי תתי מערכות.

החיפוש הראשוני אחרי ה"קוד הגנטי" של הבניין ,התמקד סביב התאוריה של המשטח האינסופי, , שכן מכיוון המבט הזה הבניין מתרחק ממערכת הבניין הקונבנציונלית ואנו נוכחים לראות שריבוי חללים יכול להווצר מאוביקט אחד.



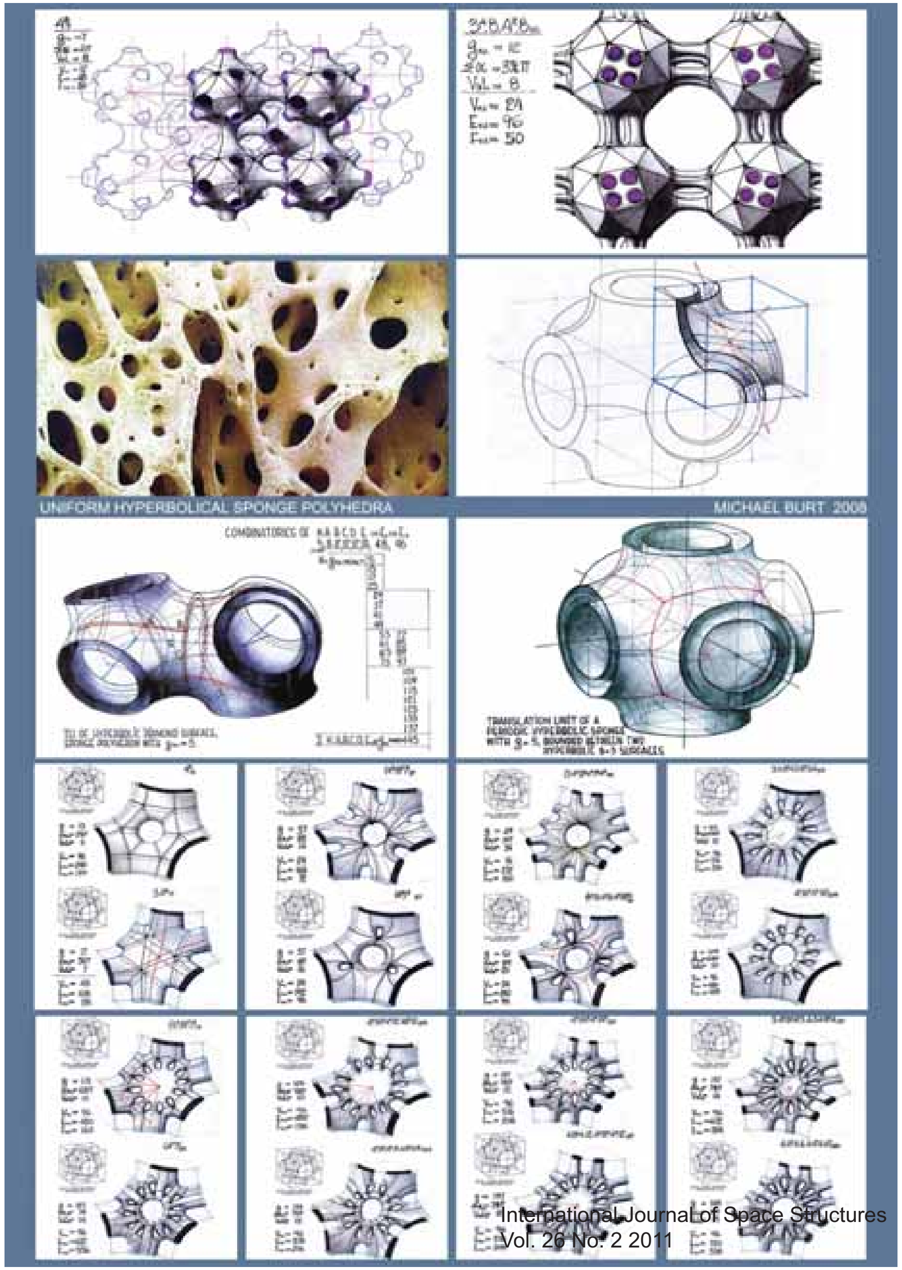
הדילמה המורפולוגית של הבניין התאי: האם נוצר מקבוצה של תתי מערכות נפרדות או ממשטח אינסופי אחד?

המשטח האינסופי כמקור השראה

במחקרו של פרופסור מיכאל בורט מתגלה הפוטנציאל של המשטח האין סופי כמערכת גמישה המכוללת צמד מערכות חללים שלעולם אינם נפגשים.

יכולתה של המערכת להתפצל ולהוליד דפוסים חדשים מבלי לשנות את אופיה הראשוני ומבלי לפגוע בהרמוניית הרציפות של המשטח שימשה כמקור השראה בפרויקט הנוכחי.

יחד עם זאת המחקר לא מעלה תשובה ברורה על האופן והדרך שיש לבחור מערכת לבניין כזה או אחר. הדיון המורפולוגי הטהור מתמצא באופן שבוא החלל יכול לארגן את עצמו בלבד.
בנוסף לכך מעבודתו עולה רק הפוטנציאל למערכת גמישה ומגיבה אך לא מתפתחת דיאגרמת השיקולים, המיקרים והתגובות אשר לפיהם מגיבה המערכת- ואלו היו שאלות שצריכות לקבל מענה במהלך יצירת מבנה המבוסס על מערכת שכזו.



הכוחות המחוללים משטח תאי

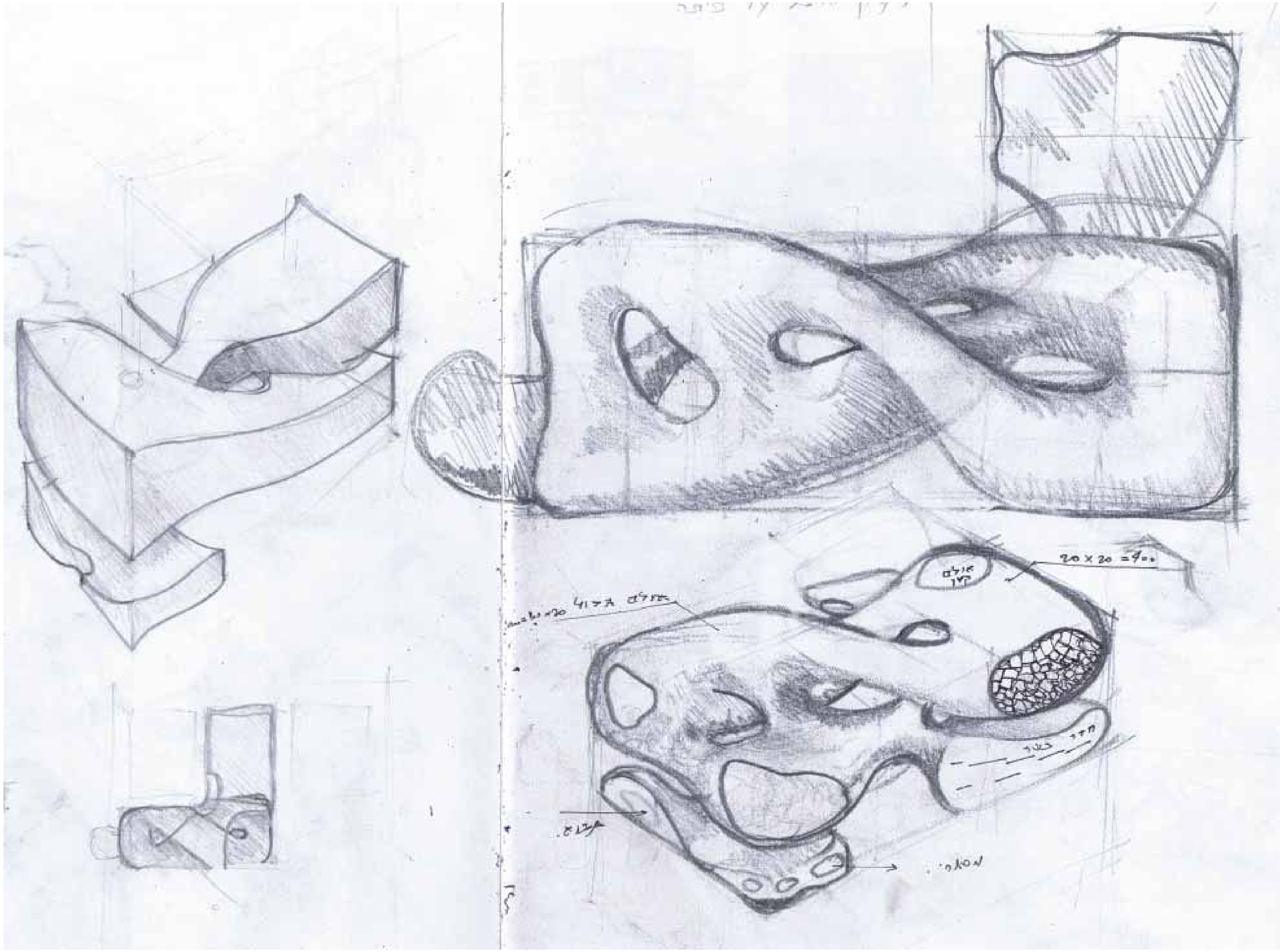
בטבע ניתן לראות כי פני המשטח מבטאים מערכת כוחות דינמית סימולטאנית.
לאורך הזמן משנה המשטח את צורתו- הוא התפתח בתנאי סביבה משתנים
וכתולדה של מאבקים ושיתופי פעולה בין תאיים.

כוחות מחוללים שאינם ליניארים כגון קצב האידוי מקרקע בוצית, מולידים דפוס
כללי העשוי מיחידות שלעולם לא יחזרו על עצמן.

הצורה החד פעמית של כל יחידה ויחידה היא ביטוי נקודתי לסך הרגעים שלה
במערכת .הדבר היחידי שחוזר על עצמו הוא השיטה, הדפוס, התדר, הקוד.

בתמונה שמימין ניתן לחוש את התאיות בעלה רק במרומז. המשטח נראה רציף
וללא גבולות ,למעט מערכת ההובלה הניכרת לעין.
יחד אם זאת ,בהגדלה נווכח כי המשטח עשוי ממליוני יחידות ,שהן חזרתיות
מחד וסינגולריות מאידך. ניתן להניח כי צורתו הנוכחית של העלה נובעת
מהדחף של כל התאים לקיים תהליכי נשימה, פוטוסינטזה, ולבצע את תפקידם
על פי מיונם לטובת הצמח כולו .
תפקודים ברמת קנה המידה של העלה כולו, כמו למשל החורים בקרבת
מערכת ההובלה נועדו להגדיל שטח פנים על חשבון מסה ולאפשר זרימת אוויר
קריר על חלקו התחתון של העלה .הביצוע חיוני לצמח טרופי זה שכן ספיגת
חמצן קטנה ביחס ישיר לטמפרטורה .

היות ושטח העליון של העלה מתחמם, האוויר שבקרבתו עולה ותופס את מקומו
אוויר חדש וקריר המוזן מלמטה. נוצר מיקרו אקלים של זרימת אוויר דרך החורים
המשרתים את הנשימה בקירור ובהגדלת כמות החמצן שבא במגע אם פני
העלה .



נסיונות ברישום לאפיון מערכת תאית שהיא משטח אין סופי

כתיבת הקוד

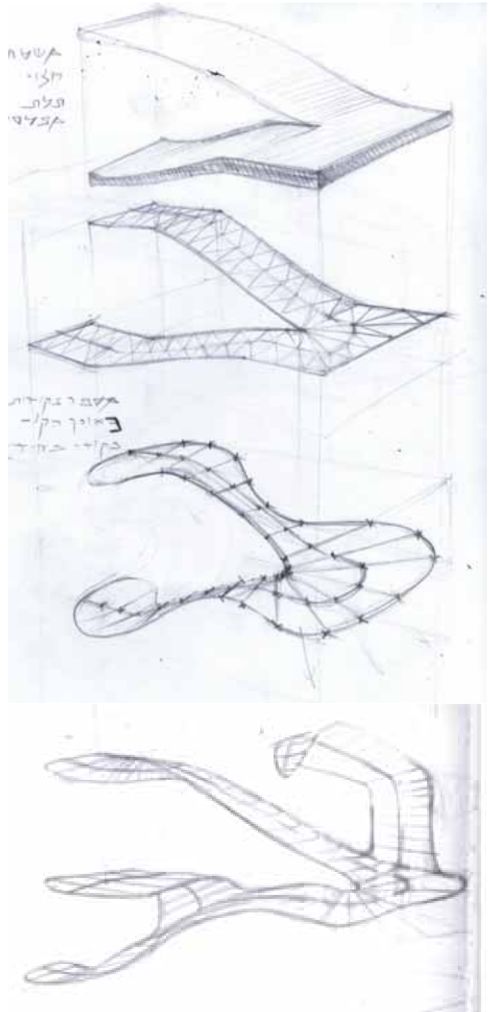
תחילתו של התהליך התכנוני היתה להתנסות בכתיבת קוד מחשב המייצר משטח .

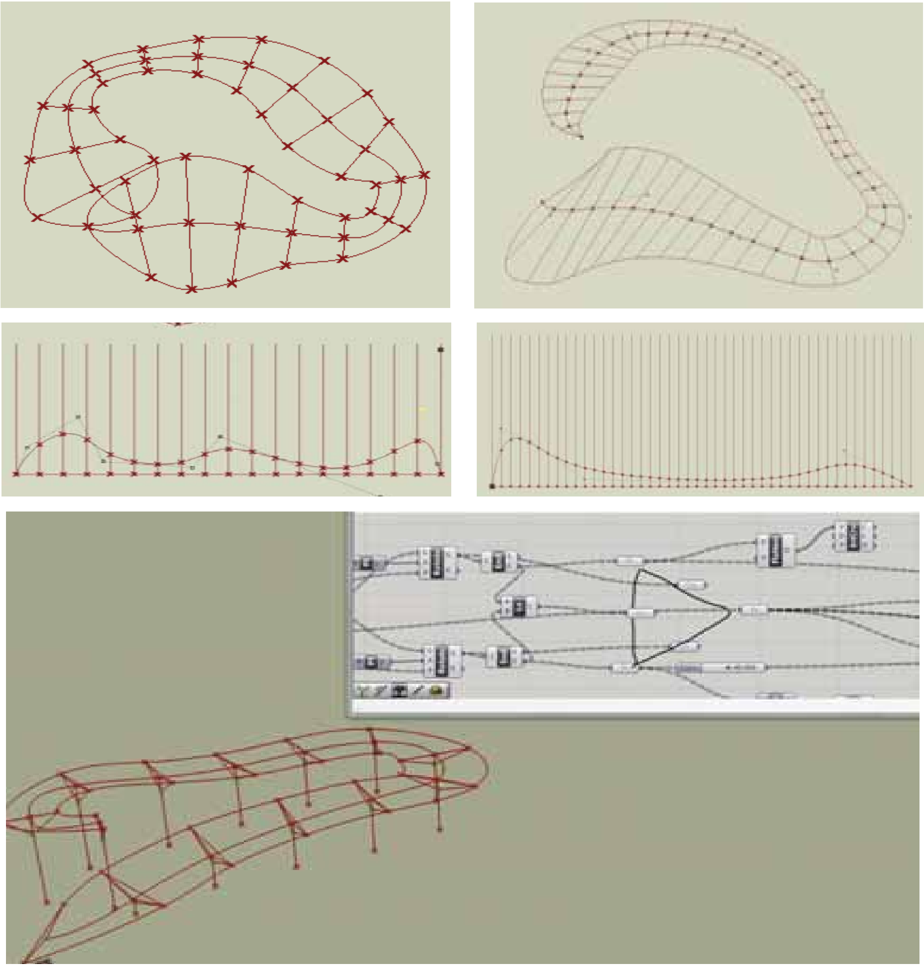
המוטיבציה היתה לייצר משטח שהתנהגותו ניתנת לתיאור על ידי גרף

באופן כזה מתקבל כלי שביכולתו לחולל כמות אין סופית של תוצרים שונים אך שלכולם כלל זהה .

בדוגמא המתוארת משמאל ניתן לראות המחשה של קוד המייצר משטח מקו מפותל במרחב.
הקוד לוקח אינפורמציה מגרף המתאר את קצב ההתרחבות וההתכווצות של הרצועה לאורך הקו .

מרחב ההגדרה של הקוד היה דרך תוכנת grasshoper, סביבה בה ניתן לרכוש תכונות של גיאומטריה תלת מימדית מתוכנת Rhino, לנתח את הנתונים ולבסוף להקרין ולשמר נתונים כפלט גיאומטרי .





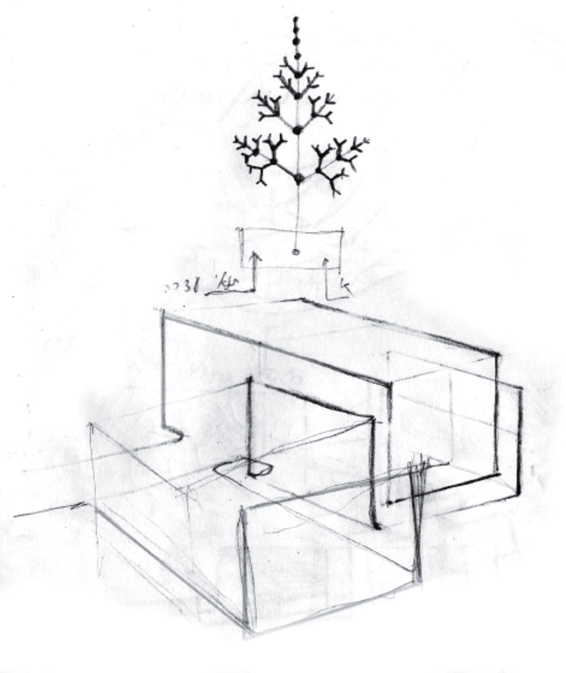
חיפוש אחרי השליטה על משטח מבחינת יכולת התקווצות והתרחבות ושליטה בשיפוע הקו בעזרת קוד grasshoper

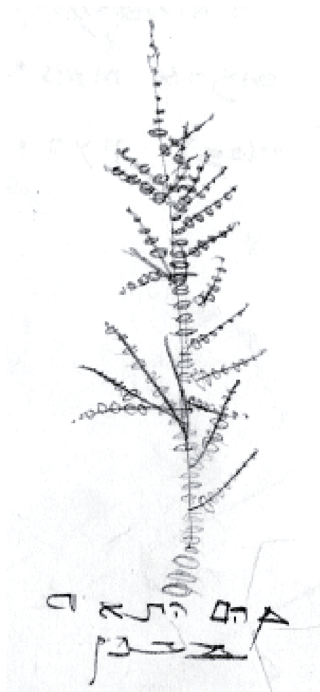
הבניין כפרקטל

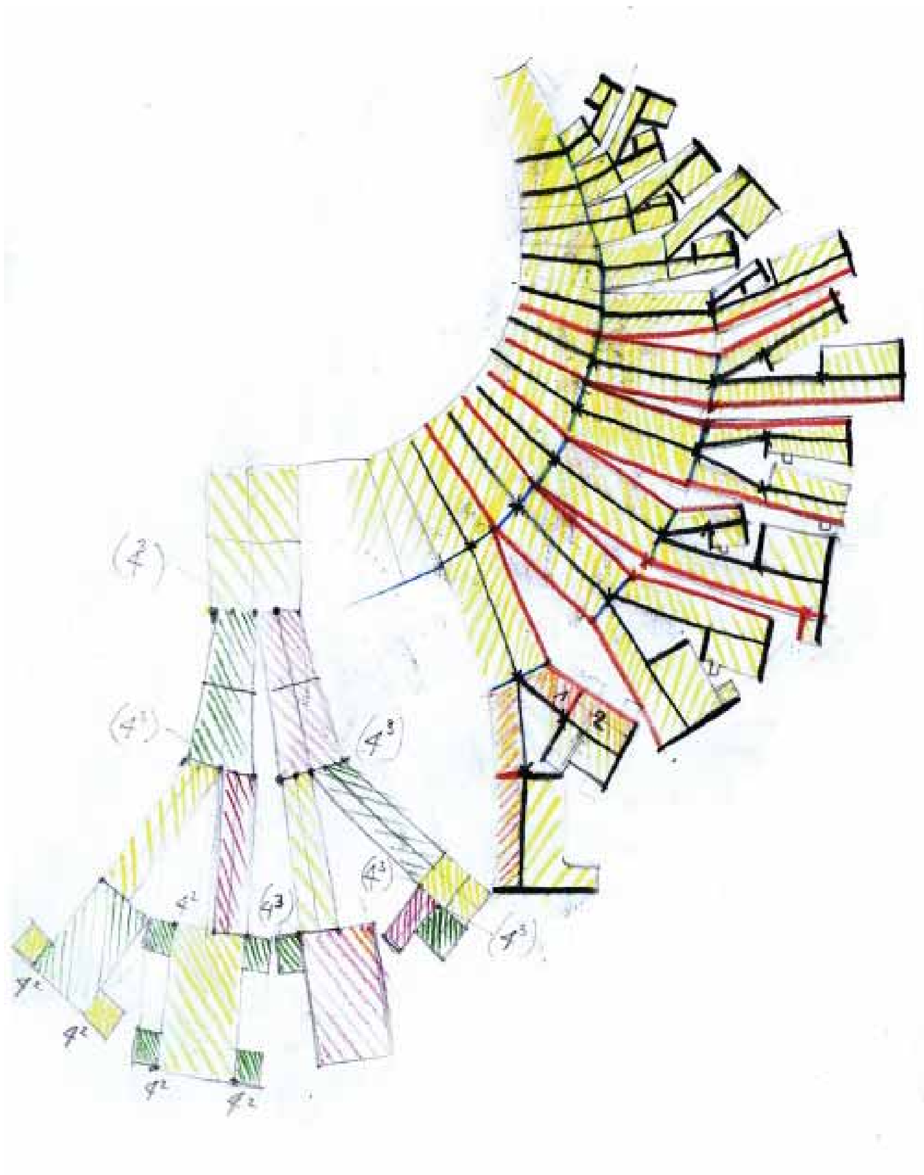
הרעיון הפרקטלי התהווה כחלק מהסטרוקטורה ובמהלך החיפוש המורפולוגי' כיוון שהיה ביכולתו לבטא תהליך אשר בו אינפורמציה מושלכת על גבי קו אך רק חלק ממנה בה לידי ביטוי בכל נקודה.

מבנה נתונים זה נבחר בגלל יכולתו להכיל את הדרך של חווית הבניין שהיא תמיד רגעים על ציר הזמן, שכן אין ביכולתינו להכיל את המציאות כולה ברגע נתון אחד. אלה שבניינים קיימים במצאות בכללותם, וחוסר יכולתנו להשיגם אינה שוללת את קיומם כמערכת נתונים מורכבת רב זמנית ומימדית.

השימוש במבנה נתונים הפרקטלי, נבחר כדרך לשלוט בחוויה הכללית והנקודתית באמצאות אותו הקוד.

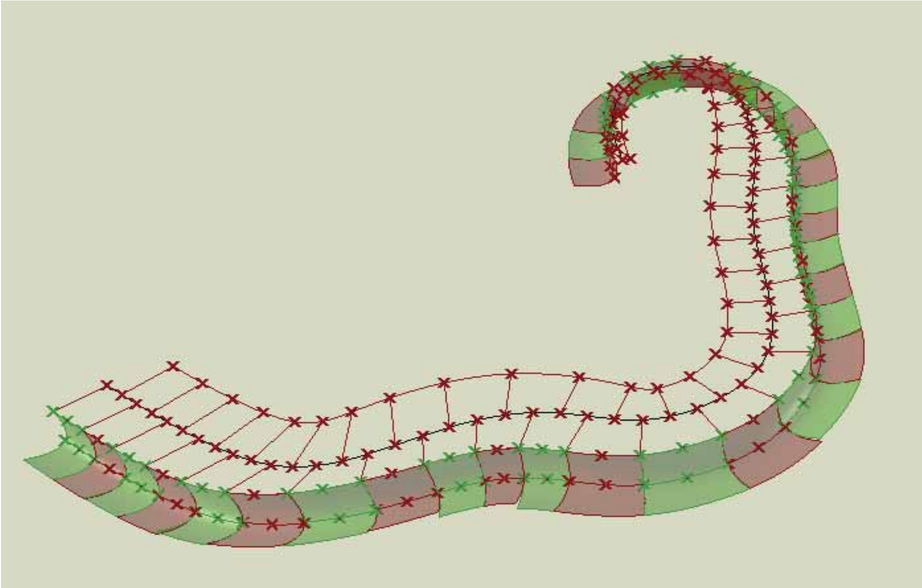


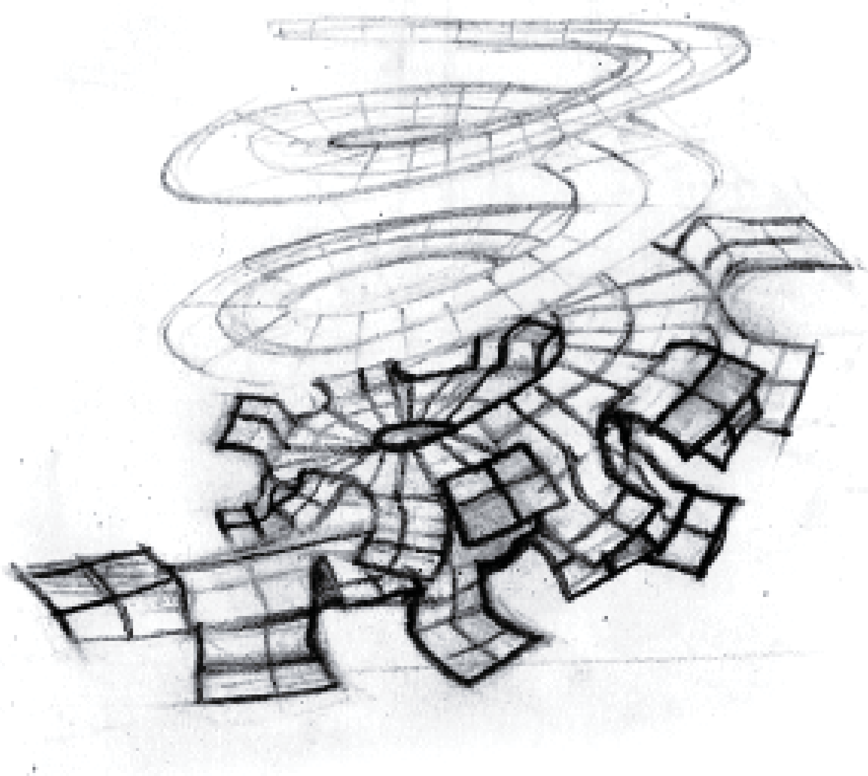


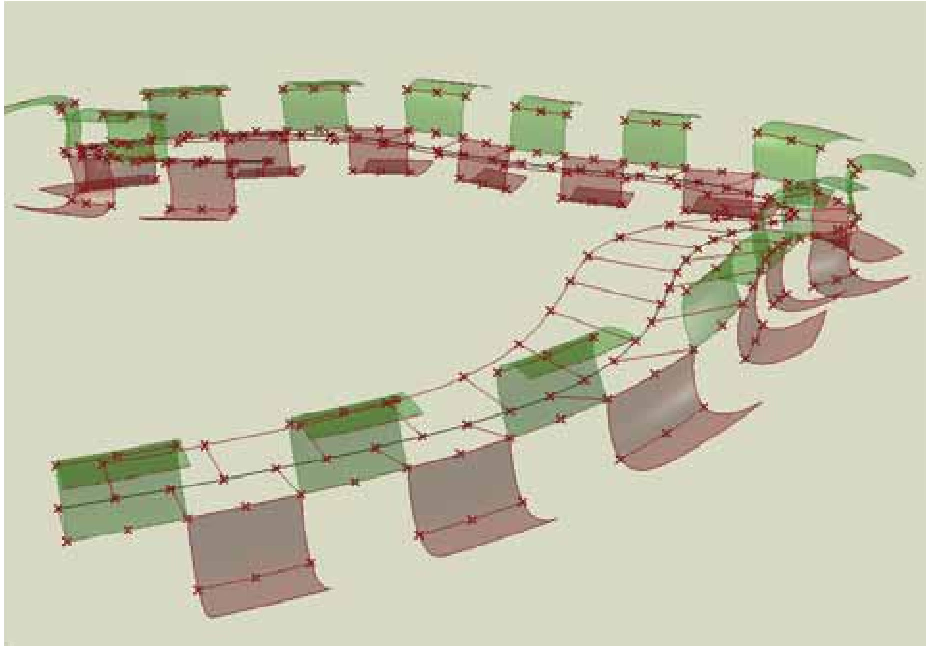


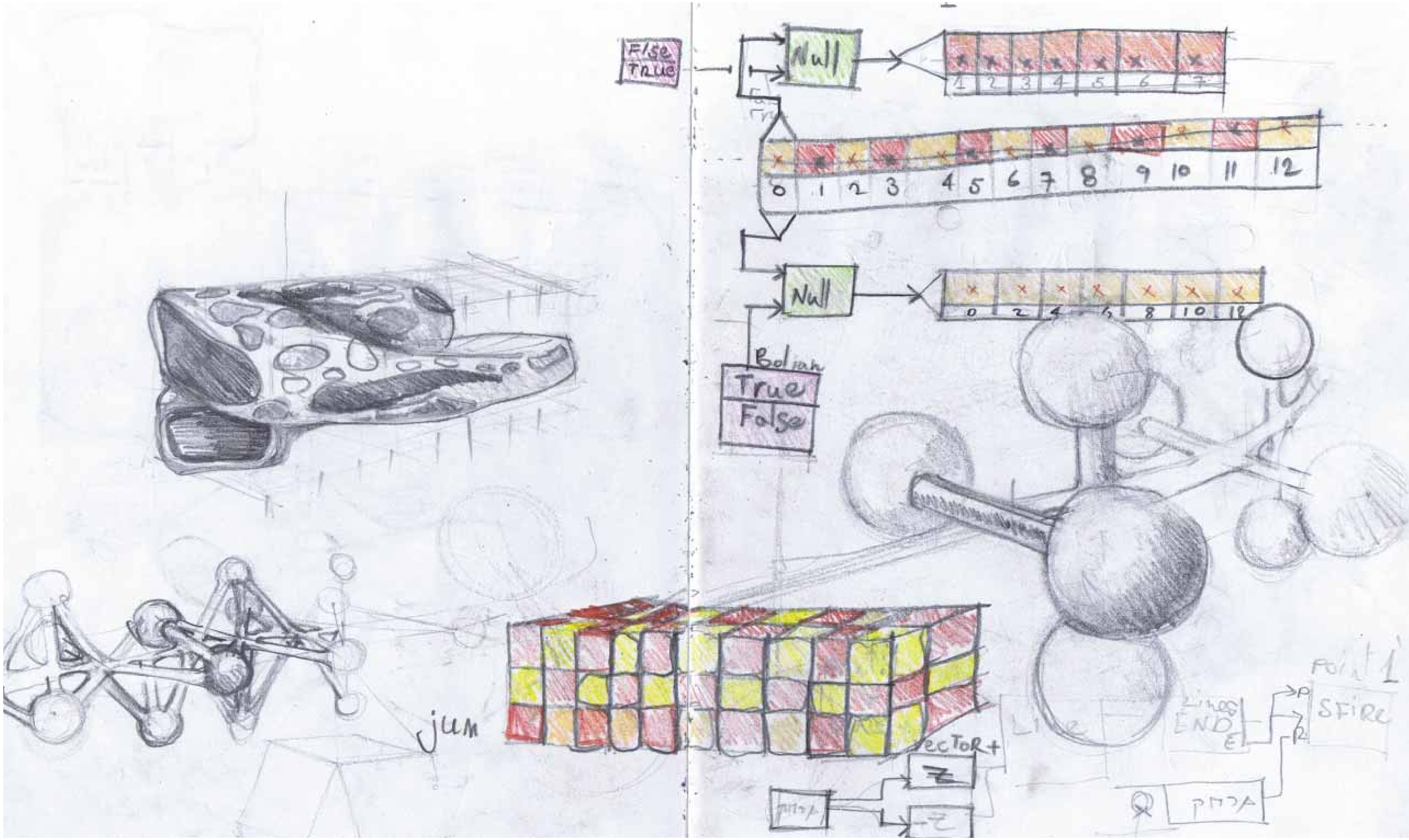
מיון וביטוי נתונים לאורך הקו

בקוד, נתונים נשמרים בחבילות סגורות המסודרות בצורה כרונולוגית.
חבילות נתונים אלו נקראות "רשימות" והן מועברות בשלמותן לניתוח ועיבוד בגוף הקוד.
גם בטבע משתלשל מעגר הנתונים של הגוף החי כיחידה שלמה. אך רק מקצתו בא לידי ביטוי בכל נקודה. היכולת לנתק פיסת אינפורמציה מהרשימה, לעבד אותה ולבטה אותה כגיאומטריה ברגע ובמקום הנכון היתה נחוצה להשלמת הקוד.

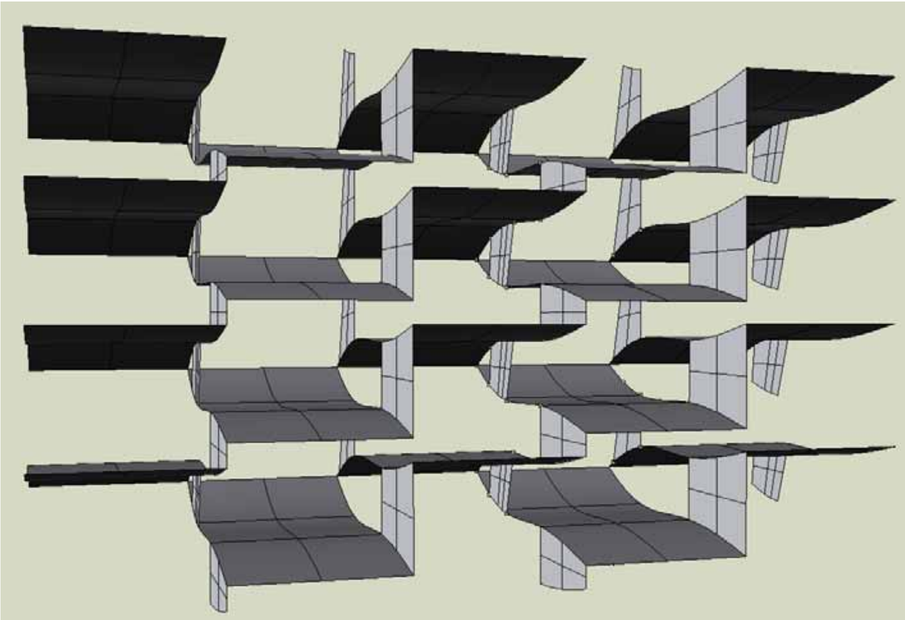








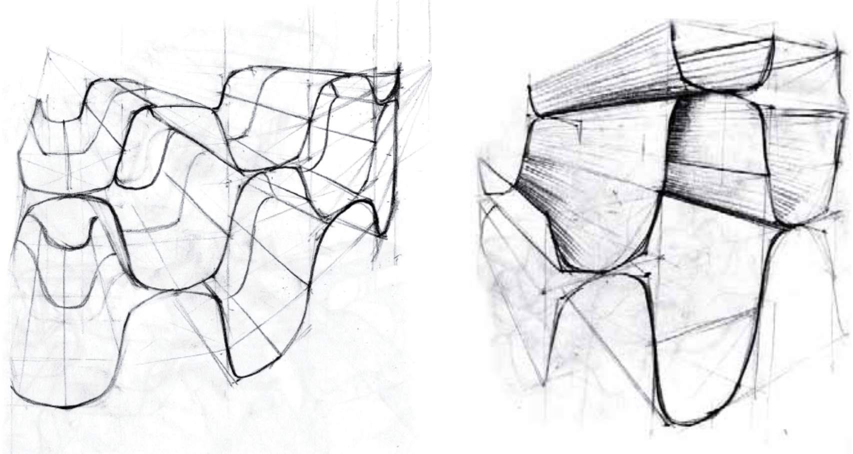
המחשה באמצעות רישום של מבנה הנתונים ומיונו

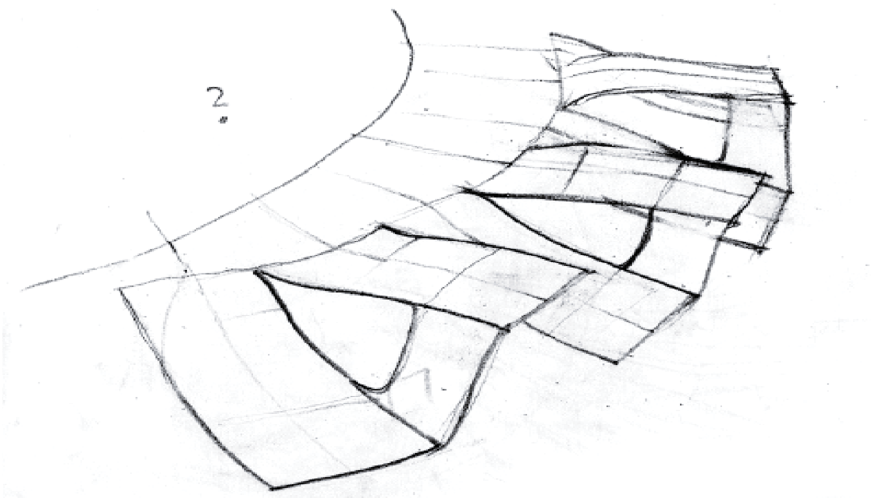


התא כחלק ממשטח

לאחר שנבחר הרעיון הפרקטלי לאורך קו, עלתה השאלה כיצד ניתן לבנות חללים אדריכלים העונים על הגדרה זאת.

הבחירה במשטחים אורטוגונליים אופקיים היוצאים מקו ומערכת הקשרים שבינהם (כפי שמתוארים בדיאגרמות משמאל) התפתח מתוך הבנה כי חללים לשימוש אדריכלי חייבים לחיות בשלום אם זקיפות האדם. בכלל זאת שליטה על השיפועים ורציפות והיררכיה במערכת התנועה .



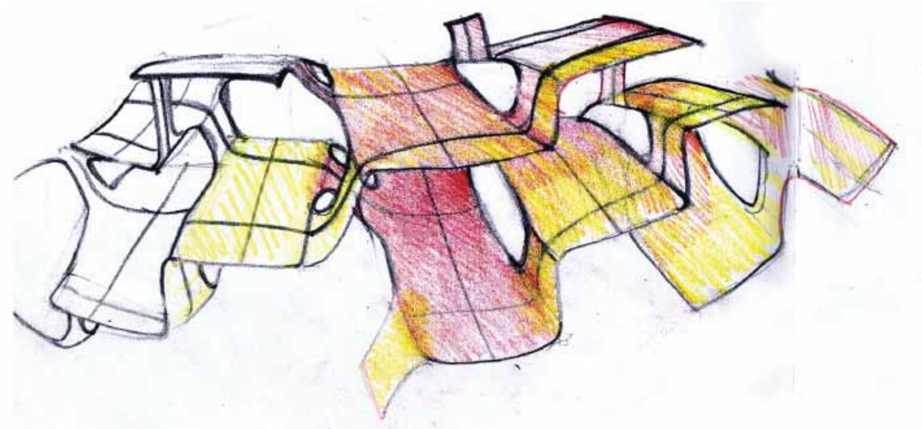


שימוש בקוד ככלי מחולל למשפחה של משטחים אינסופיים

במסגרת הנסיונות לבטה רעיונות אילו בקוד התפתחה משפחה אין סופית של דפוסים אשר כולם תולדה של קוד אחד.

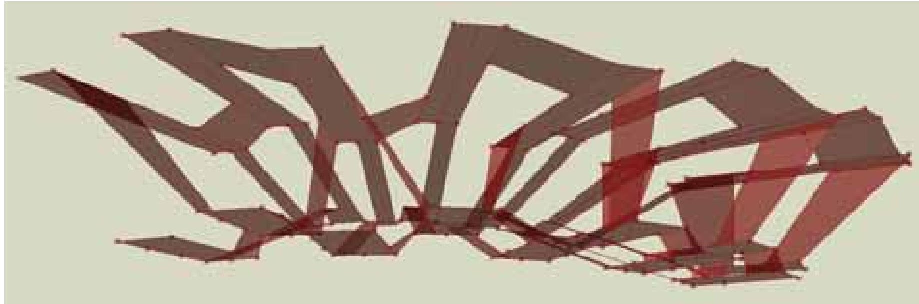
הקוד ,משליך פלט על גבי קו שרירותי הניתן לעיצוב או החלפה, משתמש בהגדרות המוזנות ע"י המתכנן.

שליטתו של המתכנן על ההגדרות וצורת קו המטרה, מאפשרים להמחיש ביטויים שונים של רוחב היחידות אורכן שיפועיהן וכן לייצר מקצבים מתפתחים (גרדיאנטים) לאורך הקו.



למרות שניסויים אילו הצליחו לבטא רעיונות מורפולוגים ולחולל מערכות לשליטה ובקרה על צורות מורכבות, נראה היה בשלב זה כי עדיין לא נמצא הכלי אשר ביכולתו להמחיש בניין תאי מתפקד.

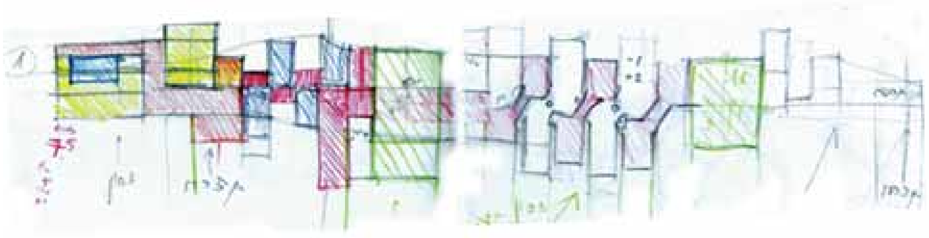
דרושה היתה פעולה דחוסה יותר באינפואמציה אשר ביכולתה להכתיב יותר מאפיינים תפקודיים וגיאומטריים מבלי הצורך של המפעיל לסנכרן בין כל החלטה והחלטה שהוא מקבל, פעולה אשר תוכל להכיל ולבטא את המאפיינים הפרוגרמטיים של הבניין.



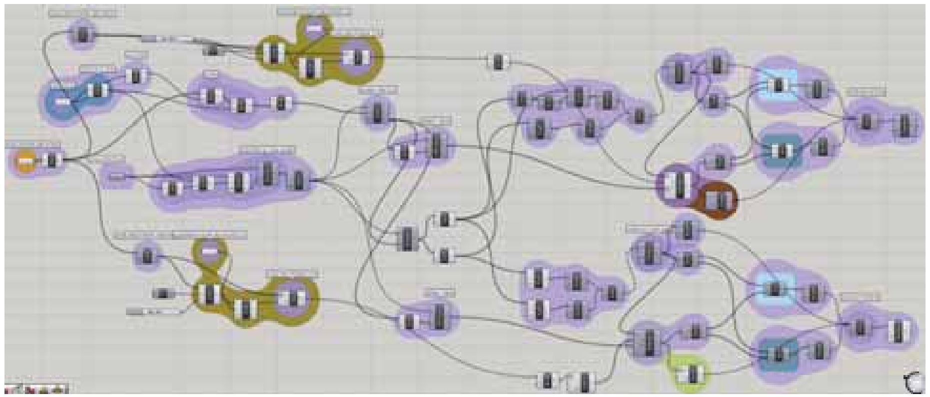
שימוש בגרף ככלי לייצוג פרוגרמה והצבתה בשטח באמצעות קוד

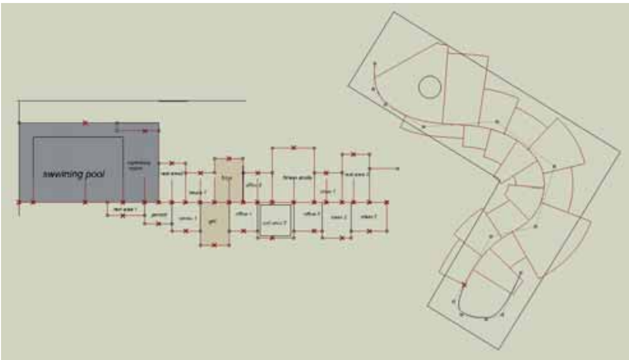
הפרוגרמה נבחרה כנושא להבעה בדרך של קוד. היא הומחשה על ידי דיאגרמה גרפית המתארת את הפרופורציה הדו מימדית של היחידות והסידור שלהן לאורך הקו. באופן זה ניתן היה לכתוב קוד שיתרגם אותן לנפחים היוצאים מקו כלשהו בשטח לתכנון.

היות והקוביות מוקרנות מקו מתפתל, יש גם בהן מידה של פיתול, וכך לכל נפח מתקבל ביטוי חד פעמי הנובע מאופן ההצבה של הקו באתר .

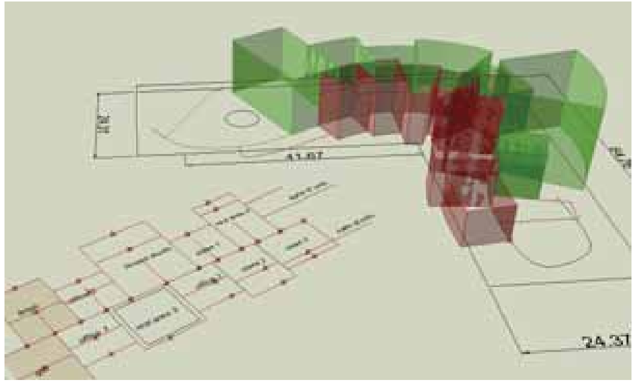


הרשת המתקבלת באתר אינה מהווה את הבניין אלה רק את המסגרת שלתוכה "ניצוקה" טיפולוגיה .
פעולה זאת נקראת "איכלוס". מבחינת הקוד פירושה לקבל גאומטריה בלתי מעוותת ,למצוא את הקוביה האורטוגונלית המינימלית שמכילה אותה, ואז, בתוך כל נפח קוביתי מעוות שהתקבל באתר, תיבנה גיאומטריה המתייחסת אל הפאות כפי שהתיחסה הגאומטריה ההרמונית לקובייתה הבלתי מעוותת .
התוצאה היא גיאומטריה יחודית בכל תא שהיא פרשנות חד פעמית בפונקציה הרלוונטית.

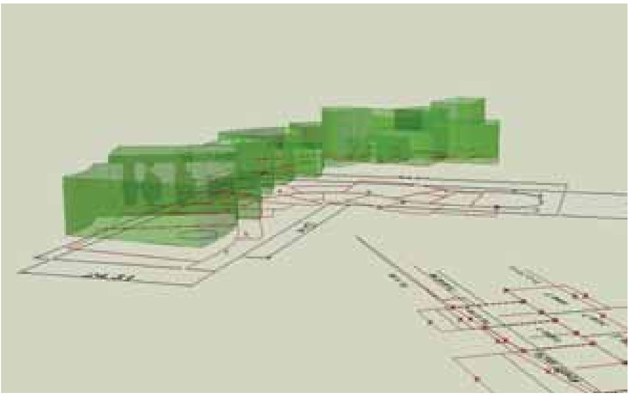




כתיבת פרוגרמה הכוללת פונקציות ושטחים על גבי גרף והעברתו לקו מפותל



בנית bounding box (נפחים) על גבי הפרוגרמה הדו מימדית

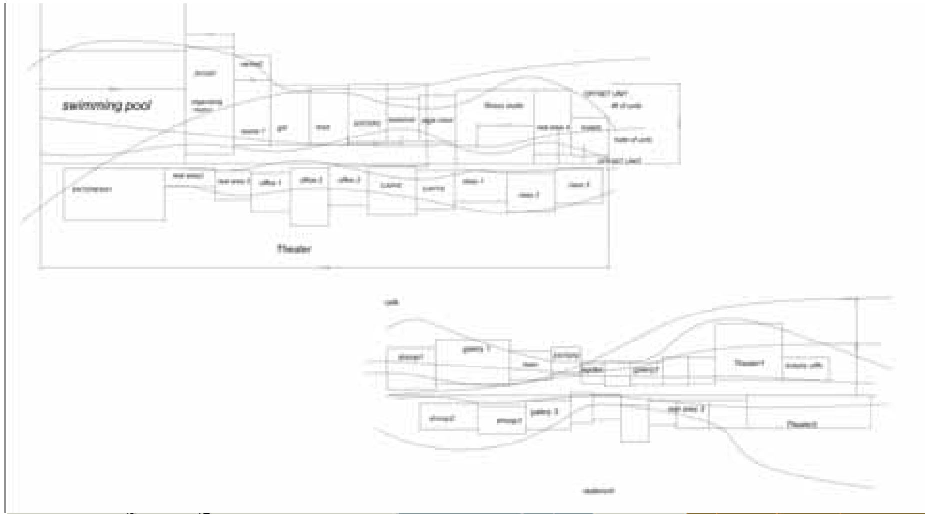


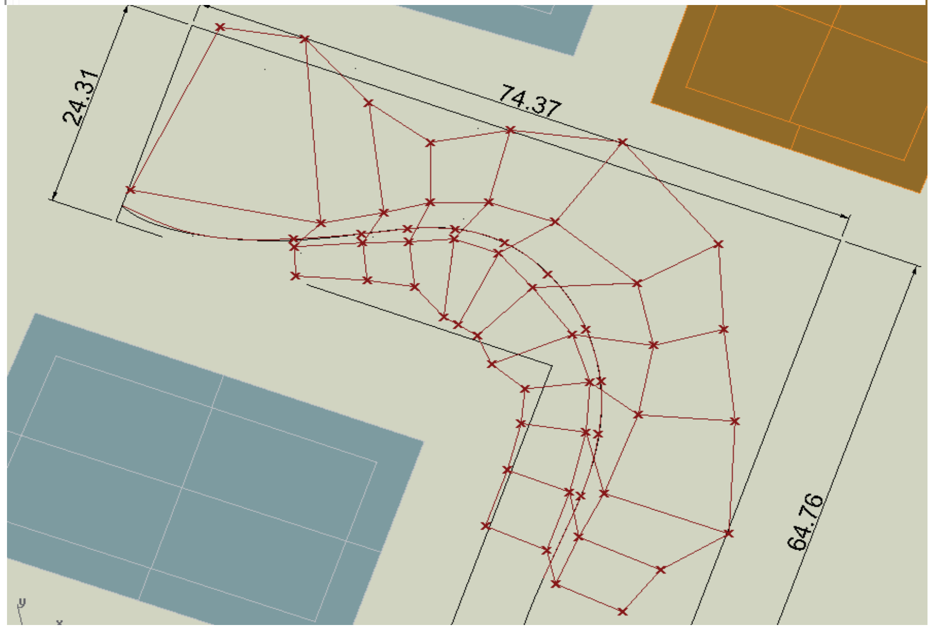
הרמת הקו המחולל והנפחים כך שיצרו שיפוע תקני (8 מעלות)

פעולת האיכלוס מאפשרת לבטא מגוון רחב של תכונות מבניות בעוד שהתא המקורי הופך לנושא לעיצוב המסוגל להוריש לכל המבנה תכונות שהתהוו ותוכננו פעם אחת בלבד.

המשמעות היא ריבוי אפשרויות נוסף: למעשה ניתן לאכלס אין סוף נושאים תאיים אל תוך אותה הרשת ולקבל בכל פעם מבנה חדש לחלוטין.

איכלוס ראשוני של תא אל תוך קוד פרוגרמטי .
זיהוי הבעיות הבאות :
גלישת המבנה מחוץ לקו הבניין, בעיה קונסטרוקטיבית, בעית השיפועים





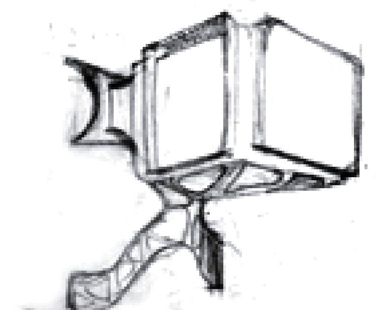
ברשת הסופית שנבחרה לאיכלוס, ניתן לראות, כיצד שתי קוביות שכנות נפגשות על פאה משותפת .הדבר מבטיח כי לאחר פעולת האיכלוס ,יתעוותו האוביקטים המאוכלסים כך שרגע החיבור בינהם יהיה רציף .

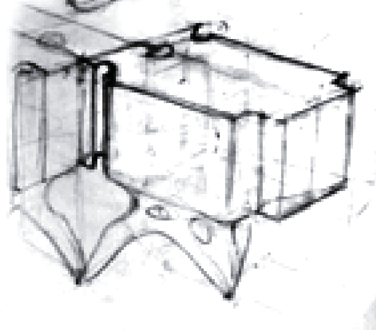
פיתוח התא

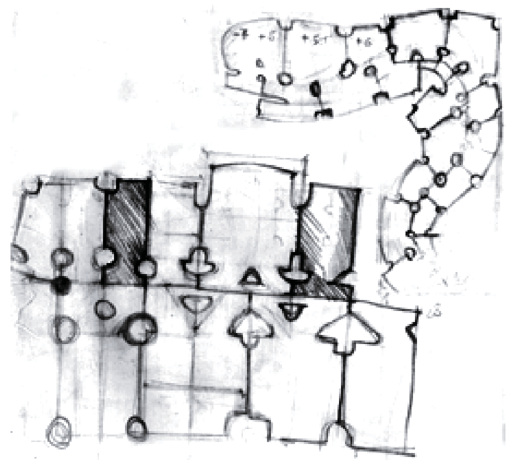
הפיתוח של התא לאכלוס עבר דרך ארוכה עד לצורתו הסופית .

בשלב זה היתה חזרה לרעיון המקבץ .

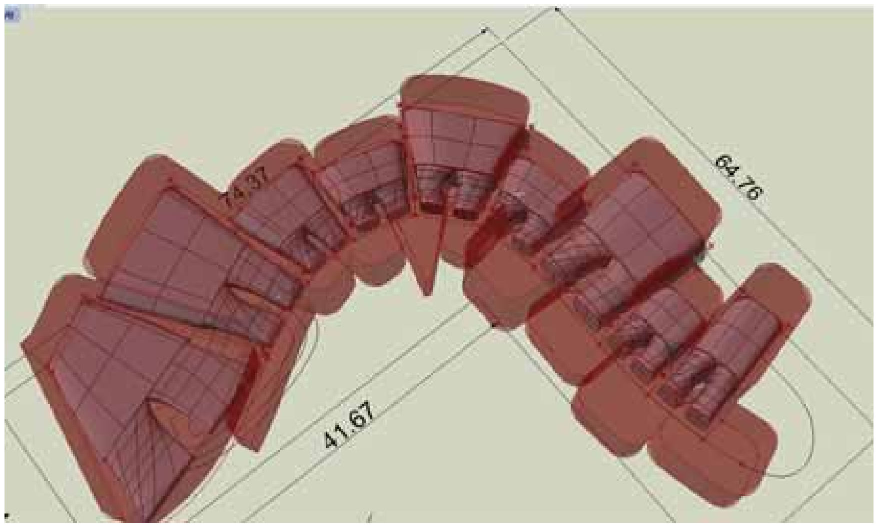
ההבנה כי קיים צורך בגוף סגור בעל נקודות חיבור והשקה לתאים שכנים דרשה העמקה נוספת על השאלה המורפולוגית.

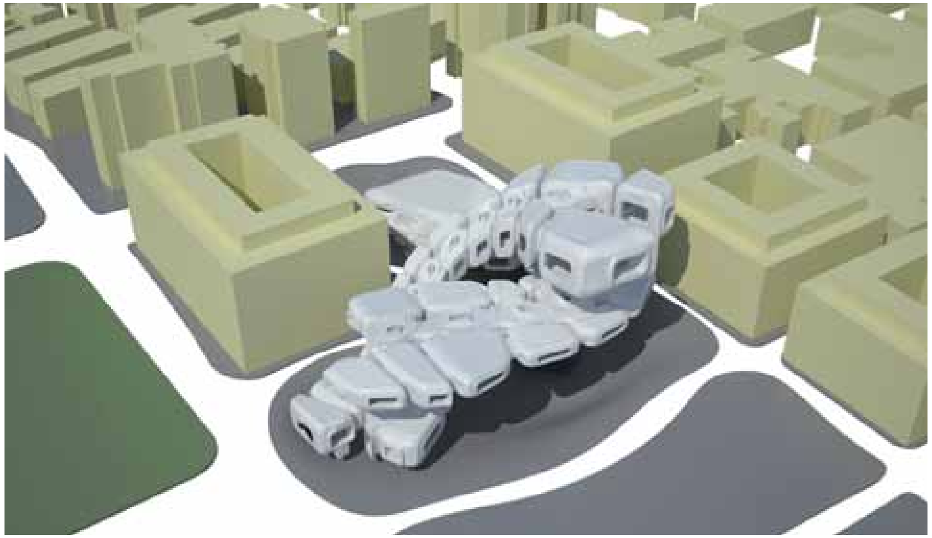


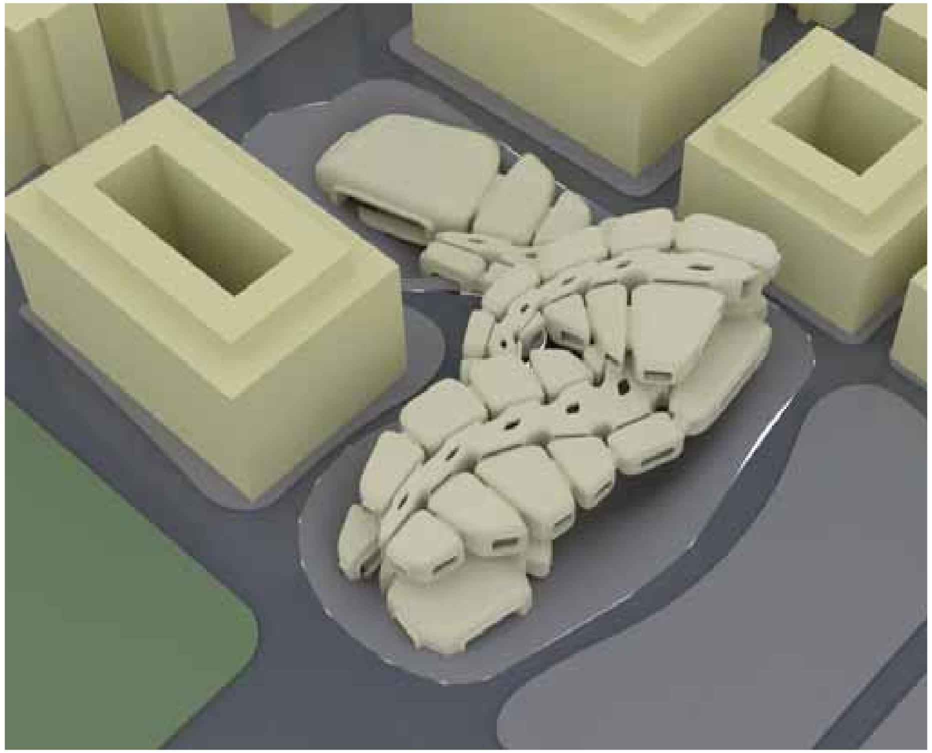


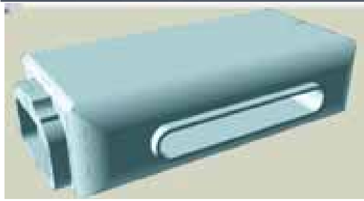


הגרסאות הראשונות של התא כללו סוג אחד של תא המכיל מחבר אינטגרלי בתוכו. הגרסאות הבאות כללו שני סוגי תאים- תא המכיל פונקציה ותא המהווה מחבר וציר תנועה ראשי.

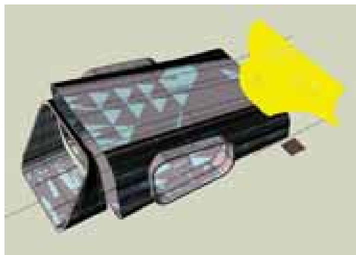


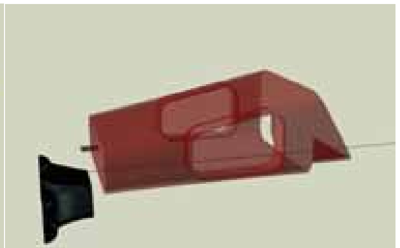






לבסוף נבחנה הטכניקה על כל אפשרויות התמרון שלה. מרמת השליטה בגרפים ובקוי הבסיס באתר ועד סוג התא ותכונותיו. מוצג כאן חלק קטן משלל הביטויים שהתקבלו עבור מספר תאים שונים שאוכלסו לאורך תהליך התכנון.

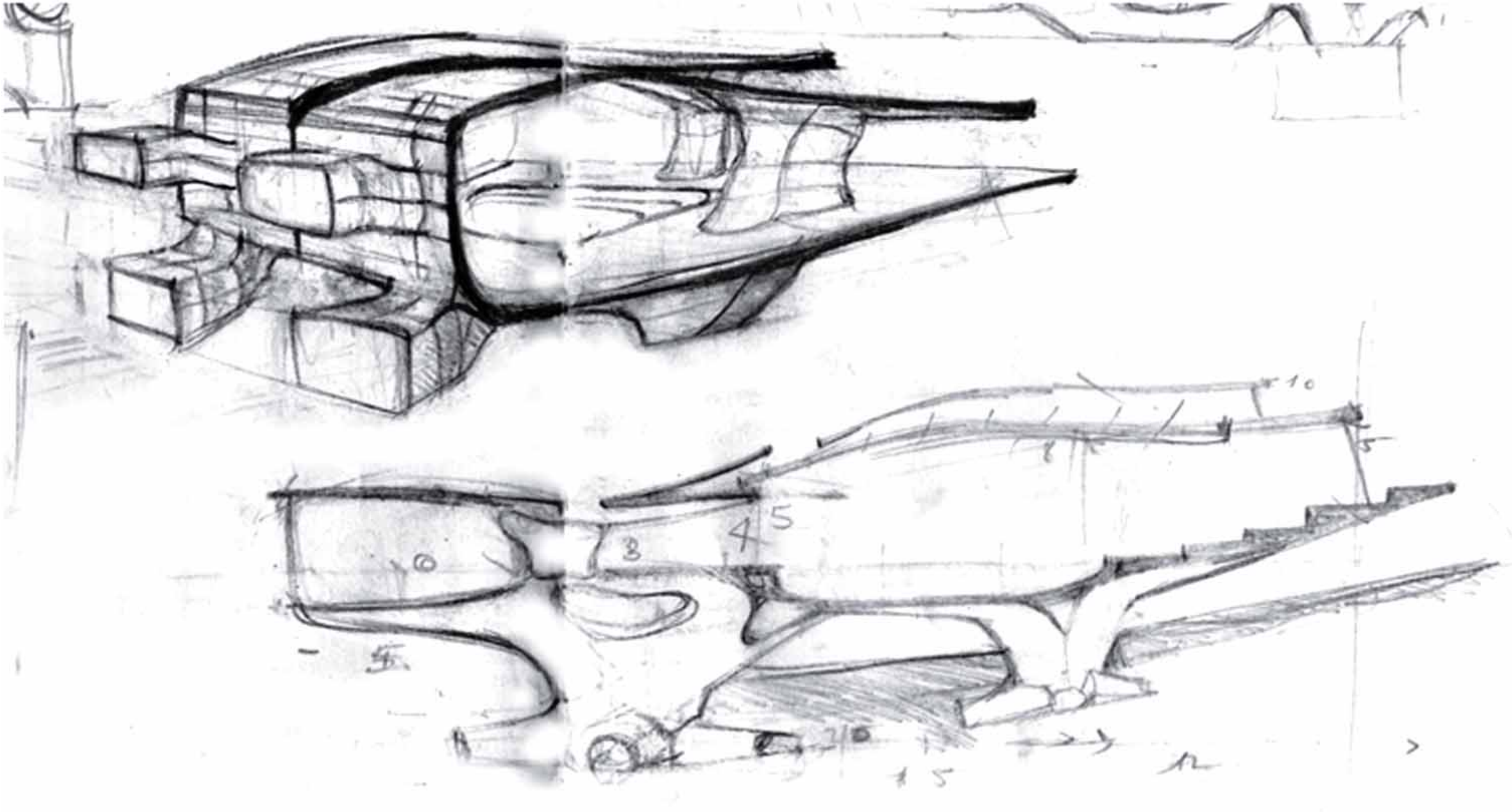




פיתוח התא

בחינת החתך בהבטים קונסטרוקטיבים וחללים השפיעה על הפרופורציות של התא לאכלוס והביא להבנה שישנה בעיה לאכלס את כל הקופסאות באותו התא .

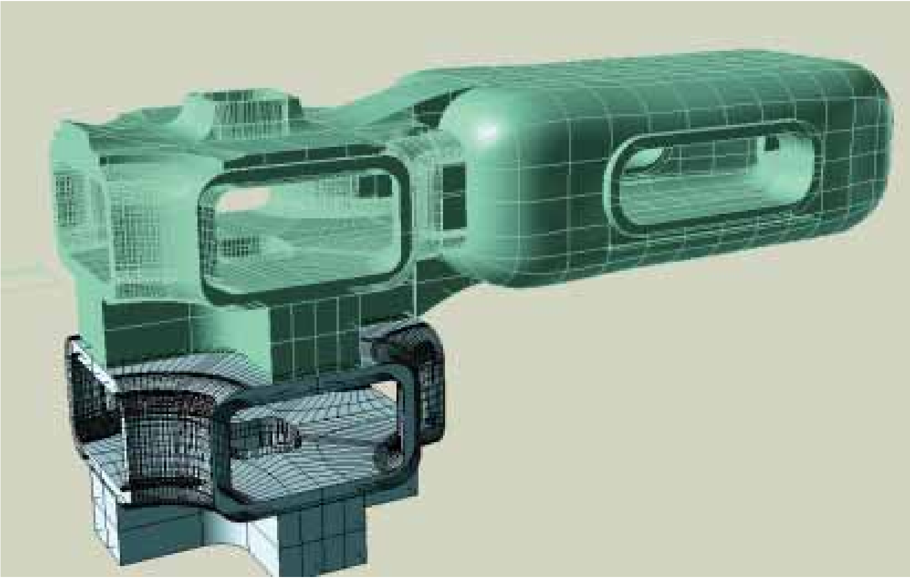
הדבר הוביל להחלטה לבחור בפרופורציות קלסיות של 1:2.



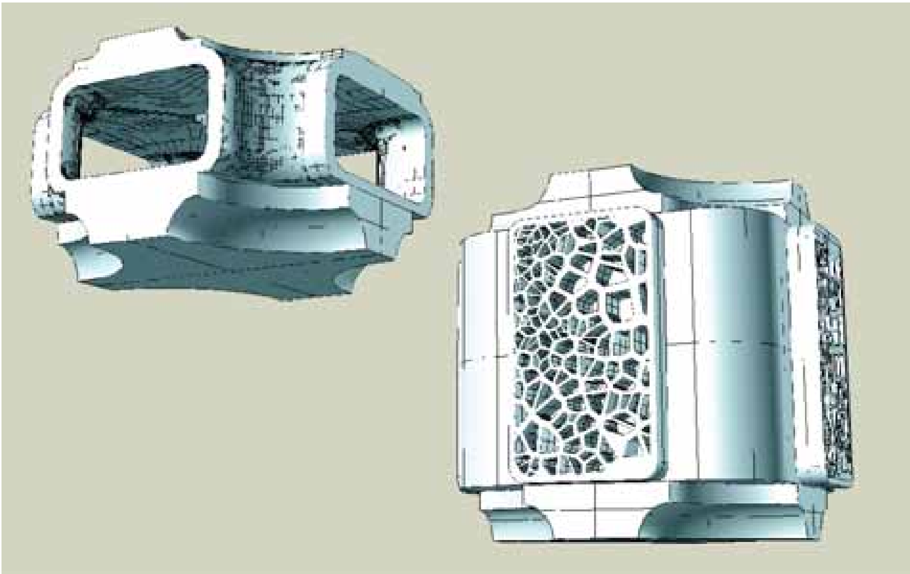
המערכת התאים הסופית לאכלוס

המערכת הסופית מורכבת משלושה סוגי תאים :
1) תא פונקציה
2) תא מקשר שיוצר את ציר התנועה המרכזי של כל אחד מהבניינים
3) תא המהווה ציר תנועה אנכי ונושא את הבניין באוויר.

תא הפונקציה הסופי לפני איכלוס יחד אם תא מרכזני



מקבץ בתהליך .משטחי המפגש בין כל שני תאים זהים כדי שבאיכלוס יווצר חיבור רציף וחלק

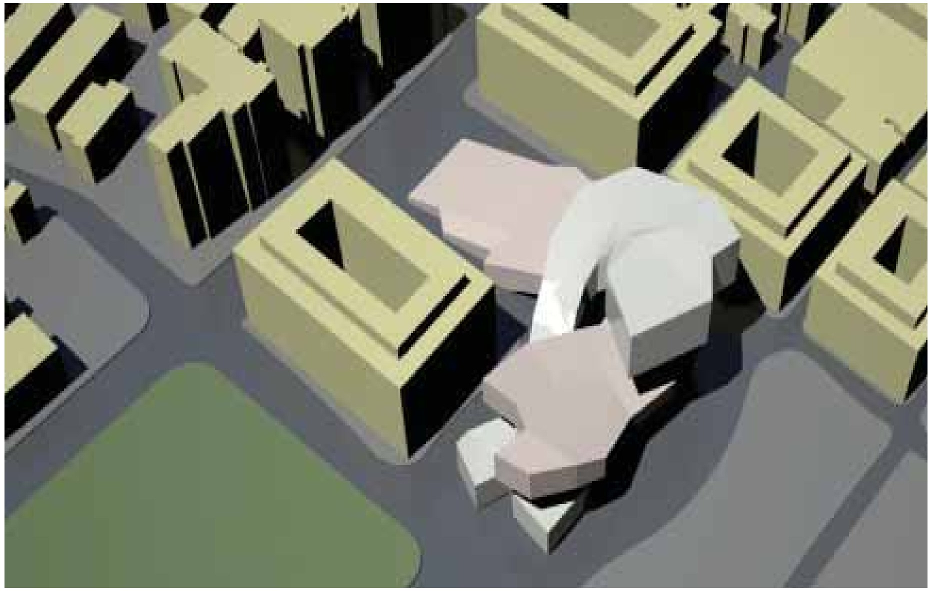


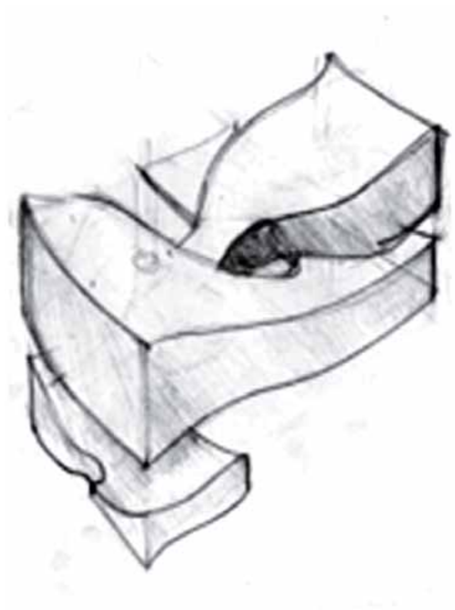
תא וורטיקלי (מימין) ותא מרכזני במבט מלמטה

החלטות אדריכליות באתר:

האתר ממוקם ממערב לשוק הכרמל בתל אביב. סביבה פעילה זאת מפגישה בין חיי הפנאי הנופש והמסחר של תל אביב עם שכונת מגורים וחיים אזרחיים פרטיים.

ההחלטה על תכנון שני מבנים נבעה מההבנה כי באתר מתקיים עימות בין שני גוונים אורבניים אילו שאינם יכולים להתקיים בשלווה האחד אם השני .





חלוקת האתר לשני מבנים השלובים זה בזה: האחד הפונה לכיוון השכונה והוא בעל פרוגרמה עם אופי אזרחי- מרכז ספורט וחינוך. השני מבנה תרבות ומסחר והוא פונה לכיוון השוק.

חריגה מגבולות המגרש:

פעולת החריגה מגבולות המגרש וניכוס חלקה של שטח ציבורי פתוח מנומקת בשלושה טיעונים:

1) השטח הציבורי ממוקם בין שני מבני מגורים והוא מוביל אל האתר שהוא מבנה ציבור ולכן צפוי לקבל ציביון רועש והמוני. על ידי תפיסתו כשטח לטובת תושבי המקום ניתן יהיה לחסום תנועת מבקרים מזדמנים ולשמרו לטובת התדיירים.

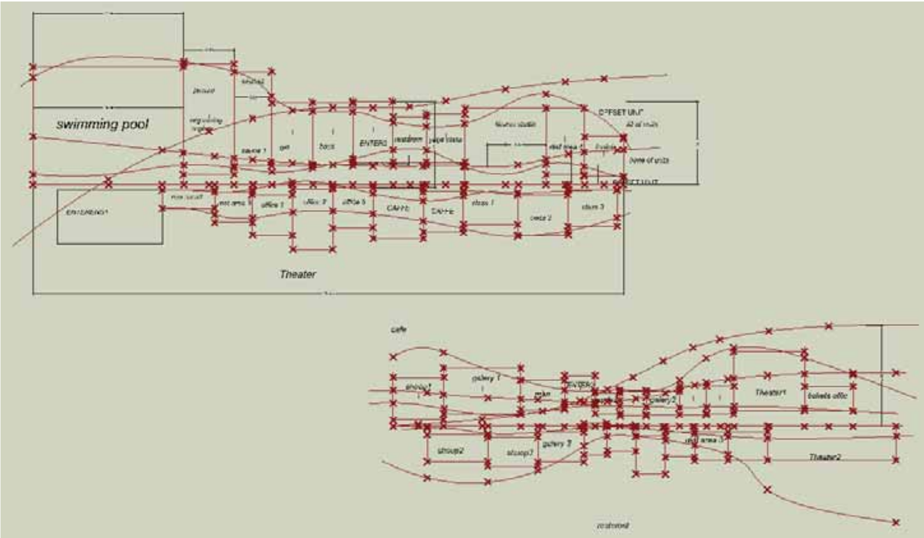
2) הרצון להכפיל את הפרוגרמה לשני מוסדות נפרדים כשהאחד הוא מרכז ספורט והשני הוא מרכז תרבות, דורש יותר שטח.

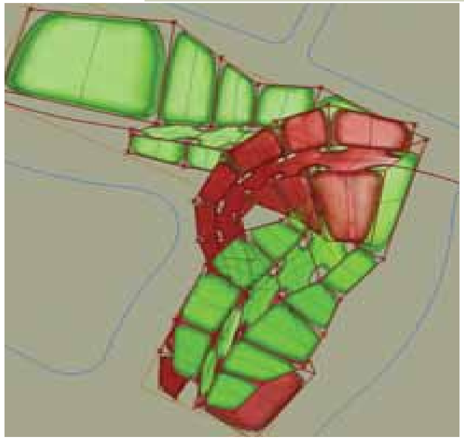
3) על ידי שיקוע הקצה הצפון מערבי במגרש שיעודו היה ציבורי פתוח ,ניתן יהיה להשיג מישור מטפס בשיפוע נוח להליכה שיהווה שידרוג לגן הקיים כיום באתר.

החלטות אדריכליות נוספות

נתונים נוספים המעובדים על ידי הקוד וניתנים לשליטה על ידי המתכנן הם גרפים של השיפוע, גובה היחידות ומרחק ממרכז הבניין של תחילתן וסופן.

על ידי איזון עדין בין הגרפים וצורתו של הקו הראשי באתר הבניין ניתן לשלוט על המערכת התאית ולעצב את תפקודו ותכונותיו הסופיות של הבניין .

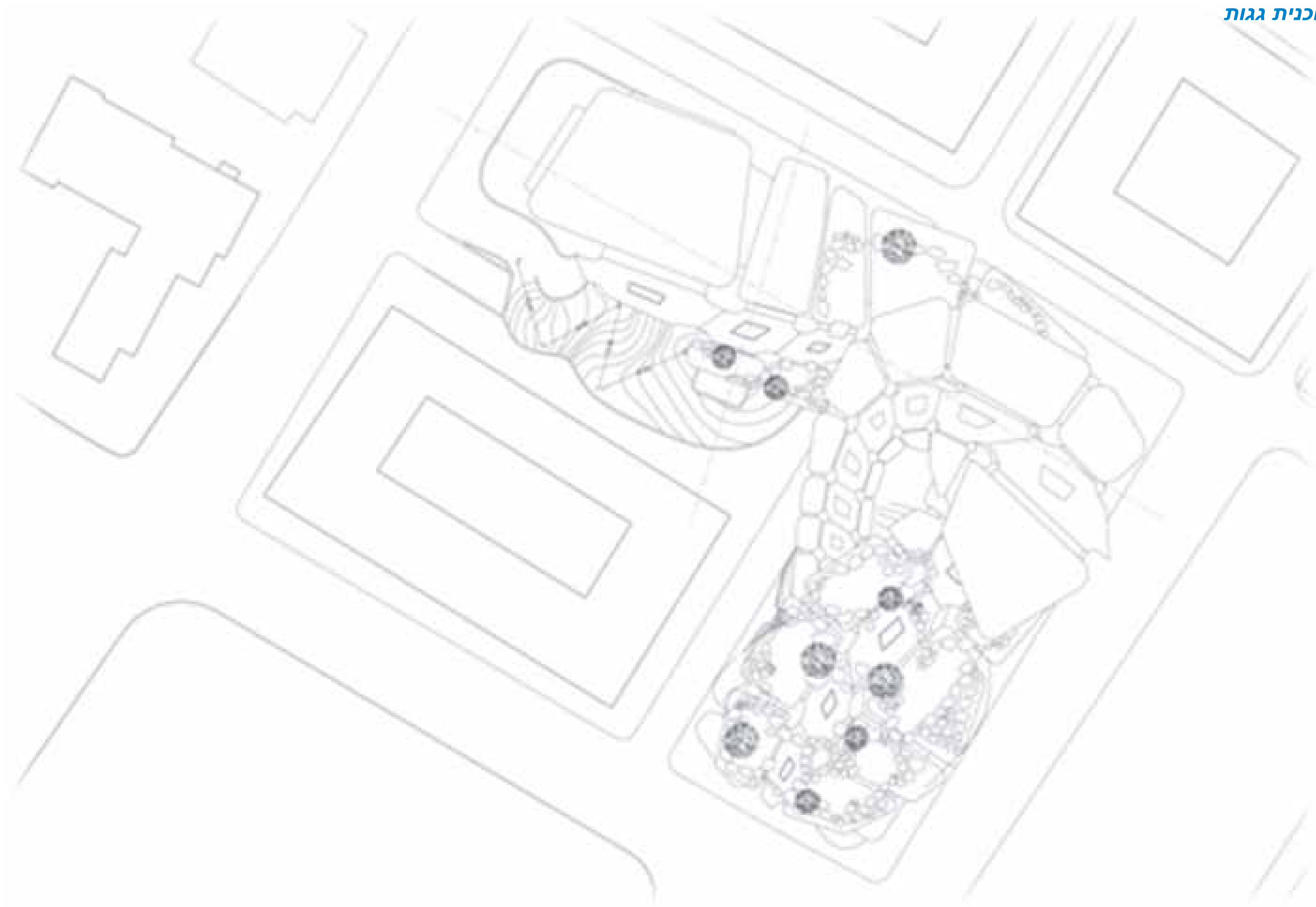




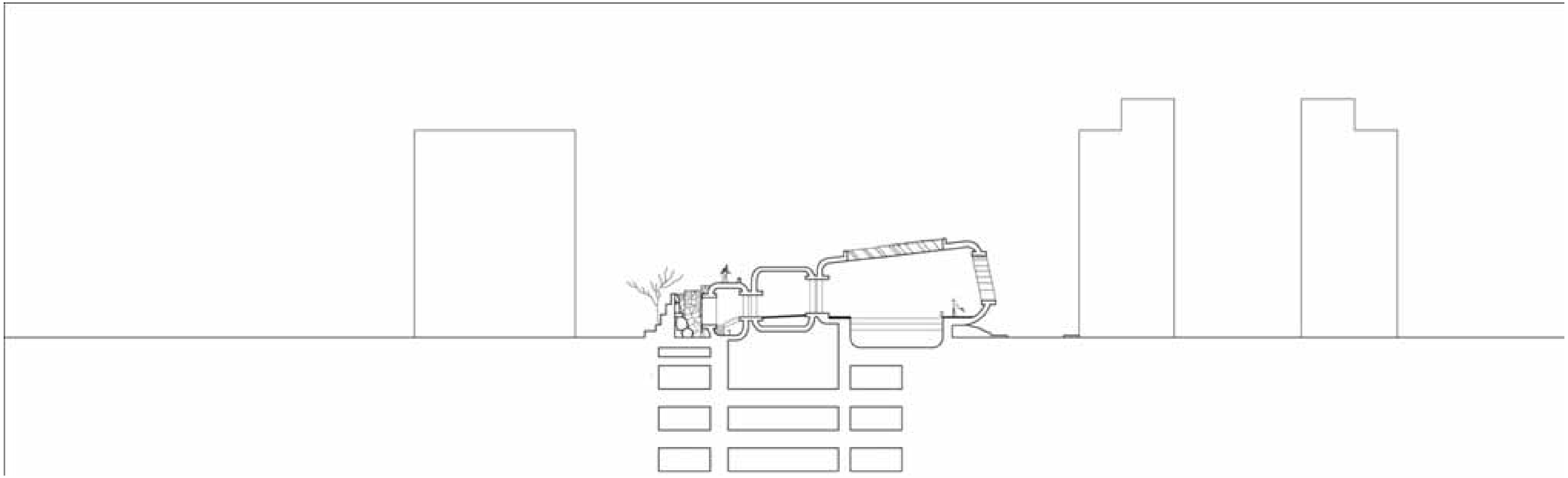
תוכנית מפלס קרקע

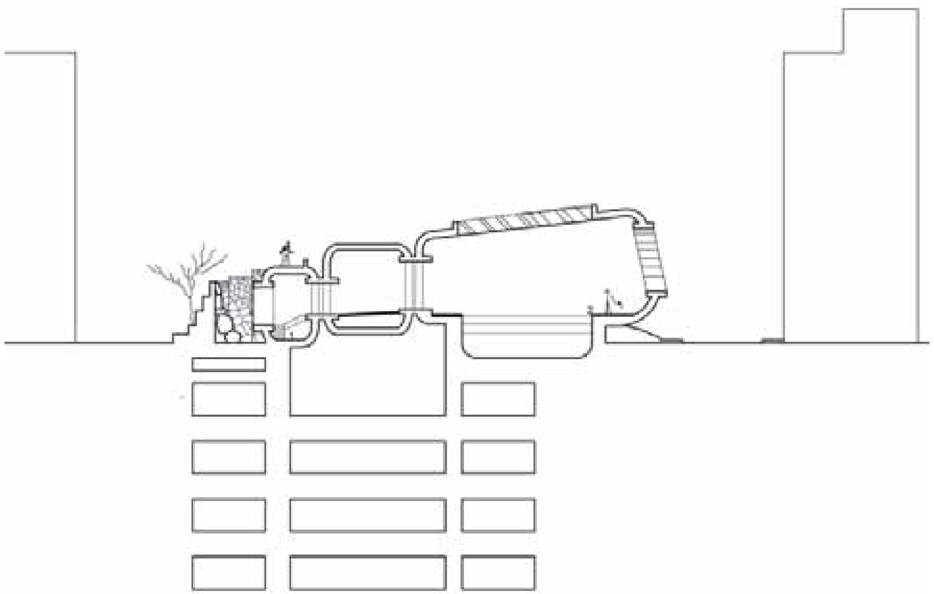
תוכנית בגובה 7.5+ מטר

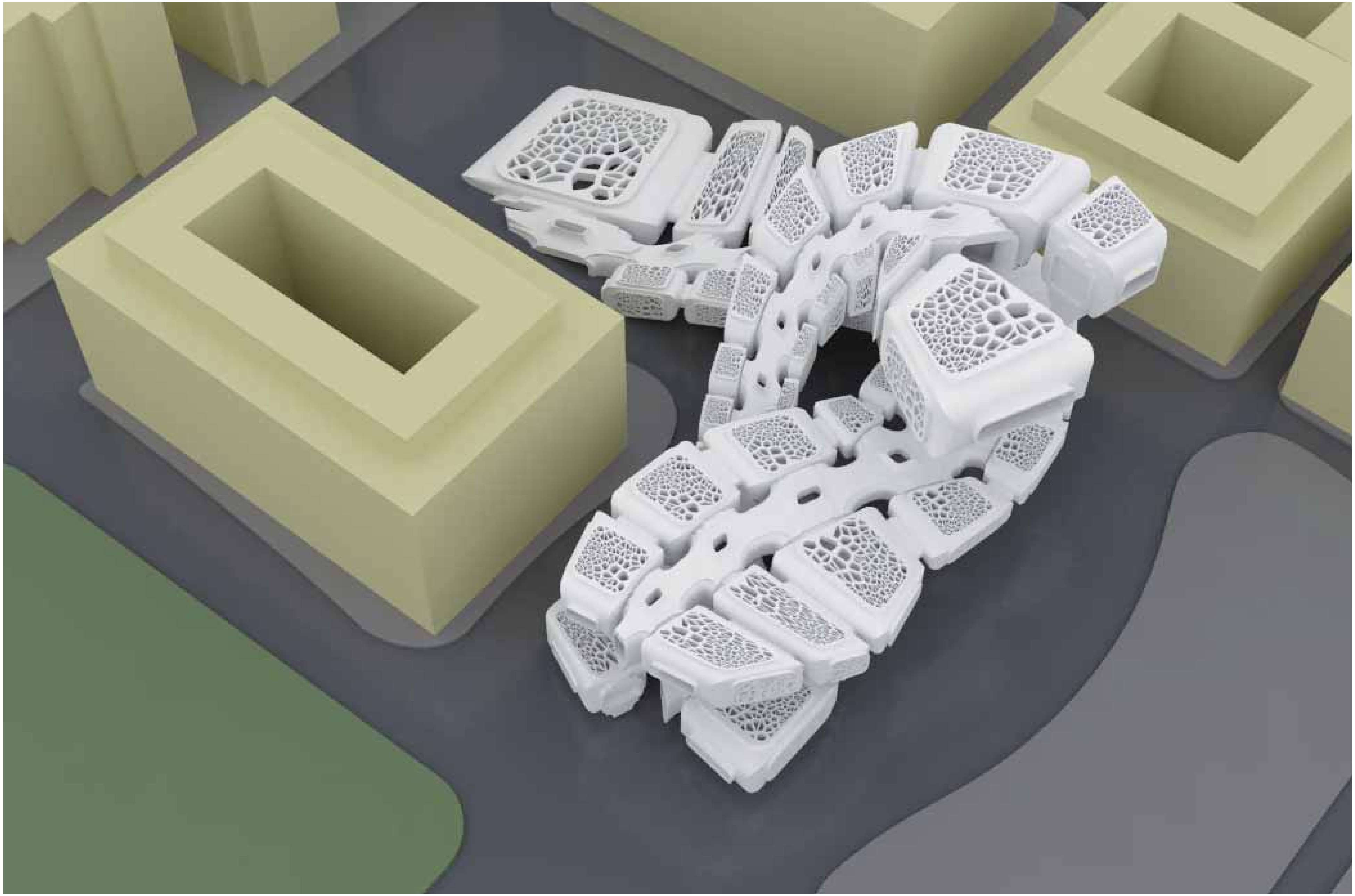
תוכנית גגות



חתכים







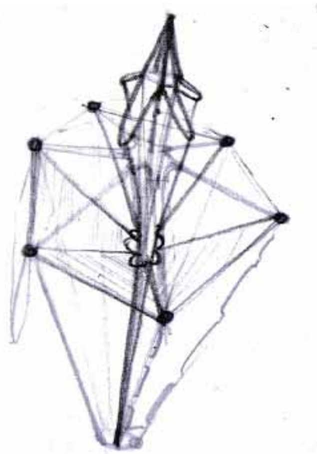
חזית תאית ביצועית :

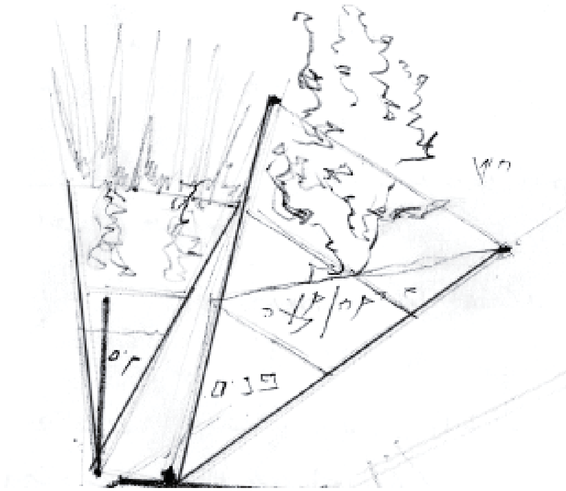
הרעיון לחזית העשויה יחידות אינדיבידואליות בעלות ביצועים תפקודיים כגון אגירת מי גשמים, שליטה על כמות התאורה או וויסות תרמי, הוגדר מתחילת הסטודיו כתרגיל .

הרצון היה לעצב מערכת שתורמת לבניין ולאיכות של חלליו מעצם צורתם הגיאומטרית של התאים.

הרעיון לחזית תאית הוא אותו הרעיון בדיוק של מבנה תאי אך בקנה מידה אחר ועל פני משטח מגנוס o (חסר חורים).

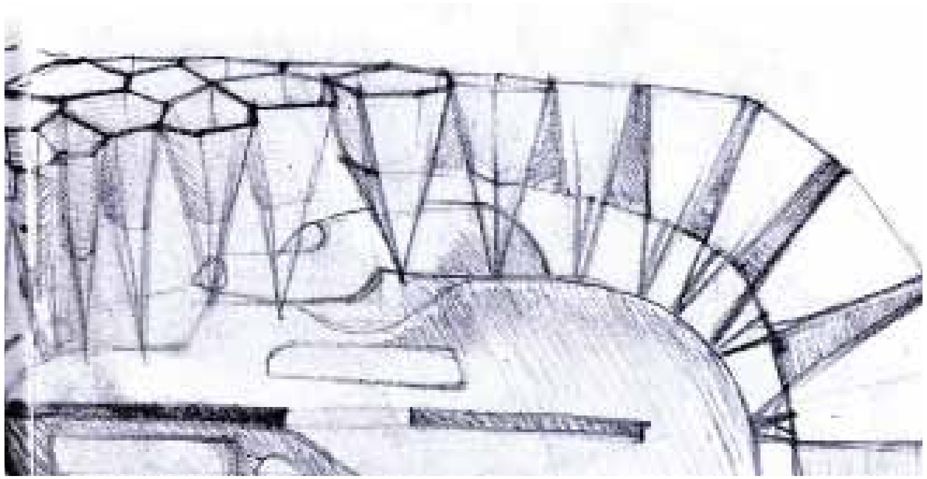
הסכמות בעמוד זה הן נסיונות לנסח את אותם תפקידים שתאים כאילו יכולים לקיים .





תא עם צמצם מבד
ביכולתו להצליל על הפתח ולבלום קרינה ישירה לחלל החדר. יריעה זאת ביכולתה גם לאסוף מי גשמים או לכלוא אוויר בגוף התא להסגת מסה טרמית .

סינון אור לפי זנית, בית גידול לצמחים וטורבינה למימוש פוטנציאל לחץ בין פנים לחוץ



דיאגרמת וורונוי כמערכת ריצוף חזית .

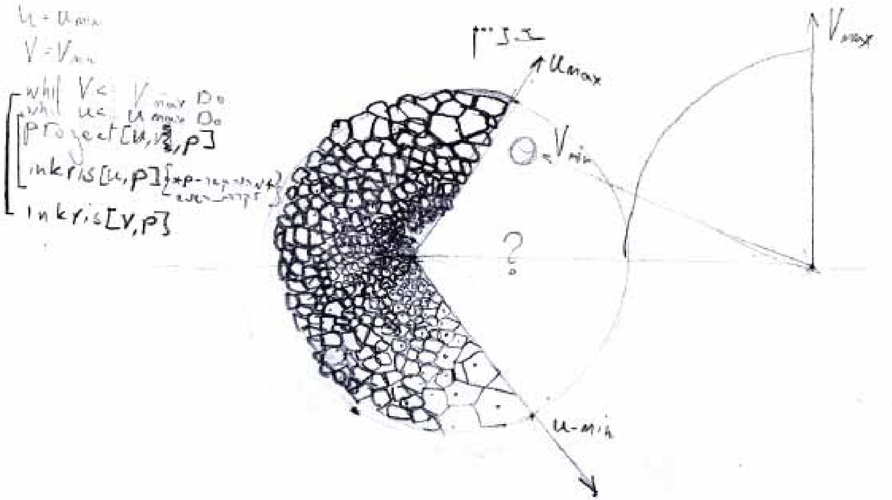
דיאגרמת וורונוי מבטאת מקום גיאומטרי שהוא הצטלבות הניצבים ממרכז המרחקים שבין אוסף נקודות על מישור .

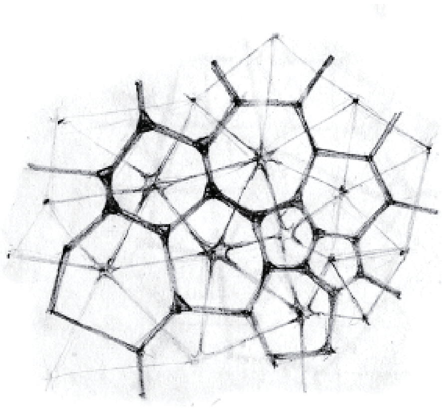
חלוקת המשטח החדשה מייצגת רגע שבו כל נקודה זוכה בטרטוריה "הוגנת" שכן, ביחס לנקודות השכנות, הגבול עובר תמיד באמצע (ממוצע גאומטרי).

מניפולציות וורונוי על אוסף נקודות שצפיפותו נשלטת, יכול לחולל ביצועי חזית שבה לכל תא הוגדר שטח ההולם את מטרתו .

כך למשל על משטח שהוא חצי ספרה ניתן להקרין אוסף נקודות שתומרן להיות צפוף יותר ויותר לכוון הקודקוד .

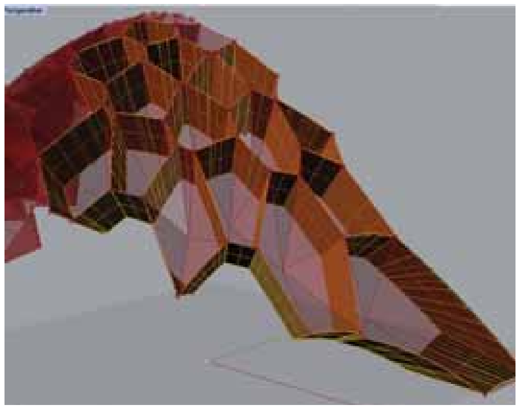
ביטויו של וורונוי על אוסף נקודות שכזה ,יוצר מערכת תאית ההולכת ומתמלאת בגבולות לכוון המרכז .





ככל שהתא ממוקם במקום גבוה יותר בכיפה הוא קטן יותר ולכן קיים יחס גדול יותר בין שטח הדופן ושטח פתח התא (לטובת שטח הדופן). כך כאשר השמש נמצאת בזנית גבוהה (בקיץ) האנרגיה מתרכזת בדפנות התא, בעוד שבזנית נמוכה (חורף) קיימת חדירה גדולה של אור וחום אל תוך פנים הבנין.

בנוסף פעולת המשיכה של גבולות התאים יכולה לאפשר הישג אדריכלי נשלט אחר- על ידי דירוג עובי הדופן כך שככול שהתא יותר גבוה הדופן יותר עבה, מושגת מסה מבודדת בחלק העליון של הספרה, וכן ביצועים קונסטרוקטיבים תואמי מומנט.



רקמה יוצרת וביטויים חלקיים של קוד גנטי שלם

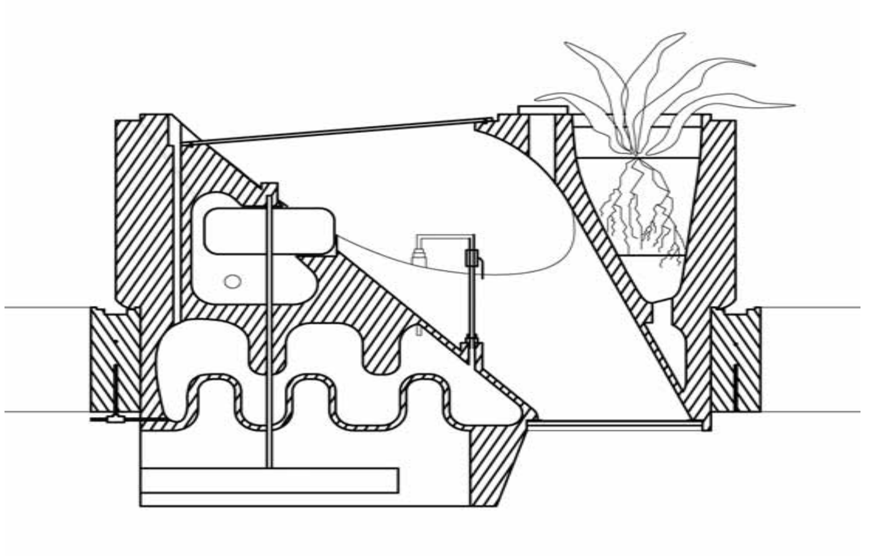
בטבע תאים מתחלקים, מתרבים ומתמיינים כתולדה של תנאי הסביבה והקוד הגנטי שלהם .

למרות שלכל התאים מידה גנטי זהה, כל קבוצת תאים מתמחה בביצוע פרטני הנובע מתפקיד הרקמה שלה הם שיכים .

תאי גזע מהווים חלקיק האחוז ברקמה החיה ויחודם הוא שביחולתם להתמיין ולבטא על בסיס מיוזה כל תא אחר בגוף.

למשל תאים עוברים של גוף האדם, תחת השפעות ספציפיות, יכולים להתמיין לתאי עצב ,שריר או עור.

תא המעטפת המתואר מטה הוא תא גזע המכיל פוטנציאל למספר תפקודים. ביכולתו להשפיע על הוויסות הטרמי של החלל שמתחתו, ובנוסף הוא מאפשר הכלה של של גן על הגג .

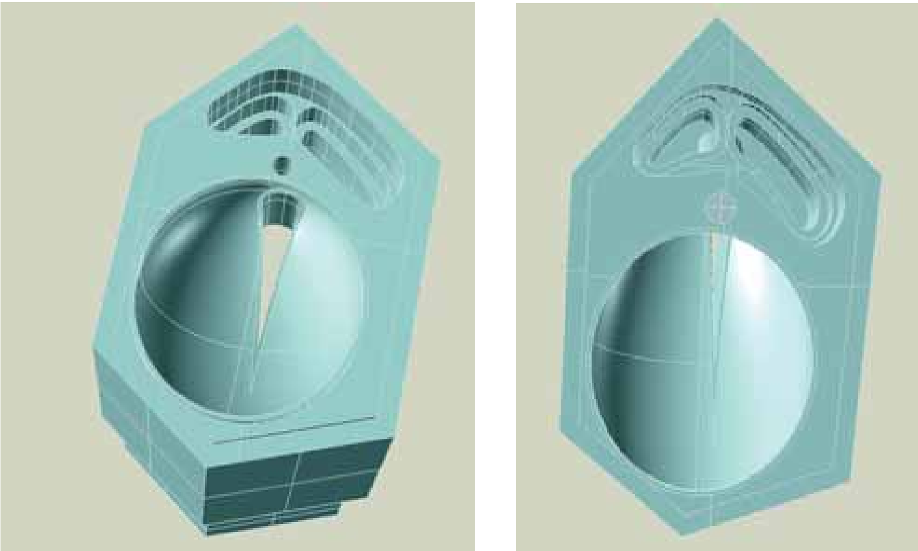


בתא ארבע אברונים עיקריים :מלכודת חום, מחליף חום, צמצם תאורה ובית גידול לצמחים.

פעולת החיבור בין הרובד של המעטפת לרובד של היחידות הפרוגרמטיות, מתבצע כמעיין שתלים המתיישבים לתוך חורים בדופן היחידה.

רמת קשר רופפת זאת מאפשרת תכנון תחזוקה ותפעול שהם מנותקים מרבדים האחרים של היחידות הפרוגרמטיות .

צנרת המים שעוברת דרך הקונסטרוקציה של התאים ברמת הפרוגרמה,היא מערכת הובלה המסוגלת לסחרר מים בין היחידות לבטן האדמה ובכך לצנן את חללי הבניין במחלפי החום המצויים בתאים.



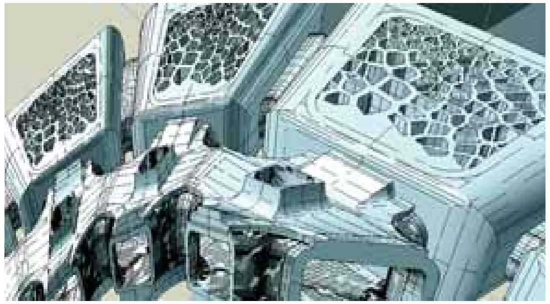
בהדמיות ניתן לראות את התא מלמעלה בזוית חורפית (אוקטובר, שמאל),ובזווית קיצית (יוני, ימין) .
פתח התאורה המצוי במרכז התא מאפשר למרבית האור להכנס בזנית נמוכה ,בעוד שבימי הקייץ בהם הזנית גבוה רק חלק קטן מהאור חודר למבנה .

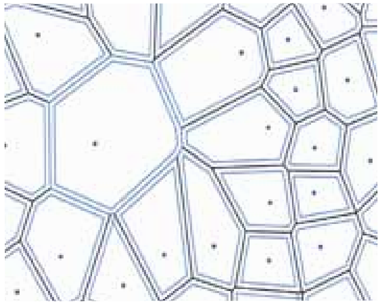
התמיינות תא הגזע על פי מיקום

הפרופורציה של גוף מכתיבה לו תכונה תאית בסיסית: היחס שבין נפח התא ושטח הפנים שלו. יחס זה מעיד על מהירות השוואת פוטנציאלים עם הסביבה, הן של מומסים והן של אנרגיה.

חלוקת המשטח ליחידות על פי דיאגרמת וורונוי, מאפשרת לכל אחד מהתיפקודים של תא הגזע לבוא לידי ביטוי עם פרופורציה ראויה להתמחותו של התא.
כך בתאים המתמחים באיסוף אנרגית שמש, על ידי המרתם לחום במשטח שחור, דרושה פרופורציה שטוחה שבה עיקר הפעילות הוא על שטח הפנים הפונה מעלה ודרומה.
בתא שכזה מתנוונים התפקודים האחרים הדורשים נפח .
ציפוף הנקודות לאיכלוס הוורונוי מגדיל אף הוא את שטח הפנים שכן משטח ההמרה של אור לחום הוא קעור.

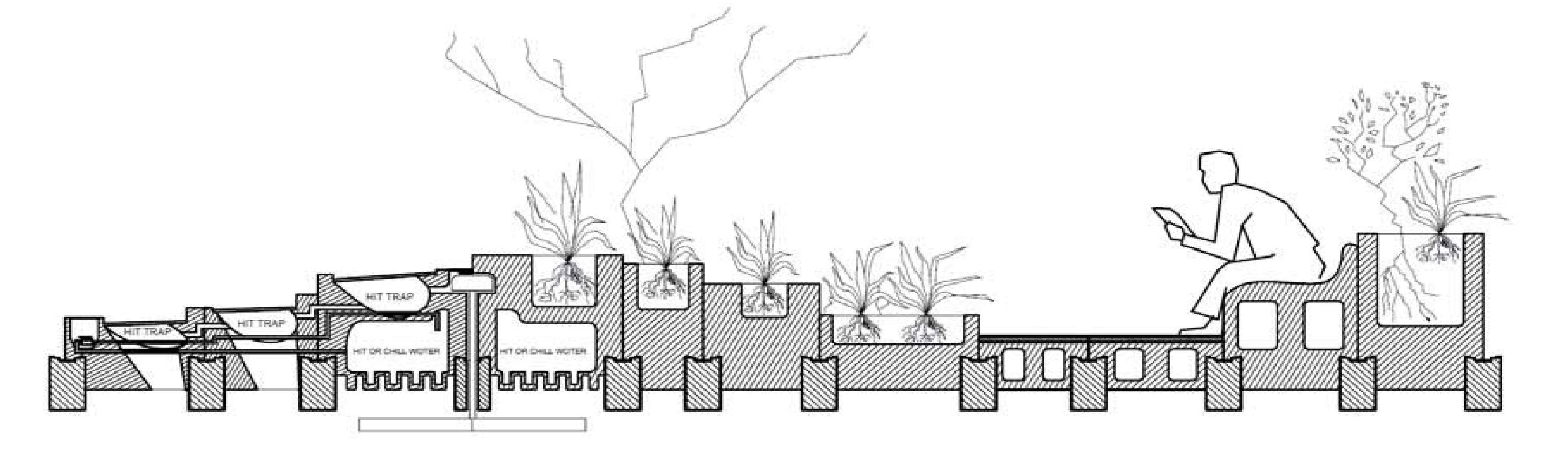
להבדיל מזאת בתא המתמחה באגירת החום, דרוש נפח גדול ושטח פנים קטן ככל הניתן. זאת כדי לצמצם את אובדן החום בהולכה.





הנקודות שאוכלסו לוורונוי במרכז החתך הן מרווחות והן מבטיחות יחס נפח שטח גדול בהרבה משל תא בעל פרופורציה זהה אך קטן יותר, שכן נפחים גדלים בשלישית ואלו שטחים בשניה.
שימוש באכלוס תאים עם דיאגרמת וורונוי הוא מספיק גמיש וסתגלן כדי להכיל בתוכו גם ביטויים אדריכליים פונקציונלים .

פעולת המשיכה של משטחי הוורונוי משתתפת גם היא בהשפעה על פרופורציות התא. על ידי משיכתם לגבהים מדורגים, ניתן לשפר את תפקודם .
כמו כן הפעולה מתבצעת ברמת הרקמה והיא מייצרת השפעות בין תאיות. כך התאים הצומחים מדרום (צד שמאל של החתך) אינם מצילים אחד על השני ואילו התאים המשטתחים צפונה הופכים בסוף התהליך למשטח הליכה ושהייה.



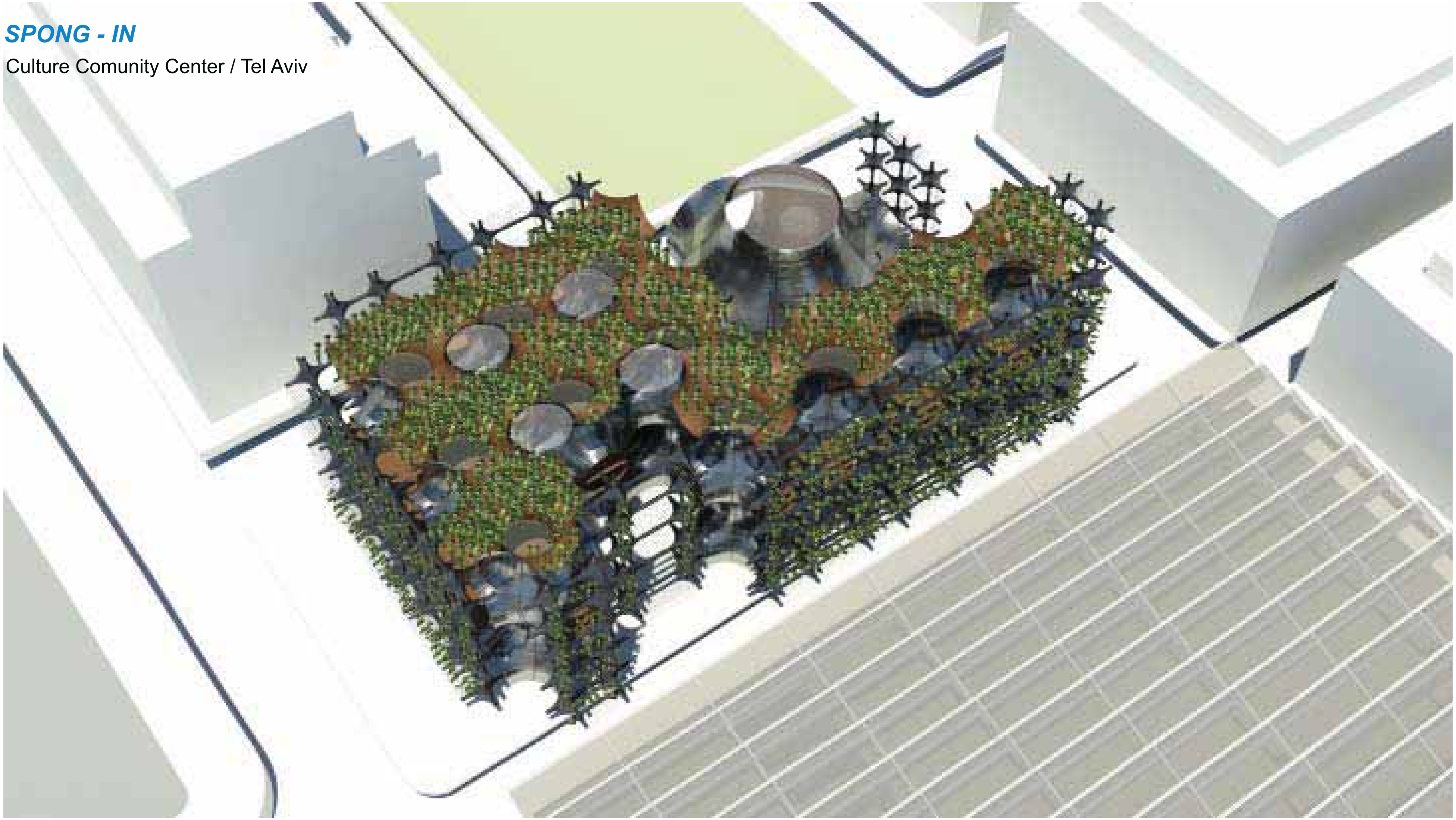
מקבץ התאים, כברקמה החיה, שוזר בתוכו מגוון תפקודים בשתי רמות קנה מידה:

קנה מידה אחד פועל ברמת המיקרו בכל תא. הוא מכיל תפקודים שהם תולדה של תכונות מקומיות פרופורציות התא ומוטיבצית התא על פי מיקומו בשטח.

תיפקודים המתקיימים ברמת הקשר הביין תאי, שהוא קנה מידה השני- האנושי, מסוגלים להכיל פתרונות מורכבים יותר מברמת האוטונומיה התאית. כגון וויסות טרמי של החלל התחתון, קיום מערכת אקולוגית של צמחים על גג המבנה, ועיצוב סביבה אדריכלית .

SPONG - IN

Culture Comunity Center / Tel Aviv



Introduction

While planning the building i have been inspired by sea sponge. The way it built, its function and especialy its role in the water.
First, i have tried to imitate the basic sponge cell but then i have desided to take the sponge quality and to conclude it on the cell character.
The initial idea was that the cell will collect rain water by its external arm and will pass it through several sells and by that will cool or heat the spaces between the cells. Its arm was not at the right shape or angle inorder to do it, so the decision was that half cell at the roof will collect the rain water.
Another parameter that i have wanted my cell to shaped by to filter the sun light which enters the inner spaces.
After determing the origin cell i have checked another three cells which arrived from the origin. I took the same cube grid and started to blow it up and to shrink it. These check came in order to obtain several cells which i can work with.

Planning the facade right after the cell design was mainly the connection of the cells to each other. At the facade, the cell became one unit of a system. By populating the different cells at the facade, i could have choose wisely for the different direction facades.
While planning the facade it has allways influenced on the thoughts of the building, because of the cell "arms" which are incomplete and has junction shape.

Planning the building has been influenced by the area itself. The field situated in Tel Aviv, near the Carmel market. The program have been determined by the functions around. there are many schools around and the big market. the field is on Daniel st. which leads directly to the beach.

The program is: culture comunity center which will include Gallery, commercial and theatre at the ground floor and library plus classes at the upper floors. the functions will be used specialy by the school students around the building and Tel Aviv residents in generaly.

For designing the building i have chosen two kinds of cells. one for the internal buildind and the other for the facade.
The two systems are connected to each other by balconies. The floor get out to the external cell and closed by glass wall which are connected to the facade.

The role of the internal cells is to ventilate the building and be used for the functions of the building.
The role of the external cells of the facade is to be the water system of the buildung.

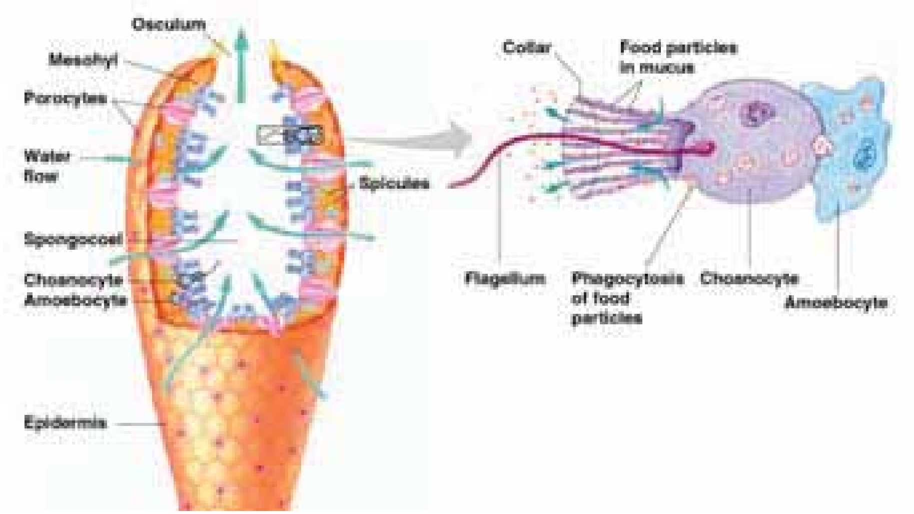
INITIAL INSPIRATION

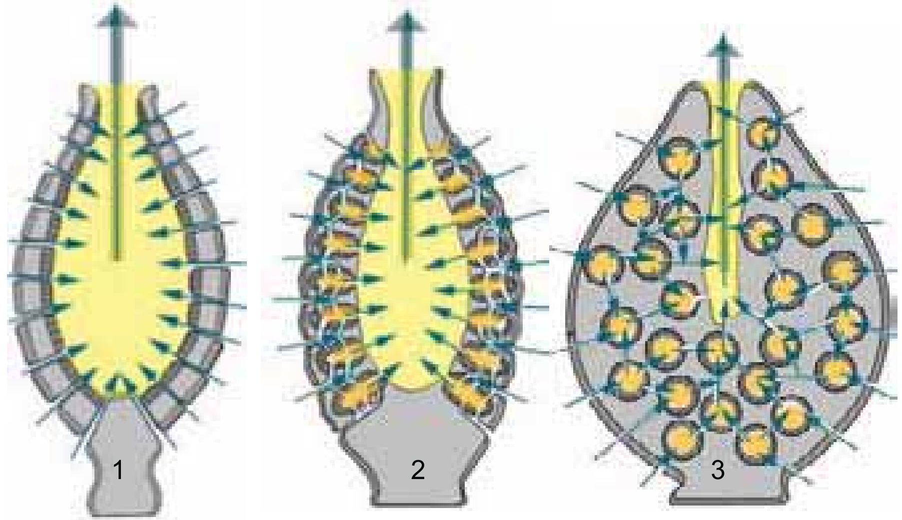
Sponges are colorful component of many seascapes. Although their similary to plants, they are animals of the phylum porifera. They are multicellular organism and have a body full of pores and cannals which water circulated through them.

1. http://www.google.co.il/imgres?um=1&hl=iw&tbm=isch&tbnid=hk5-

2. Europe, O., 2005. EUO © OCEANA Houssine Kaddachi, Available at: http://www.flickr.com/photos/oceanaeurope/6393809915/ [Accessed March 23, 2012].

Sponges have a unique system for filter feeding. the separation of the food from the water is by passing them through a mesh which strains out the food. The body wall consists of two layers of thick cells, interior and exterior, and between them- the construction of the sponge. There are 3 kinds of sponges.





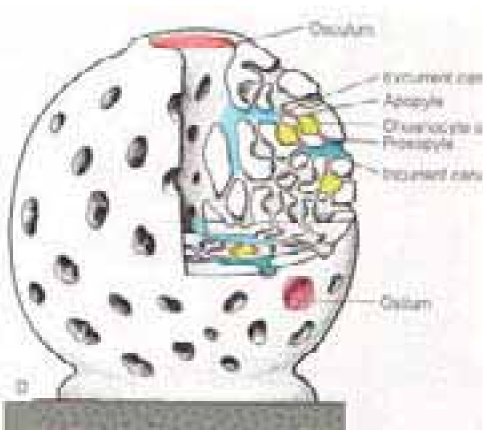
The flagellum in the collar creates a unidirectional water flaw which enterns through little pores (ostium) to the atrium and going out through a larger open-ning at the upper.

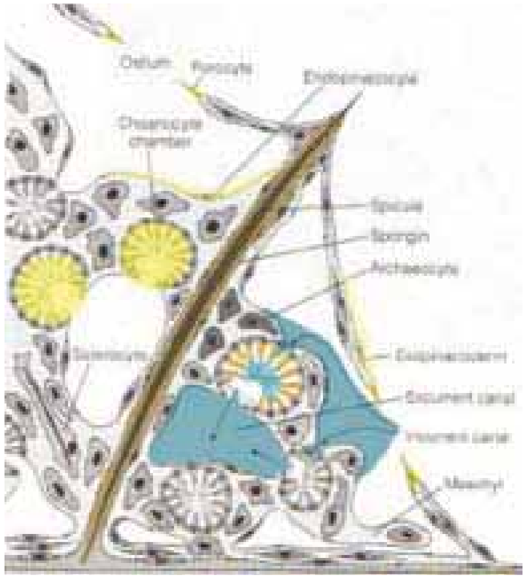
Water enterns through surface pores into interior cannals to inner rooms and then through back cannal to the atrium on its way out through the “osculum”

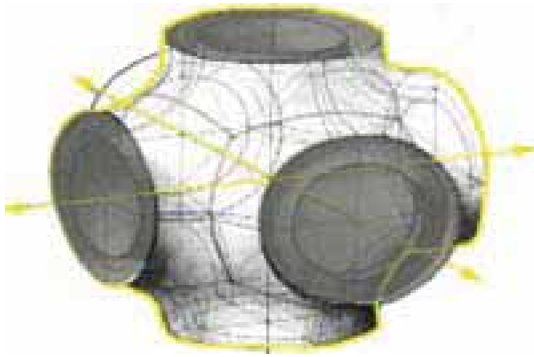
Sara, 2009. Standup Architecture - SuA: Basic structure.........................Form and function. Standup Architecture - SuA. Available at: http://sara-standuparchitecture.blogspot.com/2009/02/basic-structureform-and-function.html [Accessed March 23, 2012].

INITIAL INSPIRATION

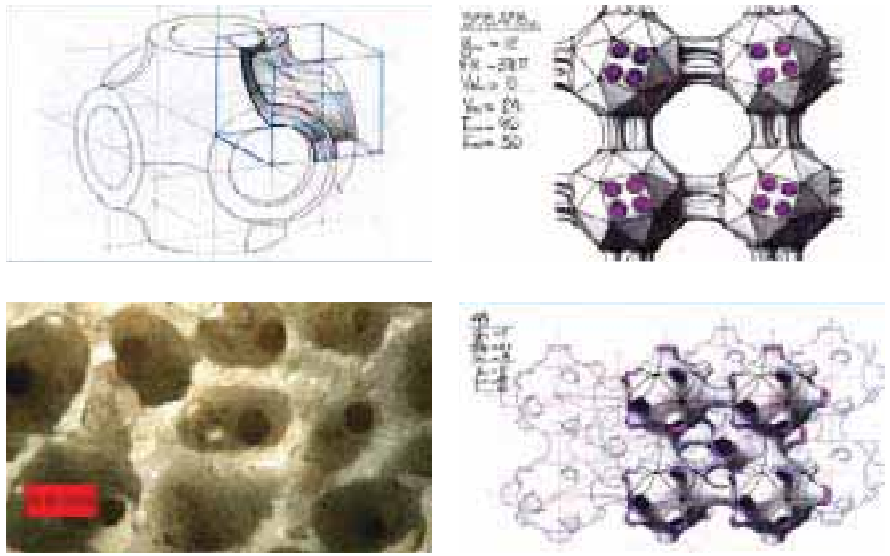
The third kind of sponge is the most efficient sponge.







The internal “room” inside the sponge can be related to junction with paths which lead to it. Several junctions are conected by those paths.

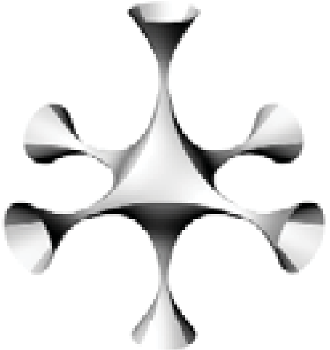


1.Ruppert, E.E., 2004. Invertebrate Zoology: A Functional Evolutionary Approach 7th ed., Australia: Thomson/Brooks/Cole.

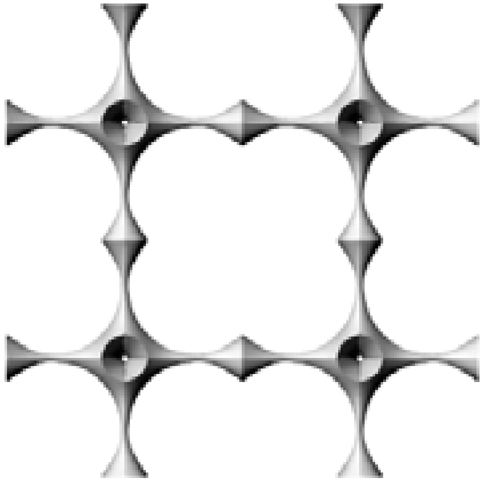
Translation unit of periodic hyperbolic sponge, Michael Burt

Cell Kinds

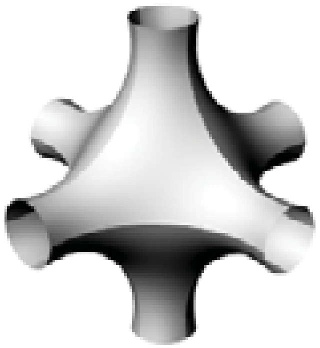
Inspired by the Sea Sponge, i have looked for the best geometry which will give me the ideal space and climate requirements.
I have made cube grid of 9/9 meter which all kind of cells builded in. All cell kinds is made as a junction where systems or functions meet.
every cell has its “arms”- The Units Connection.



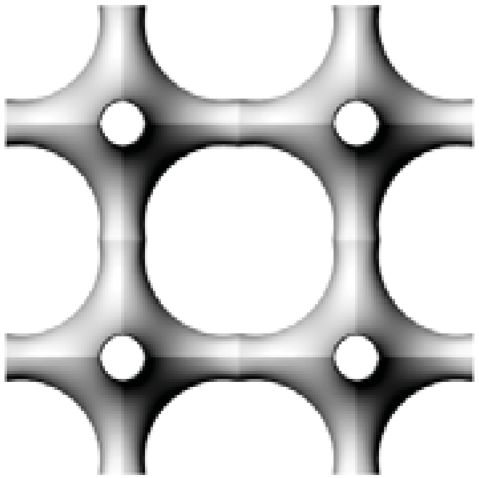
The minimum valium. Assembling four cells ENLARGE the quantity of sun light at the inner spaces.

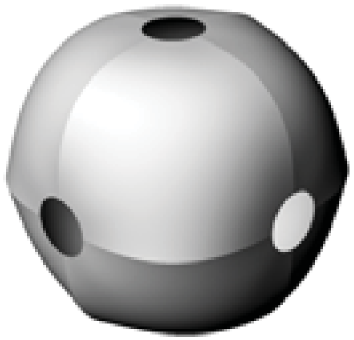


Connecting the edges of the grid. This kind of cell can function as theaters or music classes

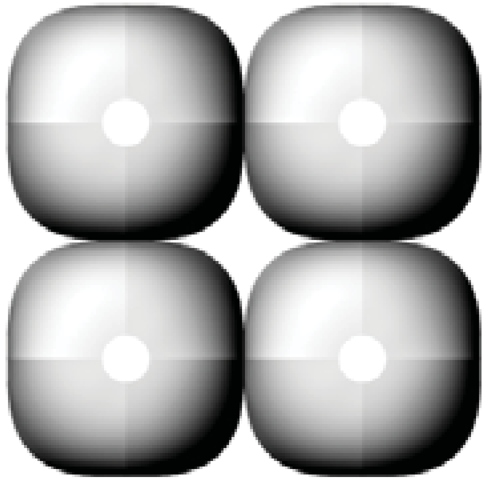


Assembling four cells can connect movement, air and water systems.

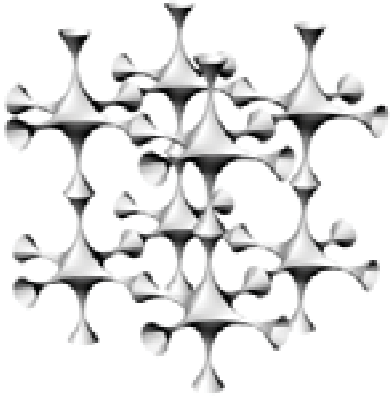
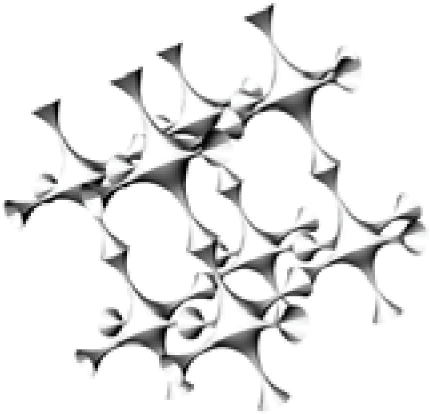
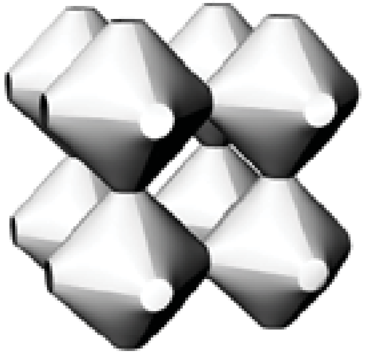
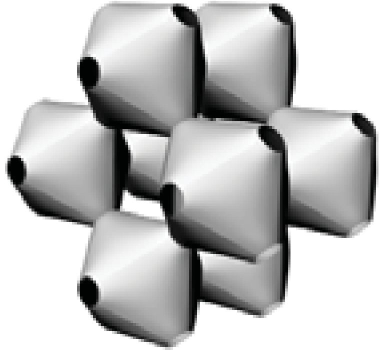
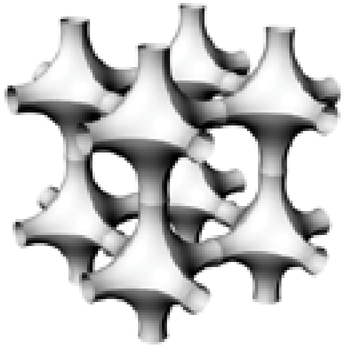
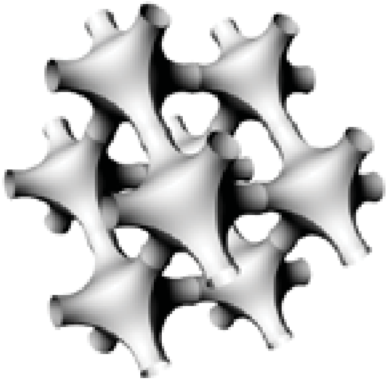
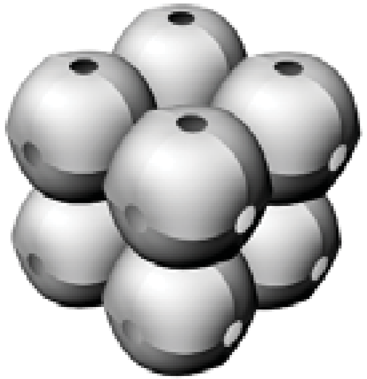
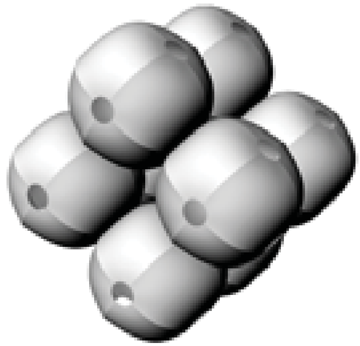




This cell can function as the space itself. Assembling four cells REDUCE the quantity of sun light at the inner spaces.



Which Space Can I Get Between The Cells?

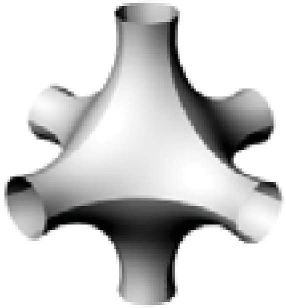
The facade

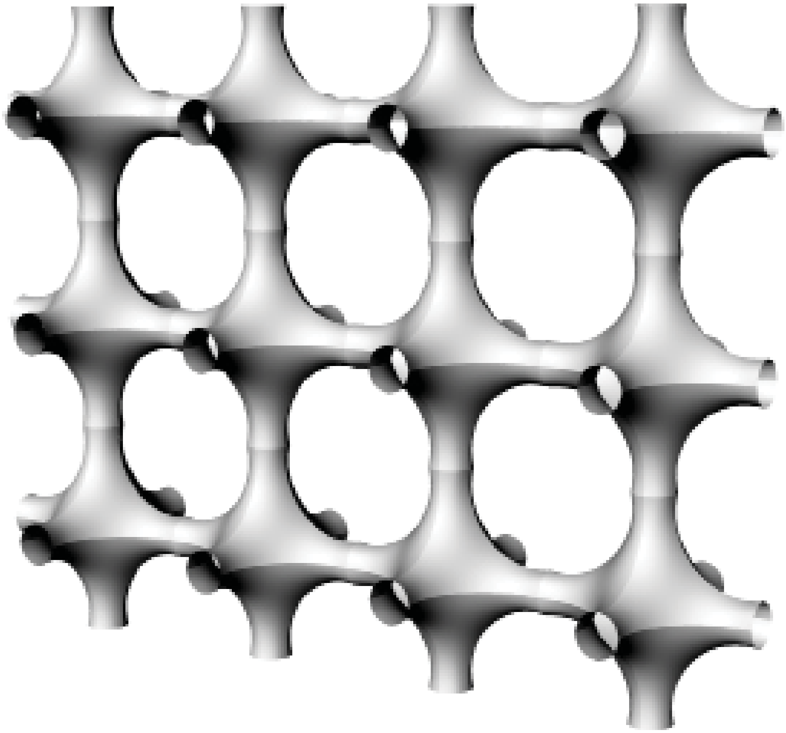
How do i imitate the sponge act of filtering?

The uniqueness of the cell is the ability to connect to other cells at the sides of it.

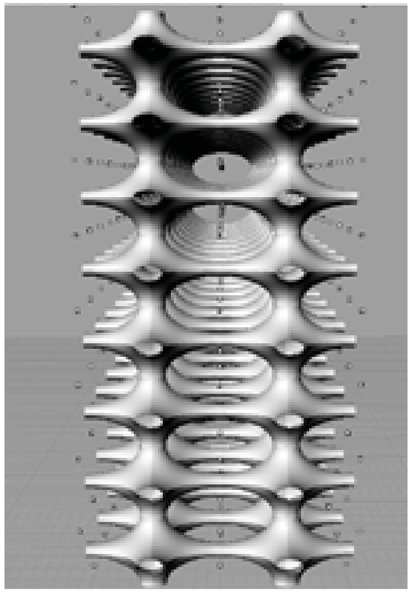
The cell is a connector between the interior and the exterior by passing air and sunlight through it and accumulate water in it.

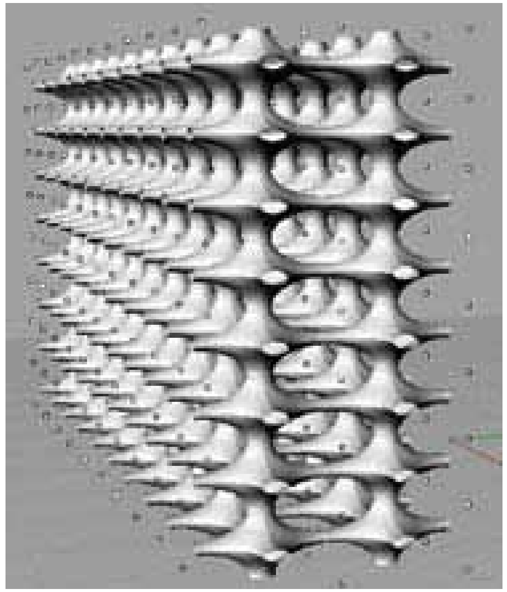
one can look on it like something that can puff up or shrink.





Two layers of the cells create another ingredient at the system- space. By that, the multiple facade can be the structure itself.

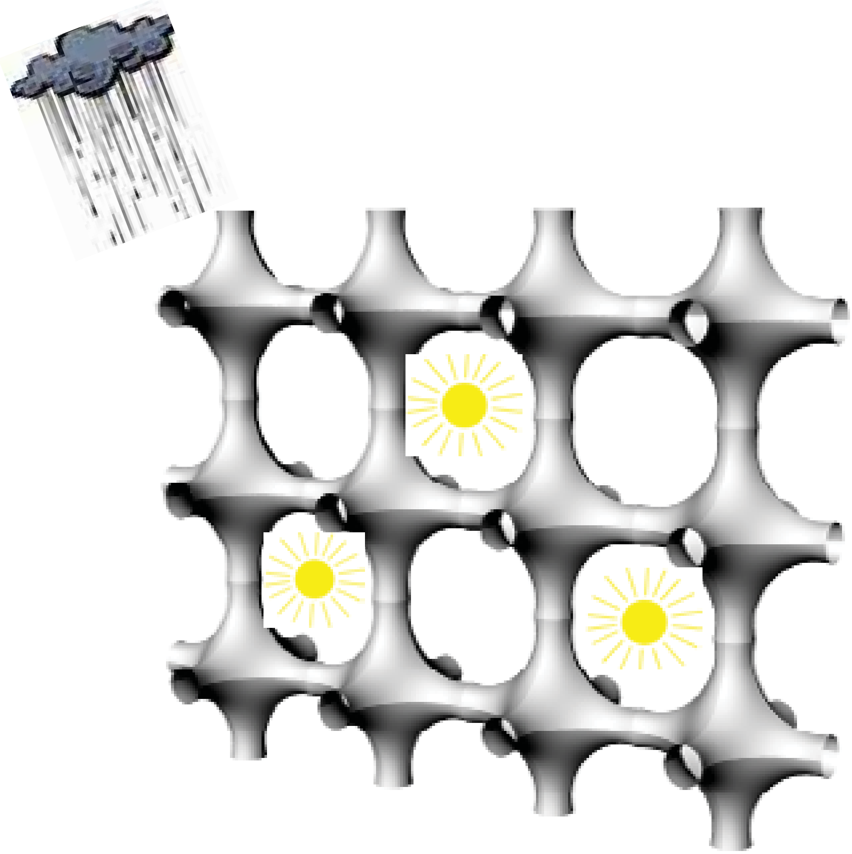


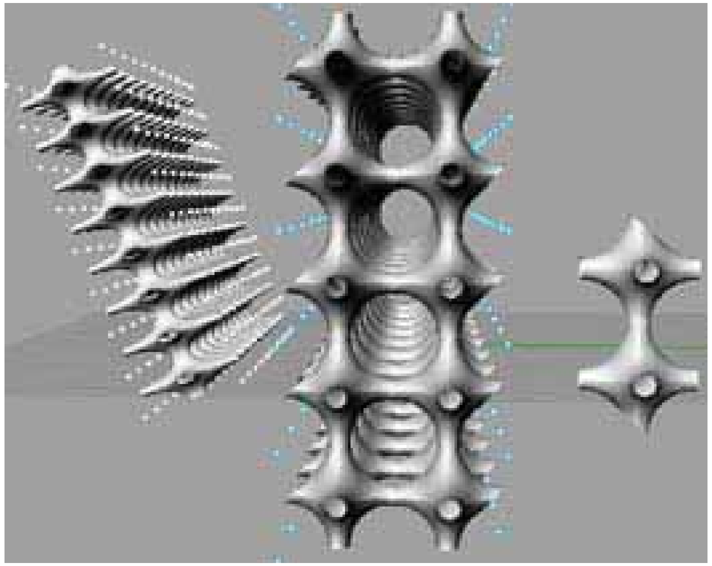


INSIDE-OUT

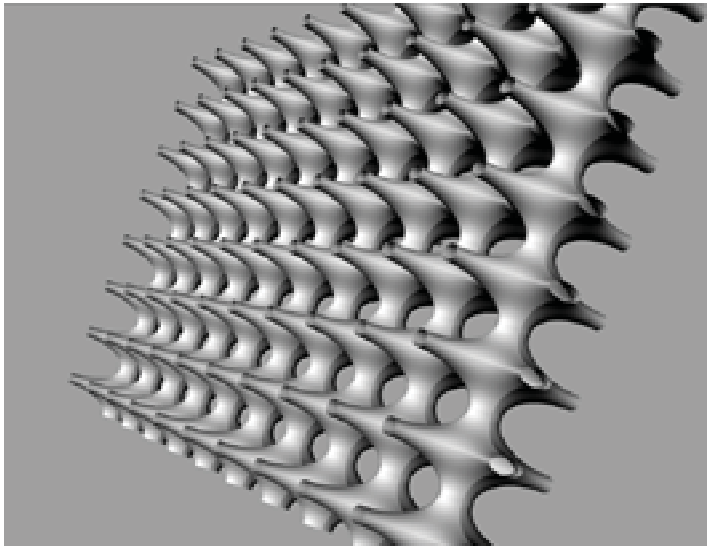
What I Want My Cell To Do?

One of its roles is to “capture” the rain water. inorder to be usefull, fasade bending is needed.
Assembling the cells creat sunlight opennings.



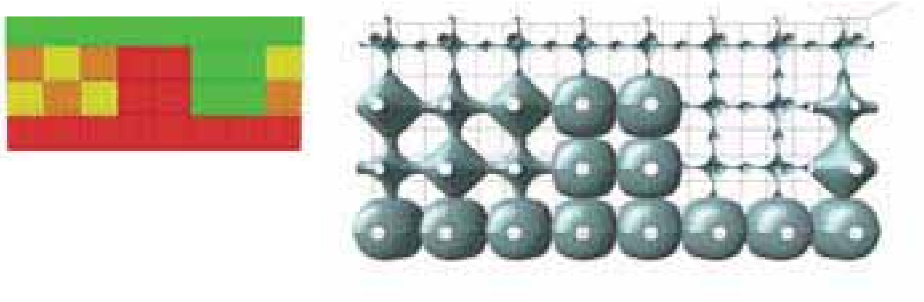


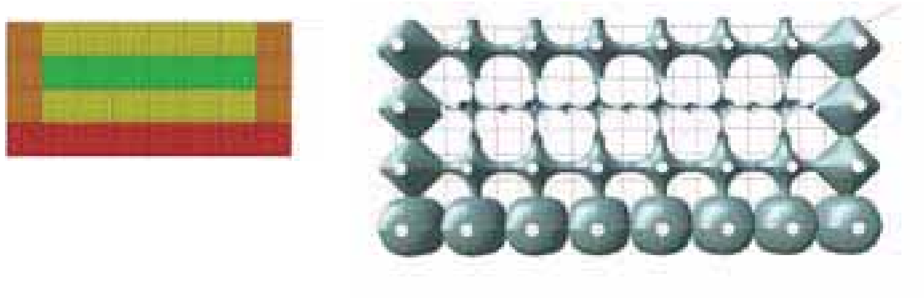
bending the cell edges

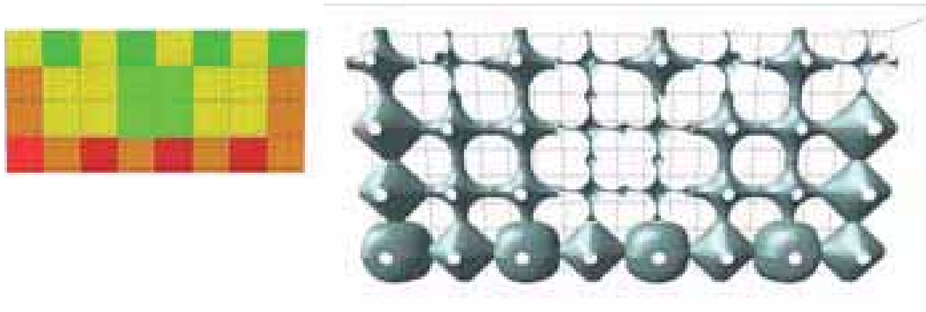


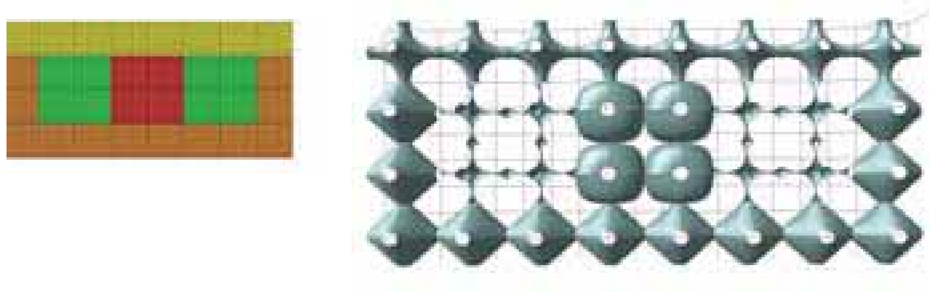
bending the facade itself.

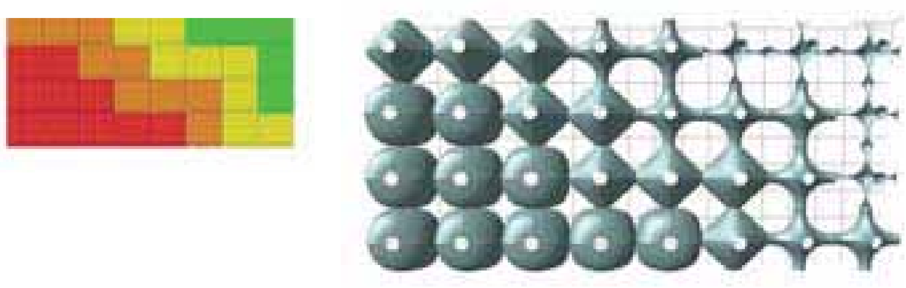
Which Space Can I Get While Planning By The Sun?











Water - Israel, Tel Aviv

מי גשמים

עונת הגשמים באזורנו נמשכת כחצי שנה, מאוקטובר עד אפריל. מסת הגשם העיקרית, כ - 75%, יורדת במשך שלושה חודשים - דצמבר, ינואר ופברואר. יתרת הגשמים, כ- 25%, יורדת בתחילת העונה ובסופה
המשקעים לאורך עונת הגשמים שונה בין אזור החוף לפנים הארץ: בממוצע, כ-50% מכמויות המשקעים מצטברות באזור החוף עד ל-31 לדצמבר.
מספר ימי הגשם נע בין כ- 60-70 בצפון הארץ, ל-40-60 במרכזה
כמו מספר ימי הגשם, גם כמויות הגשמים השנתיות הממוצעות פוחתות מצפון לדרום כאשר בגליל העליון ובצפון רמת הגולן יורדים כ- 800-900 מ"מ בשנה ממוצעת, במרכז הארץ כ- 500-600 מ"מ ובאזור אילת רק כ- 25 מ"מ בשנה. כמות הגשם פוחתת גם ממערב למזרח. במישור החוף יורדים כ - 600 מ"מ בשנה ממוצעת ובבקעת הירדן רק כ- 100 מ"מ בשנה

<u>בדיקת כמויות</u>
ממוצע גשמים בתל אביב- 550 מ"מ בשנה = 0.55
גודל הגג: 25mX65m = 1625m2
1625mX0.55m = 893m3

מחזור מי מזגנים

מי מזגנים ידועים באיכותם המעולה. מים אלו ניתנים לאגירה ומשם להפנייתם לשימושים נוספים. מי מזגנים הם מים חסרי מינרלים ולכן בבואנו להשקות גינות עם מים אלו עלינו להוסיף דישון לגינה.
בממוצע, במישור החוף בחודשי הקיץ יכול לייצר ב 10 שעות עבודה בין 30-50 ליטרים מידי יום.
<u>בבנייני משרדים</u> ובמקומות בהם יש יותר ממזגן אחד או שפועלים שעות רבות במהלך חודשי הקיץ, כמות המים היומית יכולה להסתכם במאות ליטרים ולהגיע לעשרות אלפי ליטרים במגדלי משרדים וכדומה.
שלהי קיץ 2009 כשעומס חום כבד ולחות מעיקה ירדו על גוש דן מחד והפרסומות בטלביזיה על המחסור במים הדהדו בראשו מאידך החליט מנהל ייצור בבית דפוס גדול לקחת את העניינים לידיים. הוא בדק ומצא כי בבית הדפוס מערכת מיזוג מרכזית המייצרת ביום קיץ לח כ 1000 ליטר מי עיבוי בשעה. אם ימחזר את מי המזגנים בית הדפוס אמור לחסוך כ 4000 קוב בשנה חסכון שיוביל גם לחסכון כספי של מעל 20,000 ₪ בשנה.

<u>חשיבות אגירת המים ומיחזורם בפרויקט שלי:</u>

עיכוב מי גשמים מהגעה ישירה לניקוז עירוני
אגירת מי הגשמים ומחזור מים אפורים לצורך שימוש המבנה - השקיית צמחייה, קירור וחימום המבנה
שימוש במי מזגנים

התפלת מים

התפלת מים נעשית על ידי הפרדה בין המים למלחים המומסים בהם. מטרת ההתפלה היא הפחתת כמות המלחים במים
<u>ישנן שתי שיטות עיקריות להתפלת מים</u>:
<u>תהליכי אידוי</u> – המים מתאדים בהדרגה תוך מעבר בין מספר תאים בהם רמת הטמפרטורה והלחץ הולכים ויורדים. בכל אחד מהתאים מתאדה כמות מסוימת של מים ואילו המלחים נותרים במים שלא מתאדים - אדי המים עוברים תהליך עיבוי בו נאספות טיפות המים שהן למעשה המים המותפלים
(טכנולוגיה וותיקה יותר)

<u>תהליכי ממברנות</u> – הידוע והנפוץ בתהליכים אלו הוא האוסמוזה ההפוכה. בתהליך זה מעבירים את המים המלוחים, בלחץ גבוה מאד, דרך ממברנות המאפשרות מעבר מים בלבד ומונעות מעבר מלחים. המים שעוברים דרך הממברנות הם מים מותפלים, ואילו המים שנשארים בתמיסה הם רכז המוזרם חזרה לים.
(טכנולוגיה חדשנית יותר)

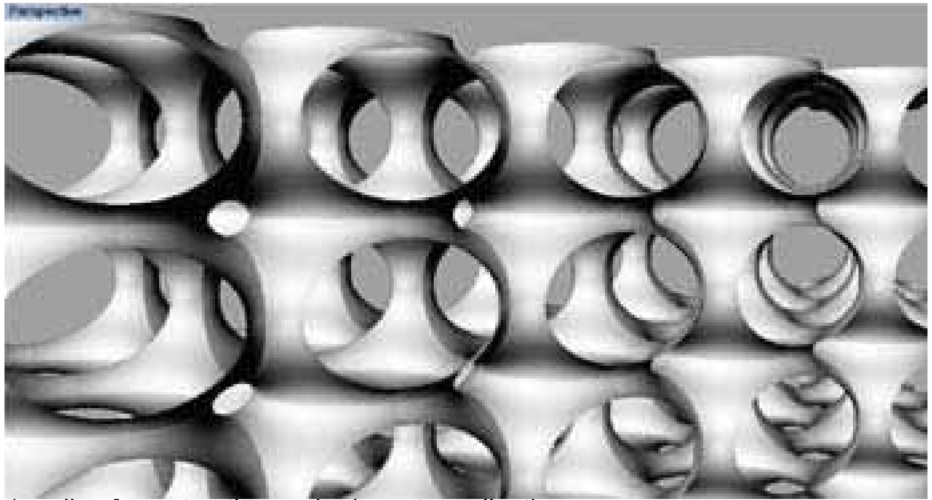
<u>סיבות עיקריות להתפלה</u>:
<u>פתרון למחסור במים</u> – אפשרות למלא את המחסור הקיים והצפוי בעתיד של מים שפירים ע"י הפקת מים איכותיים, במחירים סבירים, ממאגר מים בלתי נדלה - הים.

<u>איכות המים</u> – תהליך ההתפלה מביא לשיפור באיכות המים בבית וכתוצאה מכך גם בקולחים המשמשים להשקיית החקלאות ובמי התהום. המים המותפלים תורמים גם להפחתת האבנית במים.

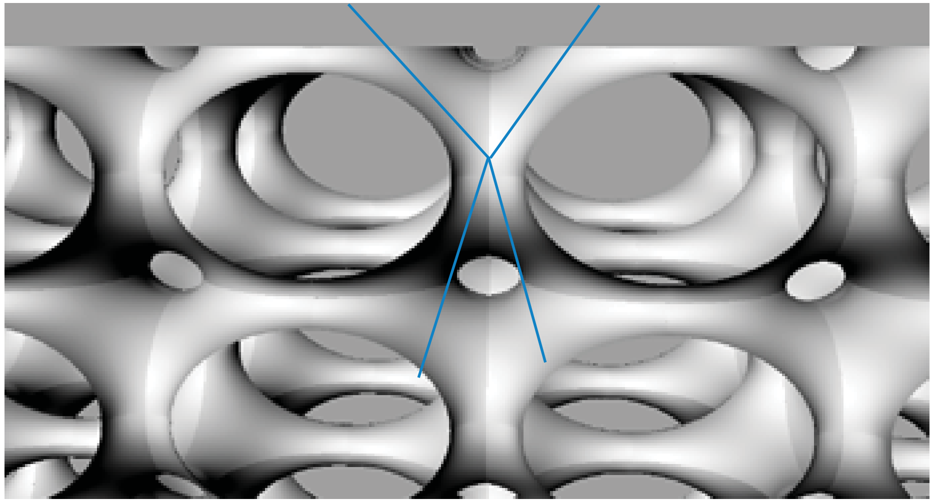
<u>יתרון כלכלי</u> – הודות לשיפורים הטכנולוגיים ולתחרותיות בשוק, עלויות ההתפלה הולכות ופוחתות והייצור משתפר ומתייעל. מים מותפלים אמנם יקרים יותר ממים שפירים טבעיים, אך העלות הנוספת היא כאין וכאפס לעומת הנזק הכלכלי של ייבוש שטחי החקלאות והגנים או הרס מקורות המים הטבעיים שלנו.
עלות התפלת 1 מ"ק מים עומדת על כ - 2.0-3.0 ₪ למ"ק, ואילו הנזקים הנגרמים עקב מחסור במים מוערכים בכ-8 ₪ לכל מ"ק שאינו מספק לחקלאות. הנזקים גדולים בהרבה כאשר מדובר בשימוש עירוני.

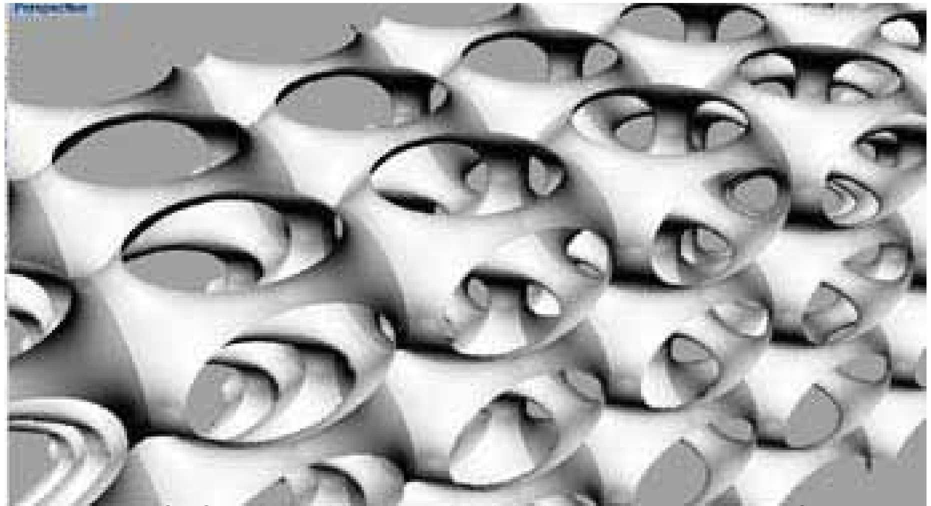
www.water.gov.il

How do i collect and reuse water

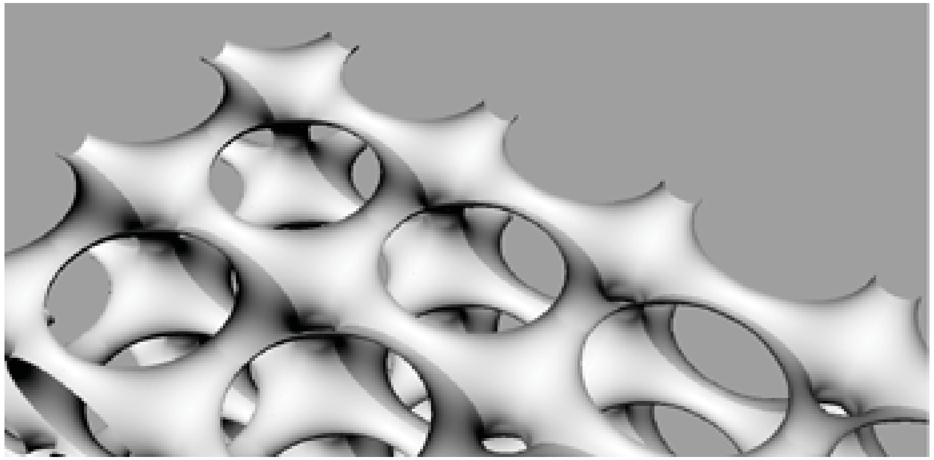


1. cells of construction and rain-water collecting





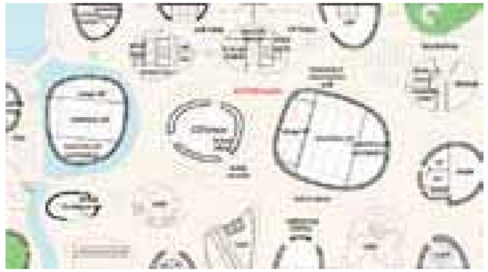
2. inner cells for function, which gets the light by the arrangement of



Half cell for collecting rain-water

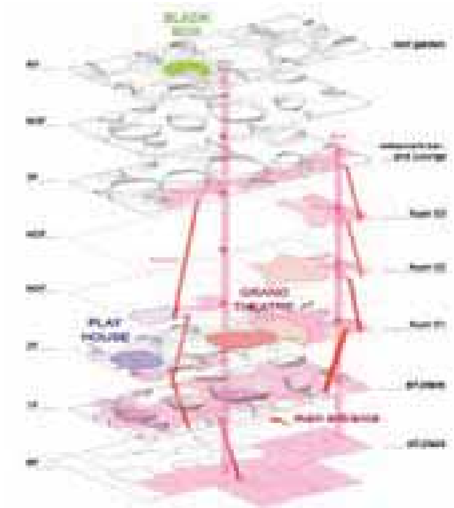
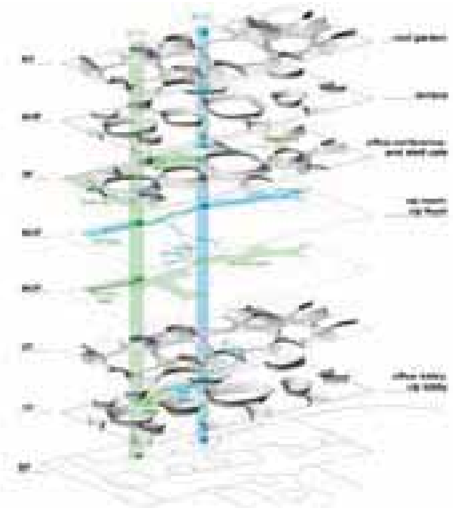
The building
aichung Metropolitan Opera / Toyo Ito



The main structure formed with several conecting curved walls, inlaid floors, inlaid interior and exterior walls and a core service wall. The curved wall structure formed with 58 curved wall units, creating many complications in building steel bar reinforcements and steel trusses. The construction technique is the first of its kind in architecture world and in Taiwan engineering industry.

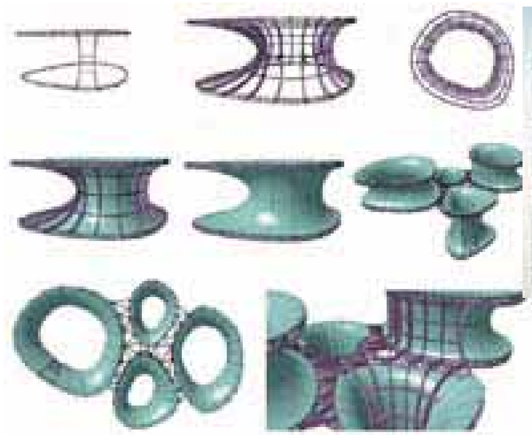
'we are making the impossible possible'.

http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html

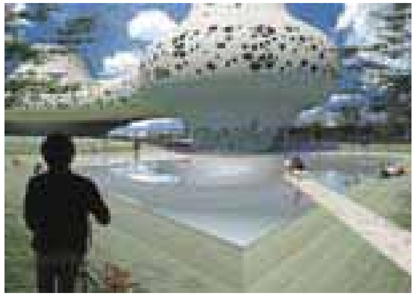
Taichung Metropolitan Opera / Toyo Ito

Variable spaces at the defferent side of the cell. The cells devided into floors



http://www.designboom.com/weblog/cat/9/view/9561/toyo-ito-taichung-metropolitan-opera.html
http://minushabensblog.blogspot.com/2010/09/toyo-ito-wins-praemium-imperiale.html

Guangzh Culture Center In China / Shuhei Endo



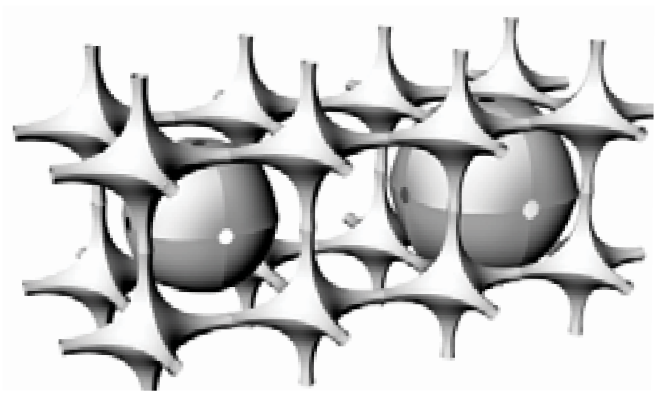
Relation to its enviroment - Two cells which contain functions and create external space and a passage below.

Every cell functioned as a unit which devided to several spaces.

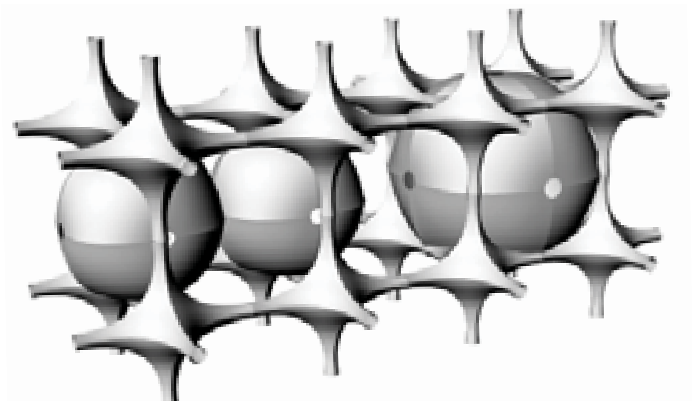
www.archdaily.com

Working with the two extrim cells for the building

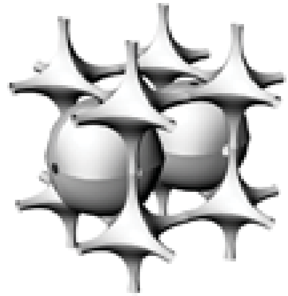
The buildind made of two systems. the external is the “nutritive” system: it functions as the construction and contains the water system of the building.



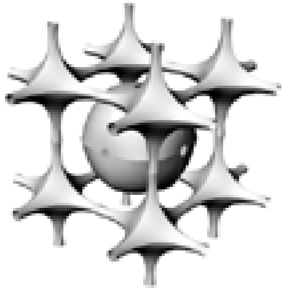
The internal system is beeing supplied by the other one. it contains the function space and air enterns throuth little pores of it to the building.



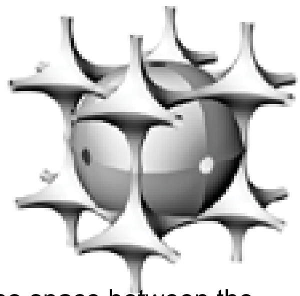
Options of reciprocal relations



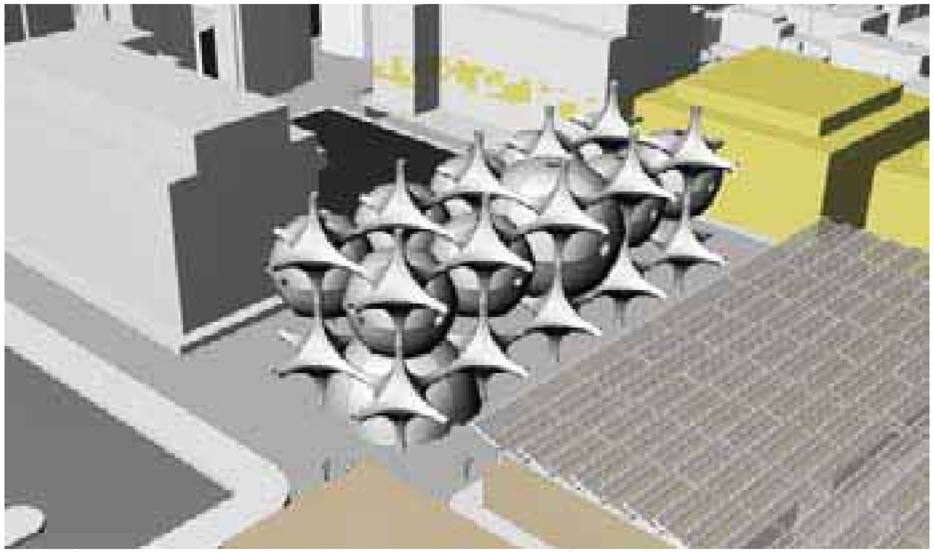
several units at the second system are connected to each other and hang up on the first one



the second system hang up on the first one



no space between the systems, direct connection



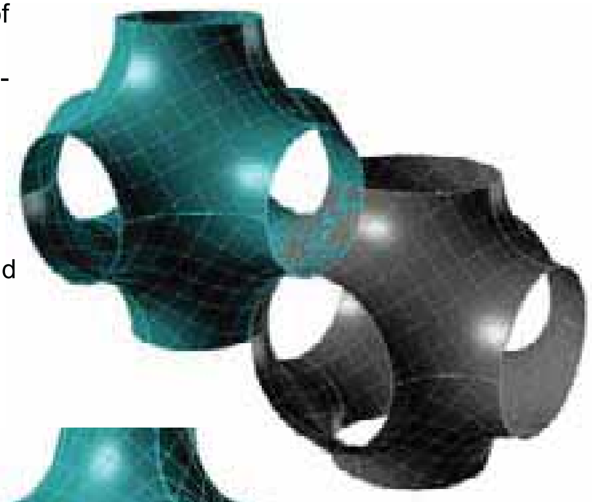
View from the entrance. The initial positioning of the building: determine the volume of each space by program and space area.

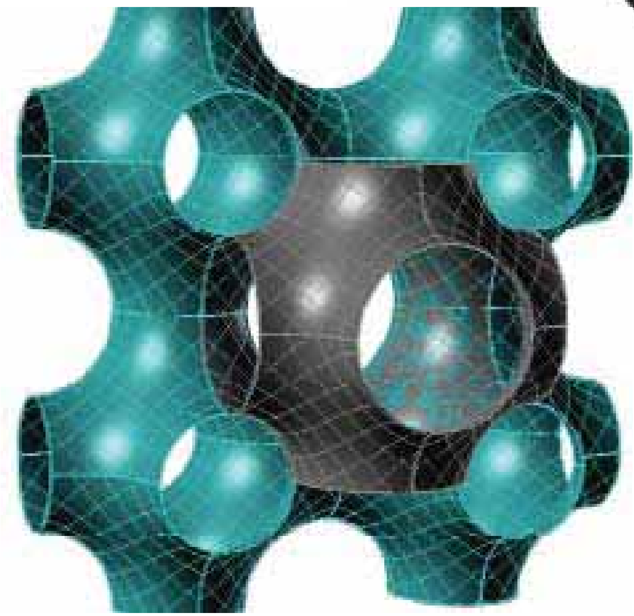
Working with the two extrim cells for the building

Decision to work with the cell and its dualic one for the internal space.   .

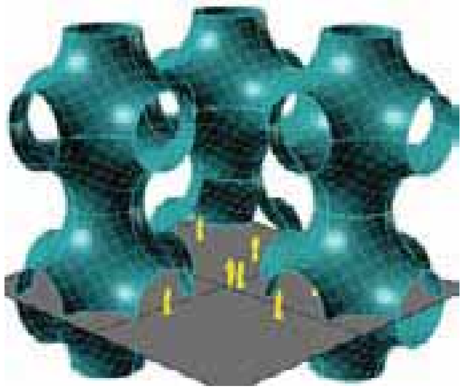
Each dualic space consists of eight cells. There is no direct connection between them unless one surface is off.

These two systems are a direct continue for the will of two systems which nourishing each other by light, air and motion.

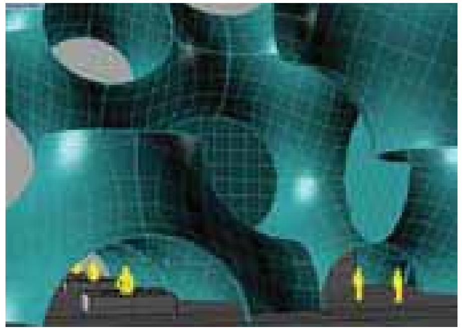




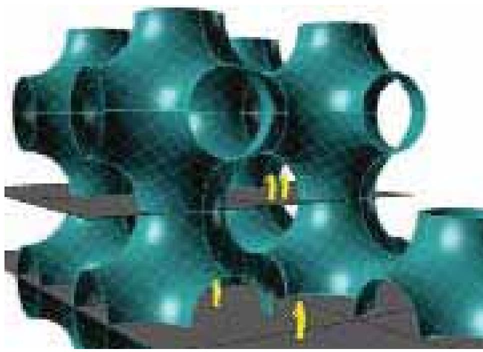
Options of reciprocal relations/ Different varios spaces



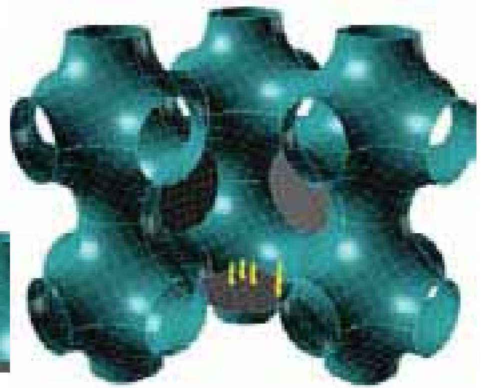
The passage between the cell and its dualic space



The entrance and the shops that are connected to the street.



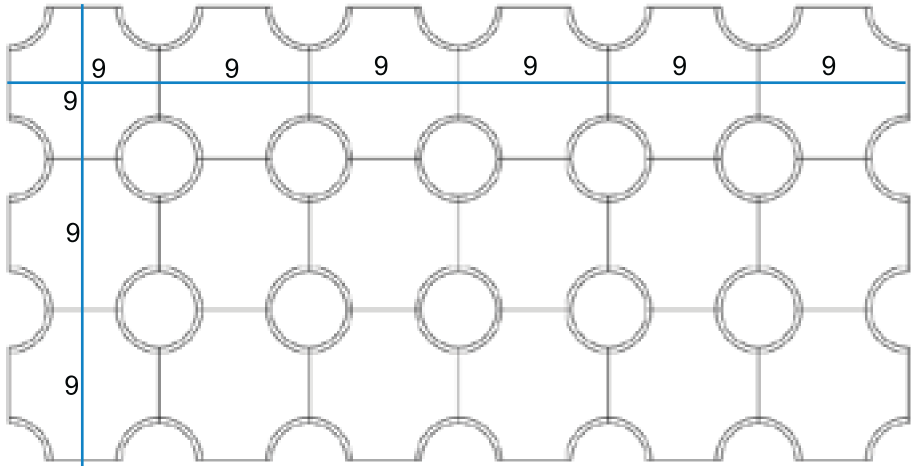
There are spaces with eye contact. It creates double spaces in some places in the building.



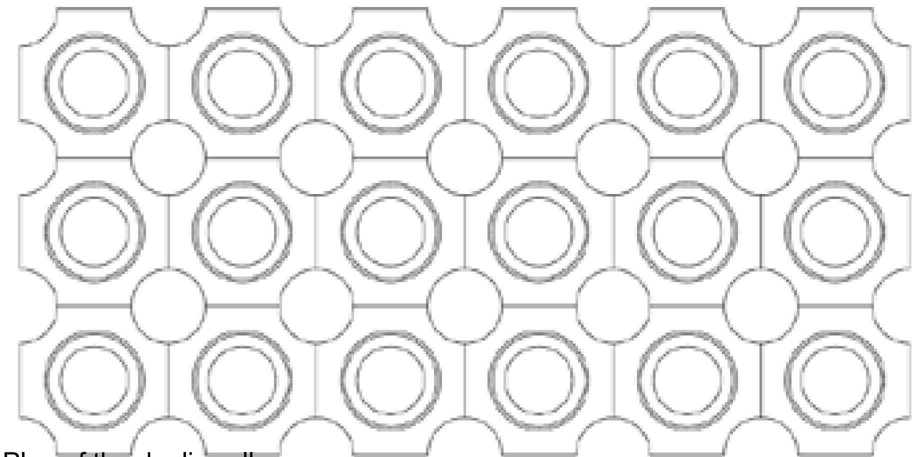
no space between the systems with no direct connection. the dualic as a separated space.

Planning the building

The grid i have decided to work with have been determined by the field. The cells size (9/9 meter) have been determind by function and by its entrance of people, light and air. The internal building cells, without the facades take 27/54 meters.



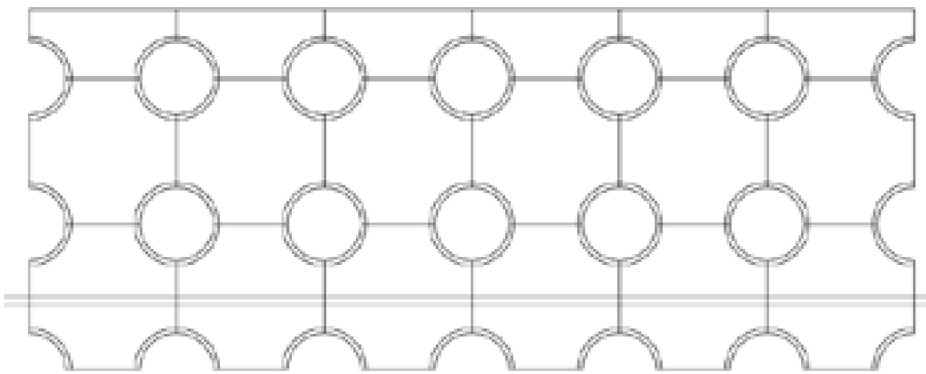
Plan of the cells



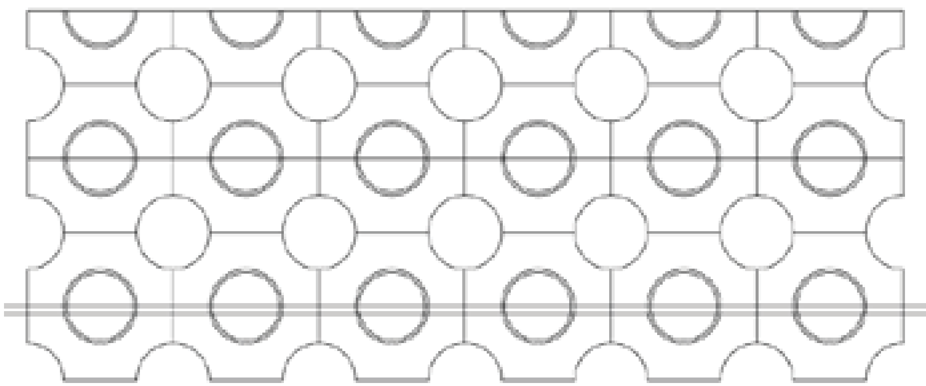
Plan of the dualic cells

Two systems - the cellular system and the duallic one in it. There are two main floors while between them secondary floors.

The height of the building consists of half cell + whole cell + half cell



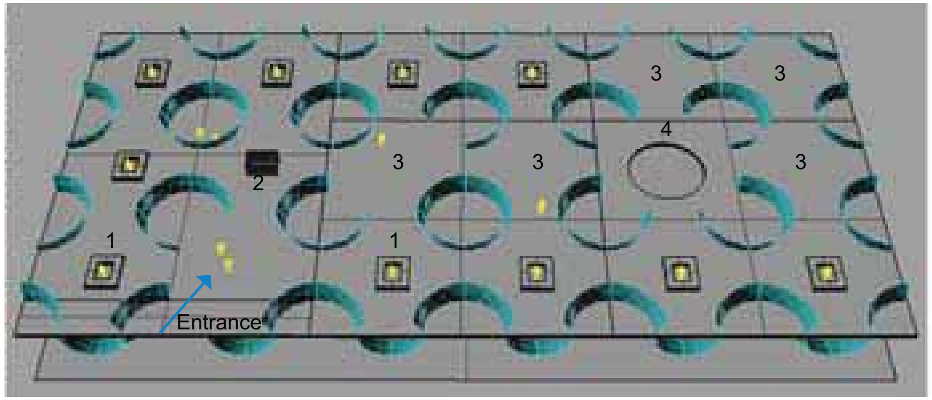
section through the cells



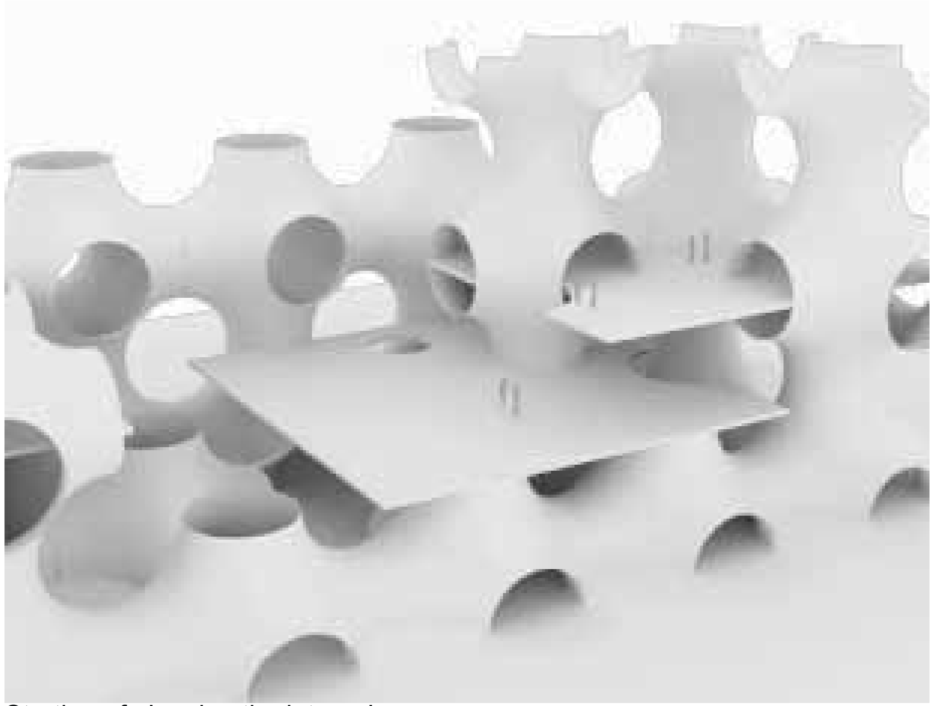
section through the dualic cells

Planning the building

Plan of the entrance floor for example:



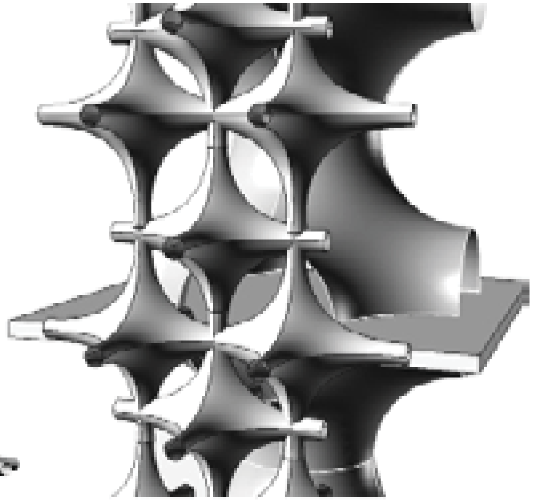
Ground Floor:
1.commerce
2.elevators
3.resturants
4. multi-purpose hall

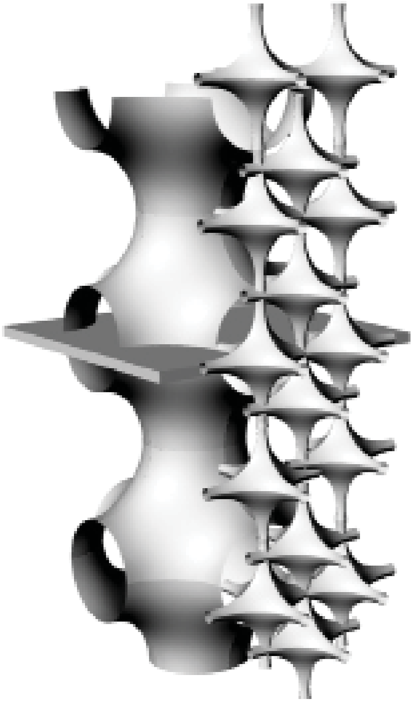


Starting of planning the internal spaces.

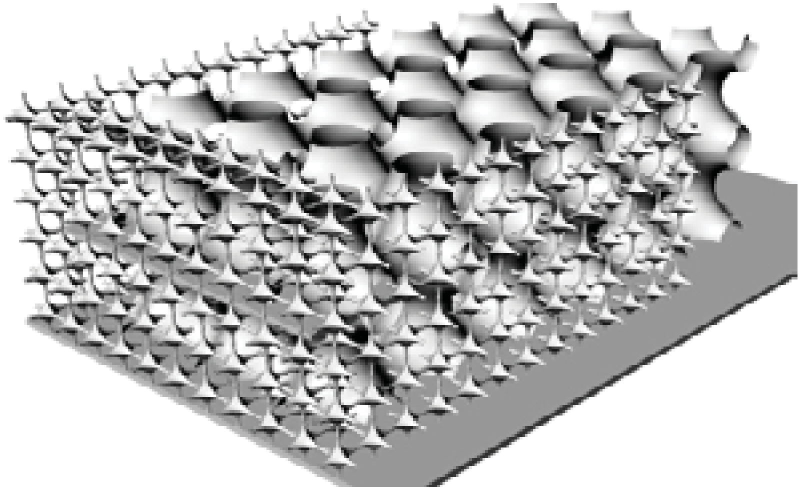
Connecting the building to its facades

How do i reduce the large opening between the facade cells?

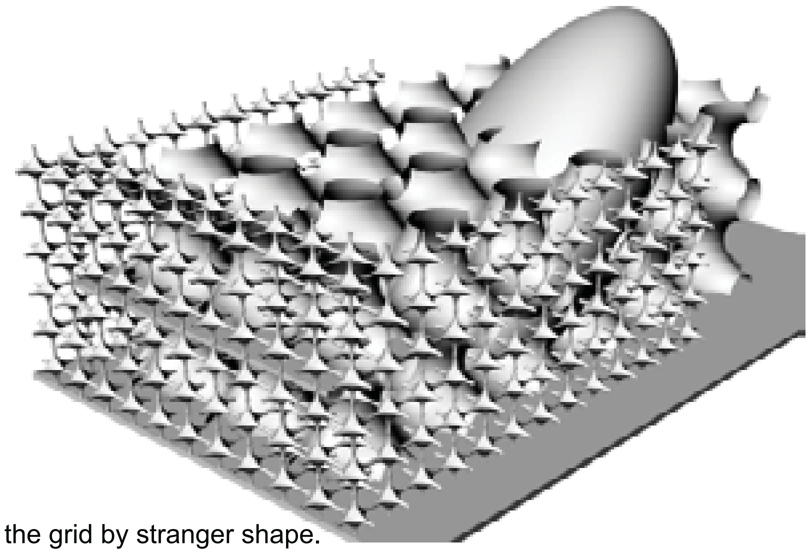




How do i treat the connection between the building cell and the facade cell?

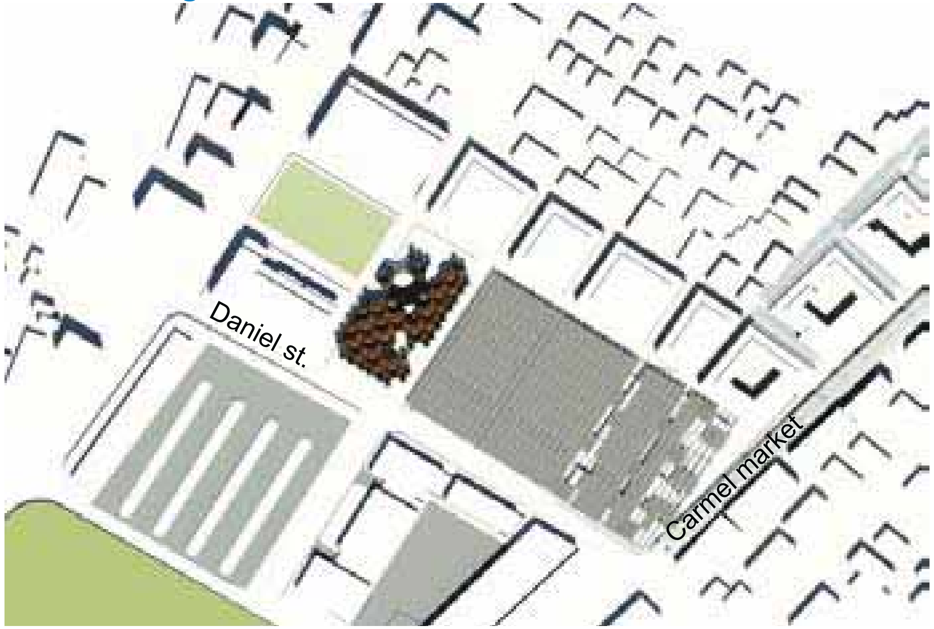


Keeping the grid as it is.



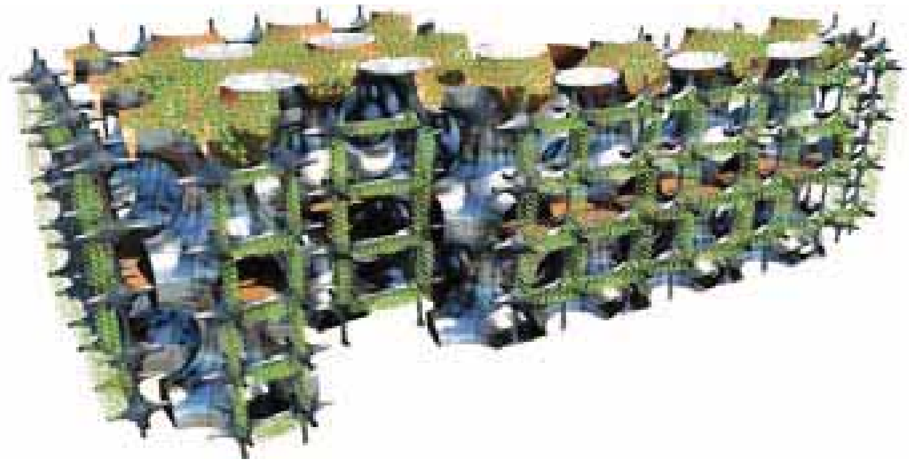
Breaking the grid by stranger shape.

The Building

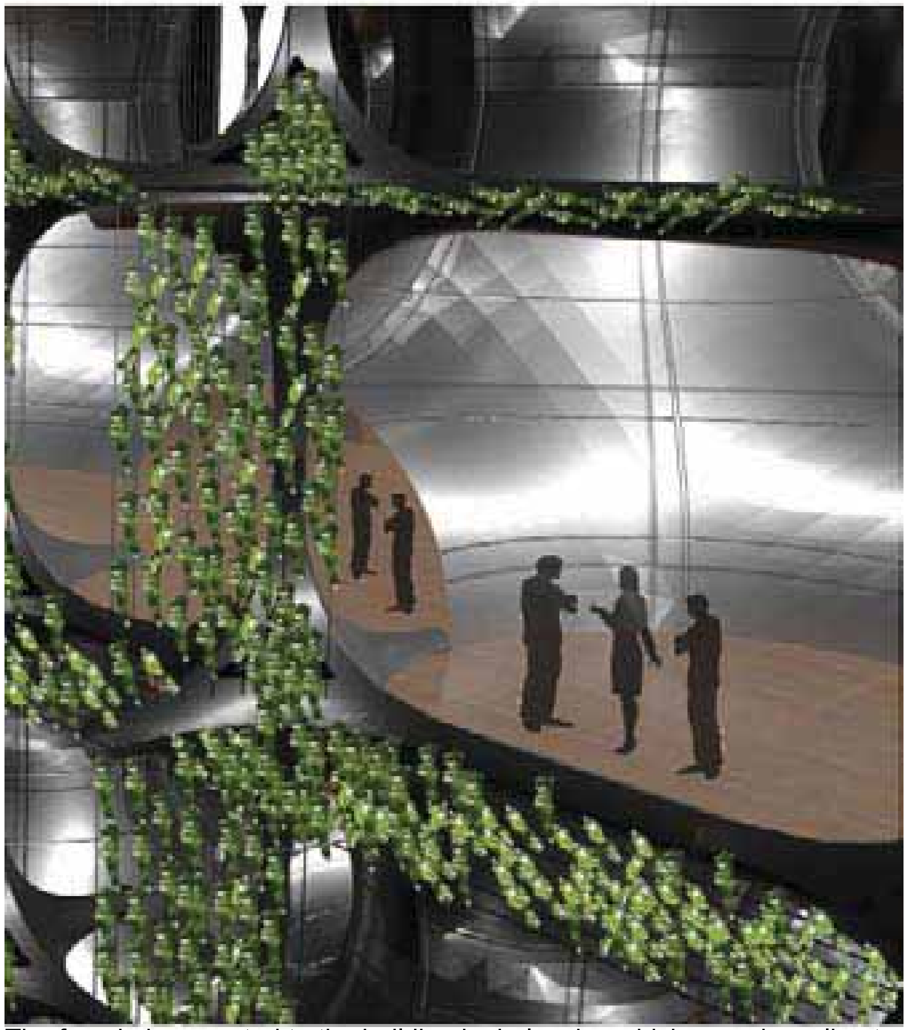


The field is situated at Daniel st. which leads to the sea and as a direct continue to Carmel market.

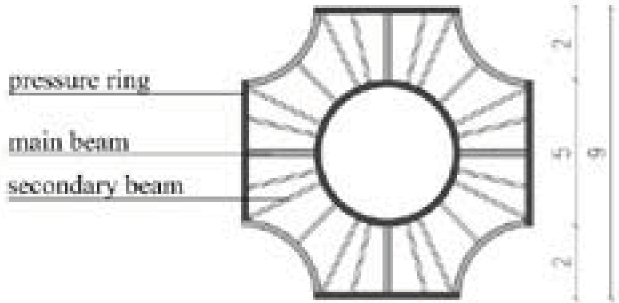

The secondary entrance situated infront of exist garden.


The main entrance situated infront of the market as a continue of it.

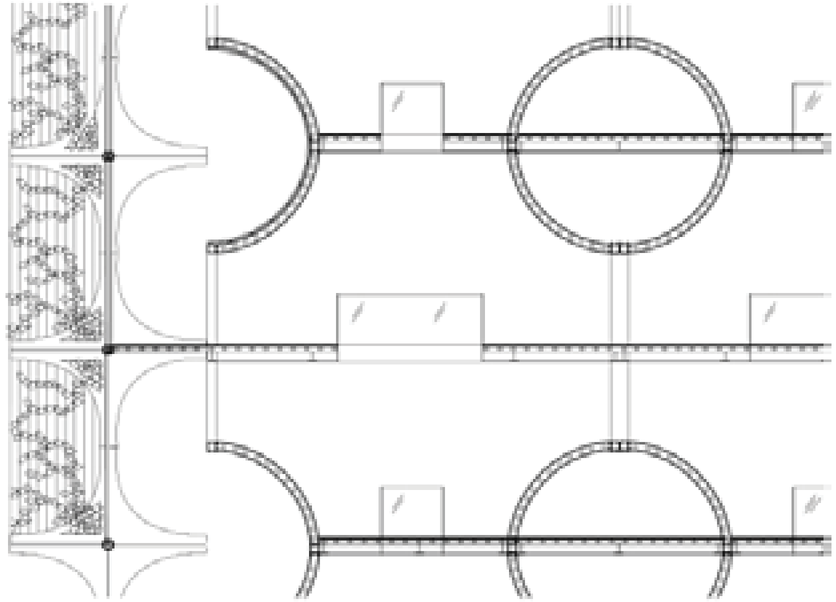
The cells



The facade is conected to the building by balconies which are micro climate space. In the external cell there are climebed plants which grows on the cables and shades the balconies.



The internal cell is made of steel I beams. At its internal side it is covered with wood, for warm feeling inside it, acustic reason for classes or theatre etc. The external side is covered by steel sheet.



Section through the internal cell and facade:
the connection between two cell kinds is by balconies.
the ventilation of the building by “pores” in the floors.

The cells

The corner of the building reveals the internal cells and use as continue to the seal.

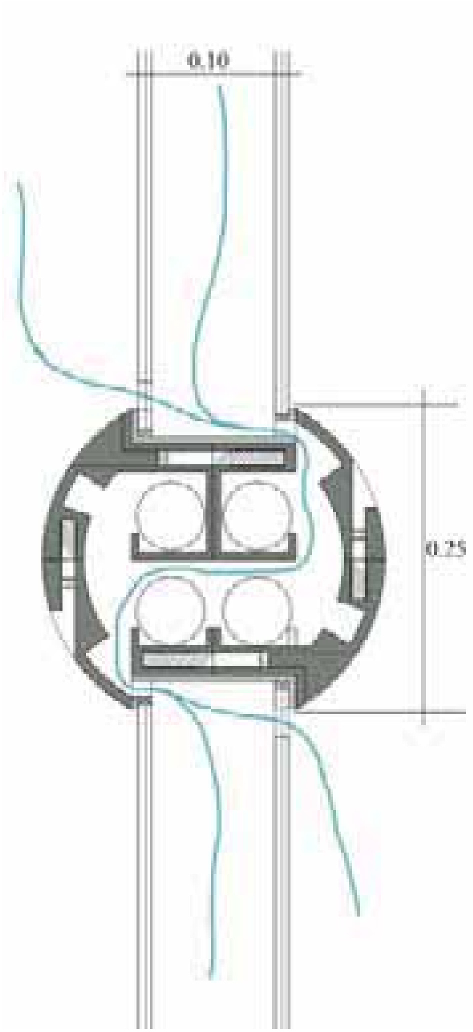
Section through the external cell "arm":
The external cell is made of cast iron. every part is casted in pattern. the parts will connect to each other by screws which have special place to go in.

The building is seald by 2 layers of glasses which hae special place for, in the arms of the external cell, as seen here.

sometimes the layers are just a glass wall and sometimes it is window.

this wall works on the "season window" technic. (see next page)

The blue line show air passing. Because of the little openings in the glasses the air will pass also throuh the cell and hot air will up so the building will be ventilated also by the facade.

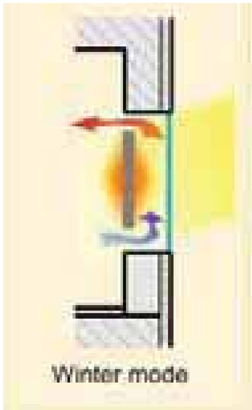


Season Facade

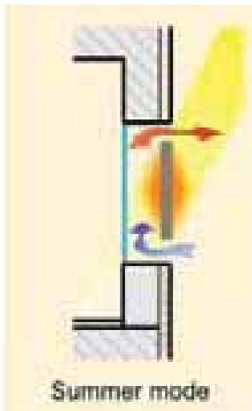
The problem with planning with glass or to choose window is that there is no good window for the summer and for the winter equally.
so i chose to use the “season window” technic.

The window frame turns in 180 degrees on vertical pivot with two glass boards. one of them is darker like in sun glasses and the other is transparent and “swallow” radiation. The two glasses are distanced one from each other. The little distance creates sort of canal which air can move in it.

<u>At the winter</u>
The dark glass is inside: sun radiation enters through the transparent glass, swallowed and warm the dark glass. The dark glass radiate warm to the inside. Air movement created at the space between the glasses because of air enterns from the little lower opening. The air get warm and get out from the upper opening.
The result- another space warming.



<u>At the summer</u>
The dark glass is outside: it stops the sun radiation from arivving the transparent glass and by that, prevent space warming. The warming of the dark glass cause external air flow between the two glases and by that the glass system get cold.



mada.org.il/sviva/window

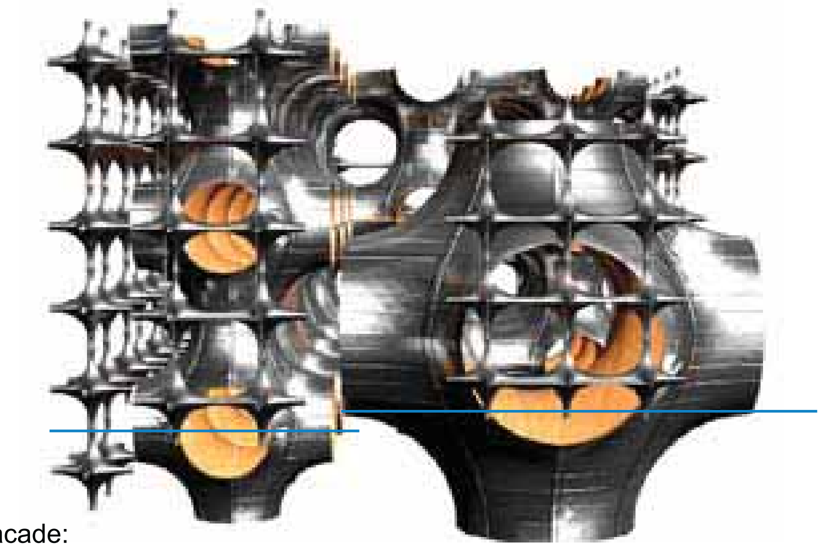
Season window will improve the conditions inside the building and will reduce the warming and cooling cost.

If we calculate, the window will save in Tel Aviv 128-295 kilo vat per hour for every meter, which also saves money.

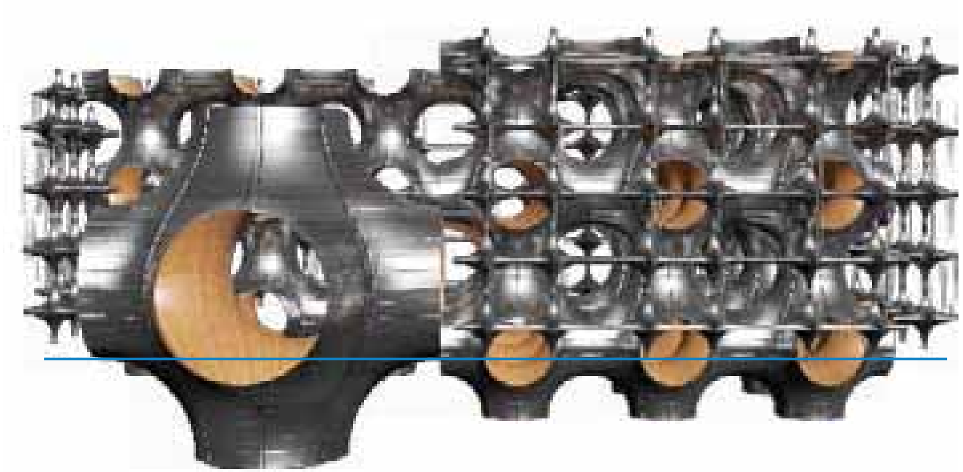
netogreen.co.il

The Building

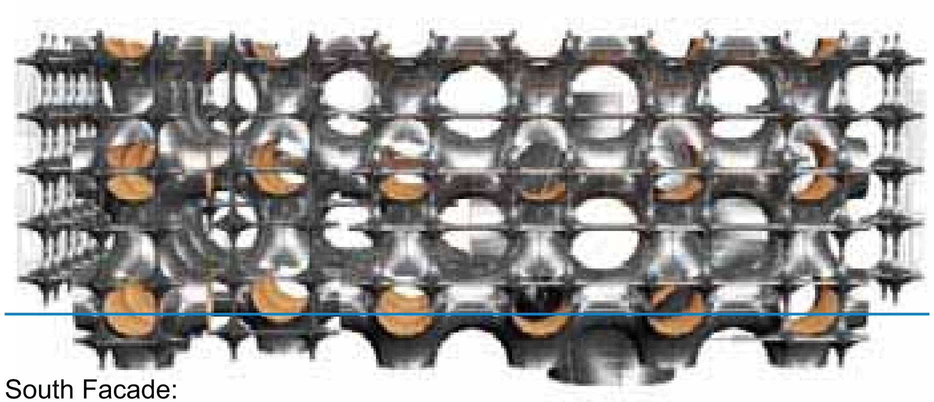
The blue line symbol the ground level.



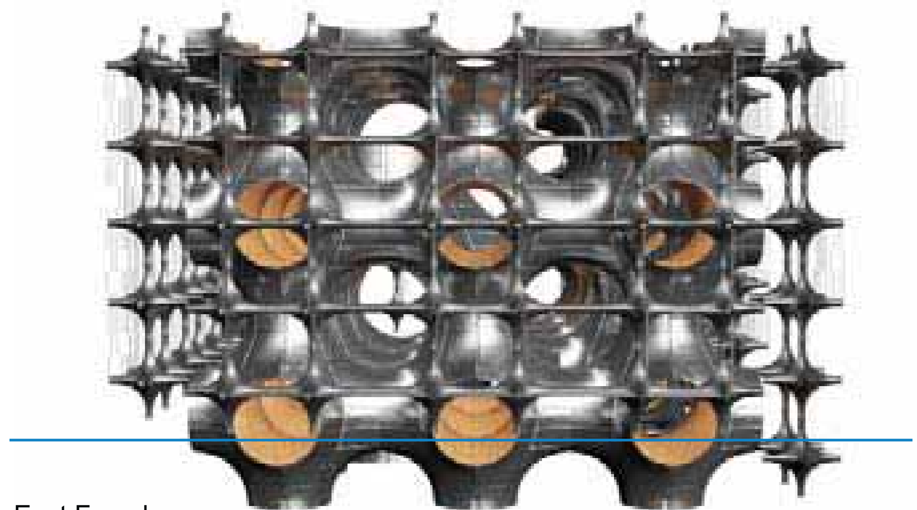
North Facade:
By taking out the ground the whole big cell of the theatre is exposed. this facade can be more exposed to sun light because it is soft light



West Facade:
used also as secondary entrance. infront of the garden.

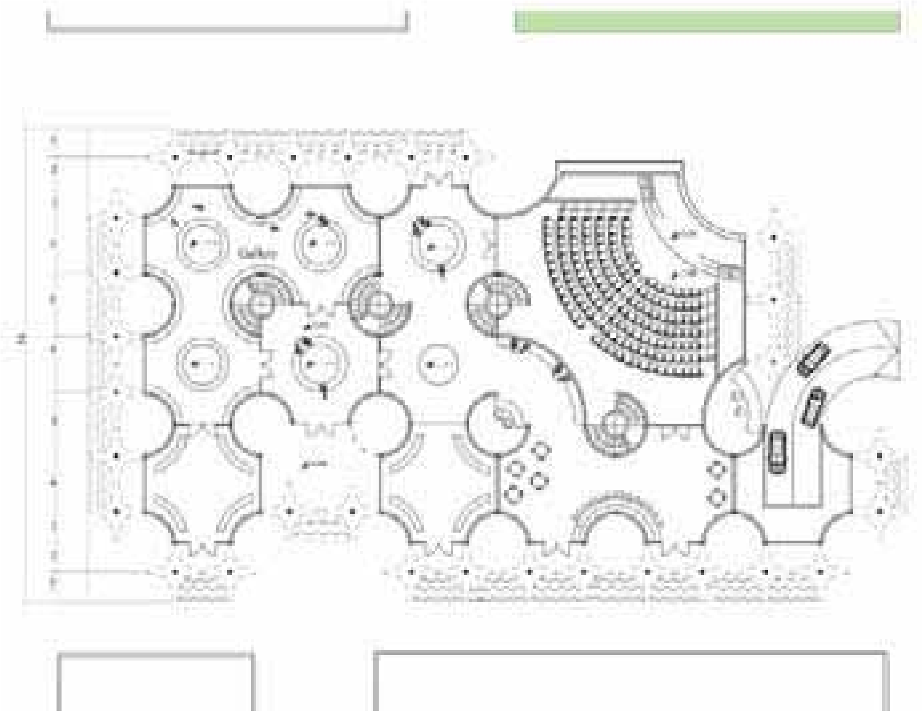


South Facade:
all of the facade has balconies. the cables are parallel to the ground.



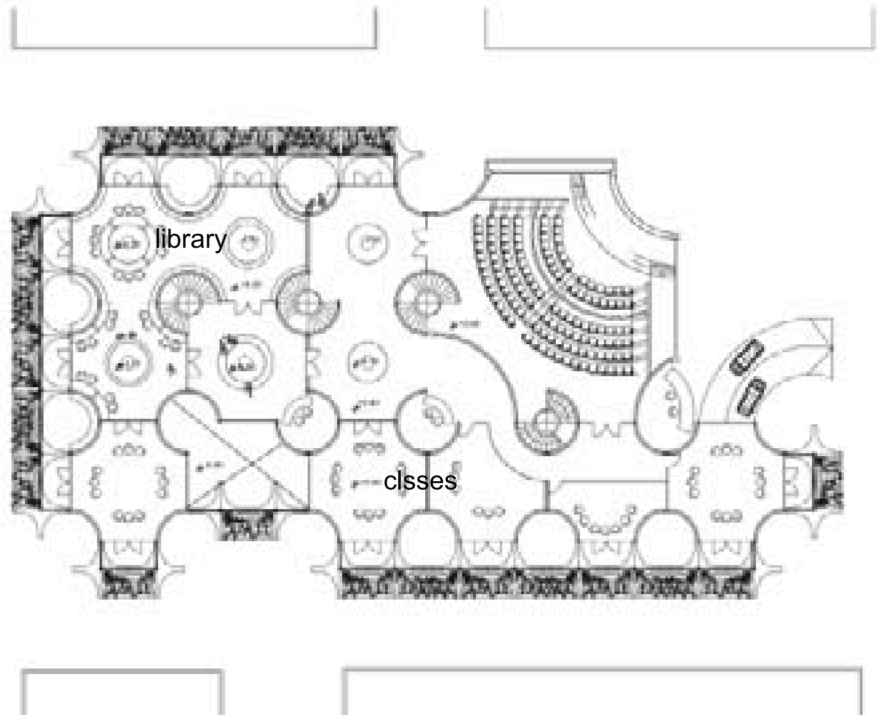
East Facade:
all of the facade has balconies.

Planning the building



Ground floor: Entrance
Gallery, shops, resturant and theatre.

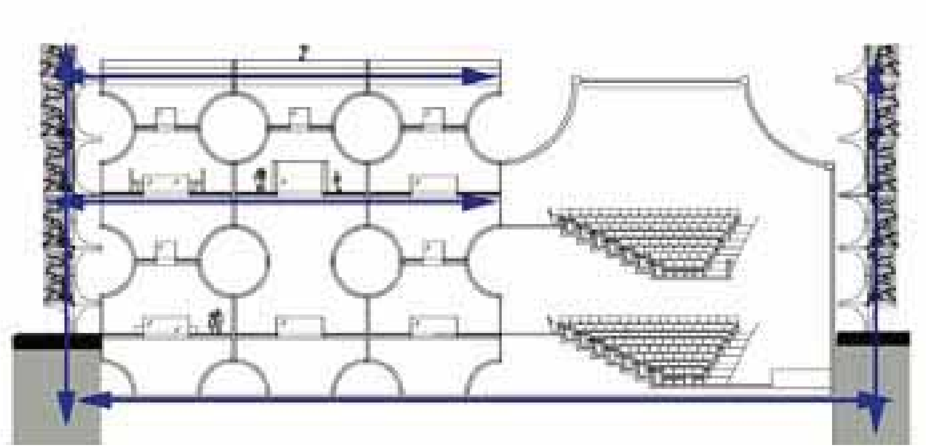
The internal cell can function as one space while sometimes the space consists of several cells.



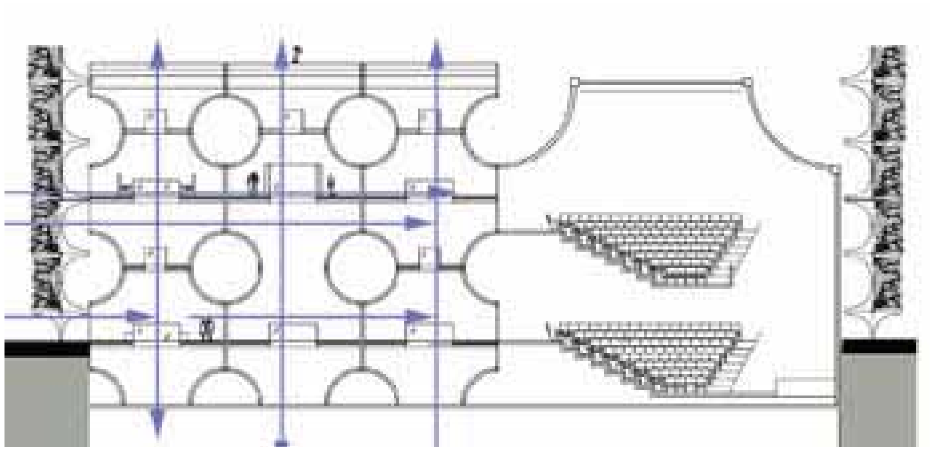
Floor 2 (+9.00):
library, general classes and the theatre.

The internal big cell influence the grid

Planning the building - principels

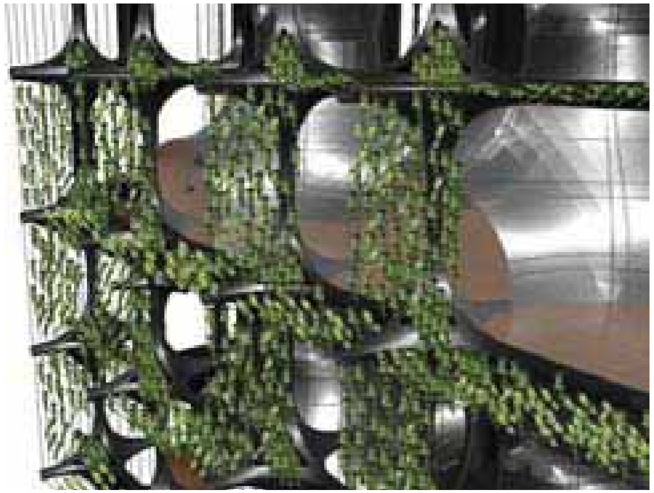


The facade is the building water system. it drains the rain water from the green roof, grey water and air conditioning water.

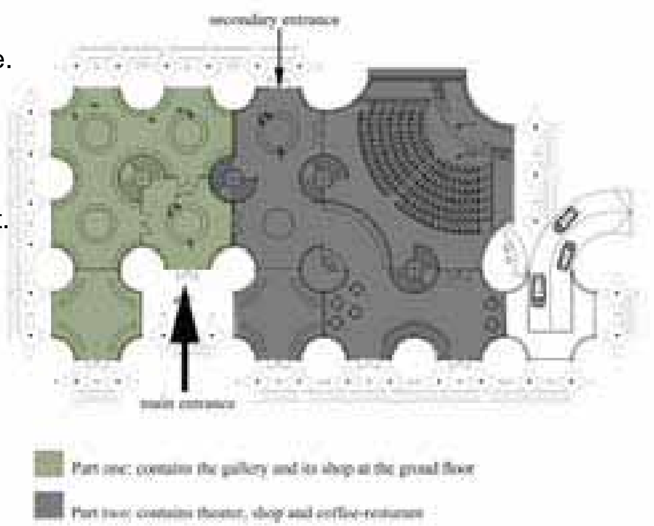


Air circulation in the building arrived from the cell geometric and the opening in the floors.

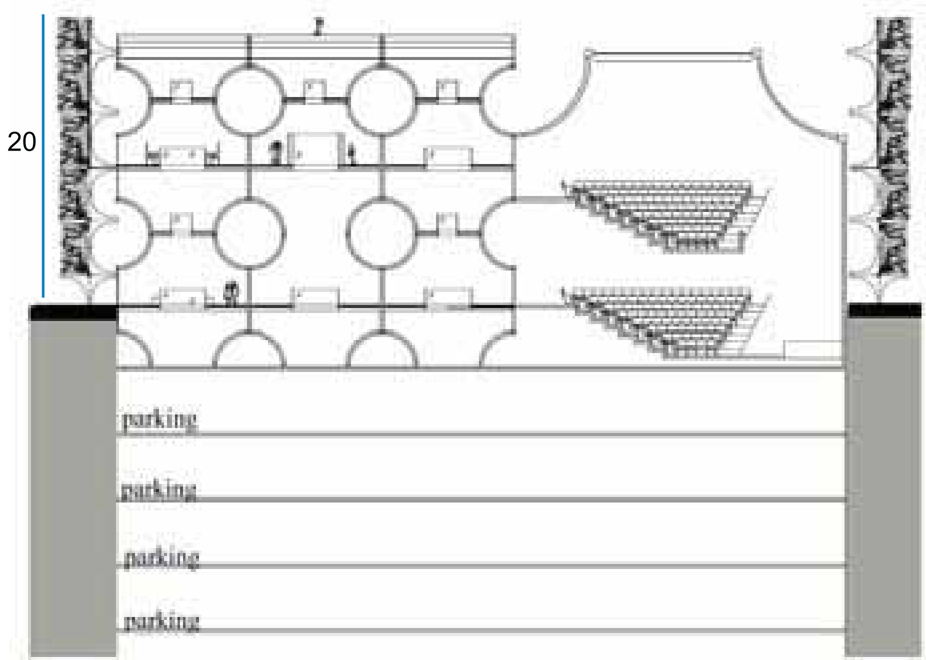
Inside the facade cell there is planter of climbing plant. Parts of the water which flow through make the plant grow on cables. The cables are in four sides so they shadow the building.
For south facade: the cables will be vertical to the building.
for east and west facades: the cables will be bending.



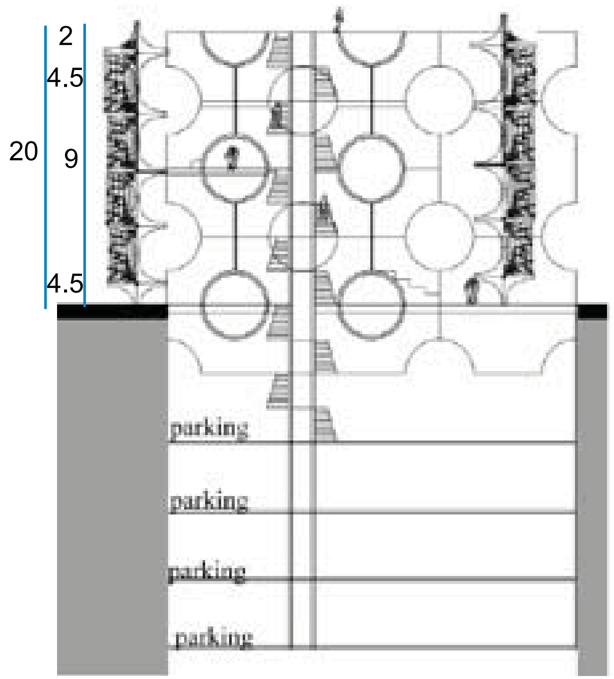
The building is flexable. it has two options of functioned:
1.As two building with separate entrances and vertical movement.
2.As one building.



The Building



Section thruogh the cells:
Air enters through the external openings and flow up through the openings in the floors.



Section thruogh the dualic cells:
At the dualic spaces there are the facilities of the building; the movement, toilet, offices and another classes.

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www.water.gov.il

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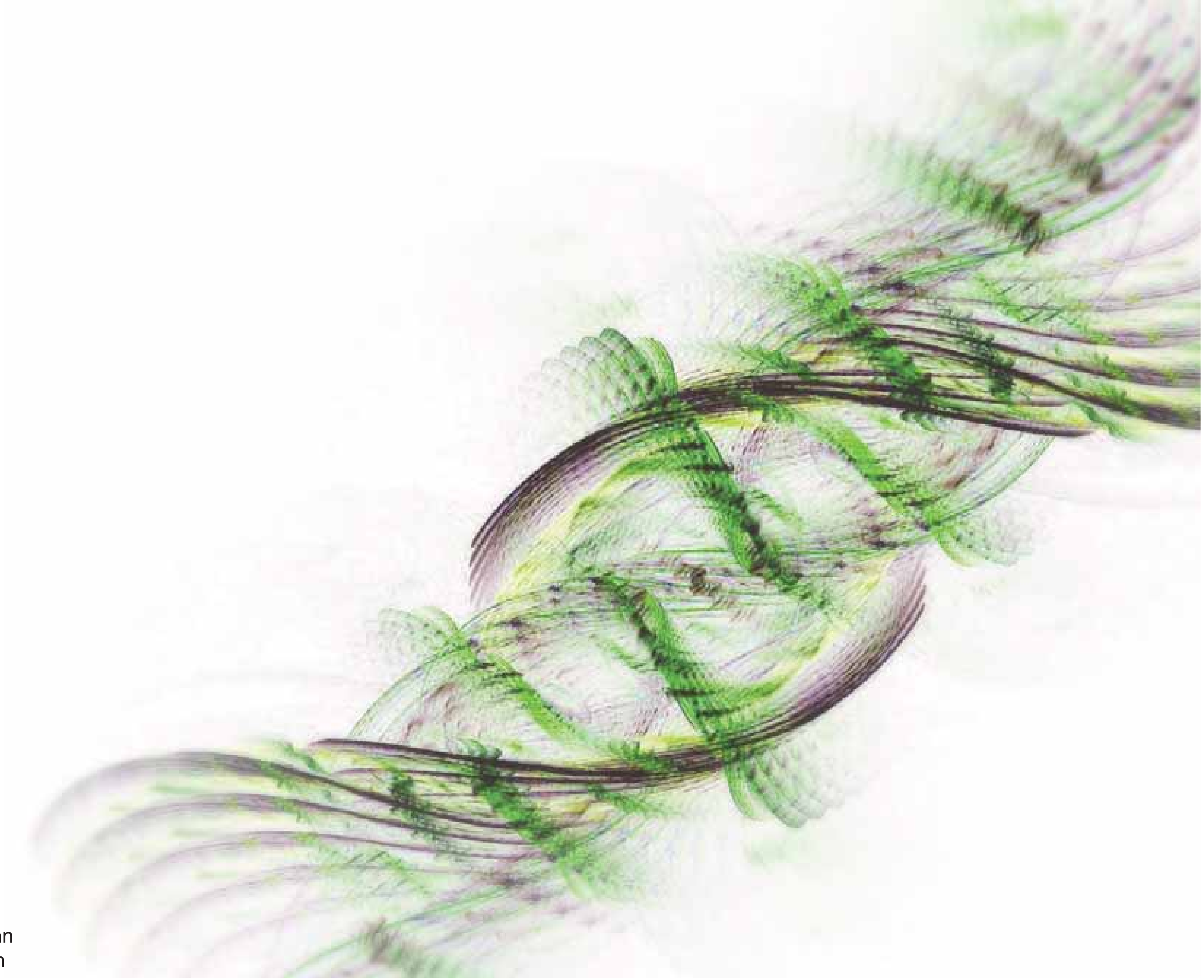
2. Europe, O., 2005. EUO © OCEANA Houssine Kaddachi, Available at: http://www.flickr.com/photos/oceanaeurope/6393809915/ [Accessed March 23, 2012].
3. http://www.google.co.il/imgres?um=1&hl=iw&sa=N&tbm=isch&tbnid=rcQzwK3eO1YJjM:&imgrefurl=http://www.noelways.com/courses/Zoology/Dissections/Phylum_Porifera/Leuconoid_1/Leuconoid_1.html&docid=ACbtCpOh1pGpHM&imgurl=http://www.noel-

SPATIAL MUSIC

Media center, Tel Aviv



Presenter: Michael Weizmann
Instructor: Dr. Yasha Grobman

The project deals with the integration of bottom-up design principles with modern digital techniques in order to develop a contemporary public building.

The development started from from the smallest scale of facade system. The experiment of the next step was to scale up the facade geometry in order to develop an cellular system of building spaces. In the final step these two systems were joined together and adjusted to the demands of public media center.

Facade structure

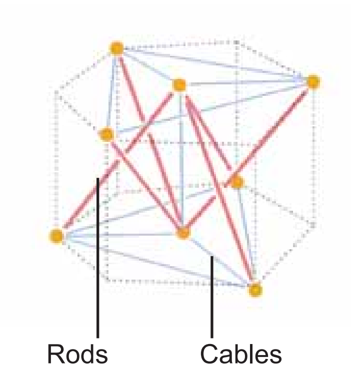
Buckminster Fuller

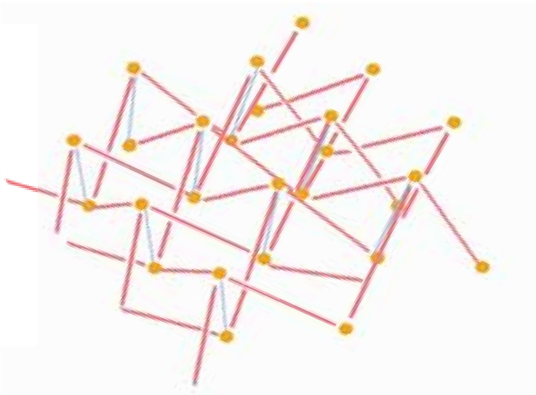
Known for his research of tensegrity structures, is considered to be the inventor of geodesic domes - highly effective construction, made by triangularand hexagonal tesselations.

http://davidszondy.com/future/city/fuller.htm

One of the important features of the structure is that the load is effectively distributed between many dome parts because of the hexagonal geometry. As soon as the structure uses lightweight steel rods, as bigger the dome is it's stiffnes grows in a higher rate than the structure's weight.

The construction of the facade was inspired by Buckminster Fuller's tensegrity module, based on a hexagonal grid and allowing assembling flat truss structures.

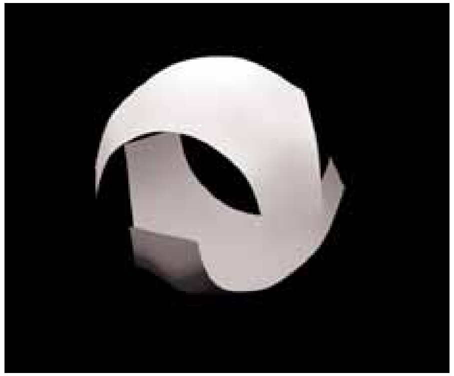




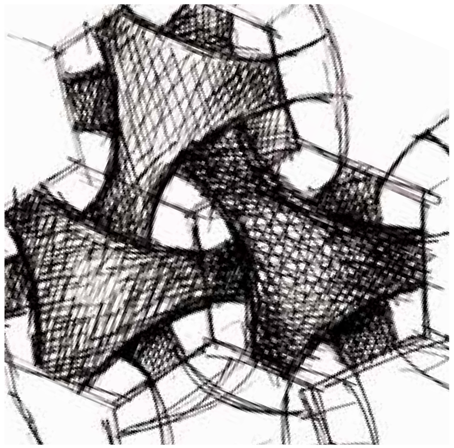
ORAMBRA parametric facade is based on the hexagonal tensegrity module. The thickness of the facade can change according to the thermal insulation needs.

("ORAMBRA - The Office for Robotic Architectural Media & Bureau for Responsive Architecture," 2012)

Cables and rods of the module were transformed into a spatial geometry of two facing domes, in order to achieve more effective distribution of load forces.

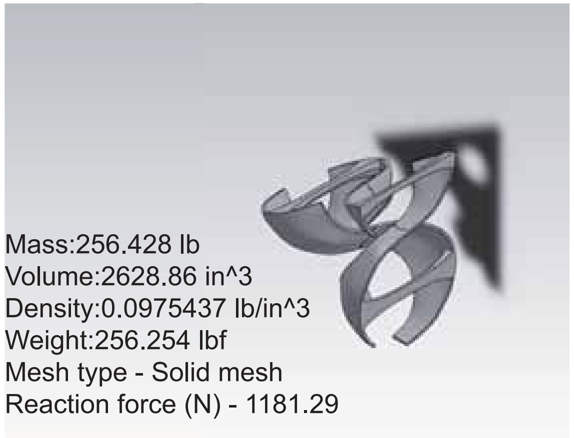


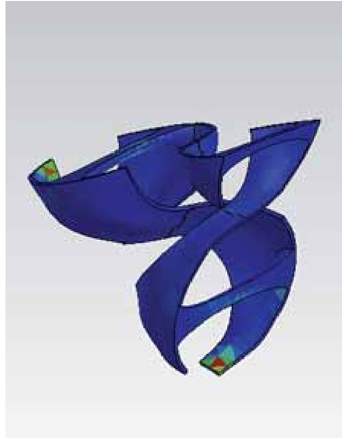
Hexagonal tesselation of the structure:

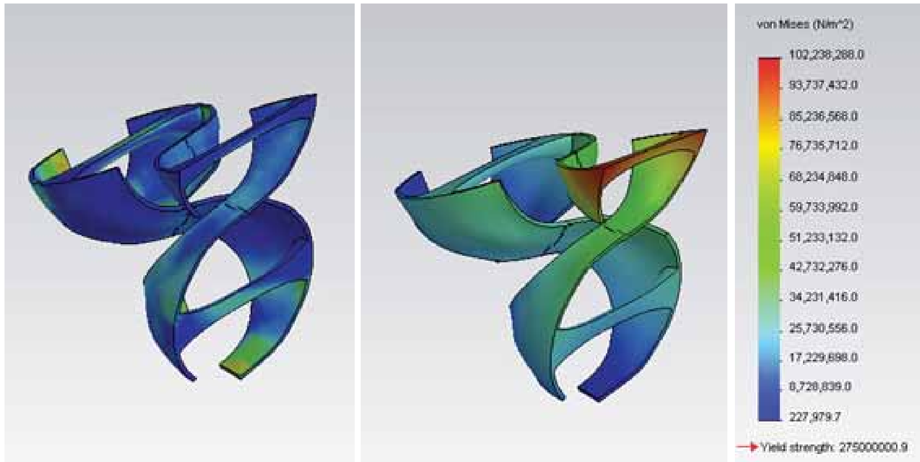


The transformation also allowes to assemble to module into curved surfaces keeping it’s structural stiffness.

FEM analysis

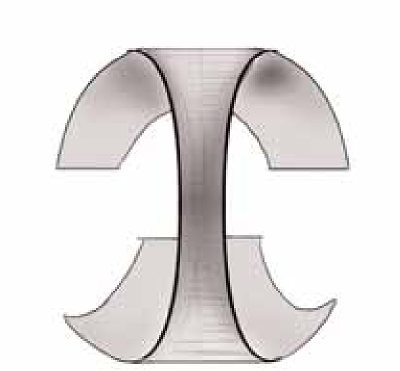


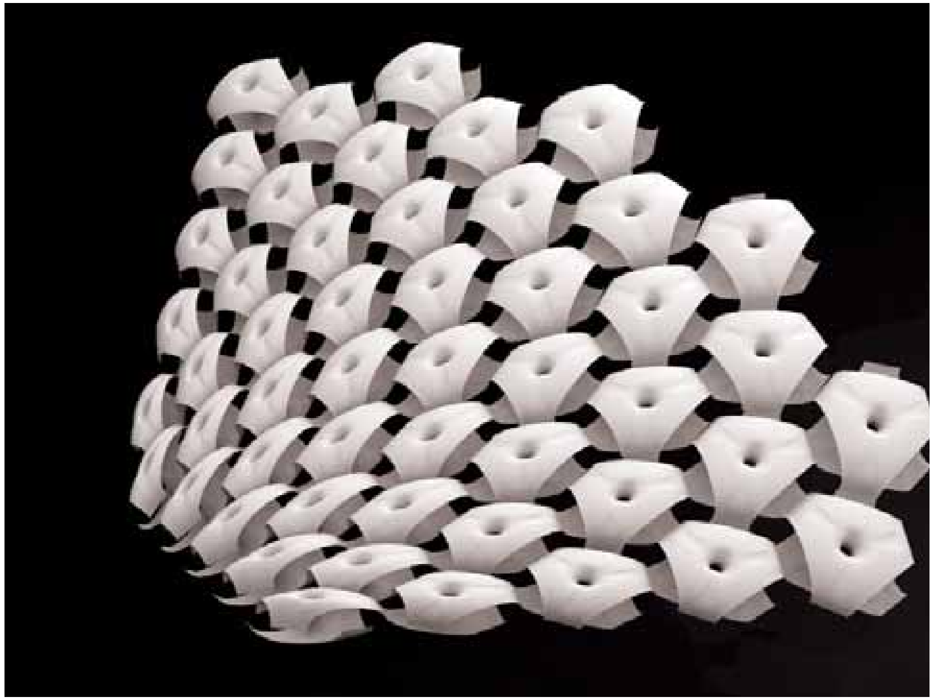




On of the problems revealed by the analysis was that the central rod causes too much load on the top dome points.

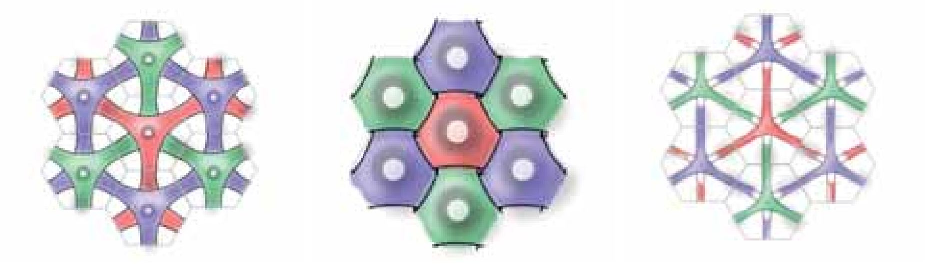
So the domes were connected with smooth surface transaction in order to trasfer load forces more effectively:



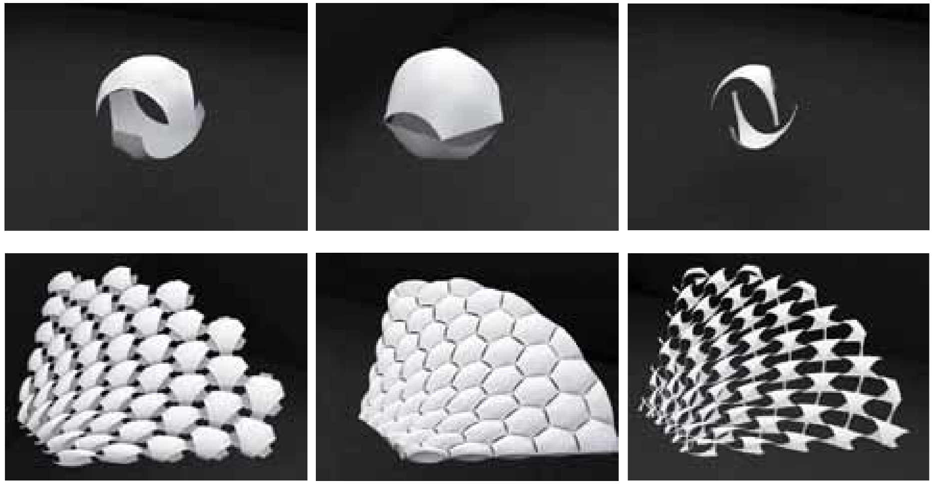


Sunlight control

Varying dome dimensions allows to control the amount of sunlight, penetrating through the facade.

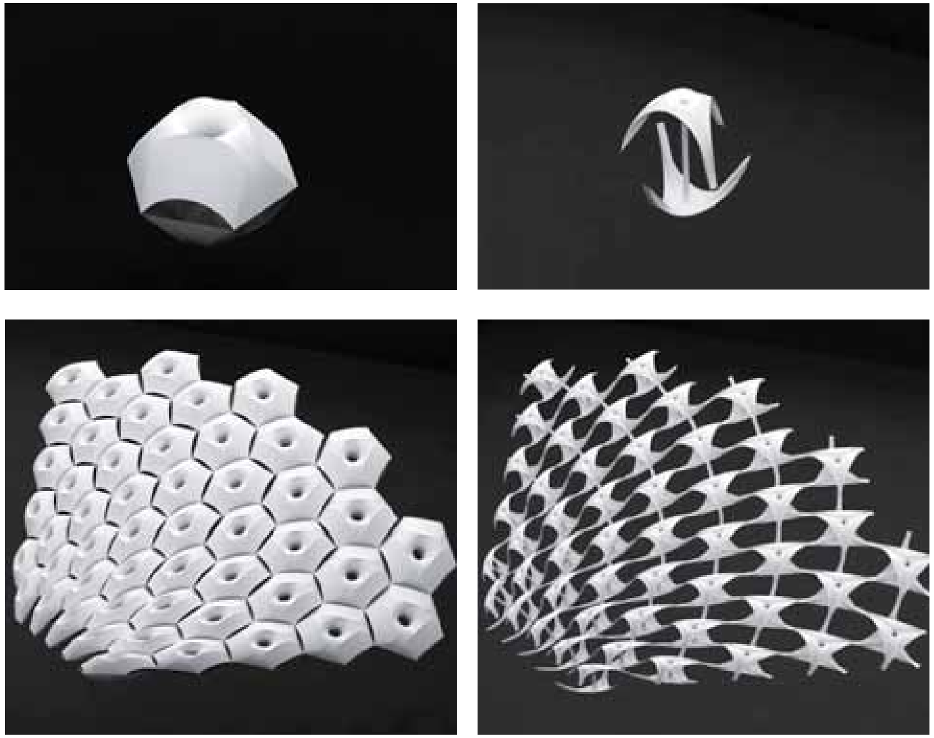


The pattern can be applied to complex, curved surfaces.

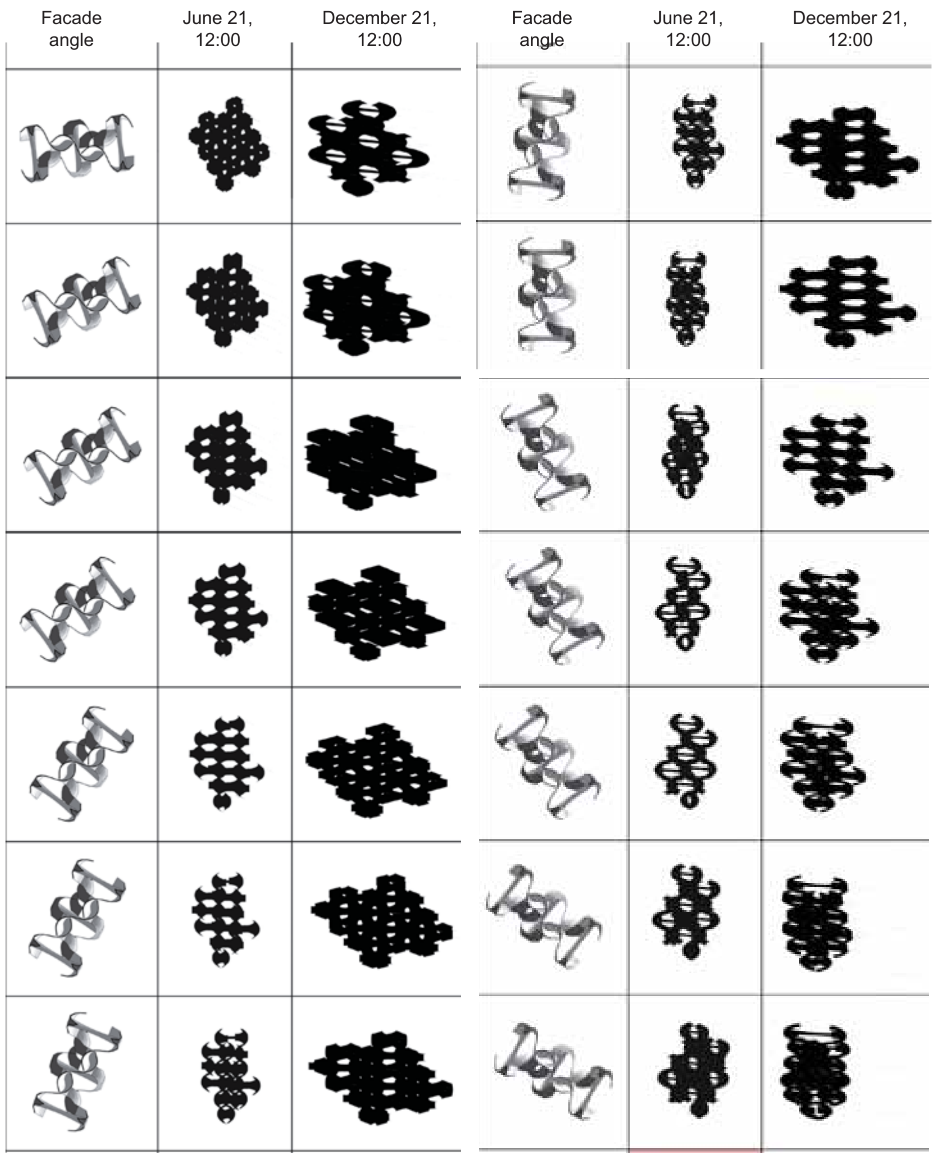


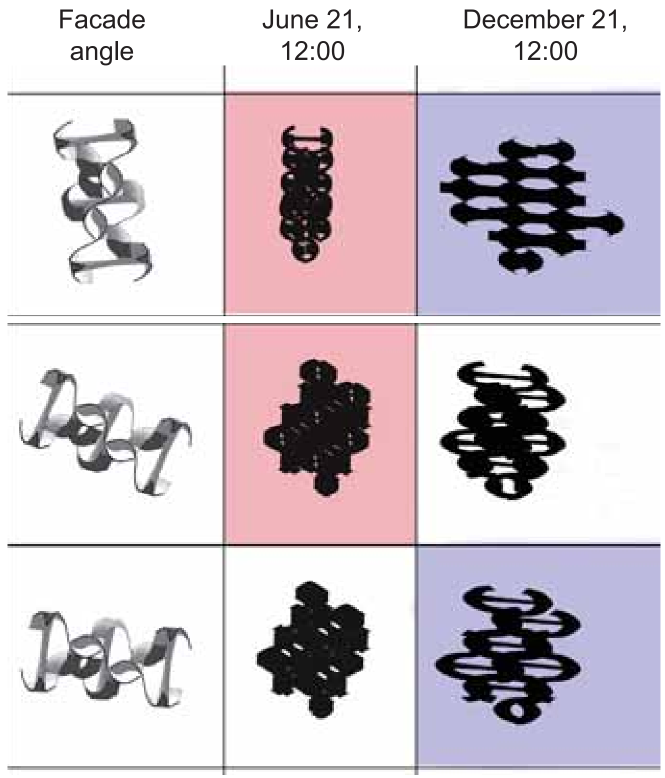
Another advantage of the shape is that the middle hole can be used for space ventilation.

For warmer facade areas the dome will grow in order to protect the building from the sunlight and the hole size will also become larger for better ventilation, still providing shadow.

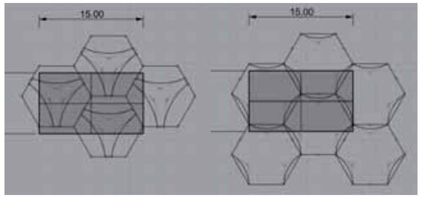


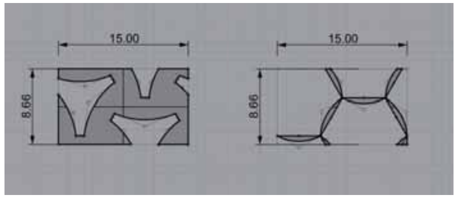
Shadow area, depending on the angle between the facade and the ground





Using Paneling Tools in order to create facade pattern with smooth transactions between the base shapes:

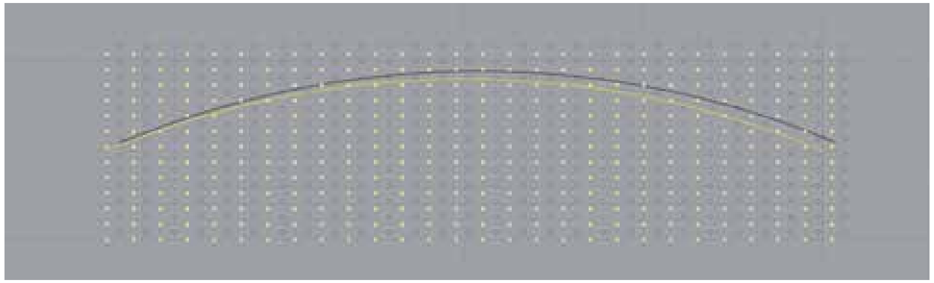




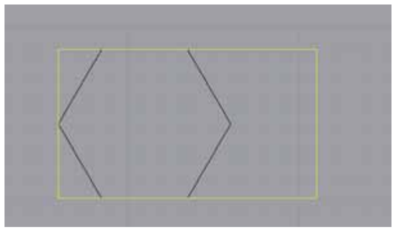
The rectangle shape shows the repetitive pattern that can be used to apply hexagonal shapes to ortagonal points grid.

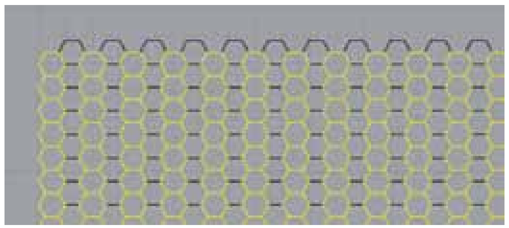
The pattern curves are determined by control points. In order to create smooth transaction between two patterns using paneling tools, the start and the end shapes must have the same relations between their control points. That's why the patterns above are too complex to be used with paneling tools.

The solution was to divide the pattern into four simpler shapes, with similar control points and then apply them on two duplicated points grids with the same attraction curve:

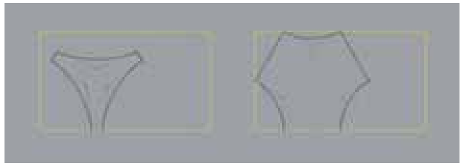


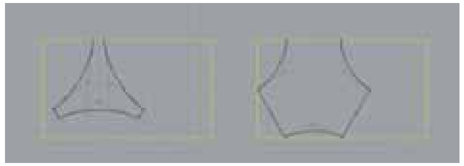
The rectangle sets the shape boundaries for the paneling grid. First, hexagonal shape is applied, in order to determine the second grid position:



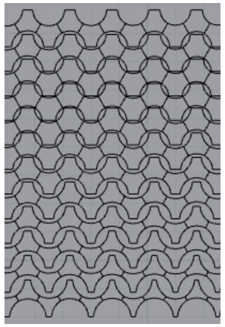


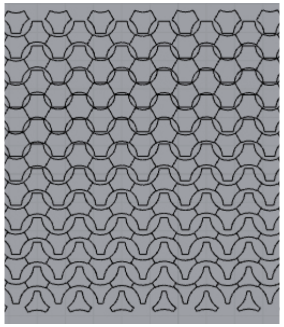
Then, the shapes are applied using the attraction curve - twice on the first grid and twice on the second grid:

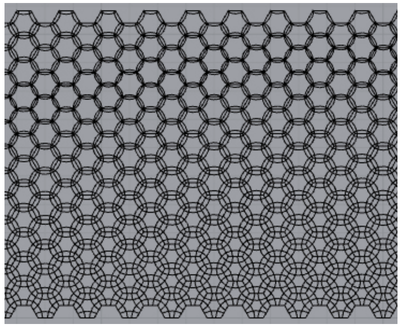




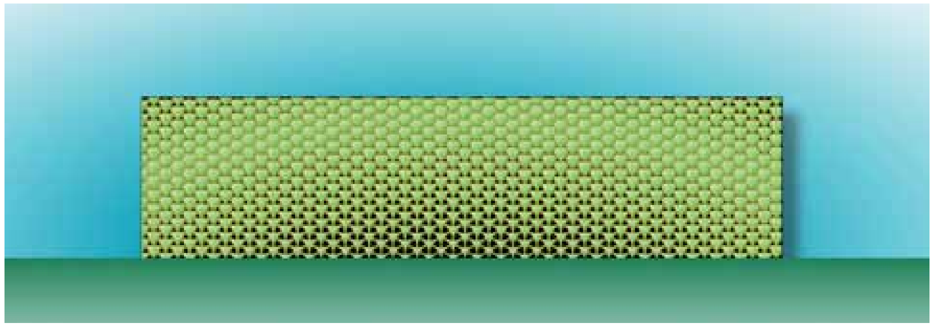
Paneling steps:

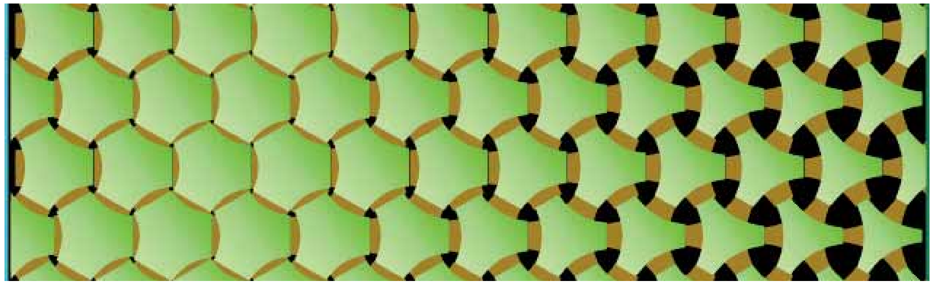




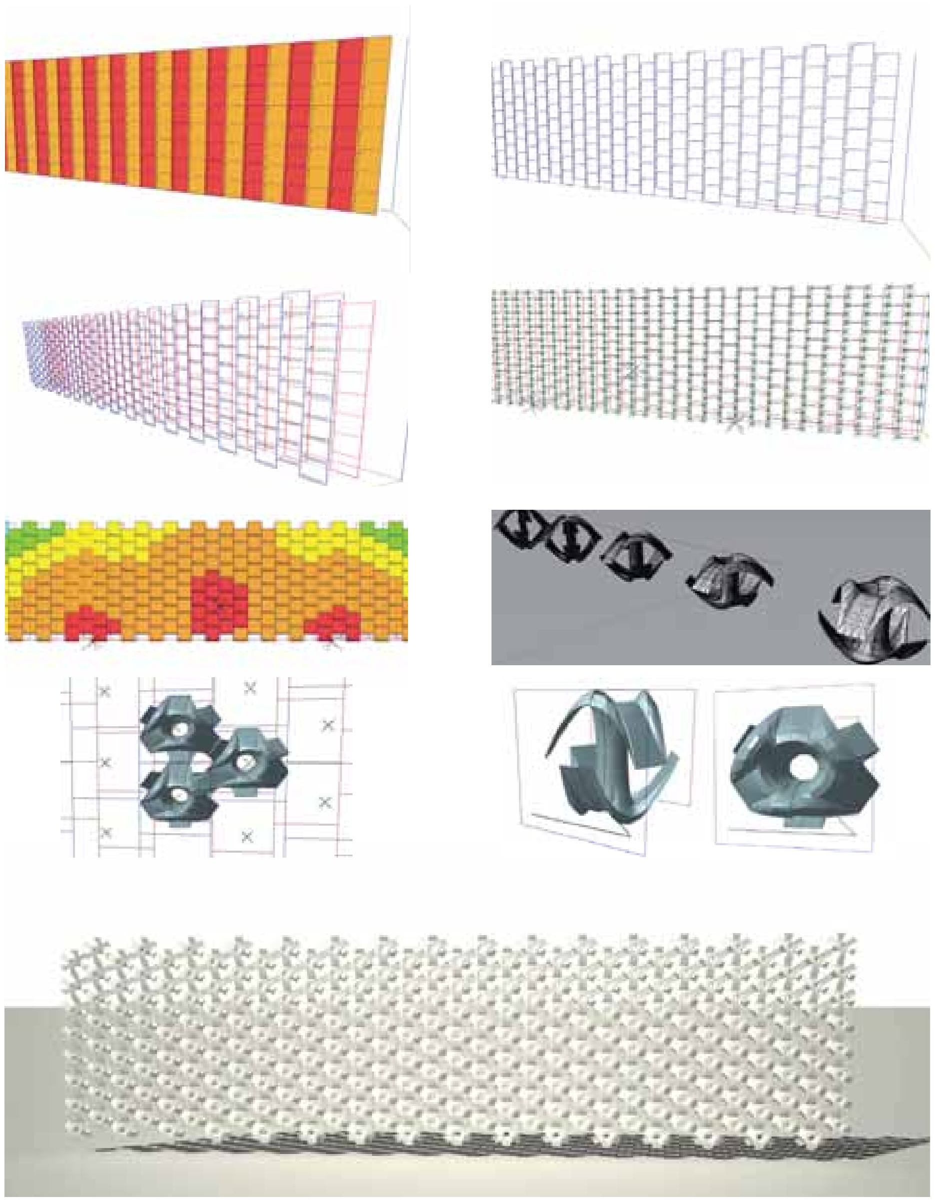


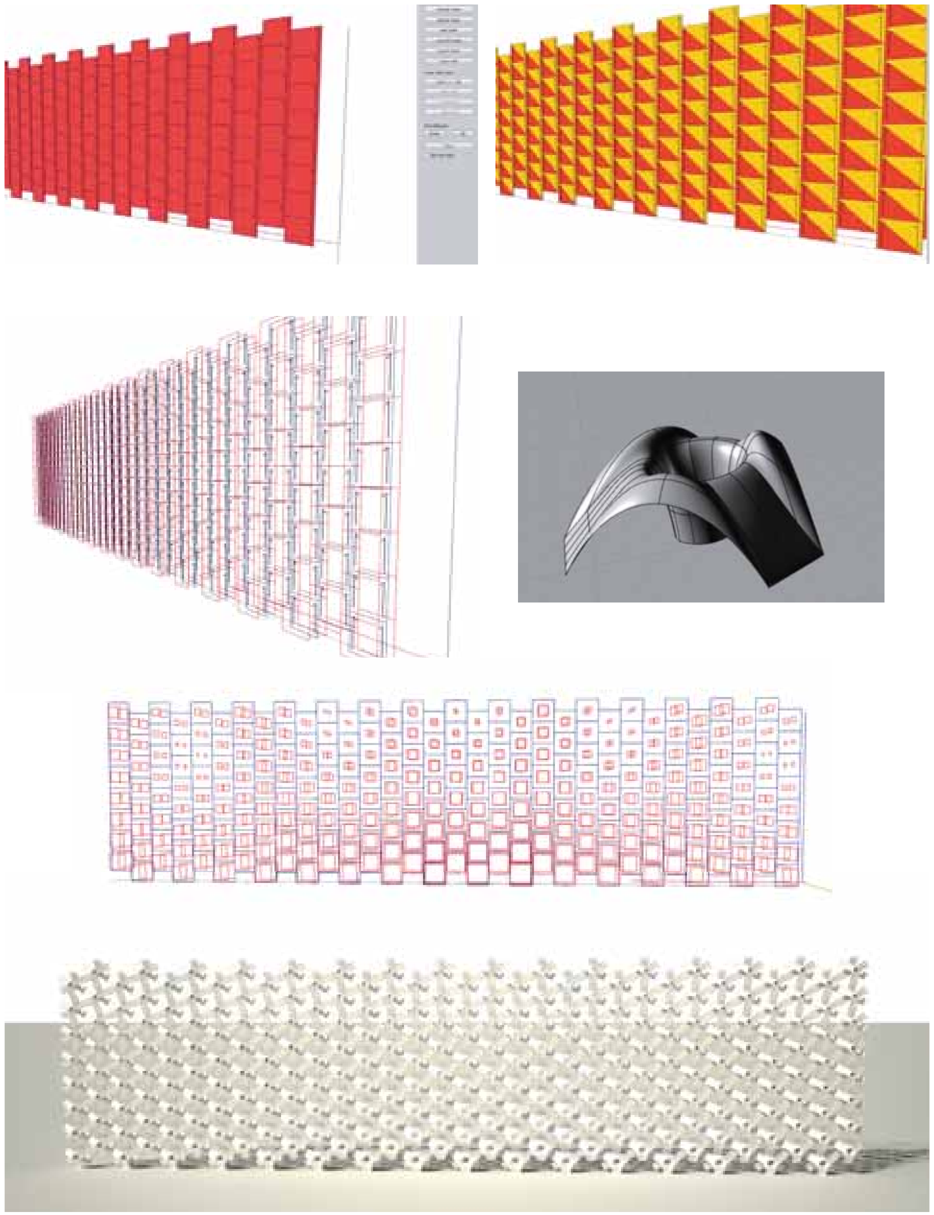
Final result:



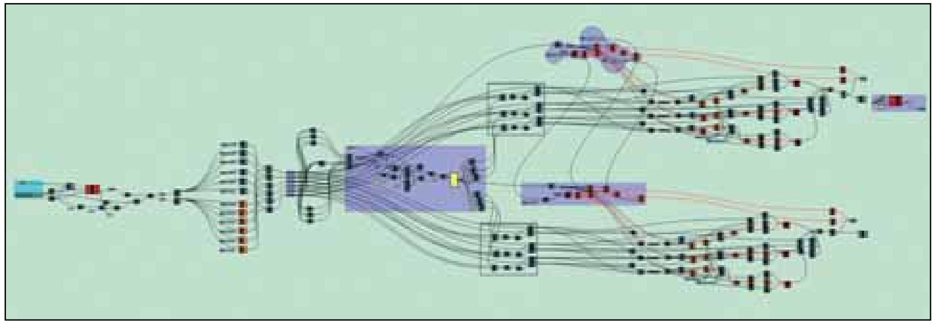


Two ways to create the facade in GEM application:

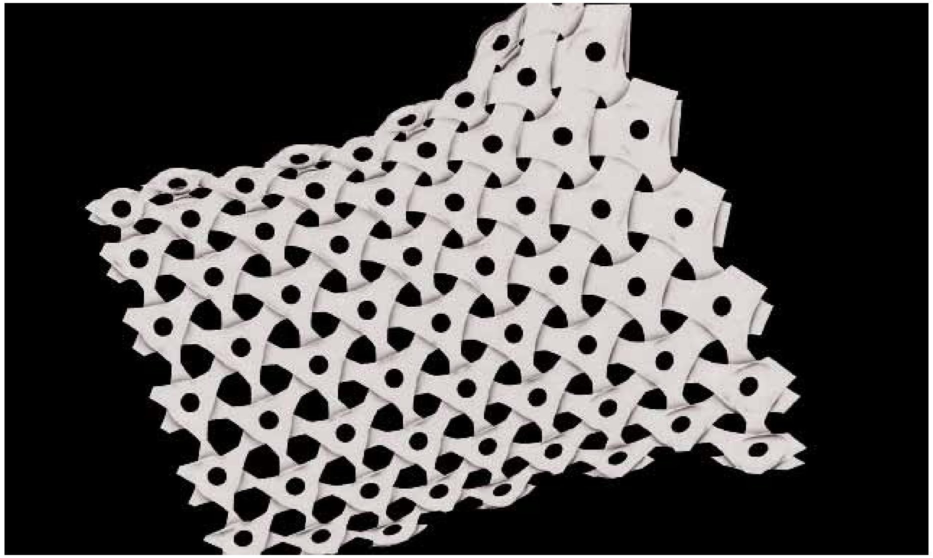




Deeper control of the final geometry was achieved by developing a Grasshopper definition for the facade:

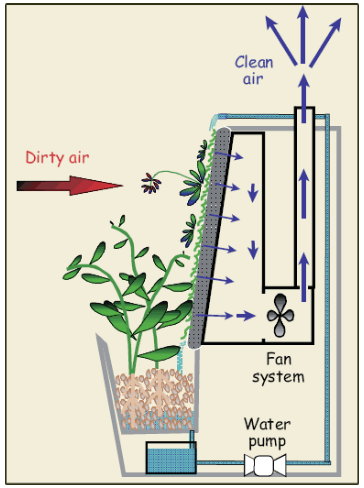


In addition to the full control of the geometry the definition allows to create smooth transactions between open and closed modules, depending on each cell's distance from an attraction point.

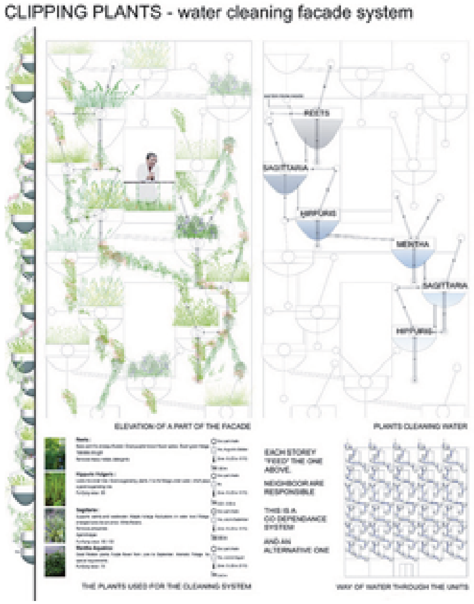


Water collecting

The Naturaire Biofilter is the result of over 10 years of research at the University of Guelph. The plant wall is actually an integrated part of the handling system for the building, Air is actively forced through the wall of plants and highly specialized biological components actively degrade pollutants such formaldehyde and benzene in the air into their benign constituents of water and carbon dioxide. The clean air is then distributed throughout the space by the mechanical system.
The biofilter improves the indoor environment through a number of ways; first in terms of its impact on the physical characteristics of the space (contaminant levels, temperature and humidity) and second, the aesthetic aspects of the biofilter. There are increasingly strong links between greening the indoor space and the well-being of the occupants. The inclusion of plants in the work environment reduced the stress levels, increased the productivity and reduced absenteeism. The Naturaire Living walls are extremely robust in their design and can be adapted to a wide range of retrofits or new building venues.
These active Living walls are an opportunity to improve the quality of the entire indoor environment not just air quality; potentially reduce the energy consumption of the building and improve the well-being of the occupants through both physical and psychological means.
Air from the room is cleaned by drawing it through the wet plant covered surface and then the cleaned air is returned to the room.



("Living Wall," 2007)



("Cliping Plants," 2011)

Loose medium walls tend to be "soil-on-a-shelf" or "soil-in-a-bag" type systems. Loose medium systems have their soil packed into a shelf or bag and then are installed onto the wall. These systems require their media to be replaced at least once a year on exteriors and approximately every two years on interiors. ("Green wall," 2012)

http://www.designbuzz.com/entry/clean-and-green-planter-wall-tiles-adds-meaning-to-your-decor/

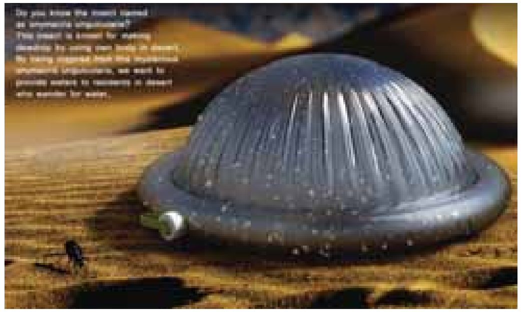
The Namibian Beetle

(Stenocara gracilipes) lives in one of the driest deserts in the world, the Namib on the southwest coast of Africa, but obtains all of the water it needs from ocean fog due to the unique surface of its back. Microscopic bumps with hydrophilic (water attracting) tips and hydrophobic (water repelling) sides cover its hardened forewings, which it aims at oncoming fog each morning. Water droplets materialize out of thin air on its back, then slide down channels into its awaiting mouth. Synthetic surfaces mimicking the beetle's back have been created that are several times more effective than existing fog-catching nets, and could be used to generate clean freshwater supplies in arid regions, refugee camps, and at the tops of skyscrapers, requiring no pumping.

("Water vapor harvesting: Namib desert beetle," 2012)

Dew Bank Bottle

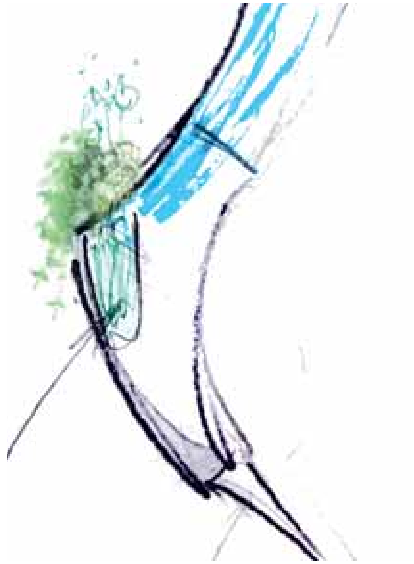
Is made is such a way that the steel body helps to assimilate the morning dew and channel it into the bottle immediately.

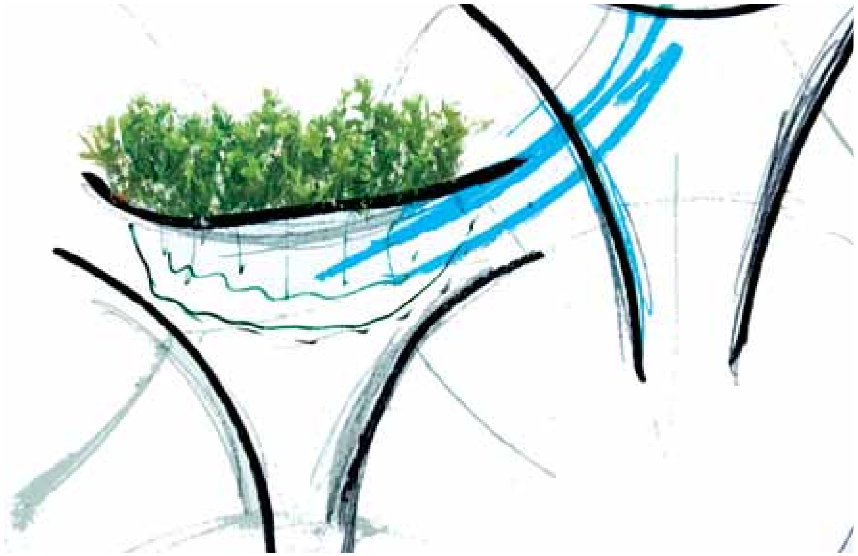


("Dew Bank Bottle," 2010)

http://greenforcesolar.com.au/wordpress/news/water-from-air-what-will-they-think-of-next/

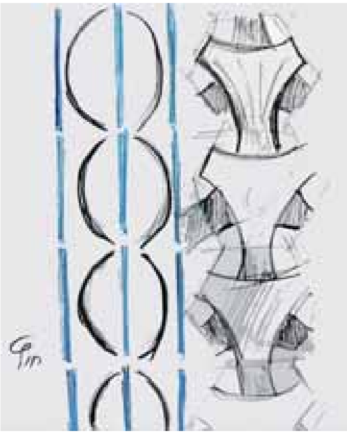
Another function of the facade is the ability to collect dew and rain water which passes through biofiltration system of the facade and can be reused in the building.

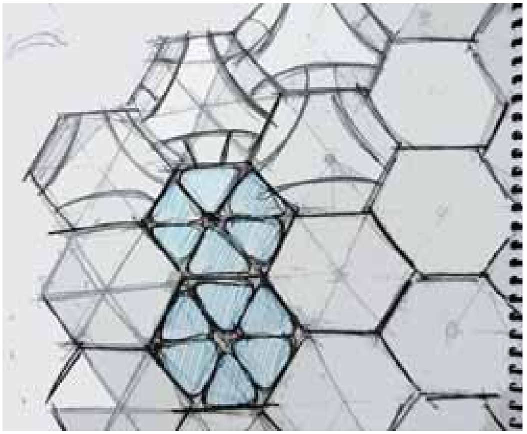


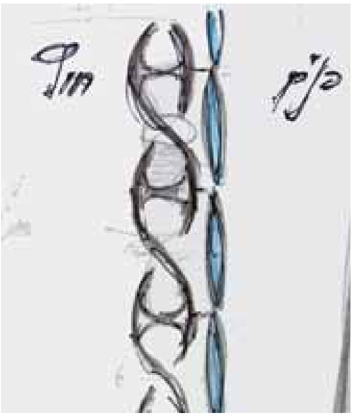


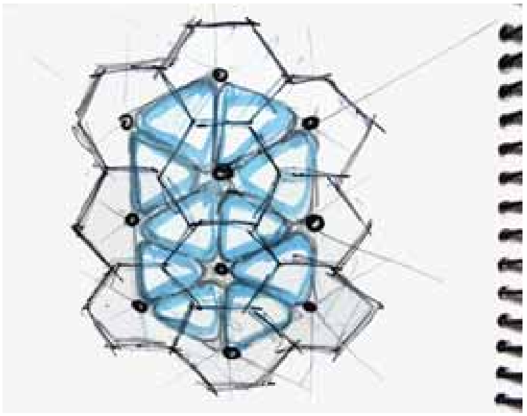
Thermal insulation

Membrane insulation “bubbles” separately from the hexagonal structure.

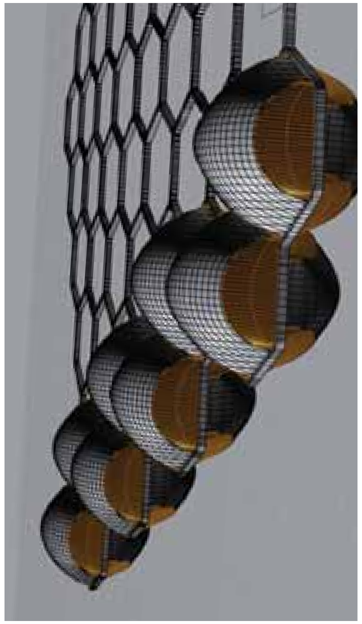


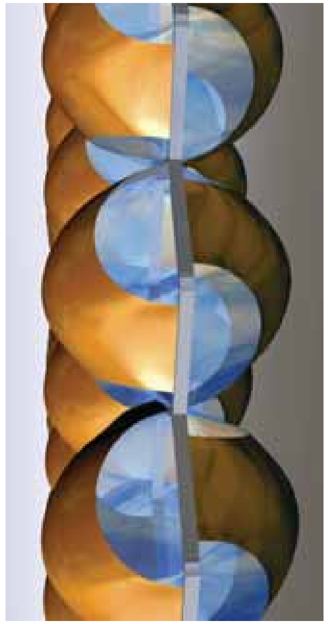


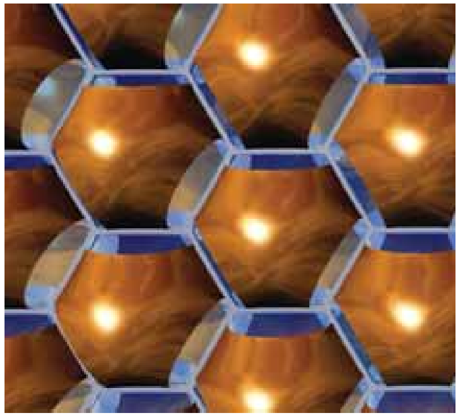


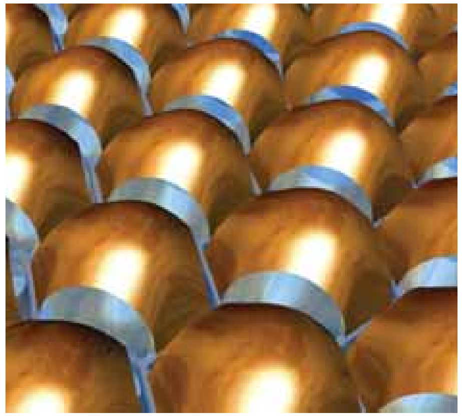


Locking air by adding hexagonal frames and closing the gaps between the domes and the frame with transparent membrane.

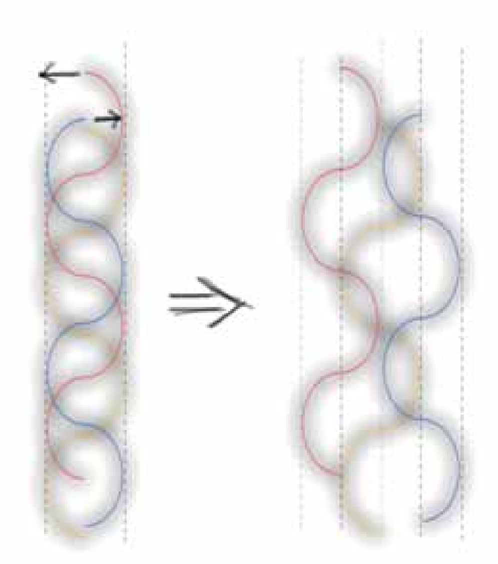


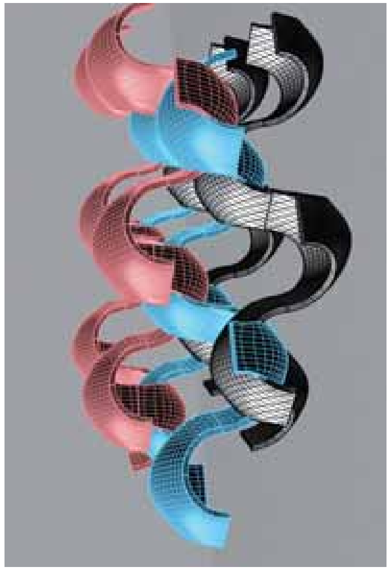


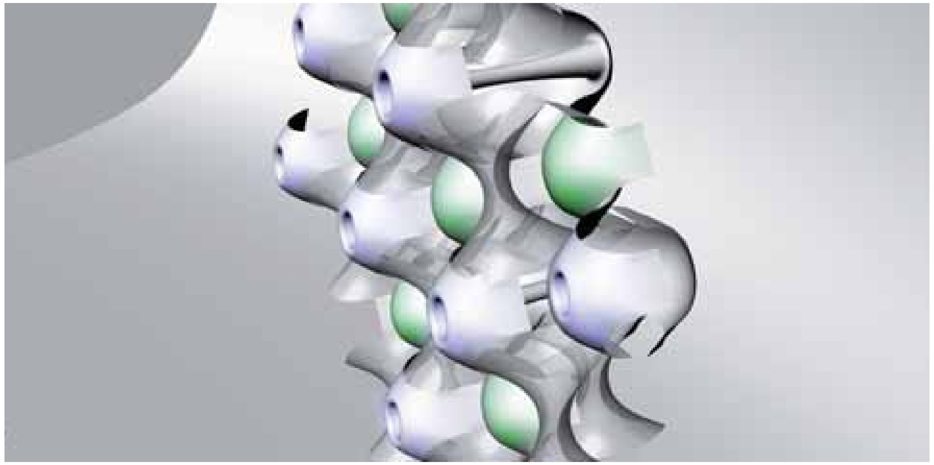


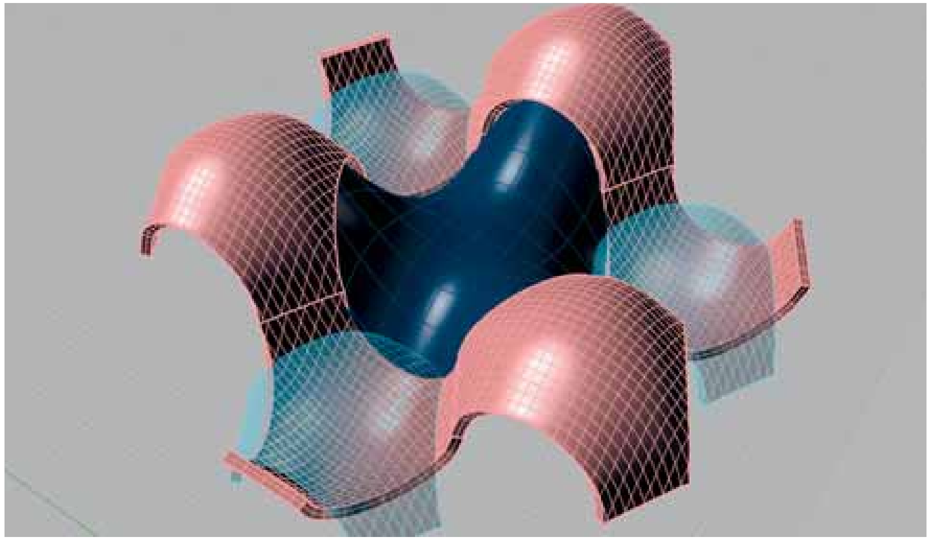


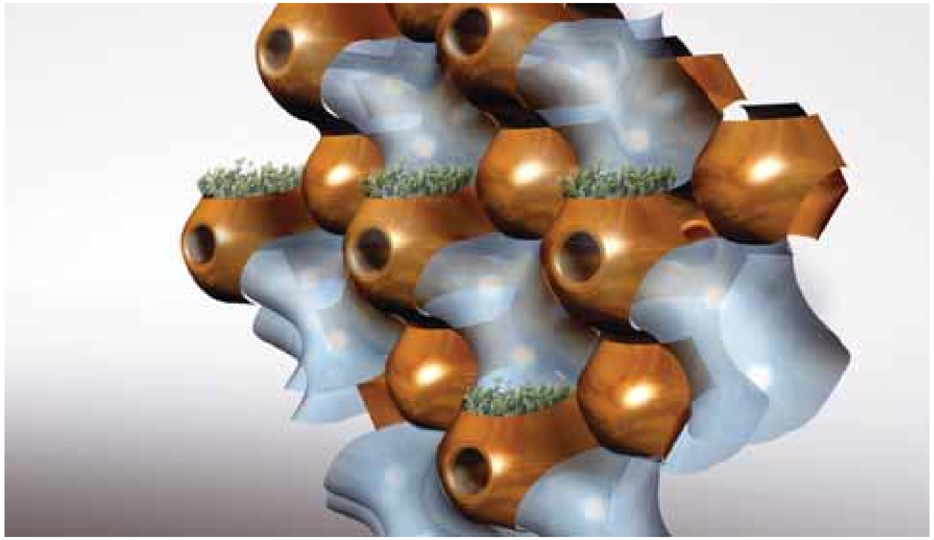
In the final version the gaps between the structural members were closed with three layers of transparent ETFE membranes, which allowed light penetrating through the facade, while providing thermal insulation.



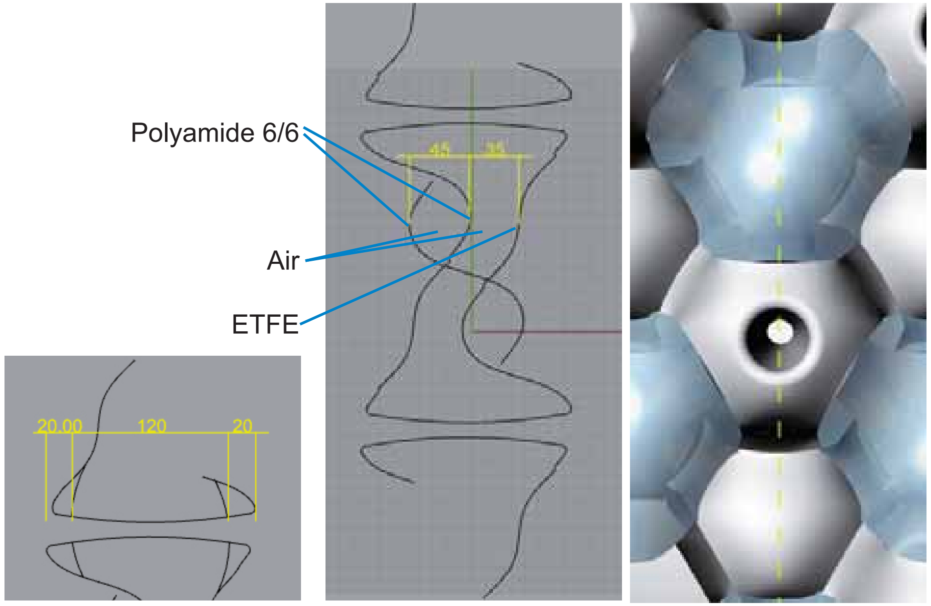


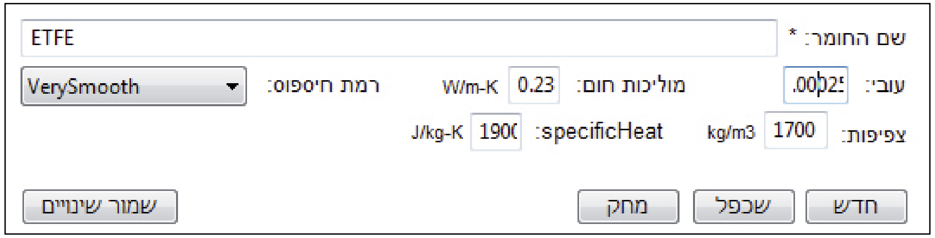






Thermal insulation analysis

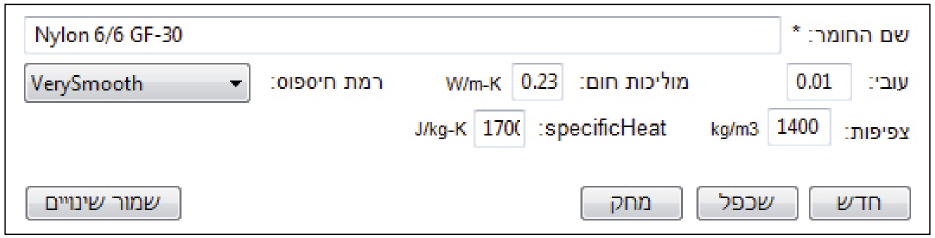




שם החומר: *	ETFE
עובי:	.00025
מוליכות חום:	0.23 W/m-K
רמת חיספוס:	VerySmooth
צפיפות:	1700 kg/m3
specificHeat:	1900 J/kg-K

חדש | שכפל | מחק | שמור שינויים

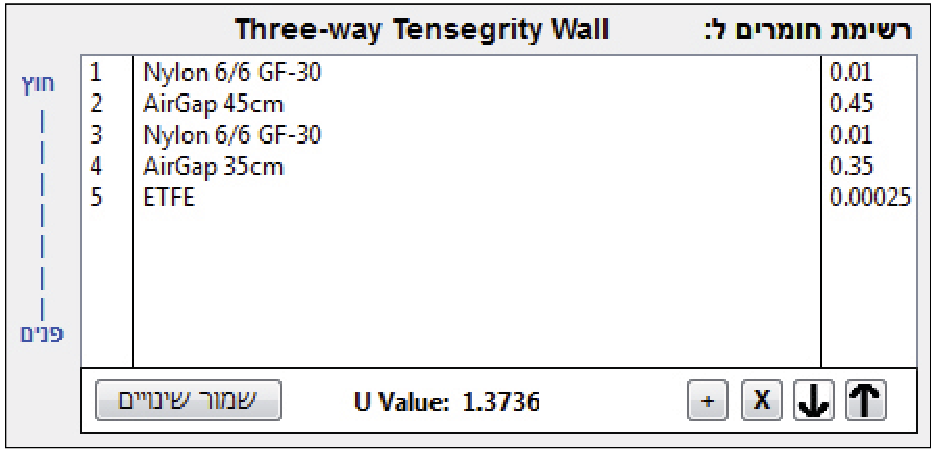
("ETFE Properties | Fluorotherm.com," n.d.)



שם החומר: *	Nylon 6/6 GF-30
עובי:	0.01
מוליכות חום:	0.23 W/m-K
רמת חיספוס:	VerySmooth
צפיפות:	1400 kg/m3
specificHeat:	1700 J/kg-K

חדש | שכפל | מחק | שמור שינויים

("Polyamide - Nylon 6,6 - 30% Glass Fibre Reinforced (PA 6,6 30% GFR)," 2012)
("Thermal Properties of Plastic Materials," 2012)



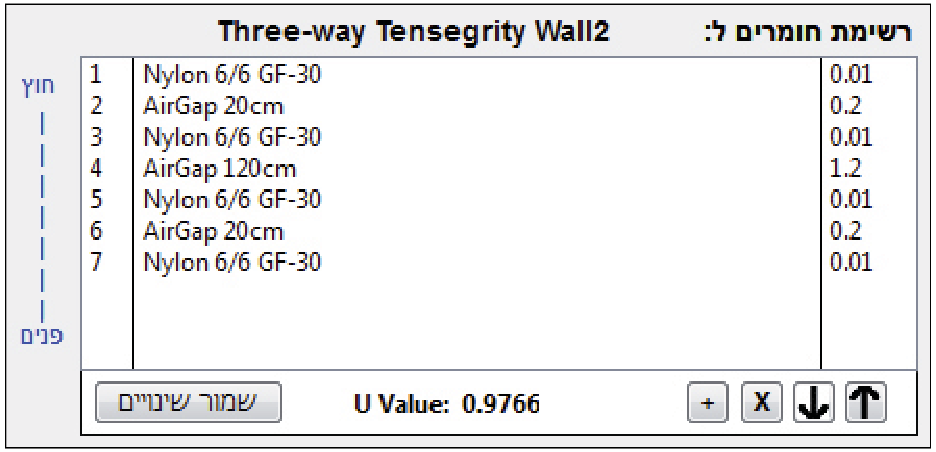
רשימת חומרים ל: Three-way Tensegrity Wall

חוץ

1	Nylon 6/6 GF-30	0.01
2	AirGap 45cm	0.45
3	Nylon 6/6 GF-30	0.01
4	AirGap 35cm	0.35
5	ETFE	0.00025

פנים

שמור שינויים | U Value: 1.3736



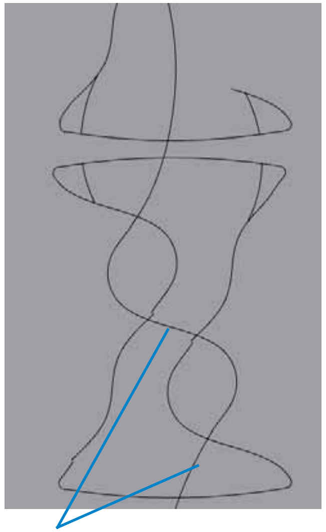
רשימת חומרים ל: Three-way Tensegrity Wall2

חוץ

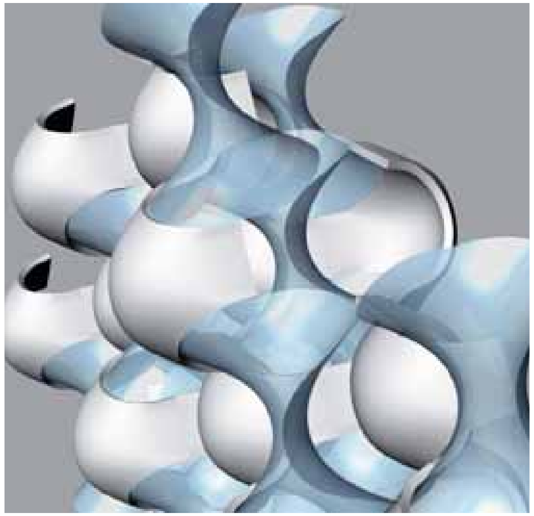
1	Nylon 6/6 GF-30	0.01
2	AirGap 20cm	0.2
3	Nylon 6/6 GF-30	0.01
4	AirGap 120cm	1.2
5	Nylon 6/6 GF-30	0.01
6	AirGap 20cm	0.2
7	Nylon 6/6 GF-30	0.01

פנים

שמור שינויים | U Value: 0.9766



Additional ETFE layer



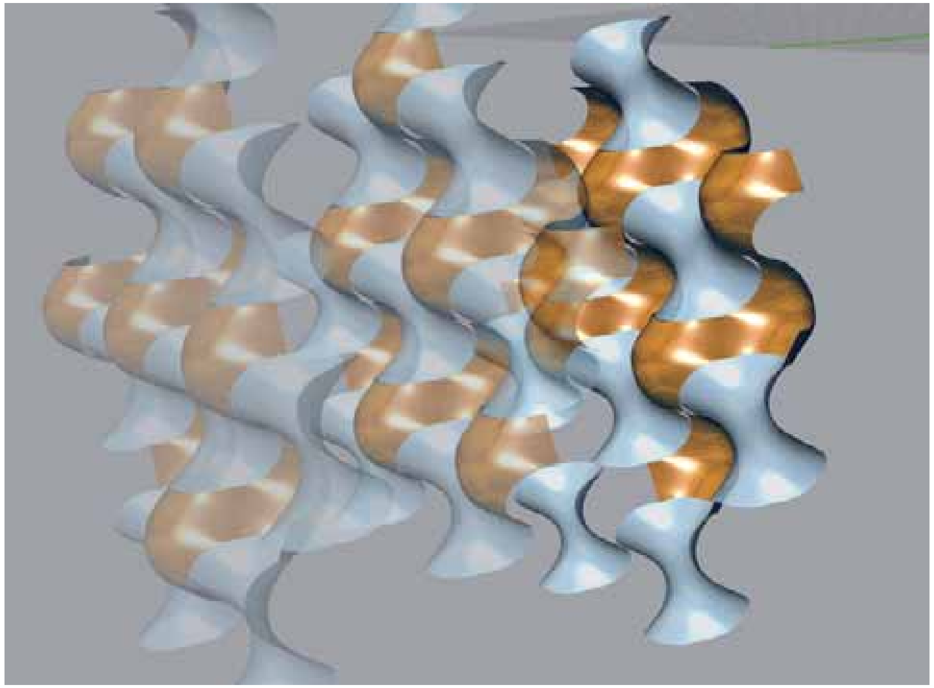
Three-way Tensegrity Wall 3 **רשימת חומרים ל:**

חוץ — פנים

1	Nylon 6/6 GF-30	0.01
2	AirGap 20cm	0.2
3	Nylon 6/6 GF-30	0.01
4	AirGap 60cm	0.6
5	ETFE	0.00025
6	AirGap 60cm	0.6
7	Nylon 6/6 GF-30	0.01
8	AirGap 20cm	0.2
9	Nylon 6/6 GF-30	0.01

שמור שינויים **U Value: 0.7843** + X

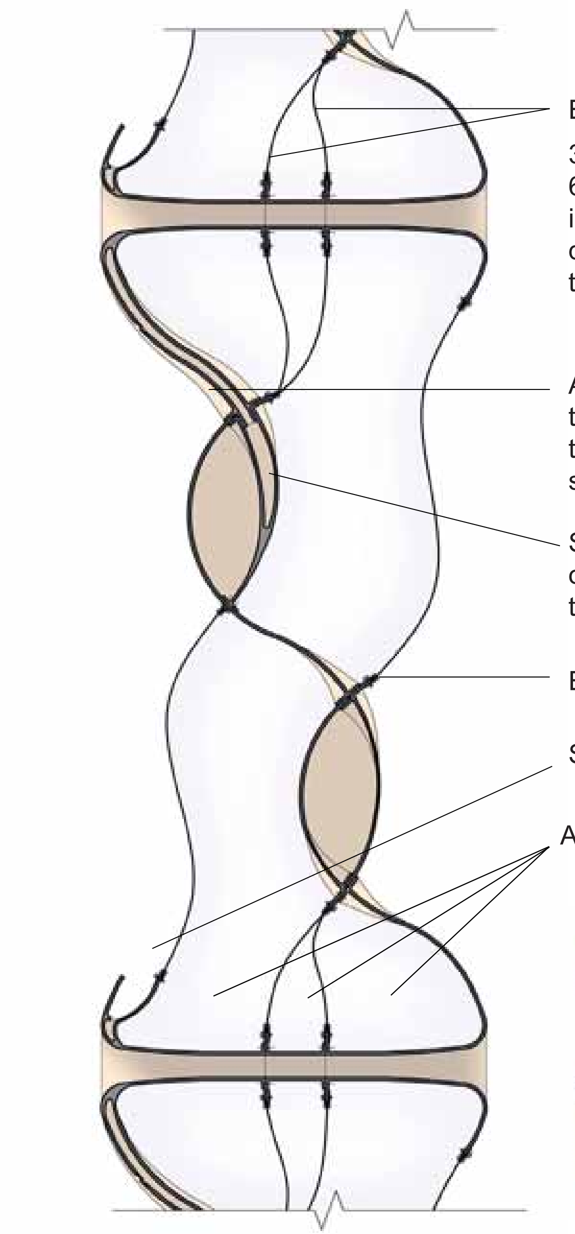
U Value: 0.9766



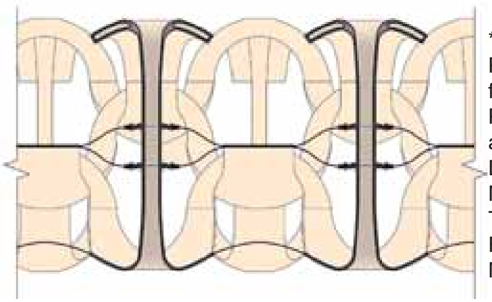
Ext Wall - A-B-5282-1-1-ytong **רשימת חומרים ל:**

1	Cement Mortar	0.025
2	Ytong-650	0.2
3	Lime-Cement Mortar	0.02

שמור שינויים **U Value: 0.8327** + X



Facade section

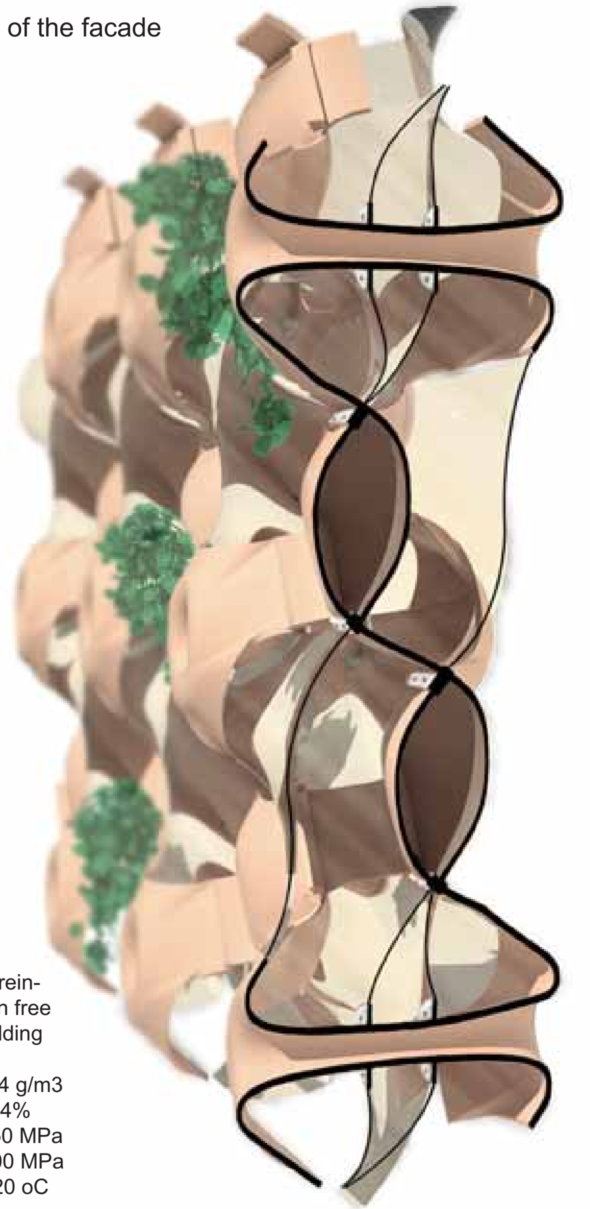


Facade plan

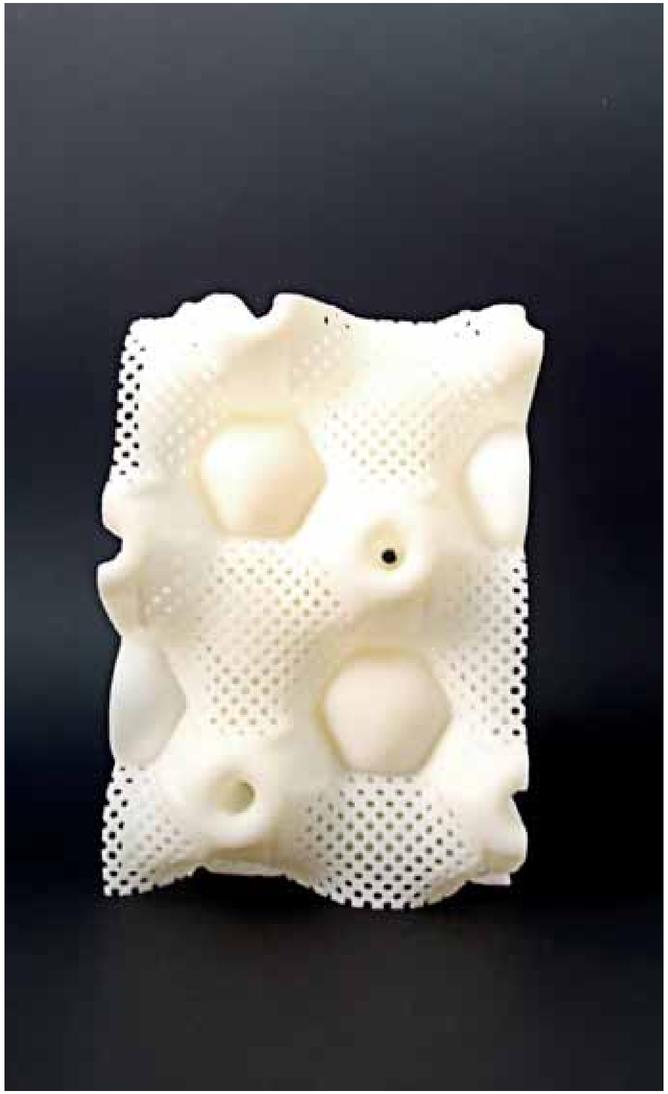
*Nylon 6/6
Properties for 30% glass fiber reinforced flame retardant, halogen free Polyamide 6/6 for injection molding applications:

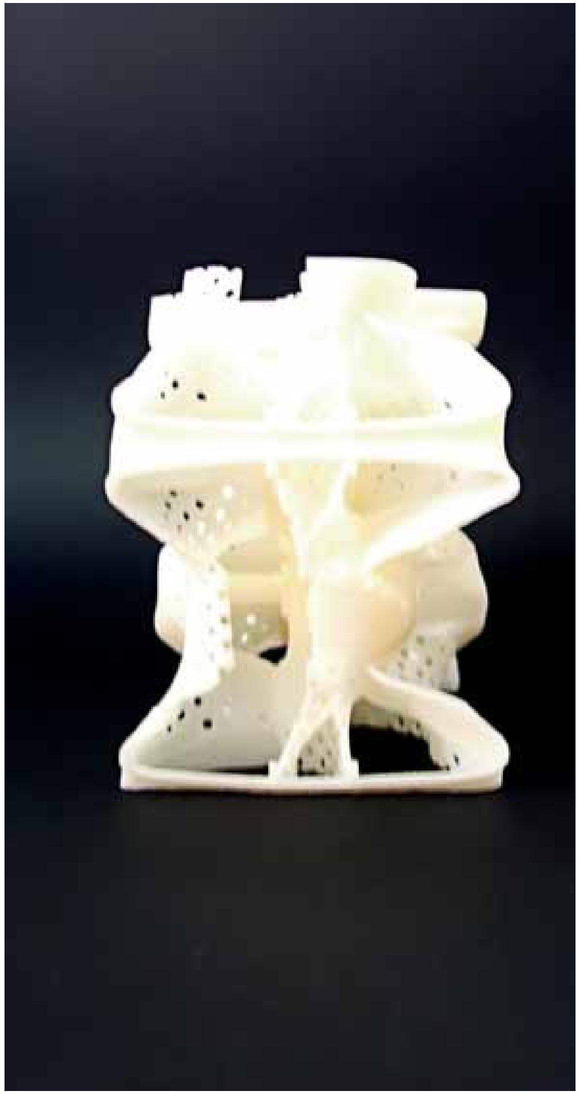
Density -	1.4 g/m3
Mould shrinkage -	0.4%
Tensile yield strength -	150 MPa
Flexural strength -	200 MPa
Max temp continuous use -	120 oC

Final look of the facade



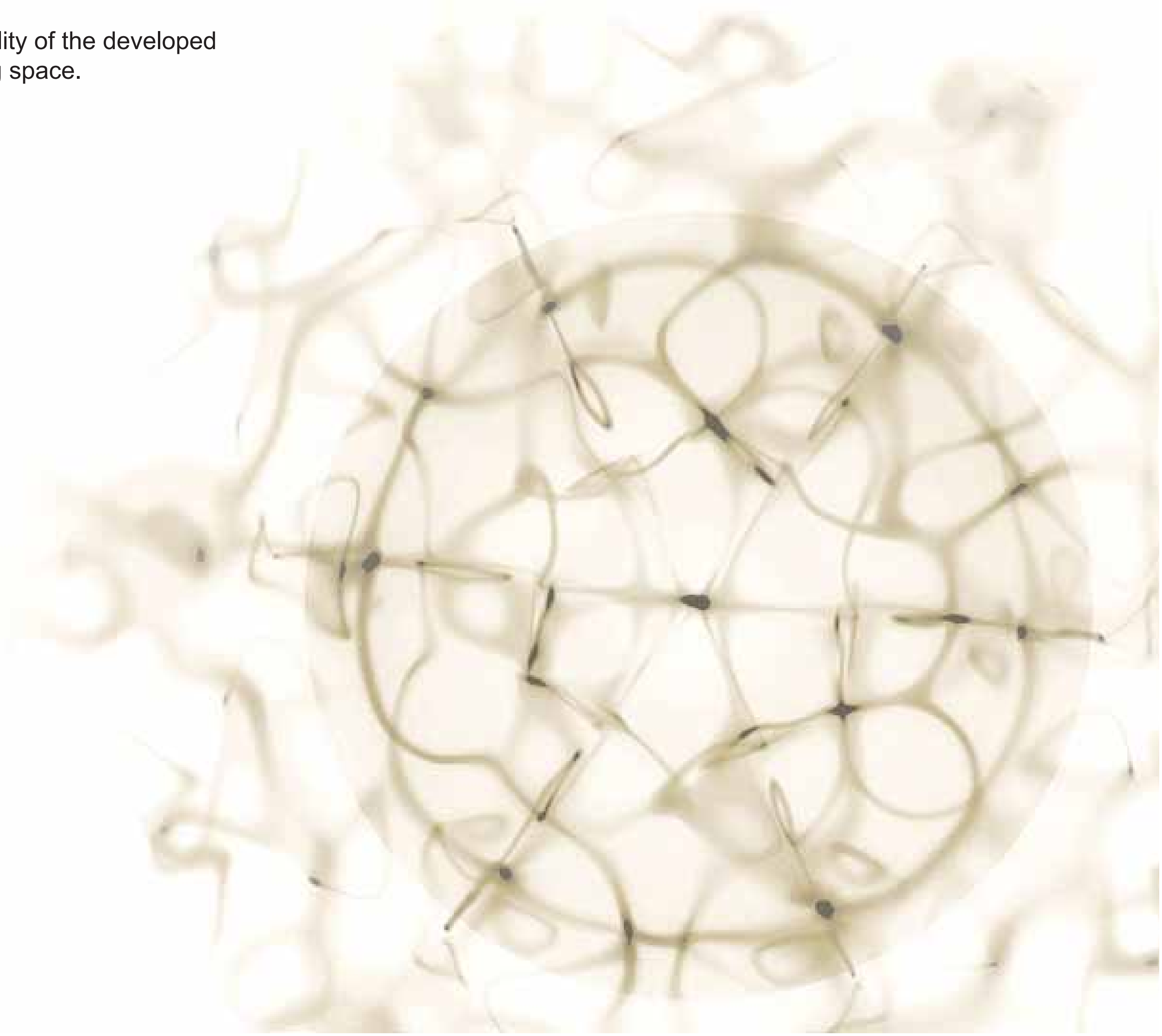
Facade Model



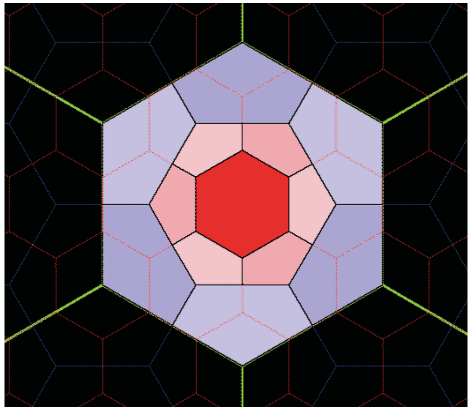
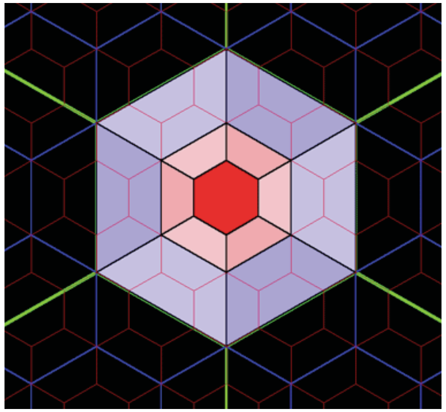


Cellular spaces latticce

The goal of this step was to challenge the functional flexibility of the developed geometry by bringing it’s module to the scale of an building space.



As soon as the geometry is based on a hexagonal grid, the research started from checking different types of hexagonal tesselations, searching for a set of rules that will be able to determine the form and the connections between the cells according to the building's program.

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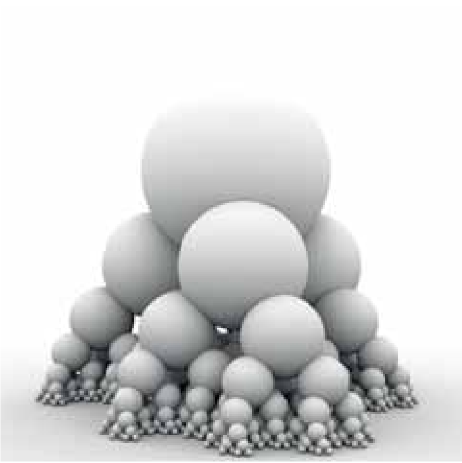
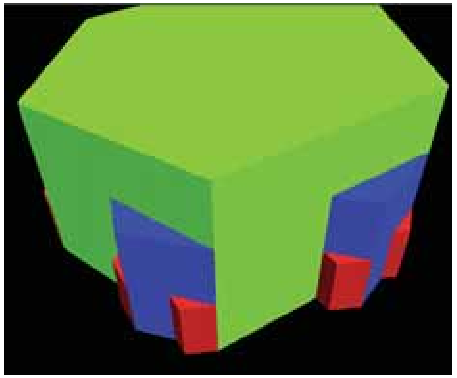


http://fc00.deviantart.net/fs38/i/2008/343/0/5/Bubble_pyramid_by_subblue.jpg

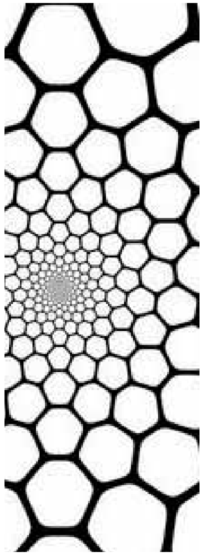


http://www-personal.umich.edu/~copyrght/image/solstice/sum04/sampler/index.html

In early stages the idea was to achieve structural unity by one single system both for the facade and for the building spaces.

Examination of the Fibonacci series was an important step in understanding the morphology of hexagonal grid.

The answer for creating the pattern below, was found in Voronoi diagram. As soon as the "relaxed" voronoi diagram generates an hexagonal grid, certain correct orders of control points used for Voronoi diagram allow generating hexagonal grids with variable cell sizes.



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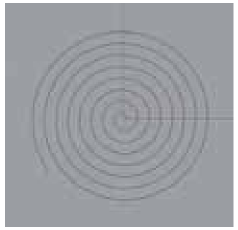
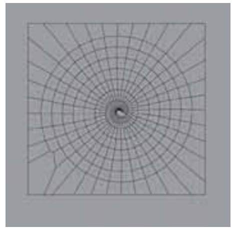
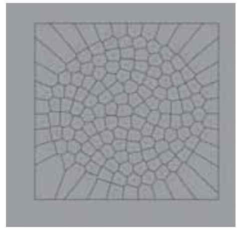
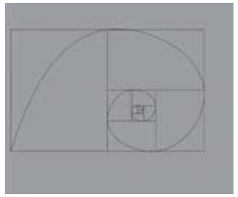
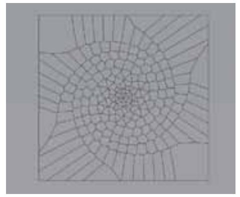
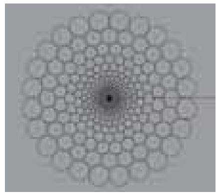
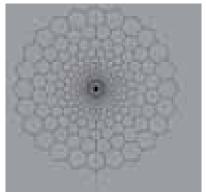
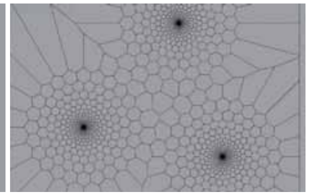
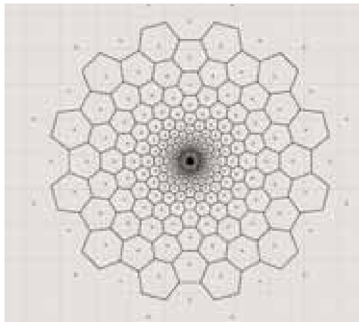
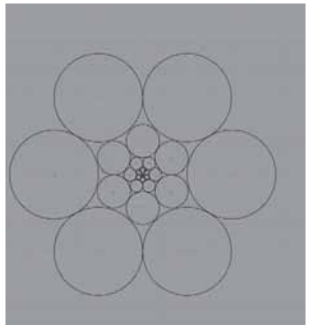
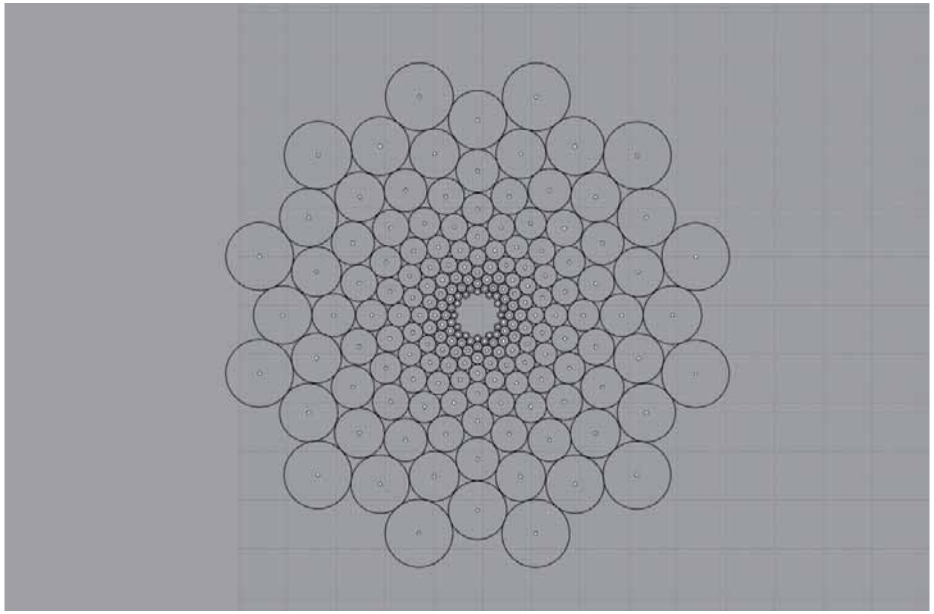
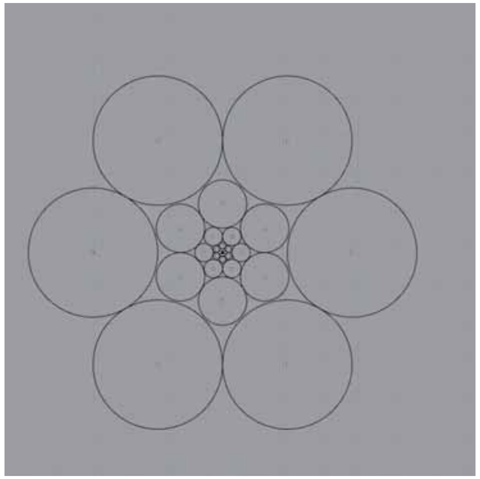
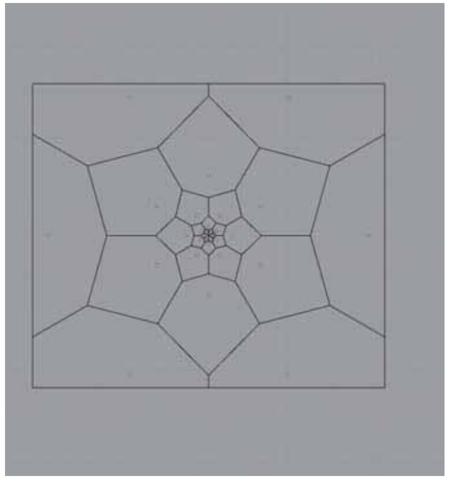
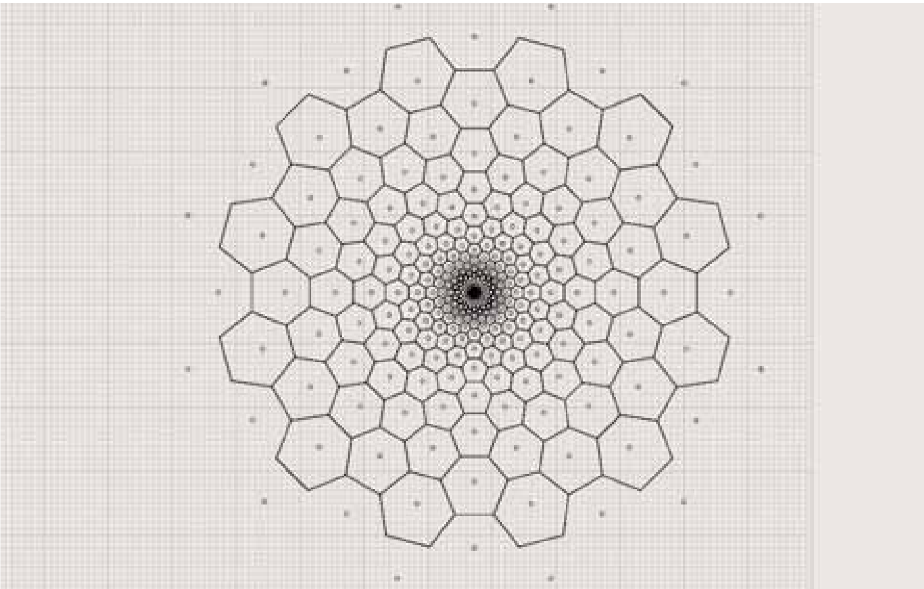





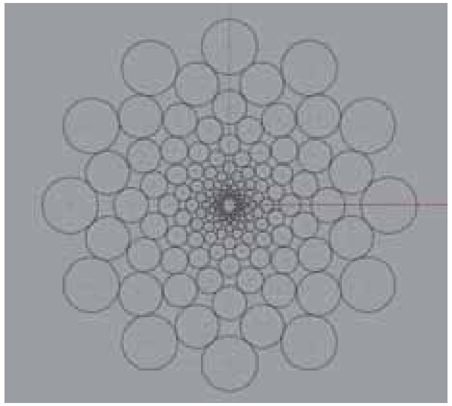







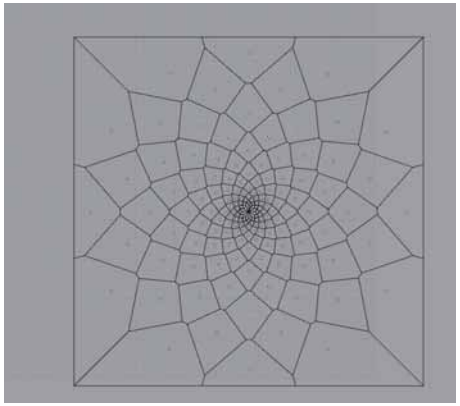






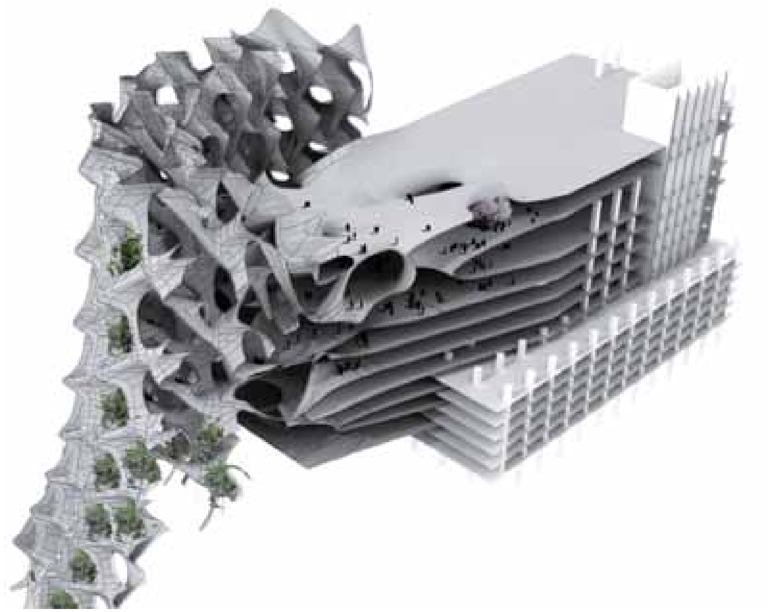






TINGWEI xu & XIE zhang

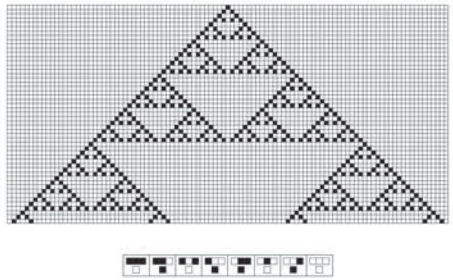
A surface system that can reveal a continually changing expression. The transforming surface can combine the multiple functions such as waterproof, lighting and agricultural planting. Rather than a traditional hierarchy design thinking, each component on the surface has equal essentiality. It is a irreducible integrity.



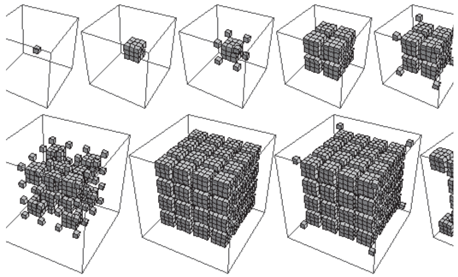
("suckerPUNCH » Membrane-Proposal for New York Sea Level Rising," 2012)

Cellular Automata

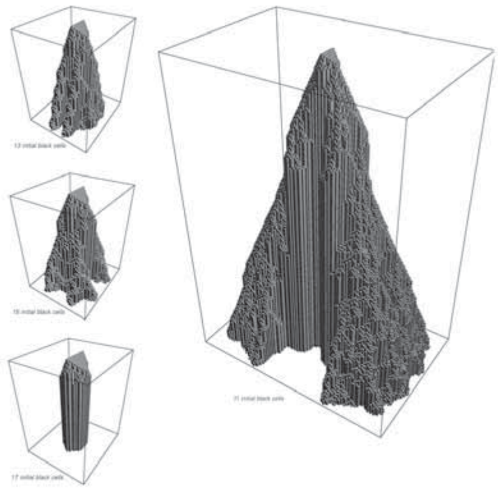
Two-dimensional:



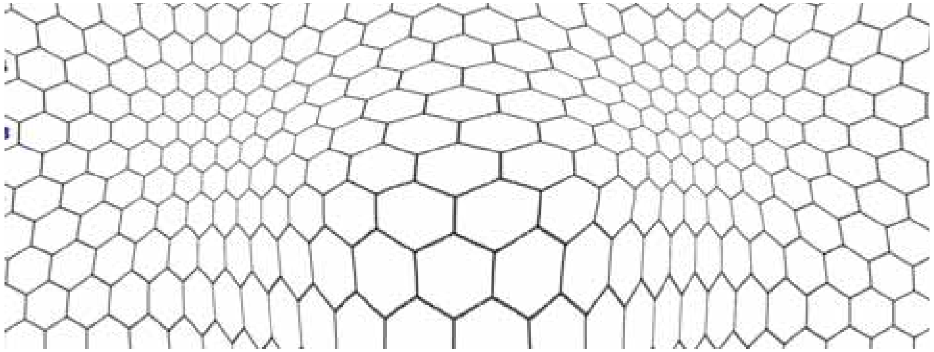
Three-dimensional:

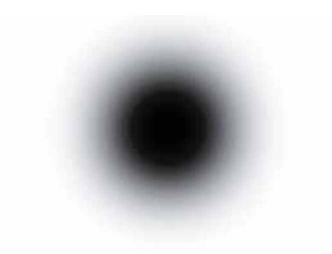


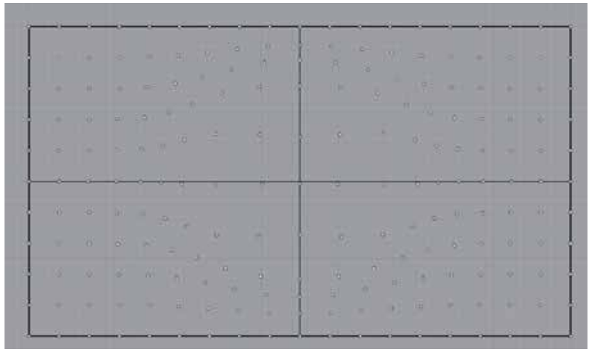
For a 1D cellular automaton, being able to see the time history explicitly down the page is really useful. In 2D the analog is a 3D history:

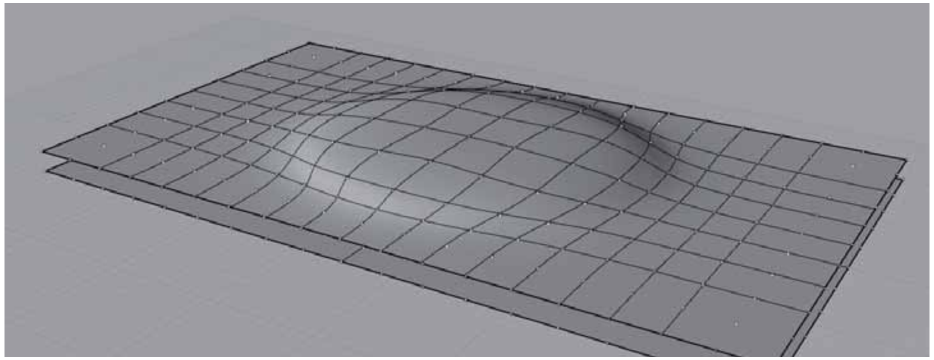


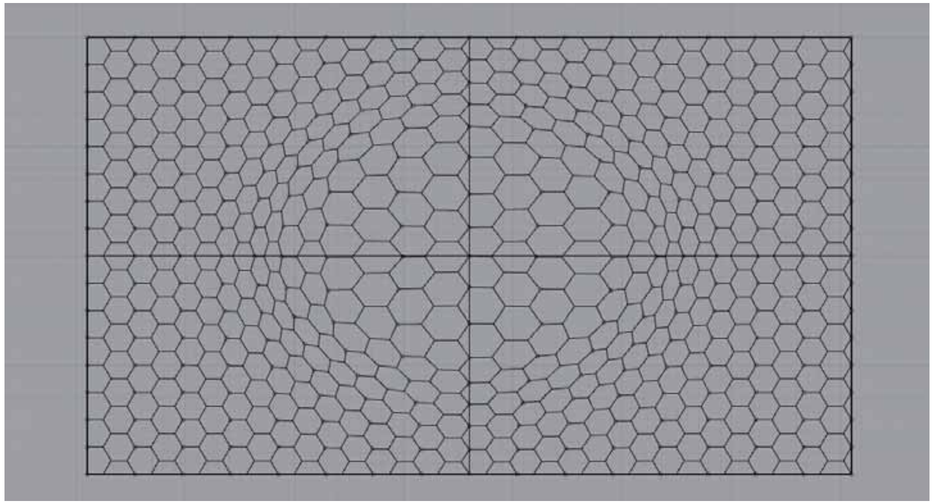
("The Generation of Form in A New Kind of Science," 2012)

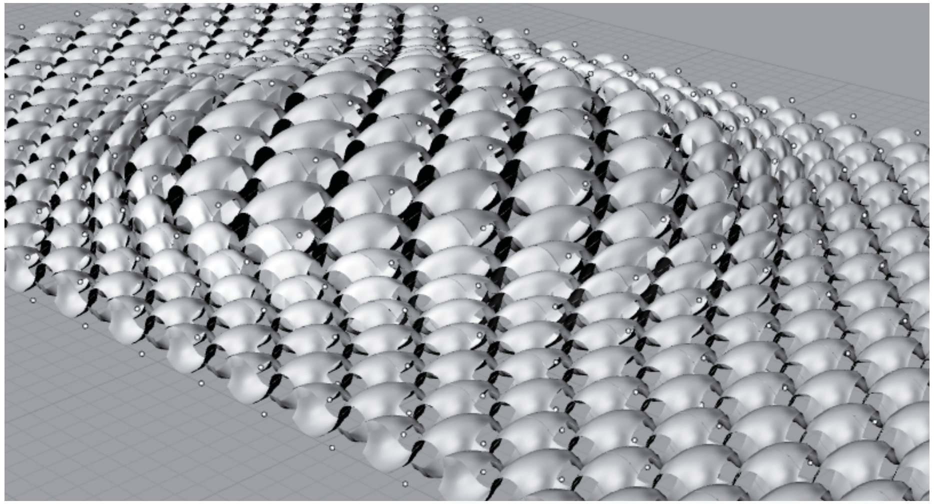


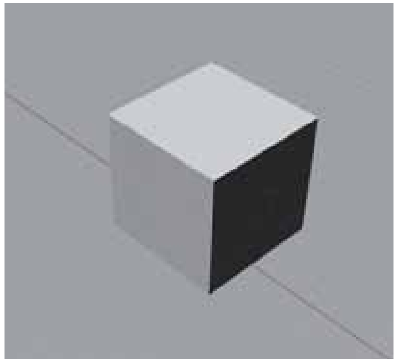


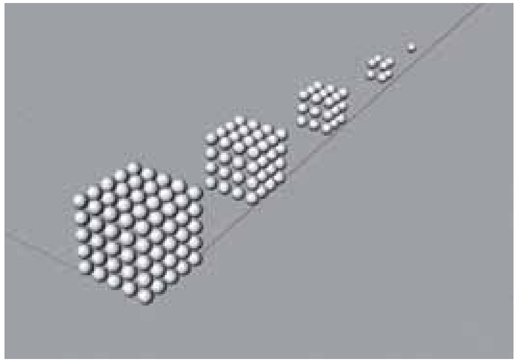


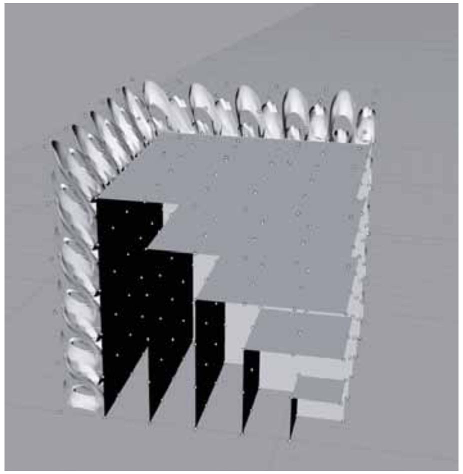


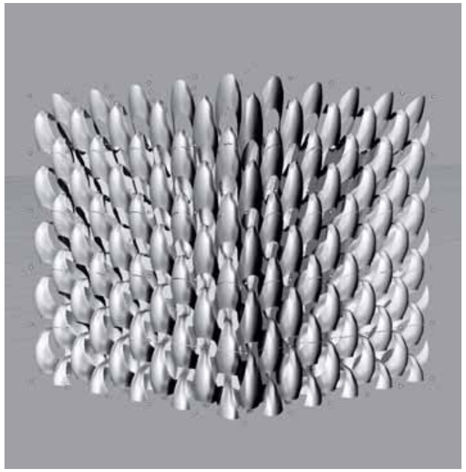


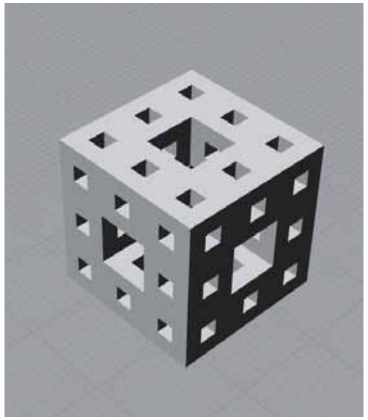


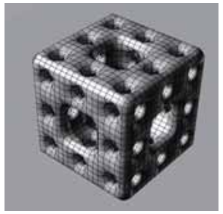


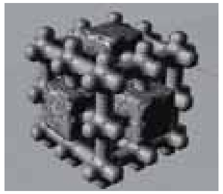


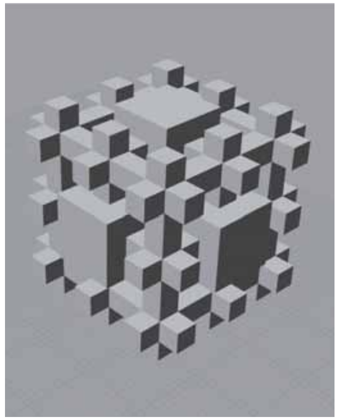


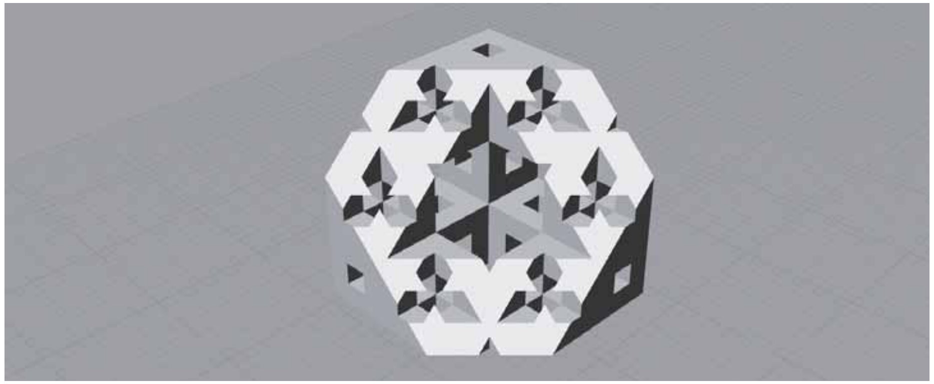


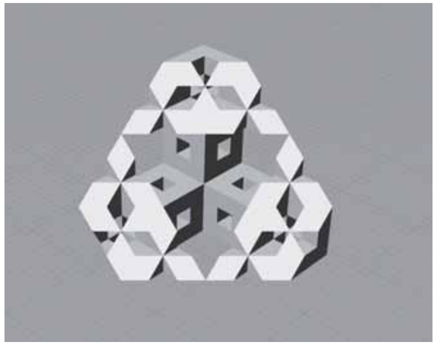


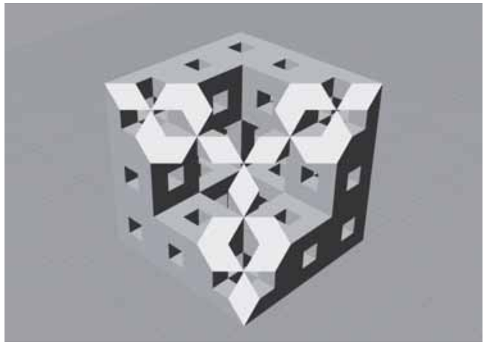


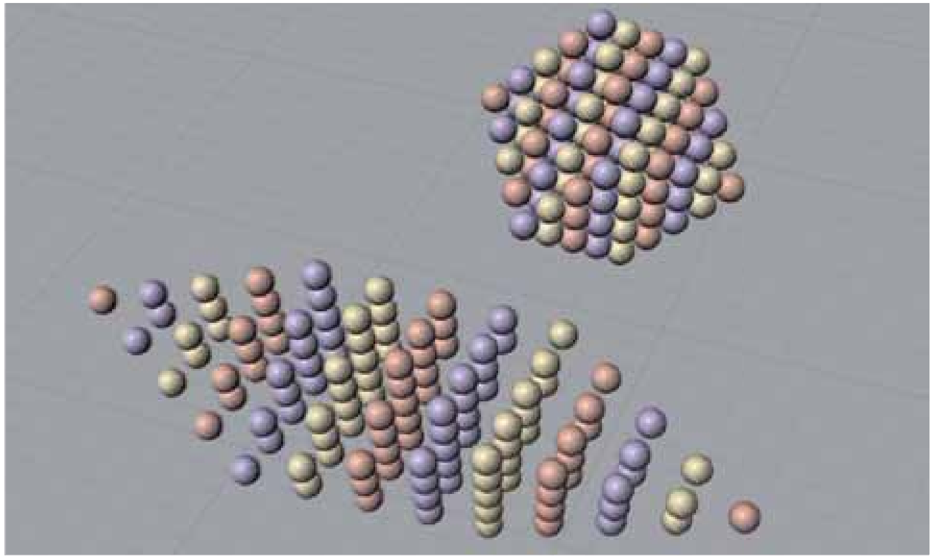


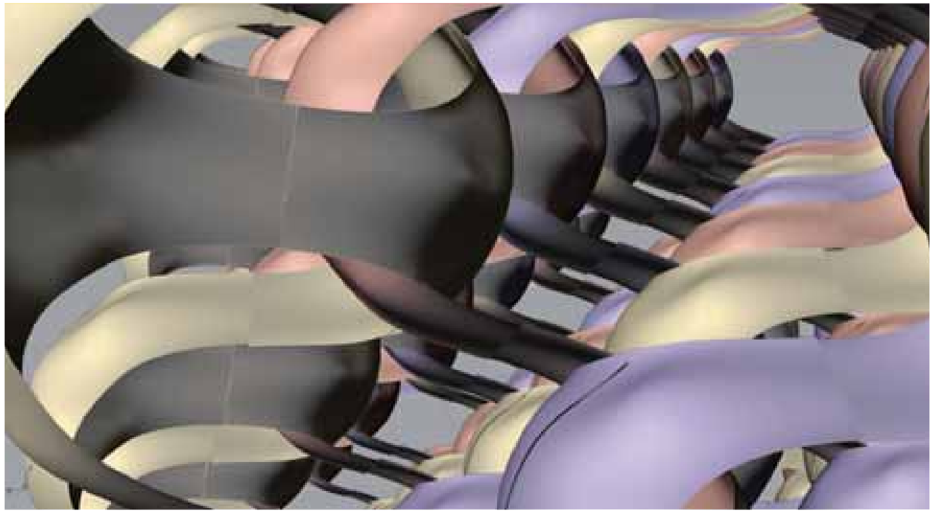


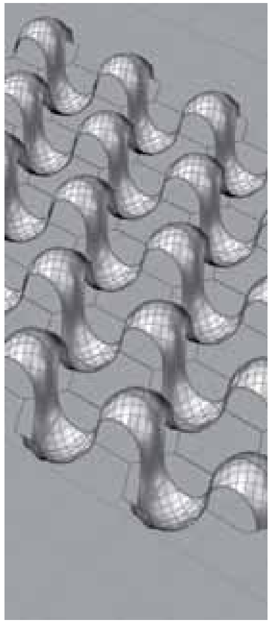


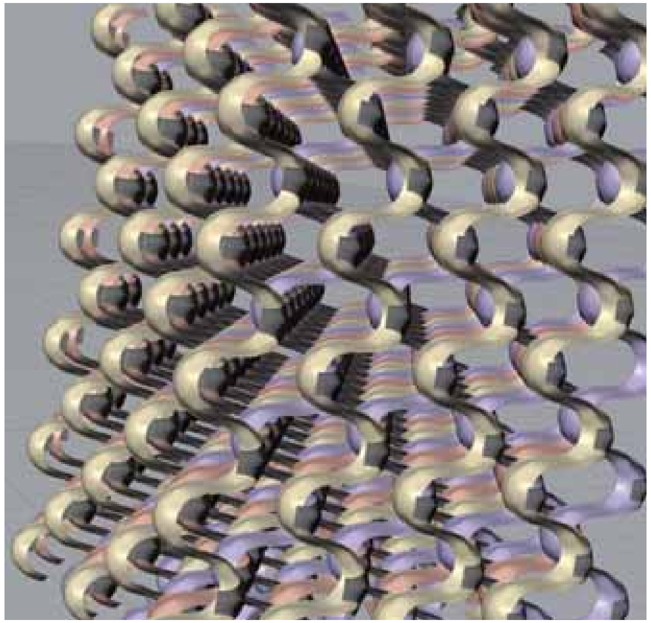


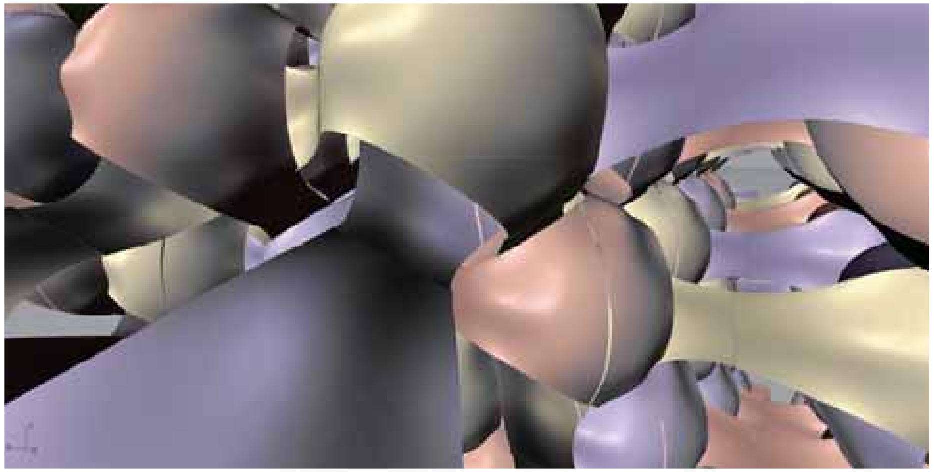


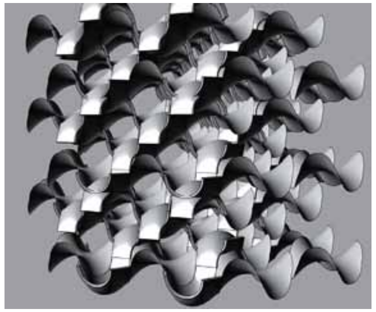
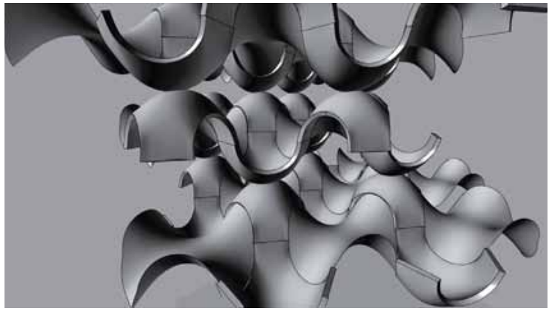
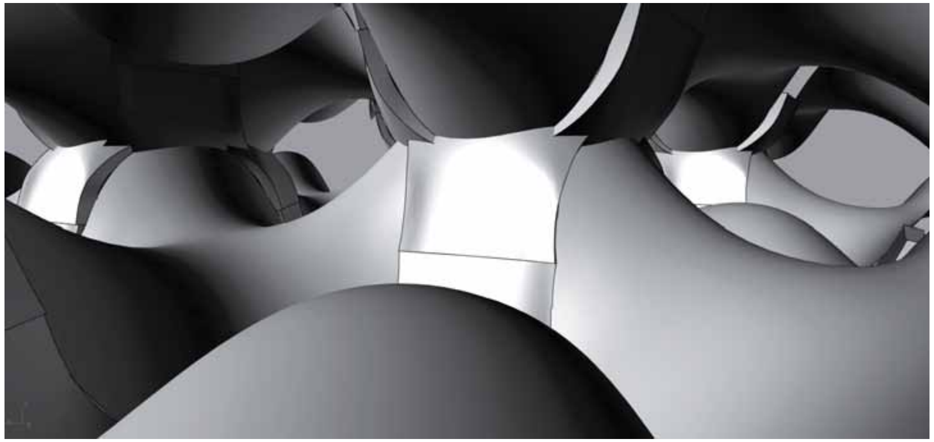
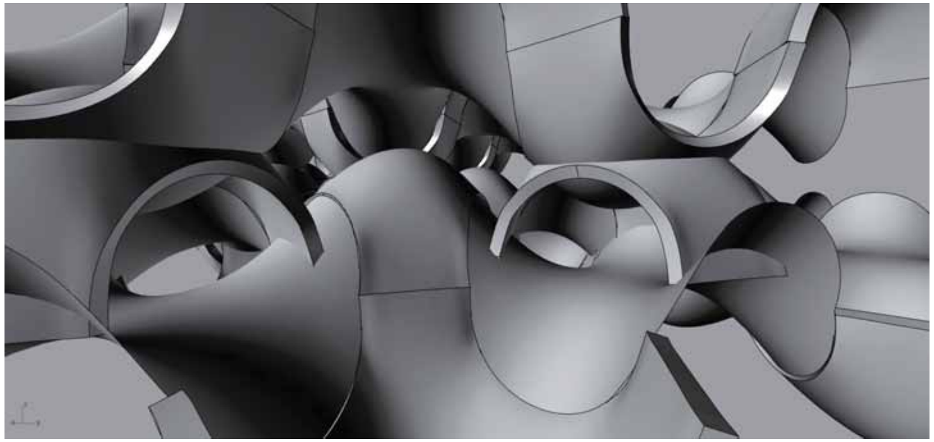
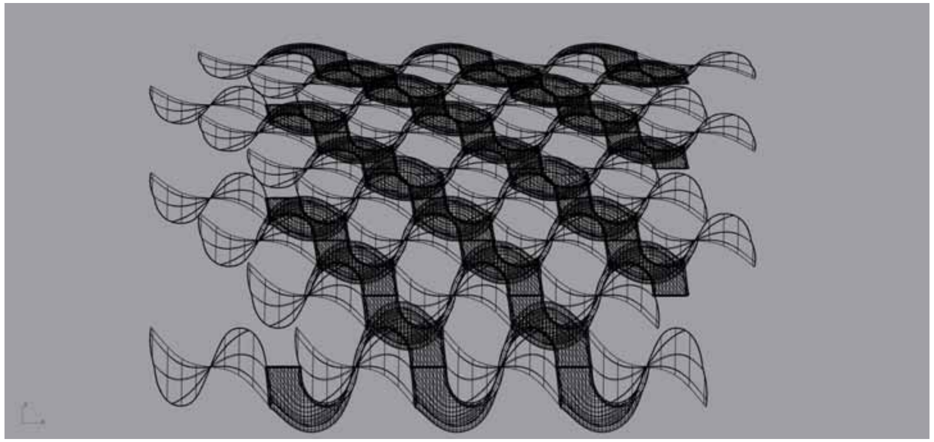
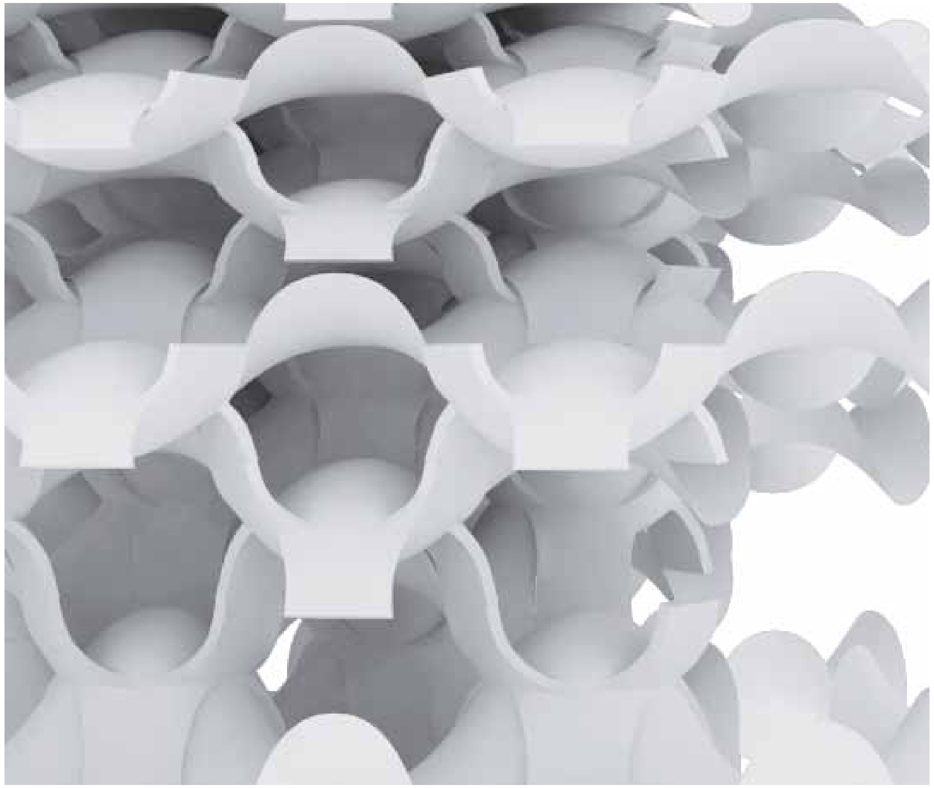




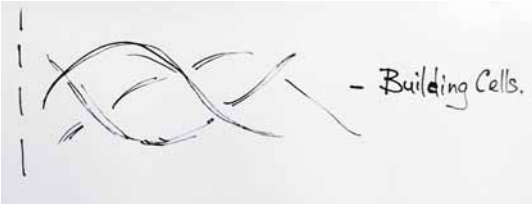


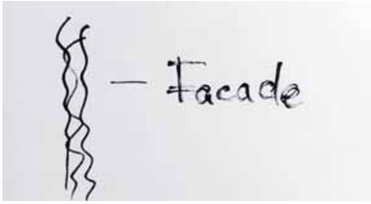


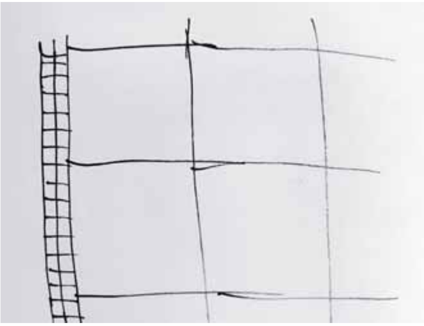


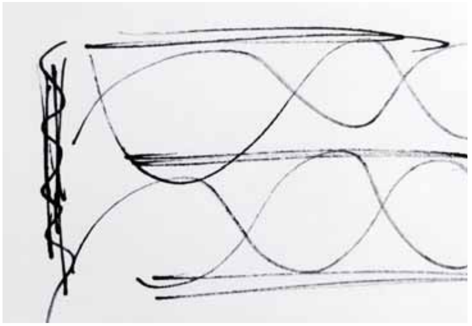







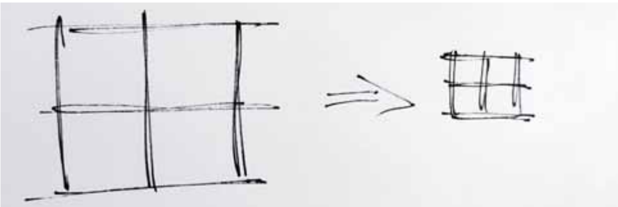
In early stages the idea was to achieve structural unity by one single system both for the facade and for the building spaces.

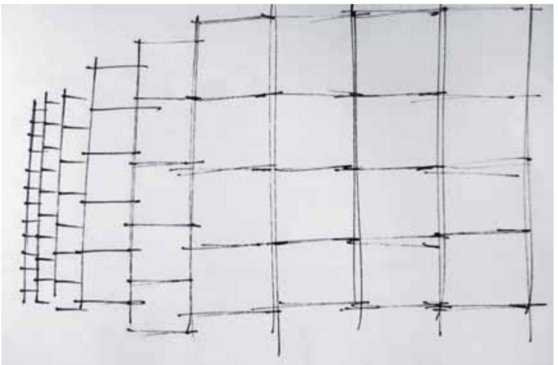


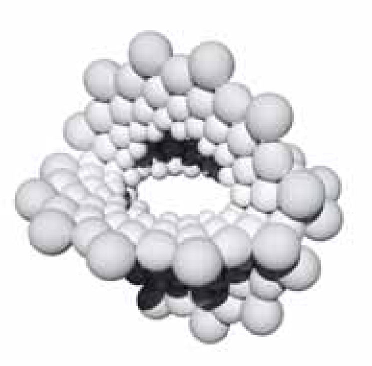


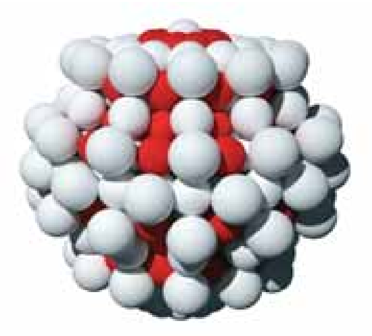


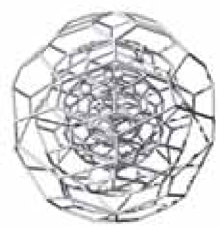


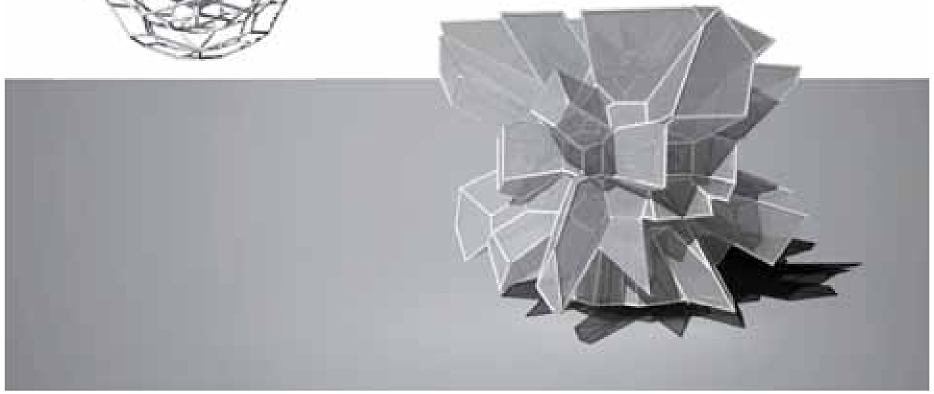


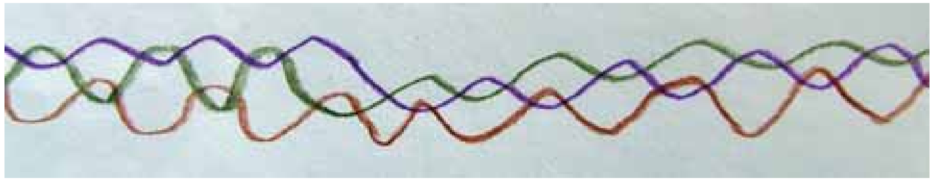


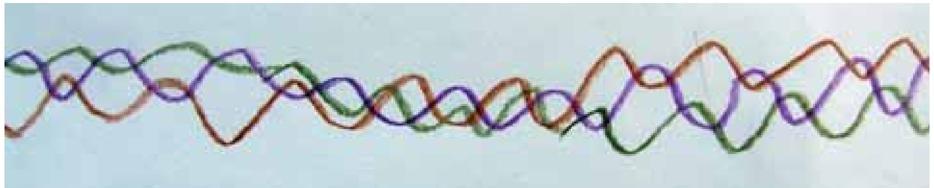


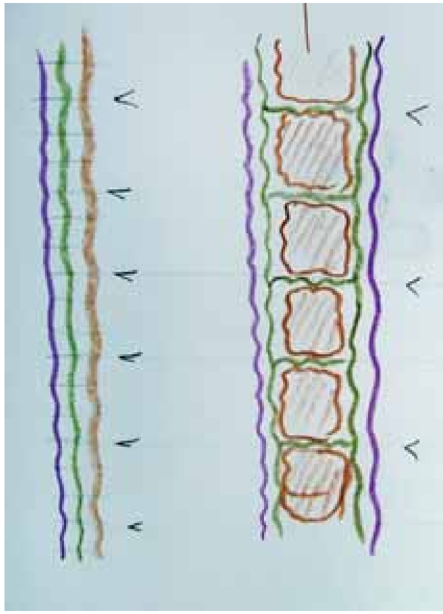


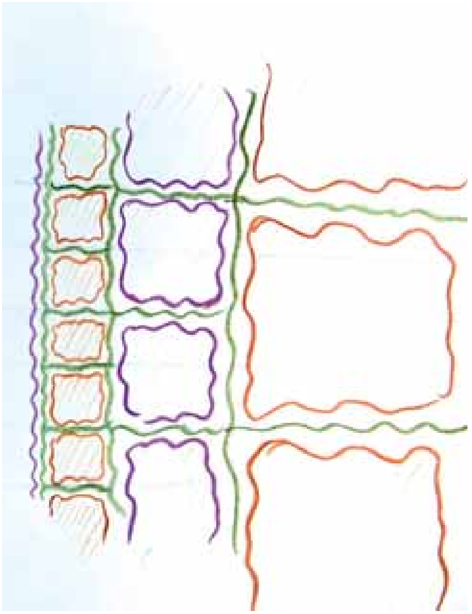


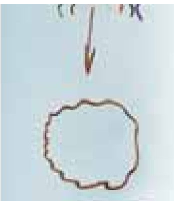


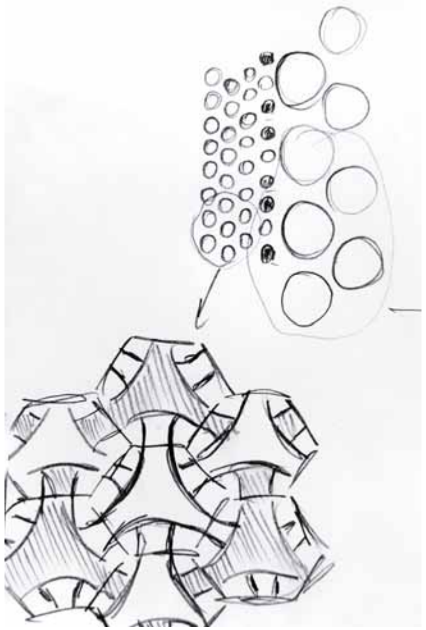


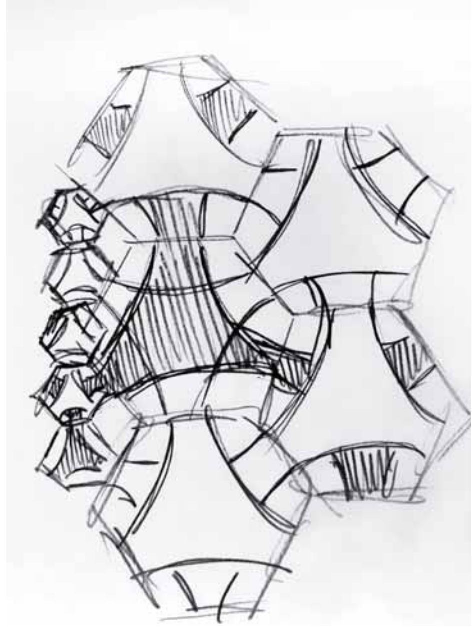




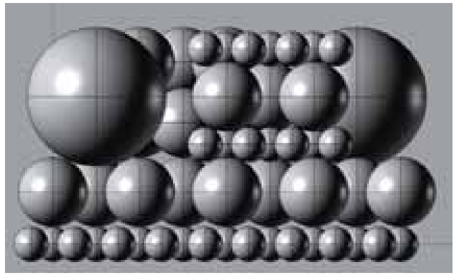




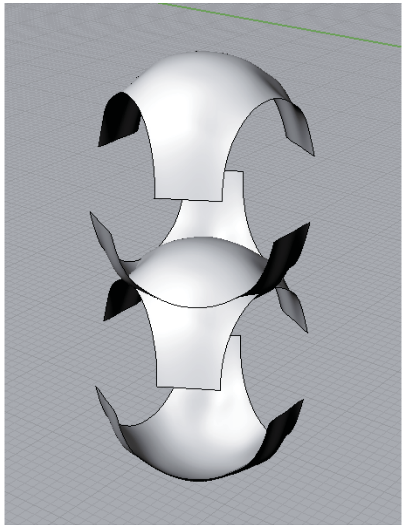
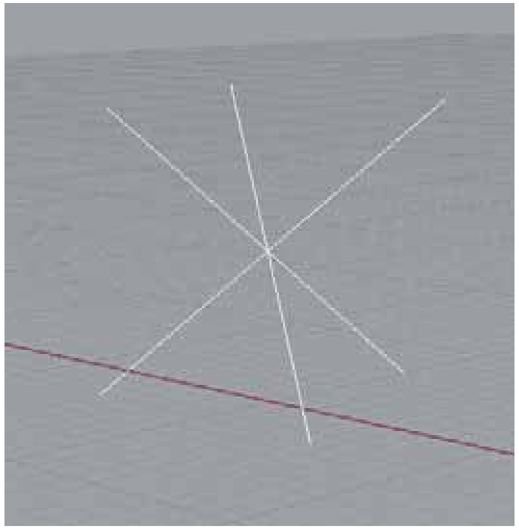




Unfortunately, creating a smooth transaction between the systems on two different scales would create also large transactional areas, useless for the building.

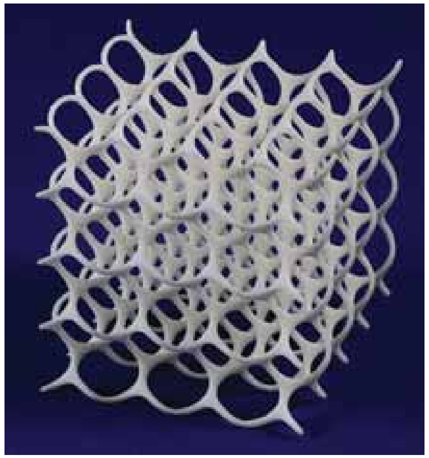
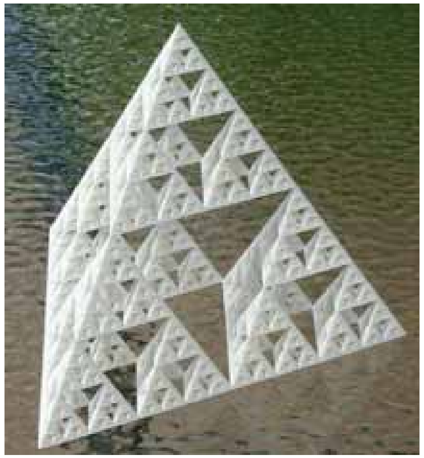


Other Variations of the geometry

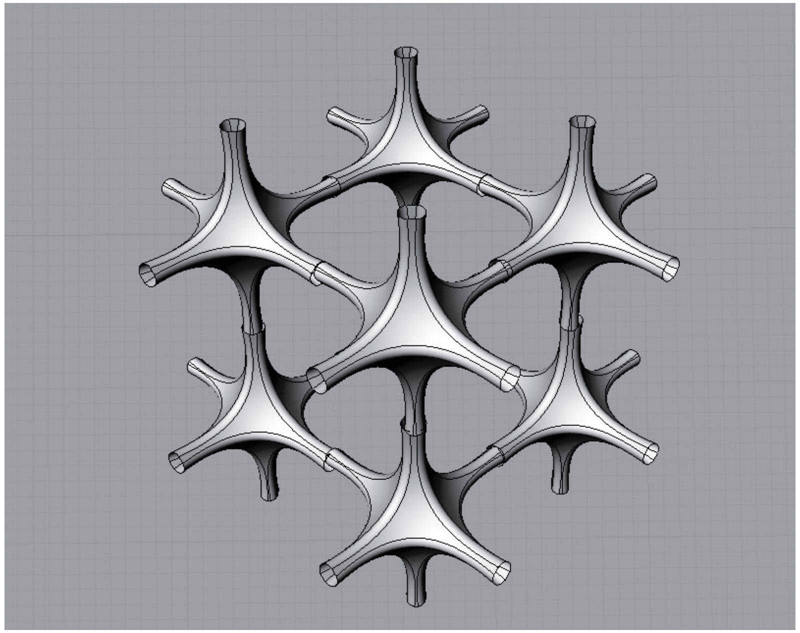



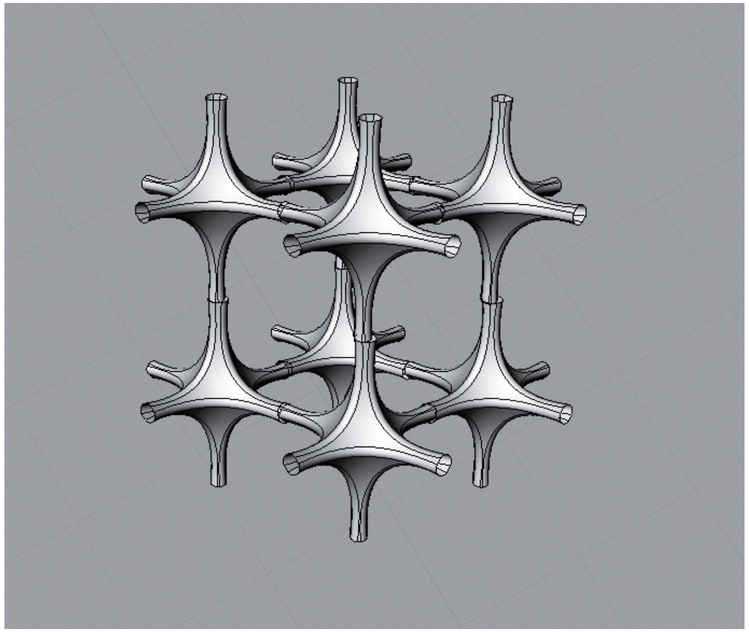

Kenneth Snelson

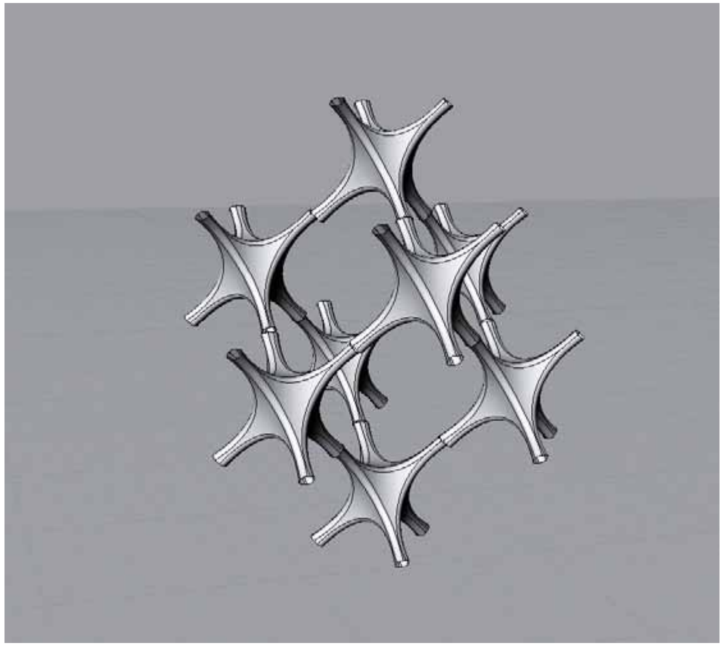

http://kennethsnelson.net/2010/8-tetrahedral-spaceframe-weave/

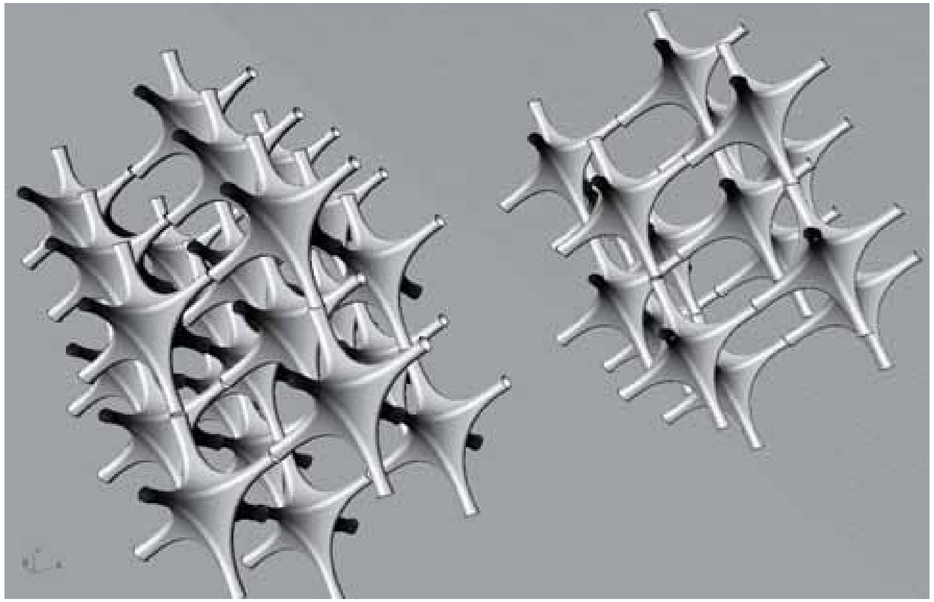



http://www.georgehart.com/rp/rp.html





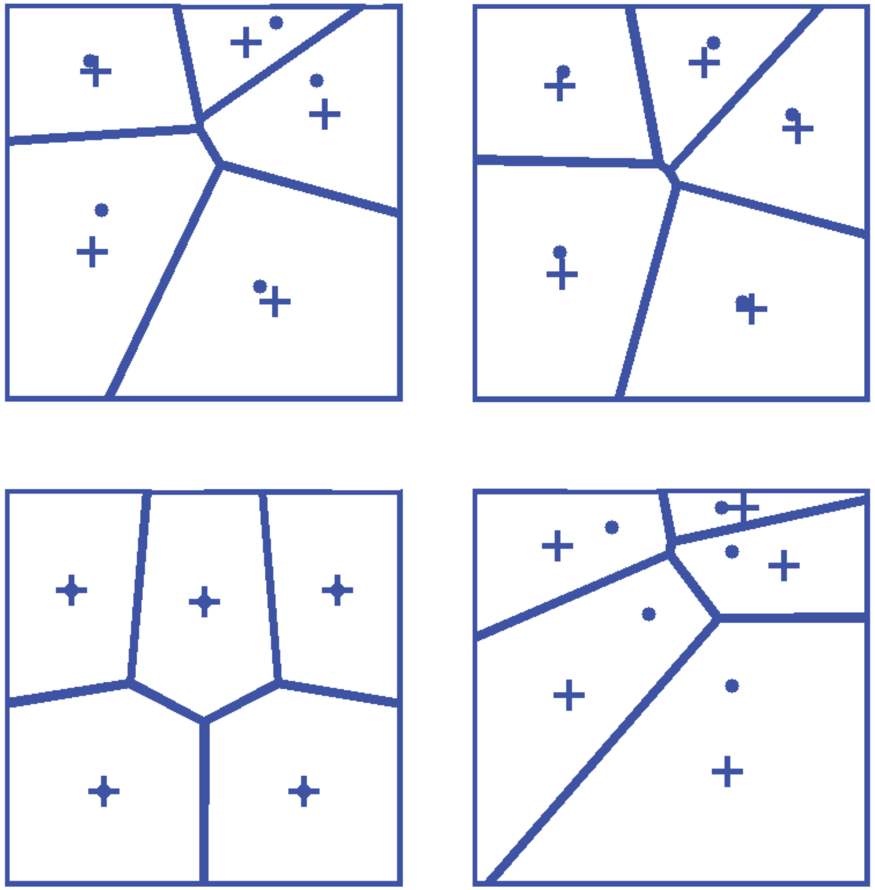




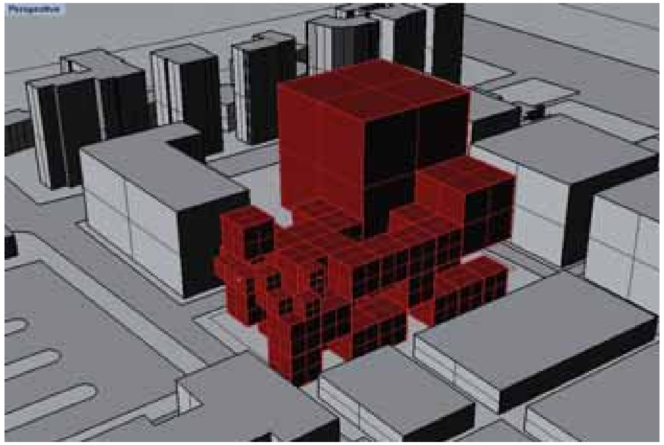
Richard Sweeney

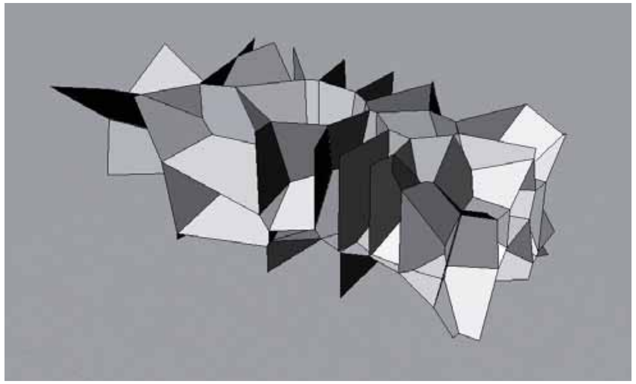
http://www.core.form-ula.com/2008/02/28/richard-sweeney/

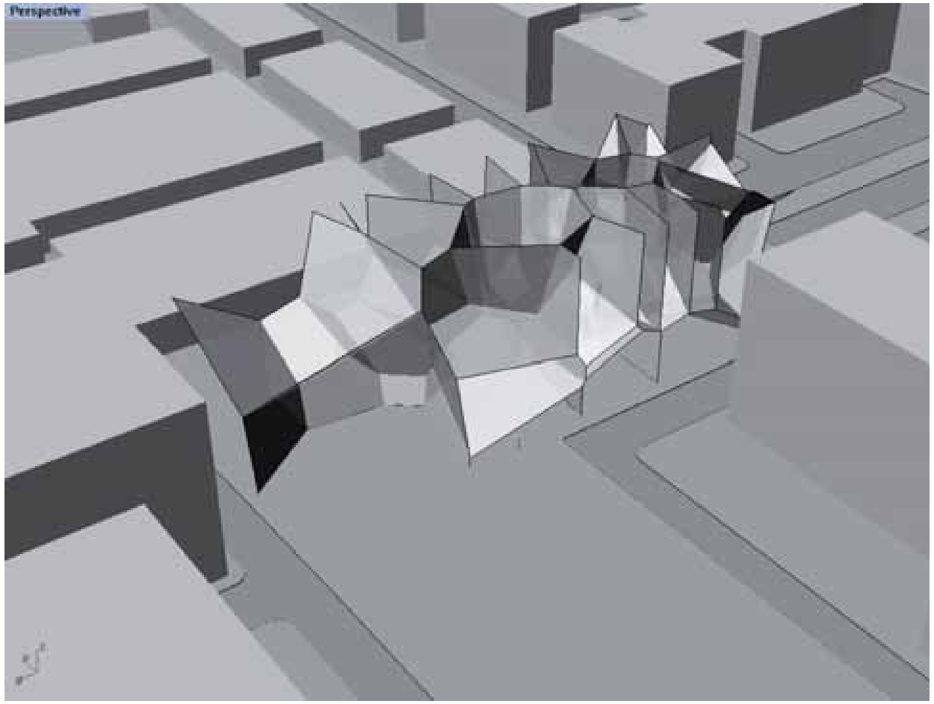
LLoyd's Algorithm

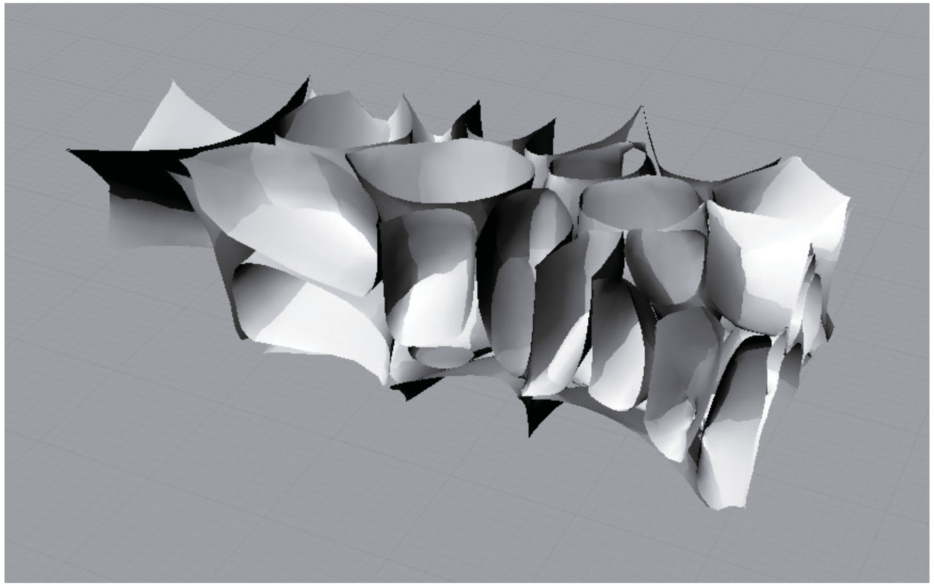


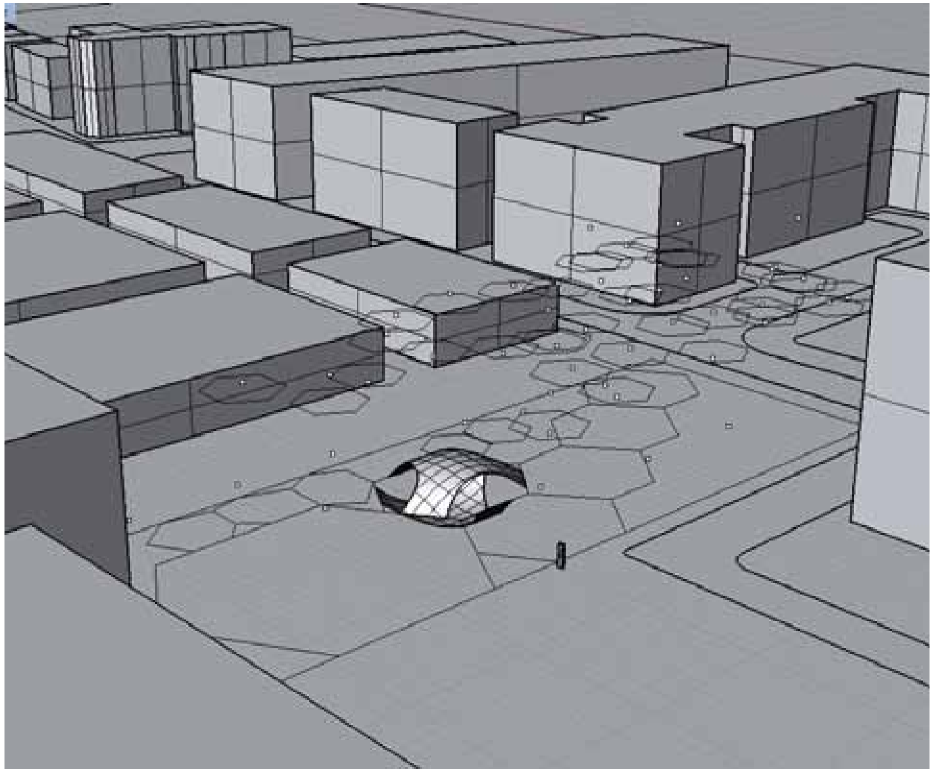
http://en.wikipedia.org/wiki/Lloyd's_algorithm

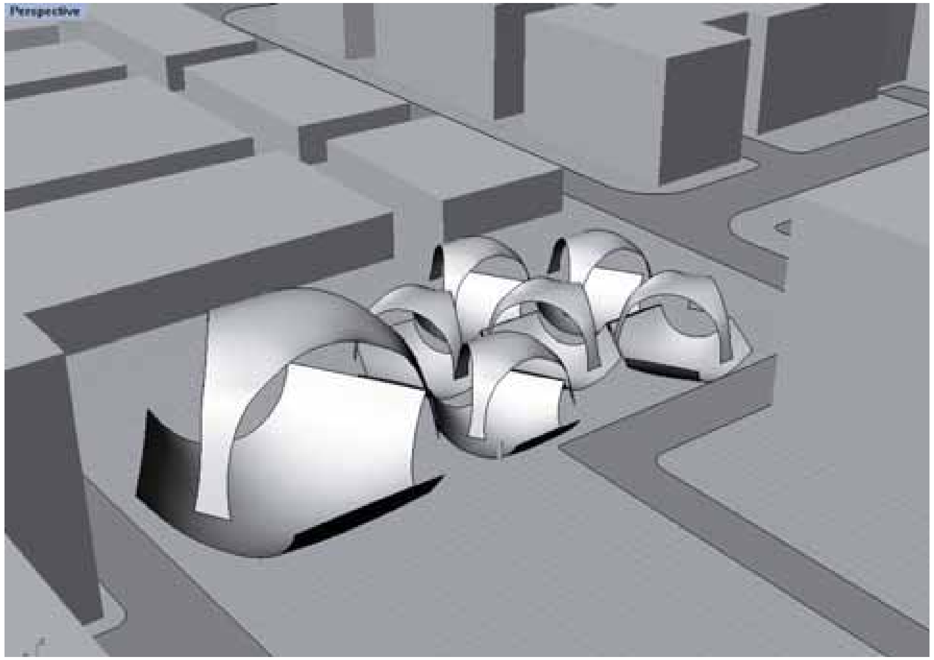


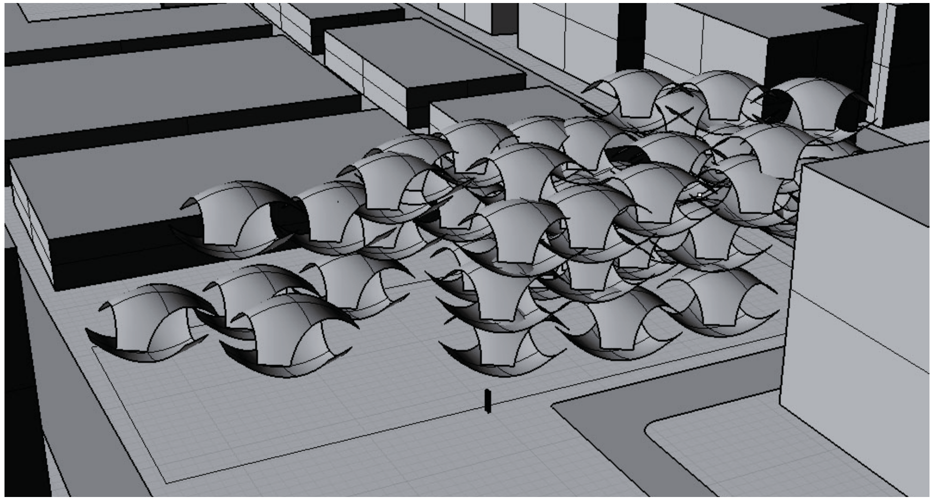


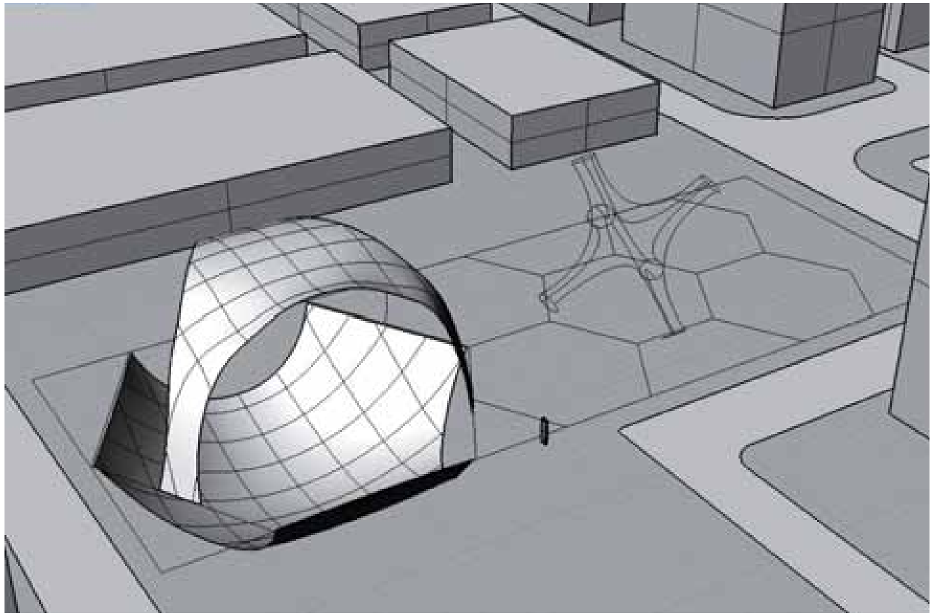

Perspective



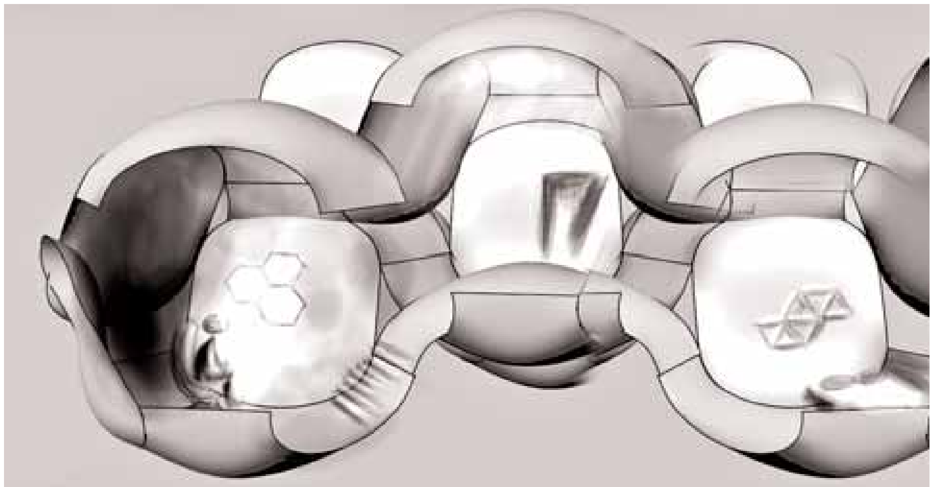



Perspective

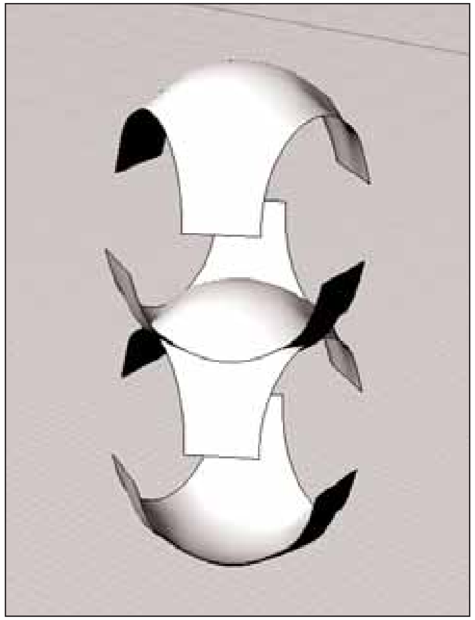


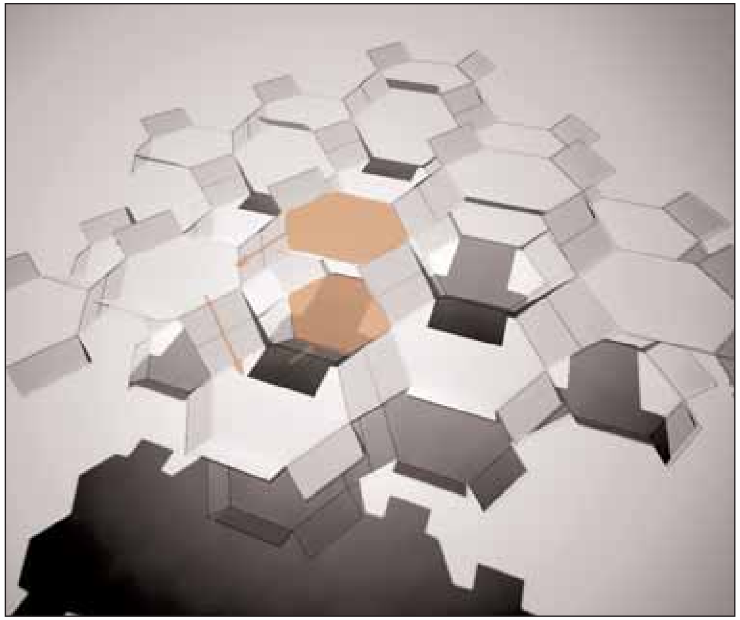


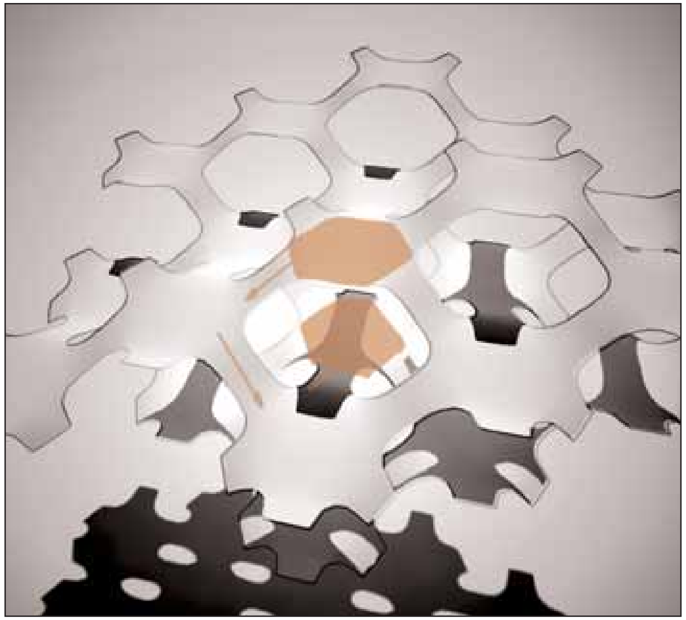
Finally, the transition between the geometries was done by “peeling” the layers of the facade and connectig them to the larger structure’s floors.

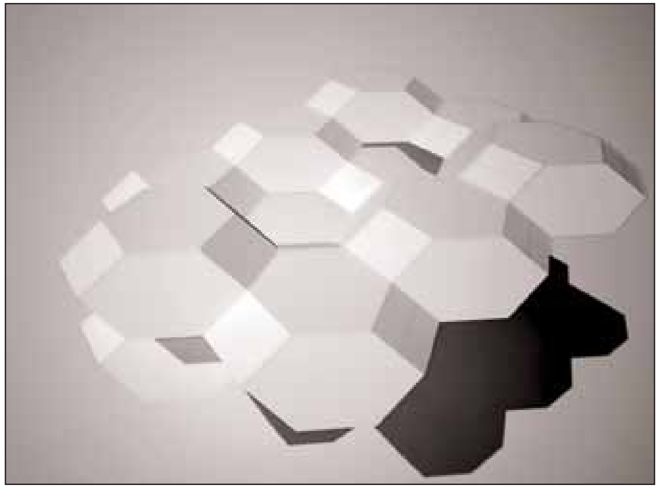


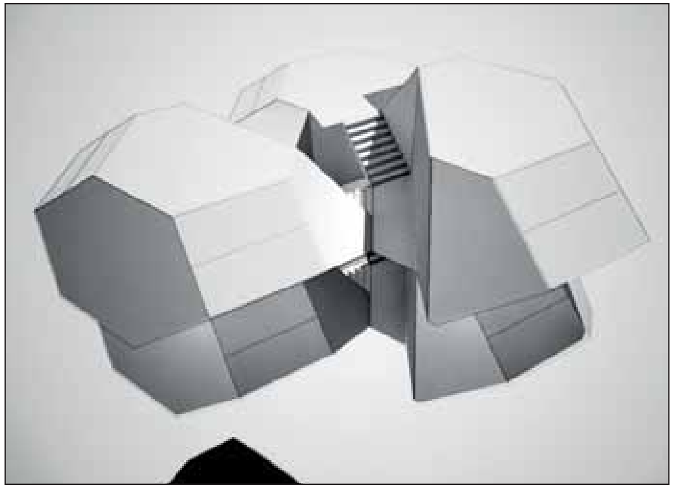
The following system was designed by simplifying the structure’s cell, in order to find a three-dimensional version of “relaxed” Voronoi diagram.

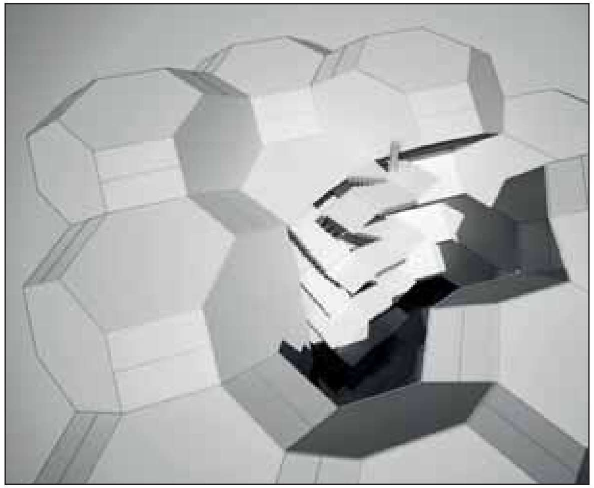






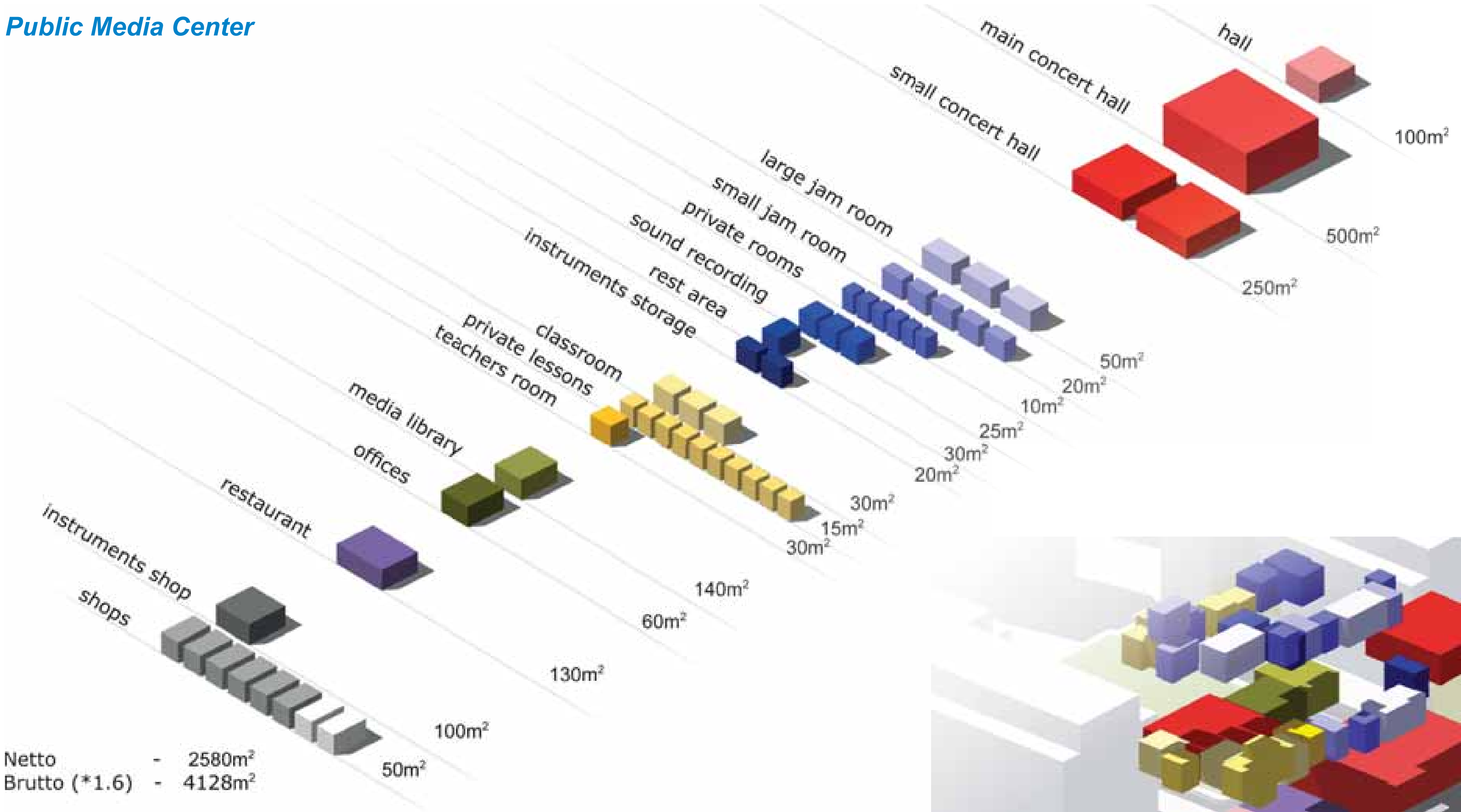


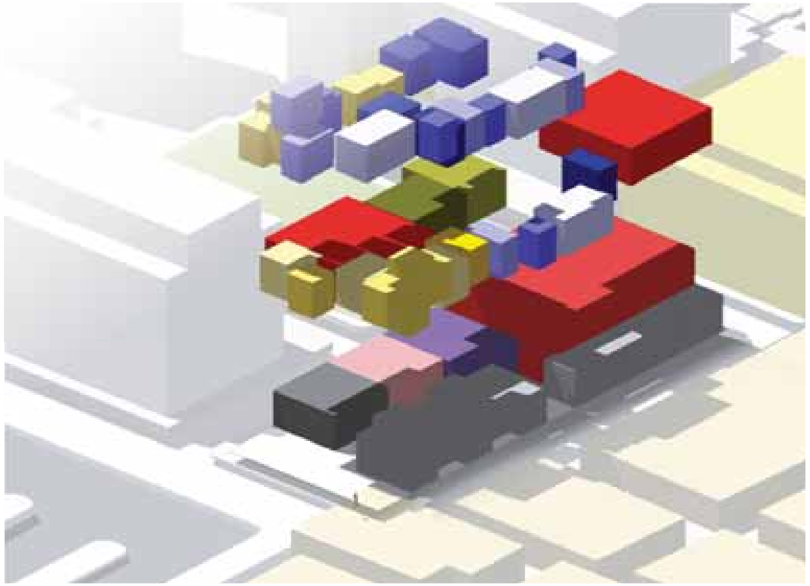




Integration of the structures

Public Media Center

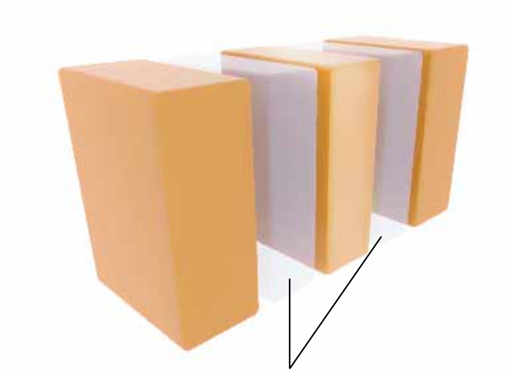




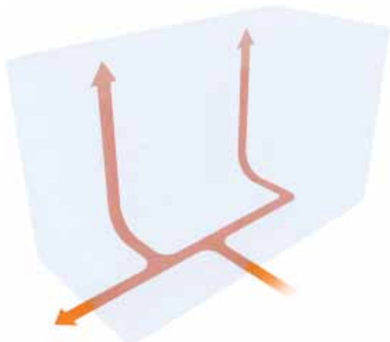
Louder functions of the building such as jam session rooms were placed closer to the market allowing interaction and bringing more sounds to the street.

More private functions vere placed oin the north part of the media center, closer to the residential area.

Another separation between different noise level functions was done by the movement system, dividing the functional spaces into three parts.



Atrium

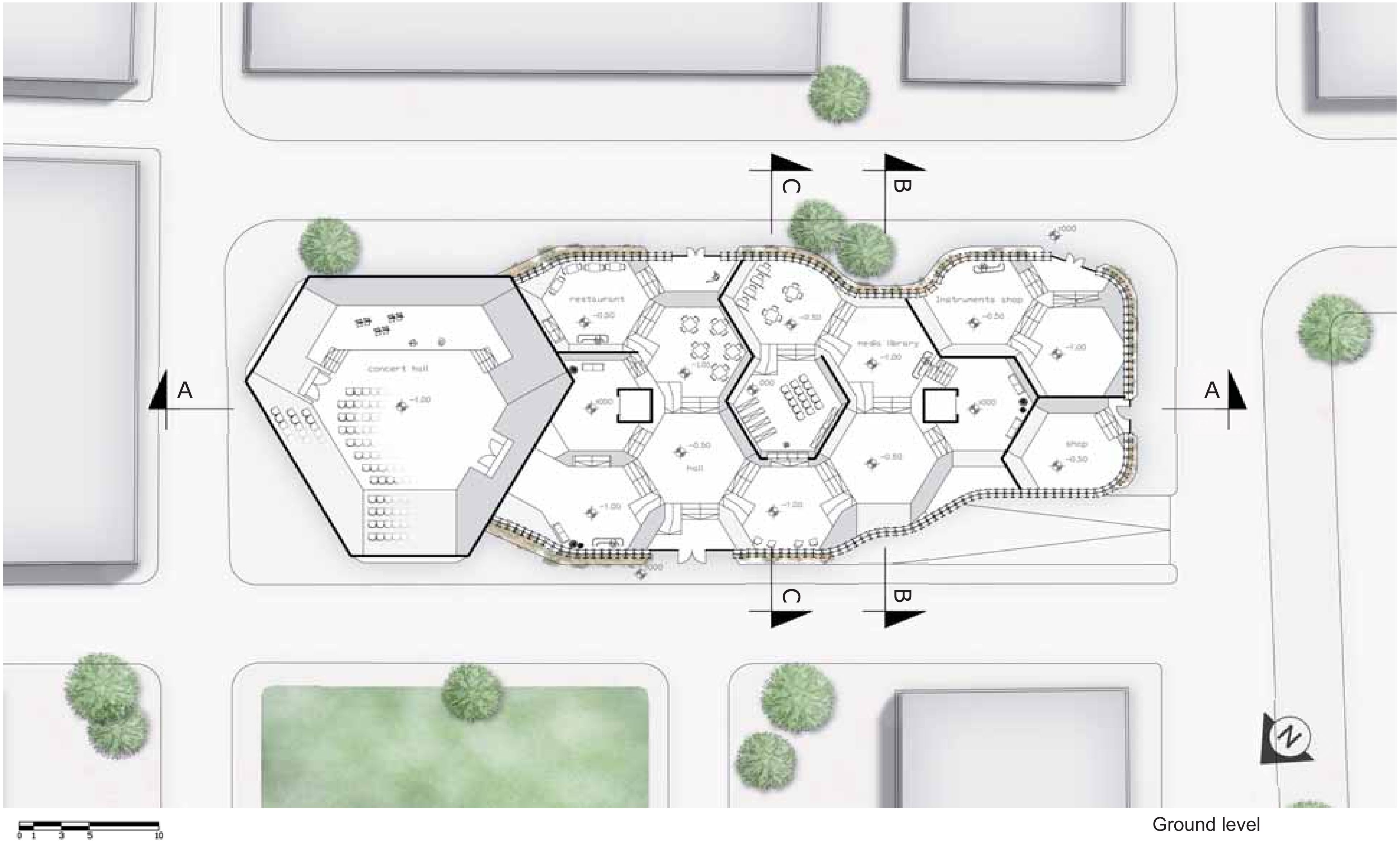


Movement system

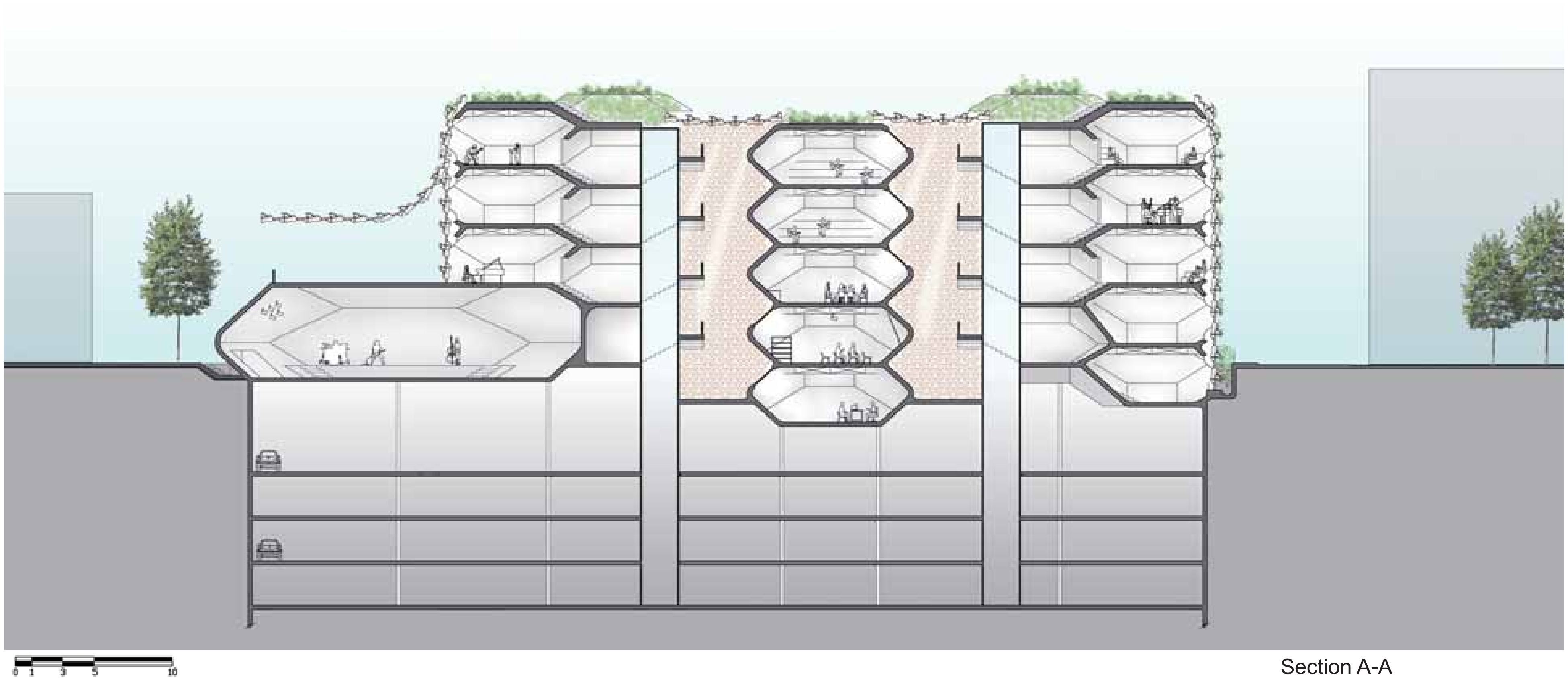
Roof plan

Building's envelope

The facade was generated using the Grasshopper definition previously developed. The south corner of the building was defined as the most shaded part, and the size of the facade cells is function of the distance from this corner.

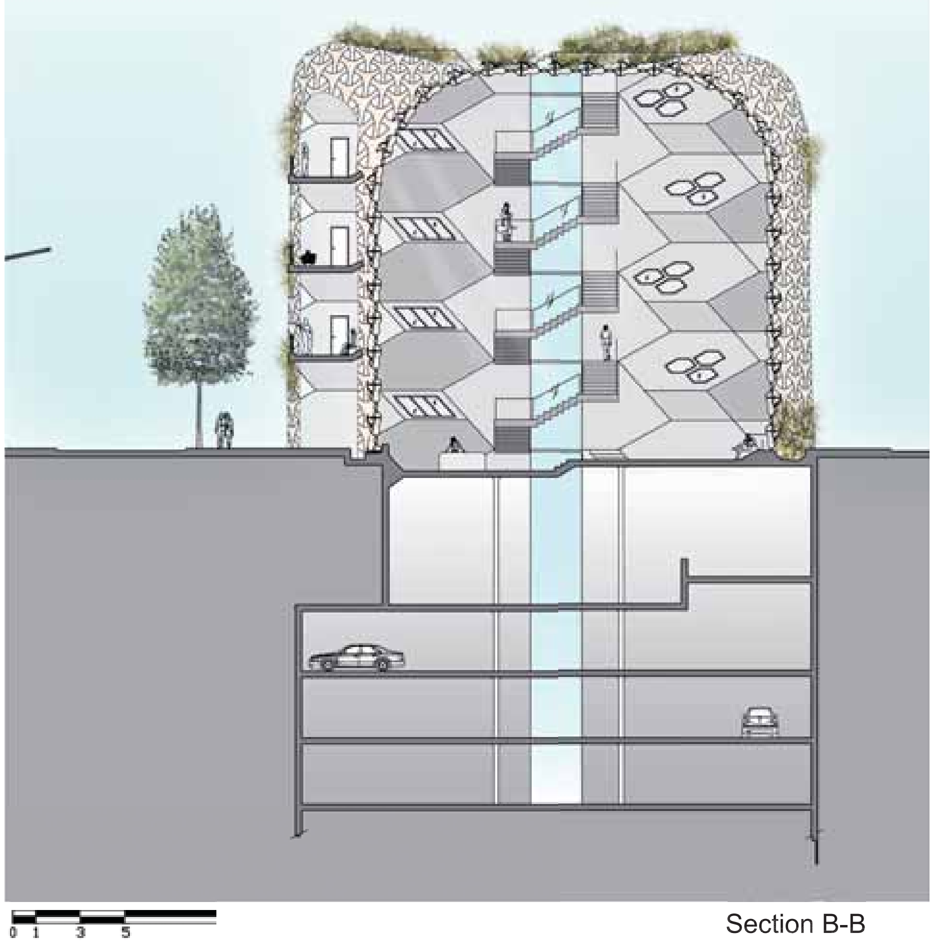


Ground level



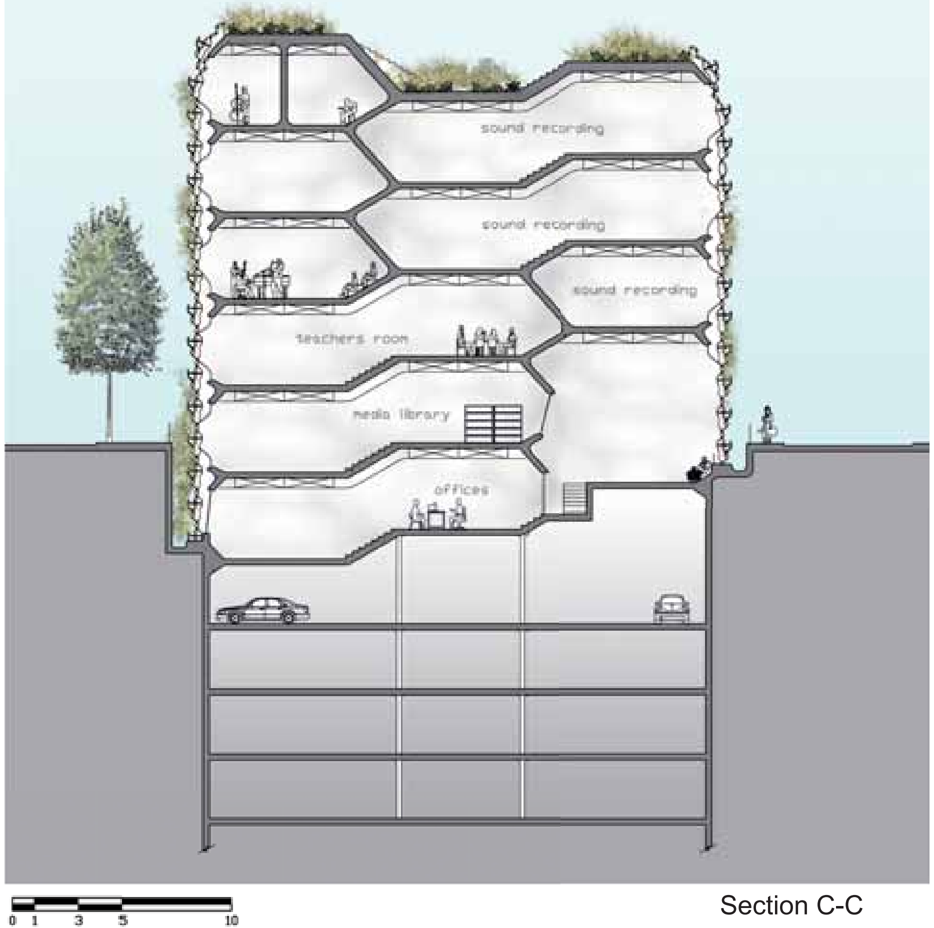
Section A-A

Section through the building's atrium and through the balcony, facing the market:



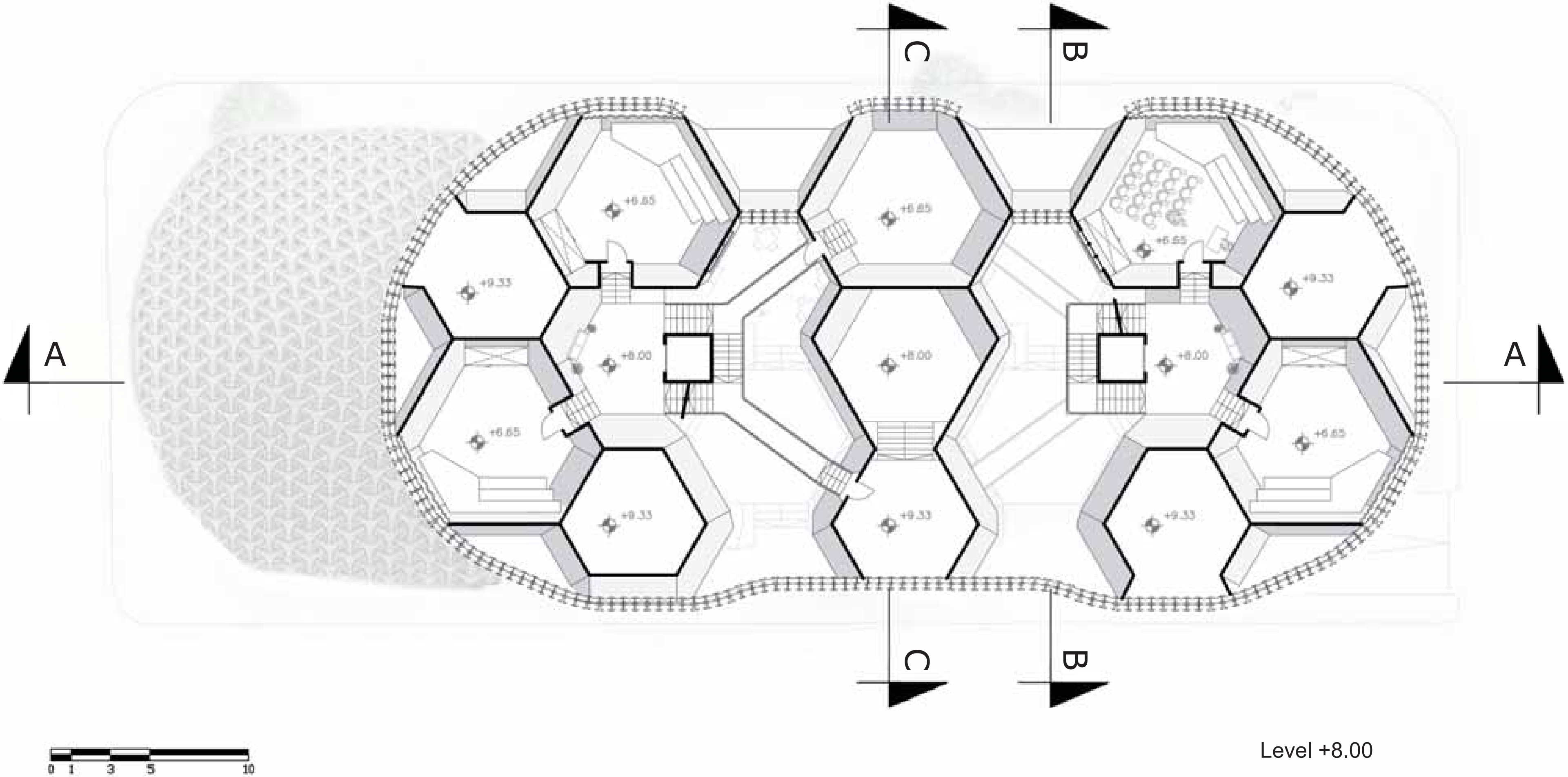
Section B-B

More "quiet" functions, that still need to be highly accesible to the visitors are placed on the first floors in the middle of the building.



Section C-C

Section through the building's atrium and through the balcony, facing the market:

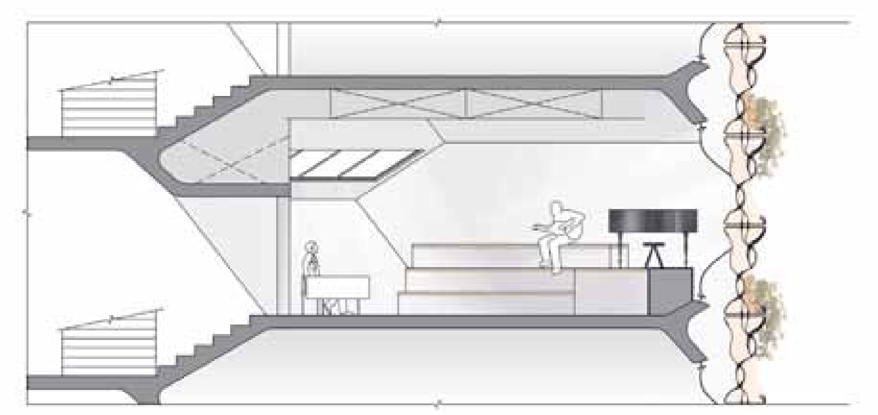


Level +8.00

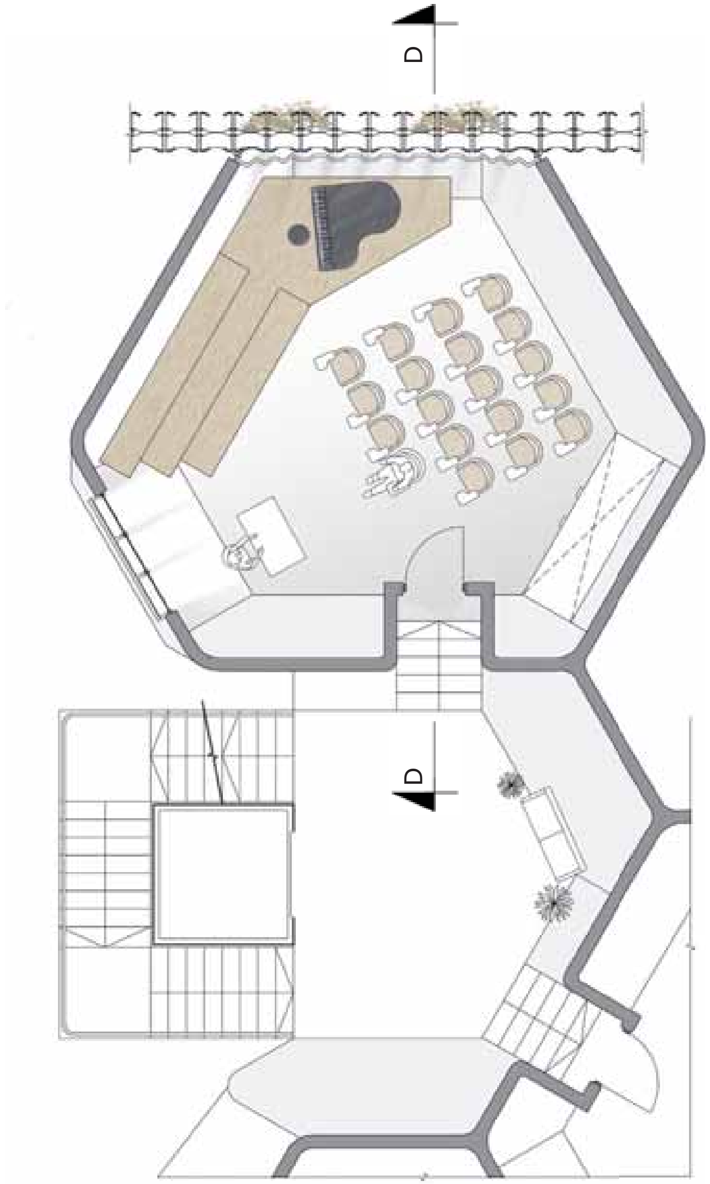
Classroom close up

Spaces for studies and jam sessions in the building are designed with the maximum flexibility, so they cuold be used for different purposes in different hours, increasing the interaction betweed different groups of people.

Location in the building



Section D-D



Single room plan

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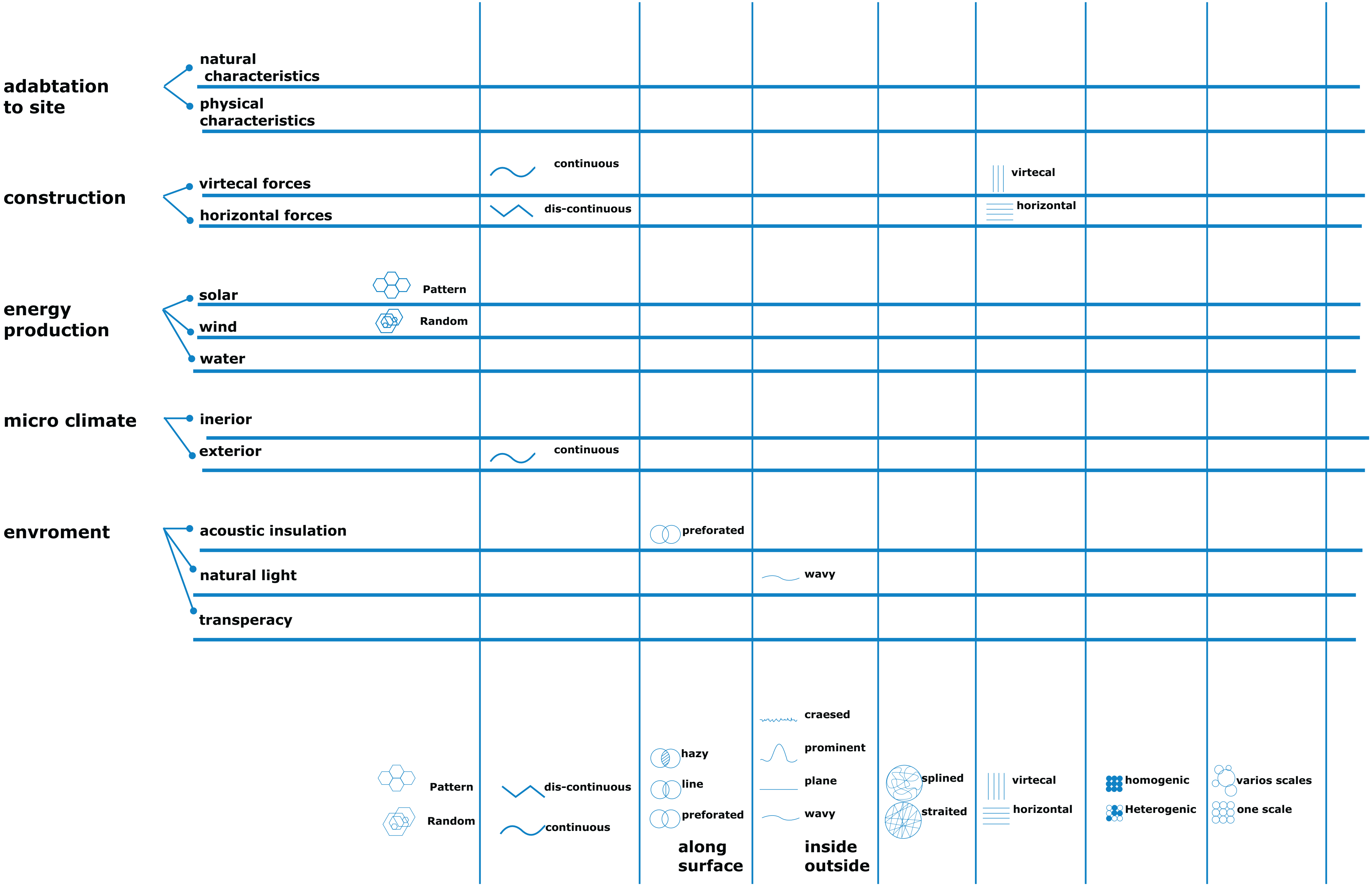
the onion cell

Amir Khatib


adabtation to site
natural characteristics
physical characteristics
construction
virtecal forces
horizontal forces
continuous
dis-continuous
virtecal
horizontal
energy production
solar
wind
water
Pattern
Random
micro climate
inerior
exterior
continuous
envroment
acoustic insulation
natural light
transperacy
preforated
wavy
Pattern
Random
dis-continuous
continuous
hazy
line
preforated
along surface
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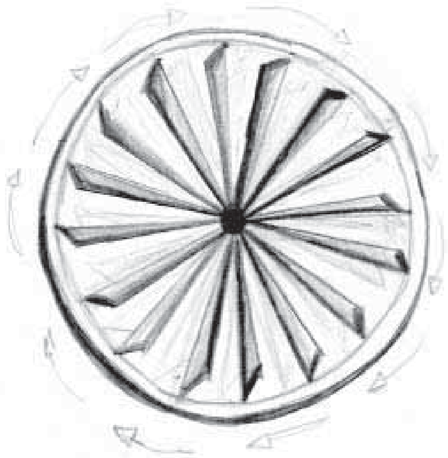
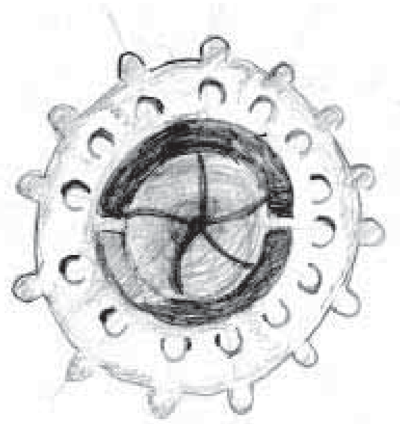
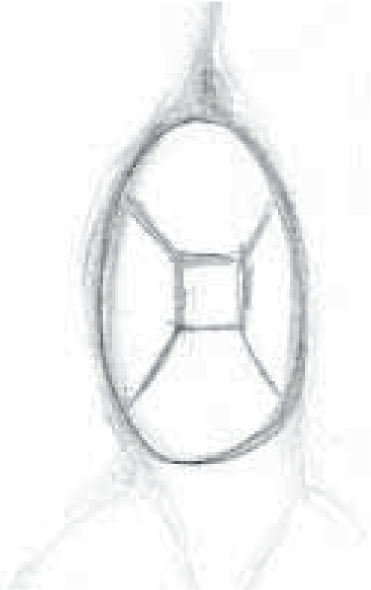
one scale

Unchosen examinations

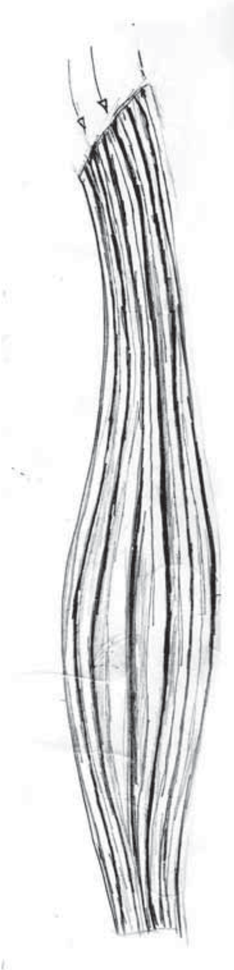






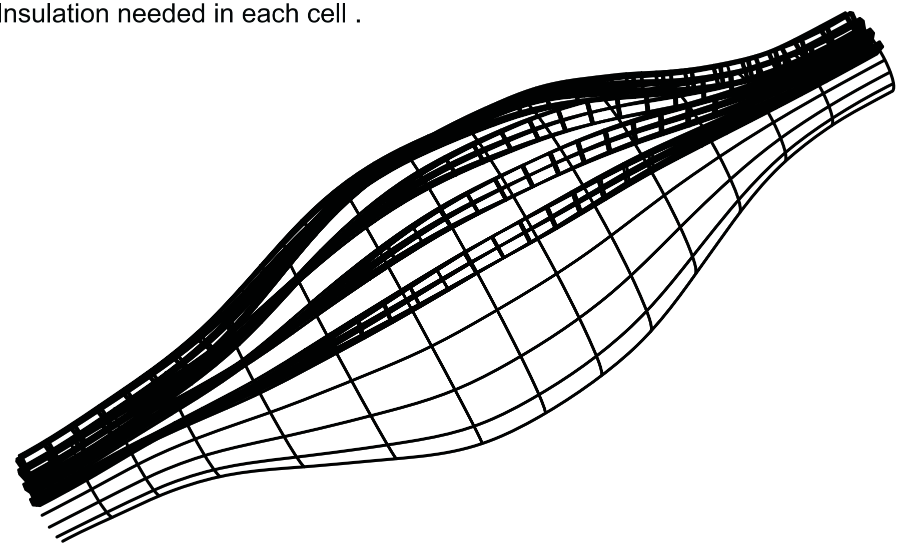
The chosen cell

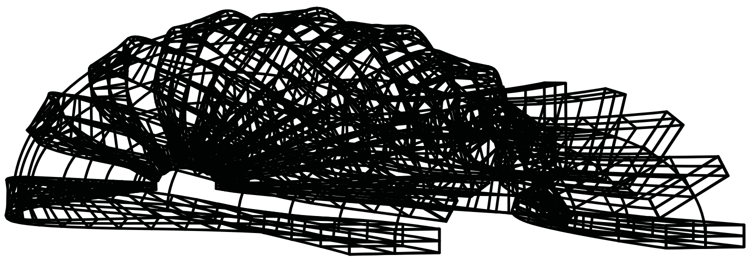
In the case of the chosen cell the two qualities were first to control the rain water flow and store it inside the each cell by creating tunels on the surface of the cell that can stream the water inside the cell. and second to Withstand the vertecal and horizontal forces in the building by creating a continuous structue vertecally and a des-continuous structure horizentally.
The cell is prominent in the center to hold the container that contains the rain water .

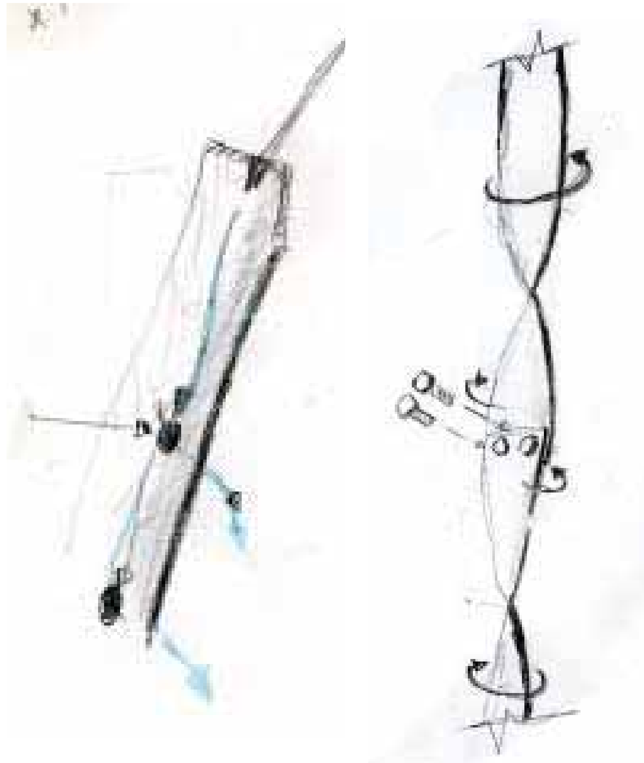


cell structure

the cell is built of Bent and twisted Concave wood strips giving it contenuousety along thye vertical axsis alowing the stream of all vertical forces to the ground , the strips are twisted in 180 digrees along the cell so each strip can stand vertecaly to centre of the cell in narrow part of the cell and lay horizentaly to the centre when at the wide part of the cell . this twist allows the same number of wood strips to fit in the narrow and the wide part of the cell , controling the twist angle can be used to control the the level of Insulation needed in each cell .

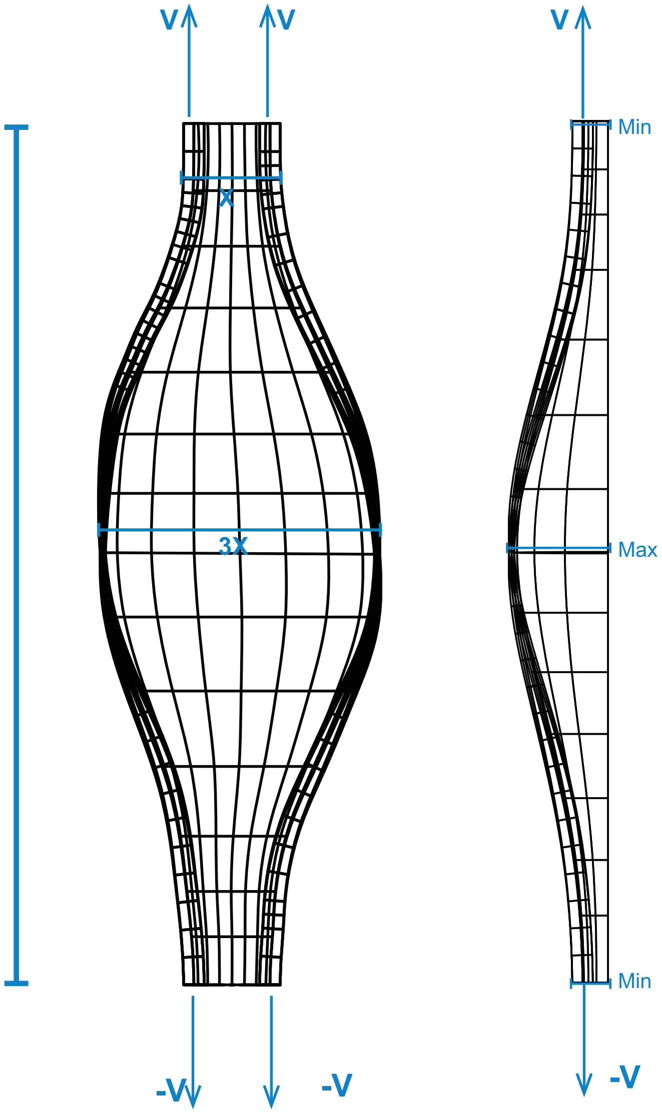


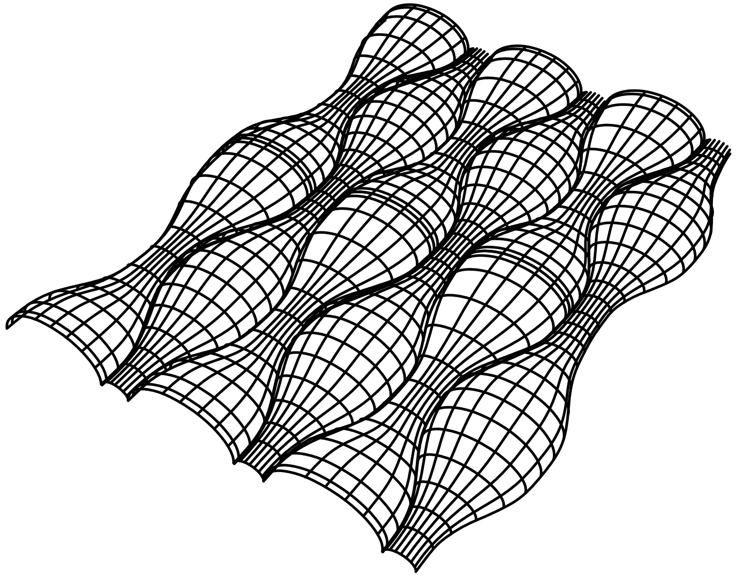




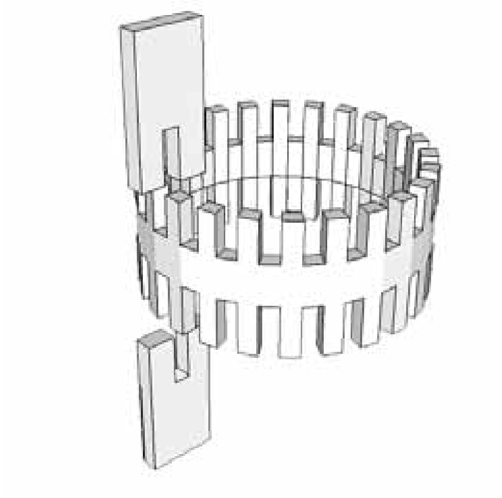
bending the strips not only adds the constructive quality of the cell becouse its Arc geometry that can allow a good and smooth flow of Forces along the facade .
concaving the wood strips is made to creat tunels along the facade that receive the rain water falling on the building and store it inside the cell .

connectivity





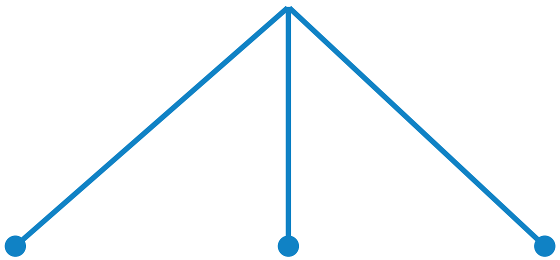
both opposite edges in the cell must be identical in both shape and dimentions and opposite in direction In order for it to connect smoothly to other cells . the completly oppositing victors in the top and bottom edges of the cell insures the smooth flow of vertical forces and gives the cell united look and Blurs the boundaries between the cells .
the typical cell's Dimensions are 2 m hight and 0.5 m width , the cell's depth is changable depending on the quantity of water we need to contain in it,



rain water

typical rate of water consumption for avarage type institution is 106-159 gallons per person per day

water uses



portable water
human consumption
drinking
cocking

graywater
domistic water
washing
bathing
dishes

black water
low-risk water
toilets
irrigation

rain water
low risk uses :

wash water

irrigation

toilet

Rain water from roofs can be captured and stored in ground floor or basement tanks (20000L being a useful capacity). If it is to be used to supply drinking water taps, showers and hand basins, subject to local regulations, it must be passed through self cleaning filters before being treated by UV disinfection filters. Continuous quality monitoring should only bring on treatment systems (possibly including chemicals) when required so as to minimise energy costs. Excess water can flow to the stormwater system as usual or to a grey water system for use in toilet flushing, irrigation, vehicle washing or other approved uses. Alternatively, rain water could be used directly for toilet flushing, irrigation and vehicle washing, possibly without any reatment.

rainfall quantities in telaviv is 500-600 MM a year

toilet
30% - 40% of building water consumption
4-6 liter per flush
rate of 50 flushes per day

irrigation
Irrigation water use can vary greatly from 1-20% of total building water consumption, depending on the facility and the amount of open space .

plant water consumption = 1.5 liter/m per day in summer day
1.0 liter/m per day in winter day

http://www.environment.gov.au/sustainability/government/publications/pubs/water-efficiency-guide.pdf

Water in Israel Water in Israel
gwri-ic.technion.ac.il/pdf/wcom/demand.pdf

Wood: the most renewable of all building materials

Growth and production of one tonne of wood absorbs a net 1.7 tonnes of co2 from the atmosphere

Production of one tonne of steel emits 1.2 tonnes of co2 into the atmosphere.

Wood framing is fast and adaptable

timber framing provides for flexibility of design, and allows modifications and tweaks to layout during the construction process .
Builders are familiar with using wood, and usually prefer it. Advantages of timber reported by builders include ease of construction and quick erection times for timber frames and roofs.
cladding cannot be nailed on to steel frames – it has to be screwed on, unlike wood frames where cladding can be easily nailed.

Snug and sound

wood is 400 times better as a thermal insulator than steel and 14 times better than concrete.
solid wood has significant thermal mass properties, retaining heat from the day and releasing it at night.
A steel framed wall will have an overall r-value of only 46-70% of a similar wood framed wall with the same amount of cavity insulation. r-value is the measure of the total thermal resistance of a building element to heat-flow when the internal and external environments are constant.

A thermal break is needed when using steel to improve insulation and avoid the buildup of moisture condensation which can lead to mould.

Wood doesn’t rust

wood framing used appropriately in accordance with building standards, will usually far exceed a service life of 50 years .

Wood can take the heat

Average building fires reach temperatures of 700 to 1000°c.
steel weakens as its temperature climbs above 230°c, retaining only 10 percent of its strength at 750°c.
wood does not ignite until it reaches over 250°c. once it catches fire, wood develops a protective insulating char layer.
beams of similar size because the interior of the timber remains much cooler

No shocks or surprises

wood, when dry, is a natural electrical insulator and will not conduct a current or become live – the reason many power poles are made of wood

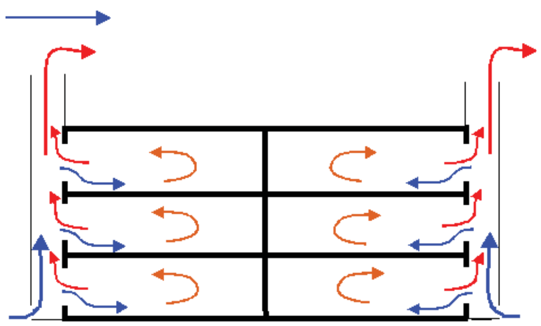
http://www.nzwood.co.nz/images/uploads/file/Benefits%20of%20timber%20in%20house%20construction/Benefits%20of%20Timber.pdf

Natural ventilation

Natural ventilation is the process of supplying and removing air through an indoor space without using mechanical systems.
There are two types of natural ventilation occurring in buildings: wind driven ventilation and buoyancy-driven ventilation.

Buoyancy-driven ventilation

Buoyancy driven ventilation arise due to differences in density of interior and exterior air, which in large part arises from differences in temperature. When there is a temperature difference between two adjoining volumes of air the warmer air will have lower density and be more buoyant thus will rise above the cold air creating an upward air stream.



Estimating buoyancy-driven ventilation

$$Q_S = C_d\, A \sqrt{g\, H_d \frac{T_I - T_O}{T_I}}$$

QS = Buoyancy-driven ventilation airflow rate, m³/s
A = cross-sectional area of opening, m² (assumes equal area for inlet and outlet)
Cd = Discharge coefficient for opening (typical value is 0,62)
g = gravitational acceleration, around 9.81 m/s² on Earth
Hd = Height from midpoint of lower opening to midpoint of upper opening, m
TI = Average indoor temperature between the inlet and outlet, K
TO = Outdoor temperature, K

Natural Light

1. natural light analizes :

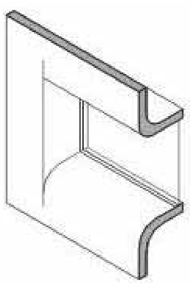
 * Site location
 * Climate / Air quality
 * Reflection from nearby buildings
 * Light obstecles

2. Building plan and placing

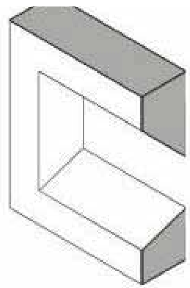
3. Window posetionand dimention

עומק חדירת אור מחלון צידי

עומק חדירת אור יום מחלון צידי עם מדף אור



משטחים מעוגלים
סביב החלון



משטחים משופעים
סביב החלון

1.More facade area facing north and south

2.Install high windows

3.Surfaces with high reflection.

4.Installing light shelves to increas light access distance

5.Sloping ceiling to increas light access distance

6.Filter light entrance

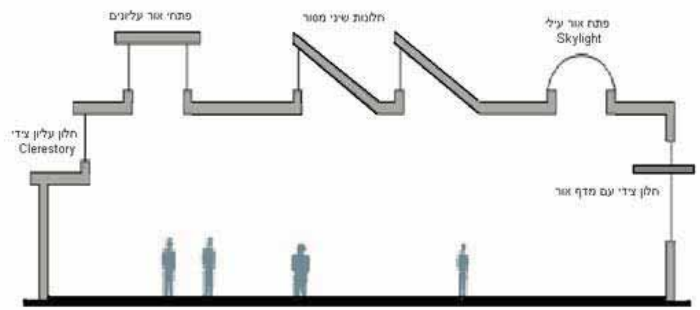
7.Separate view windows from light windows

8.Parallel windows

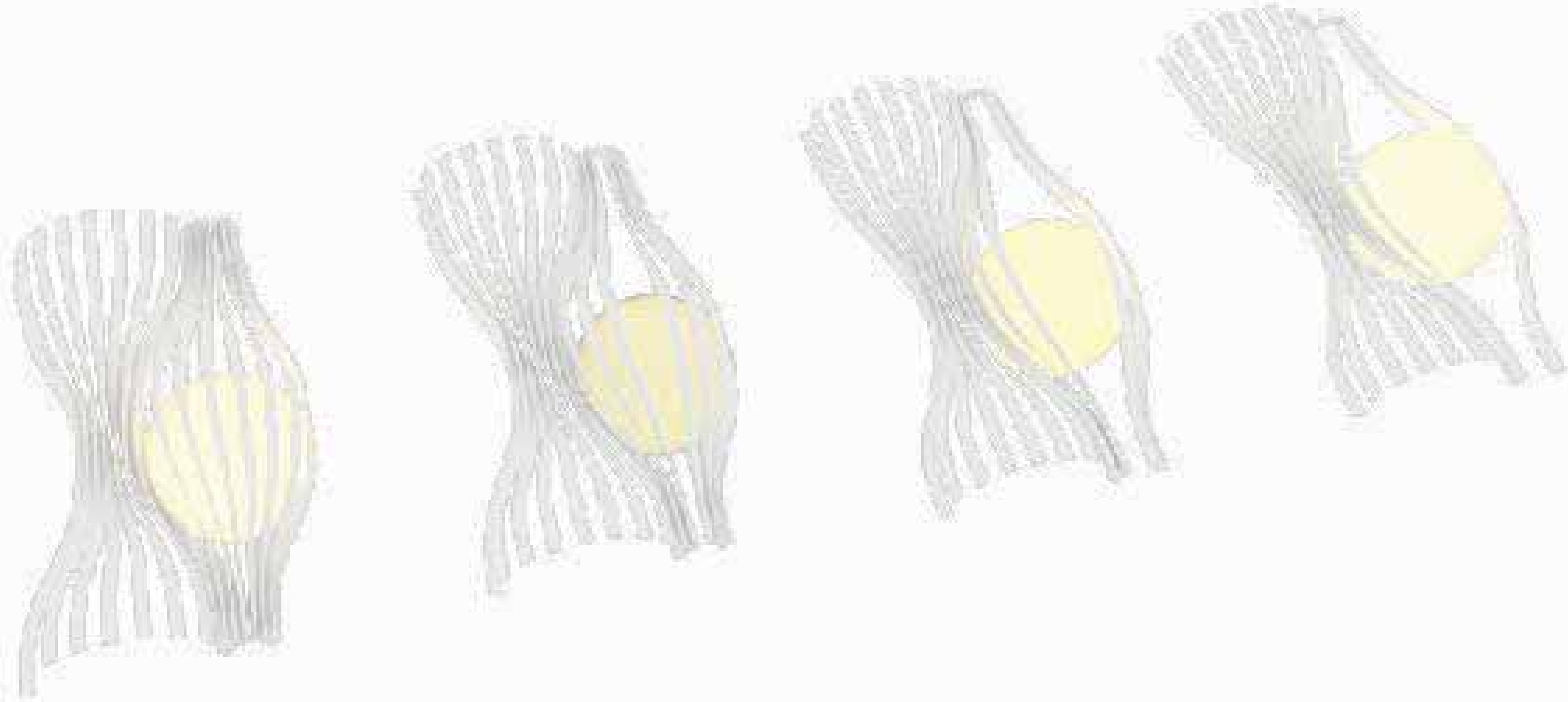
9.Increasing wall thickness for :
 a.to soften the contrast of light by softening angle between the window and the wall
 b.to combine shading eliments with the wall .

10.Not to creat windows that are lower than working surfaces .
 window area that is not meant for lighting will only case heating.

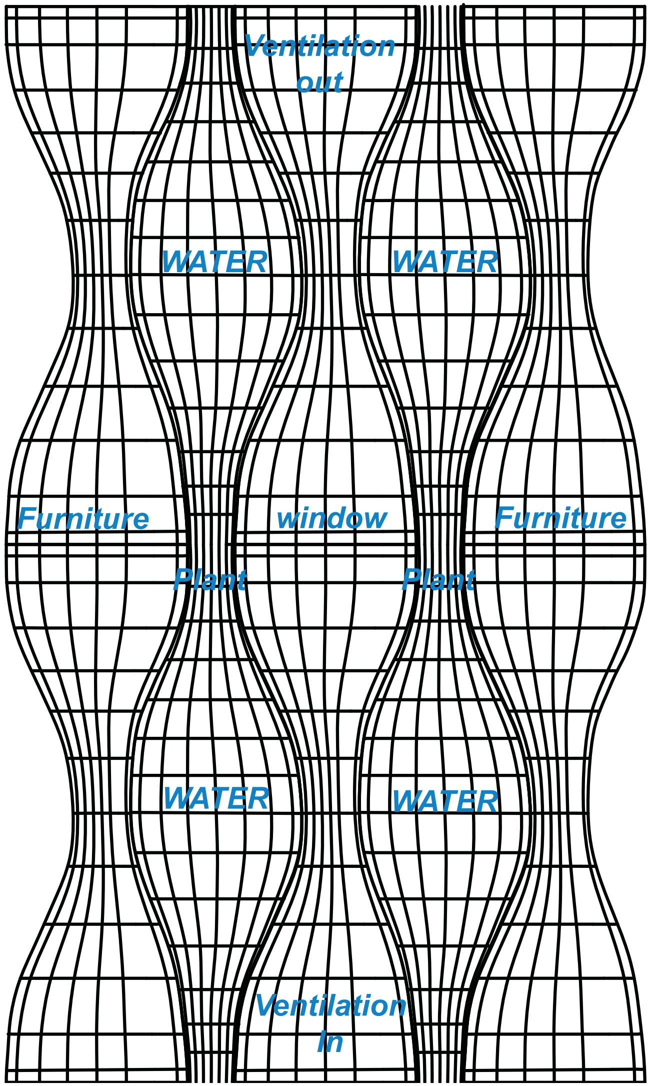
11.windows that face working surfaces



סוגי חלונות ופתחי אור

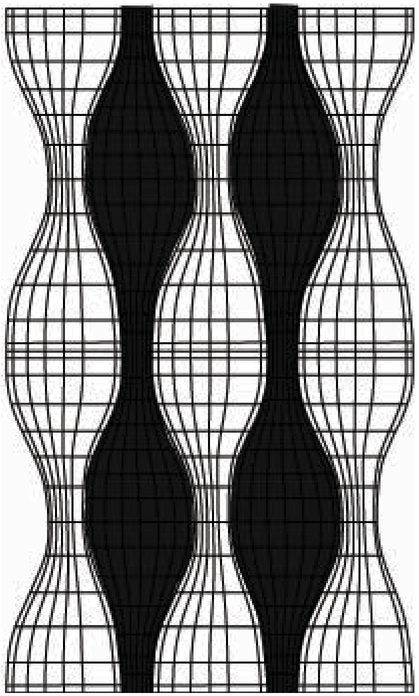


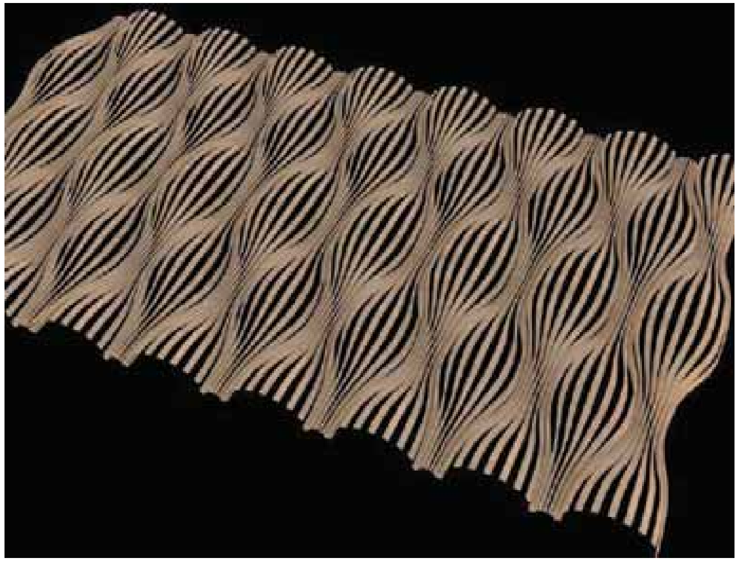
complex system

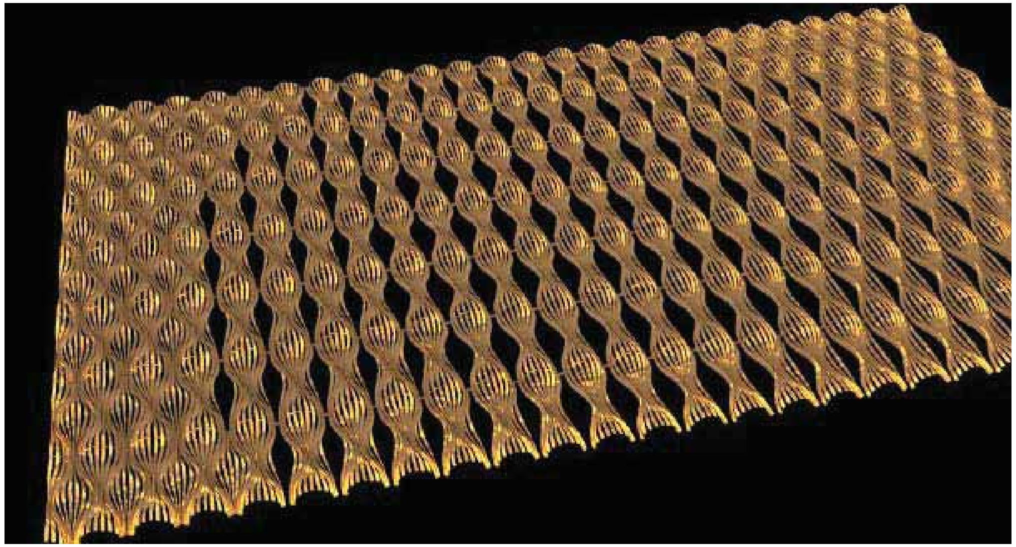


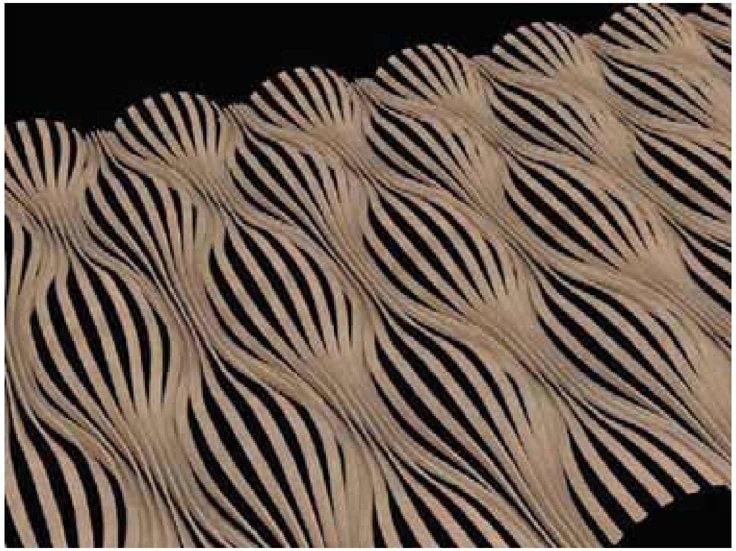
a number of cells working together as a complex system of functions can answer the buildings needs of water ,natural lighting , Ventilation , vegitation , micro climate , Insulation and even Furnituring . by combining a group of cells and applying three functions for the most to each cell , this allows the facade to react and respond to more needs of the building.

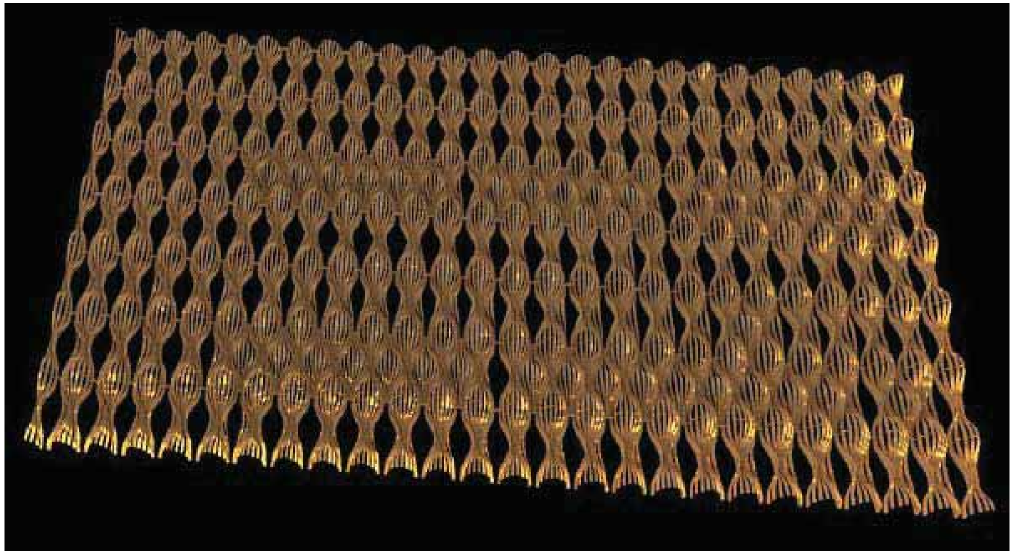
this orientaion of the cells creats a Dashed setuation Tightness and openness as shown in the diagram below this gives the facade the advantage of controling the natural eliments entering the building,

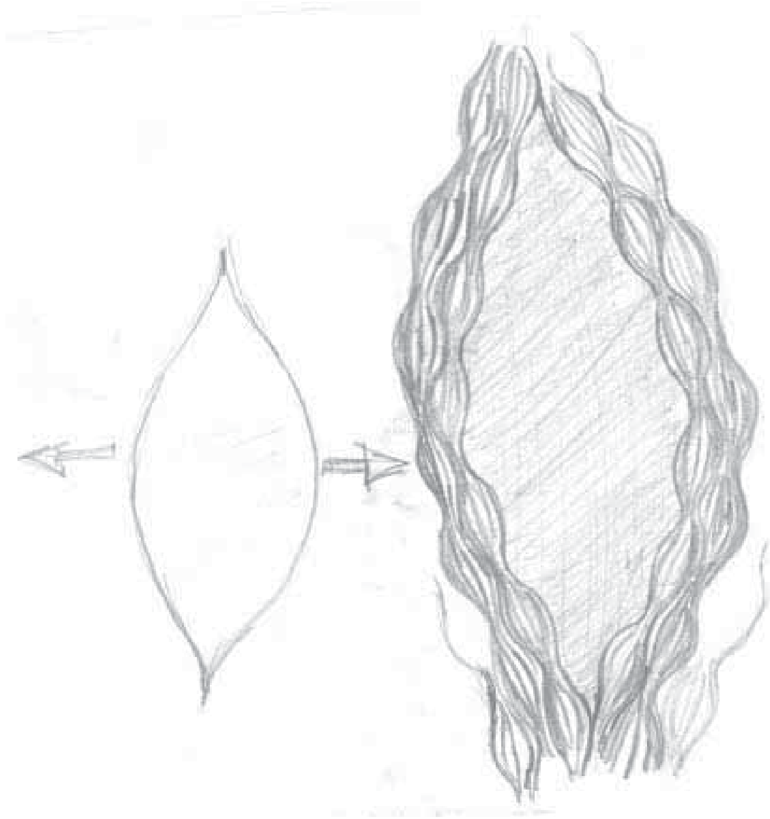






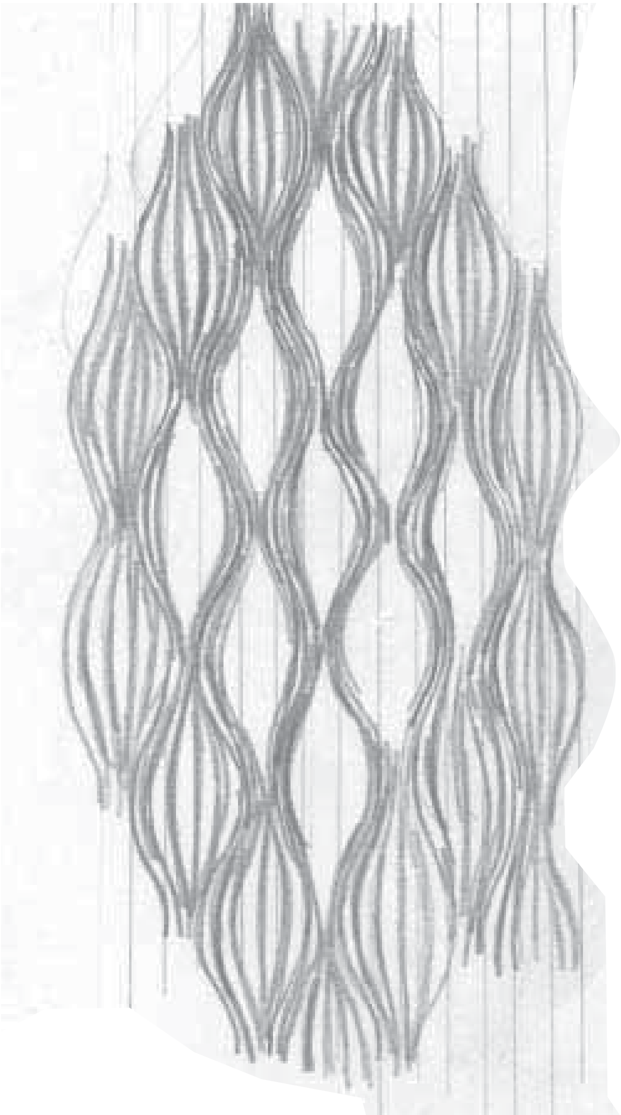


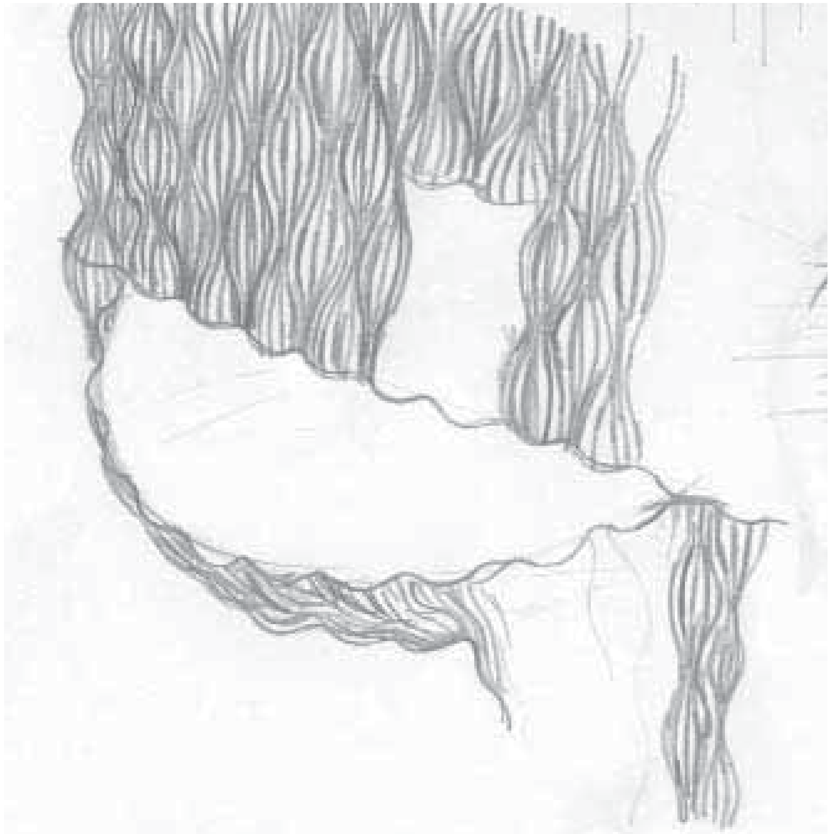


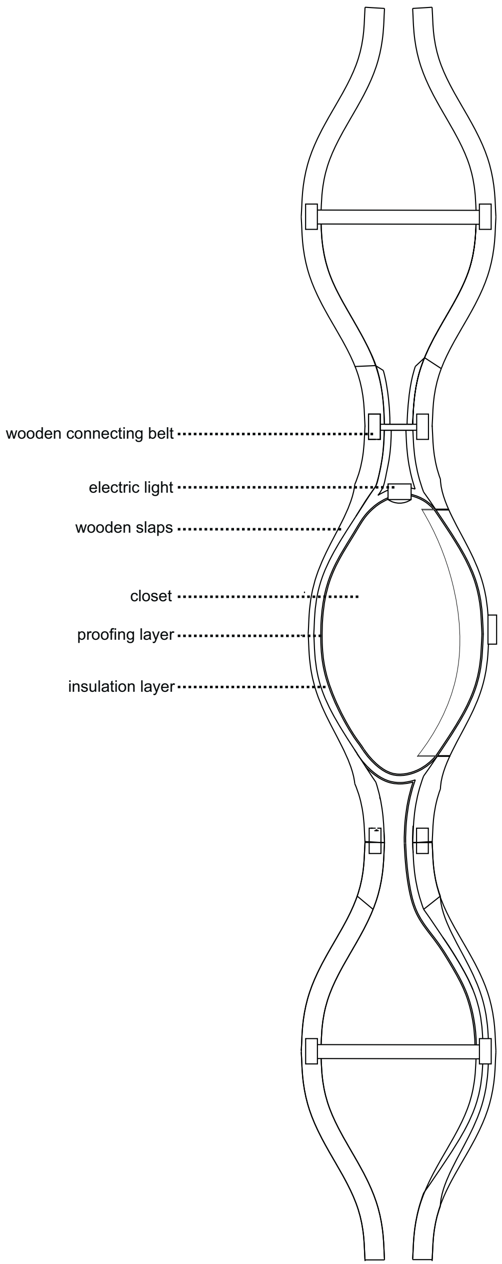


for big opening in the facade the cells can separate from each other creating a big void between the that can function as a big window

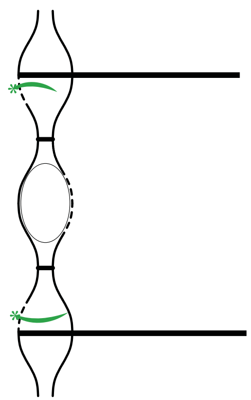
separating the cells along the other horizental axis can create an entrance opening in the facade .



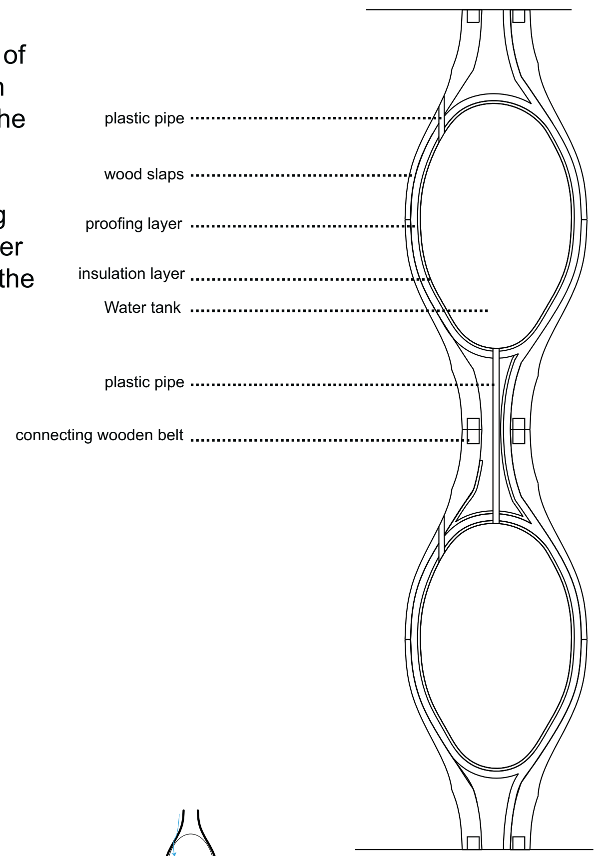


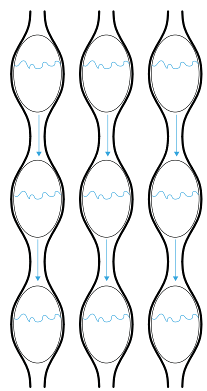


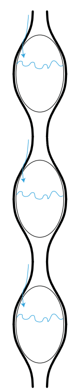
some cell can function as furneture that can be used from the inside of the building by puting its large inside volume into use

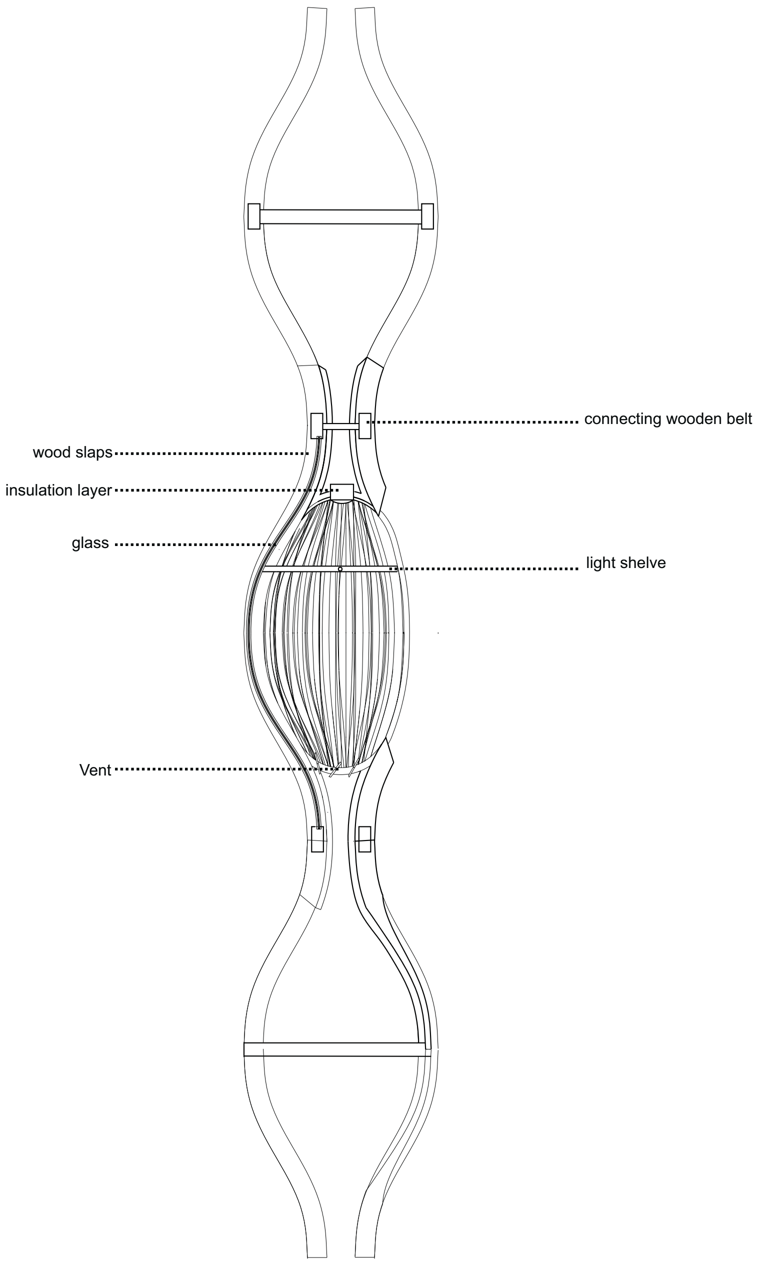


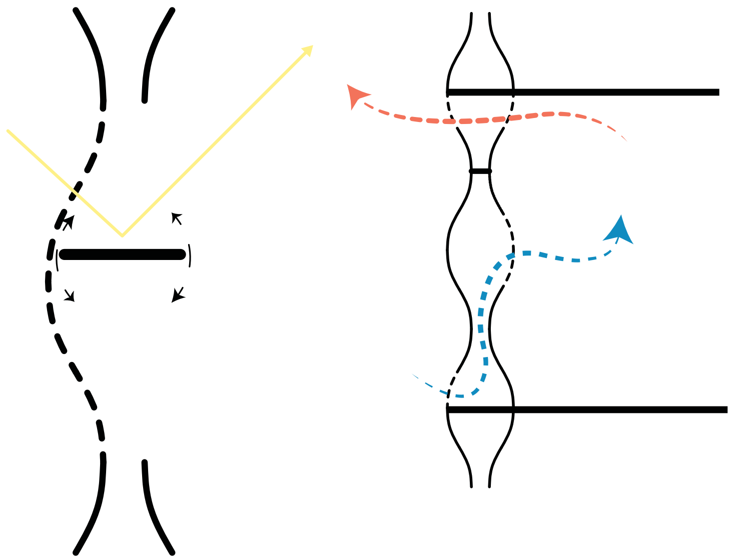
using The slope close to the top of each cell we can easly drain rain water falling on the facade into the water container tanks inside the cells , i also used the Continuity of the water containig cells along the virtecal axis to move the water from tanks and put it into use in the building .



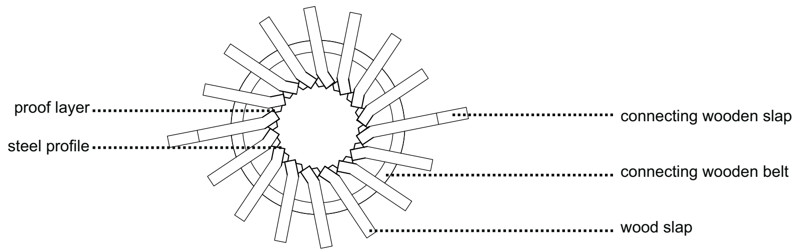


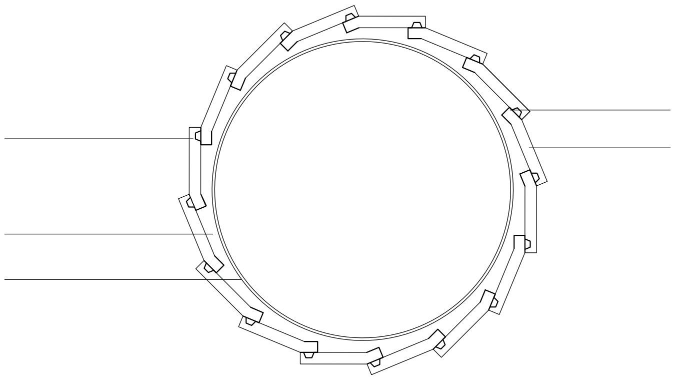


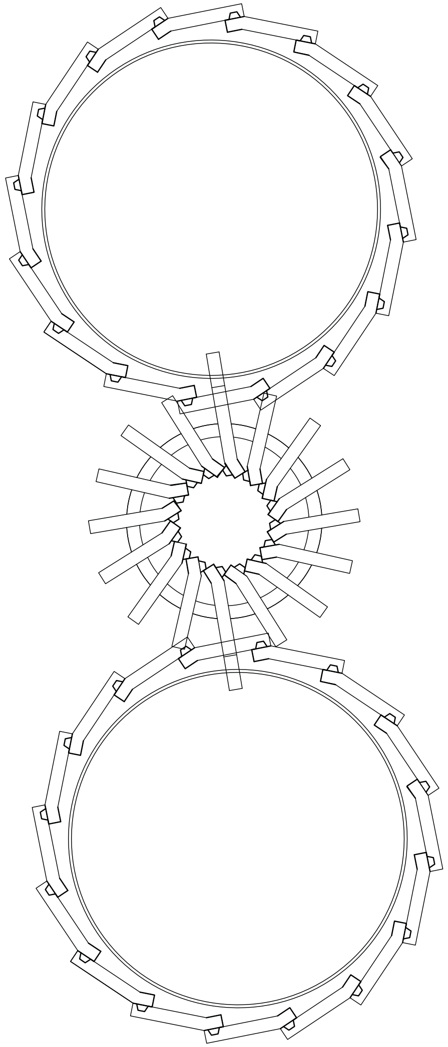


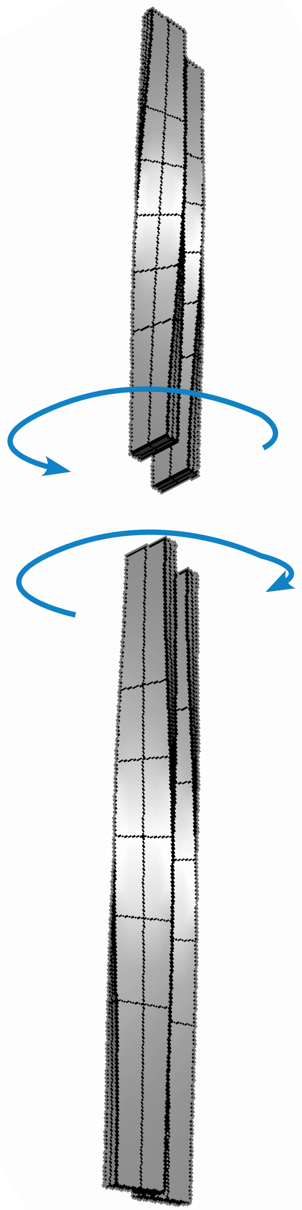


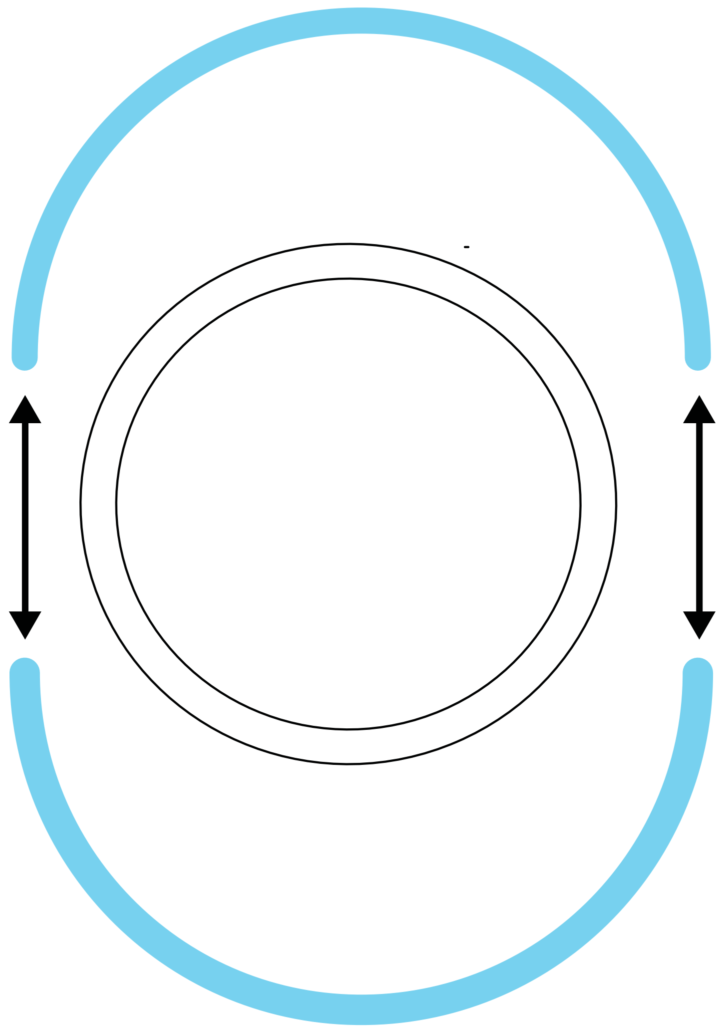
in this section i used the The slope to enter virtecal light more inside the building by directig light shelfs in the wanted angle .


proof layer
steel profile
connecting wooden slap
connecting wooden belt
wood slap

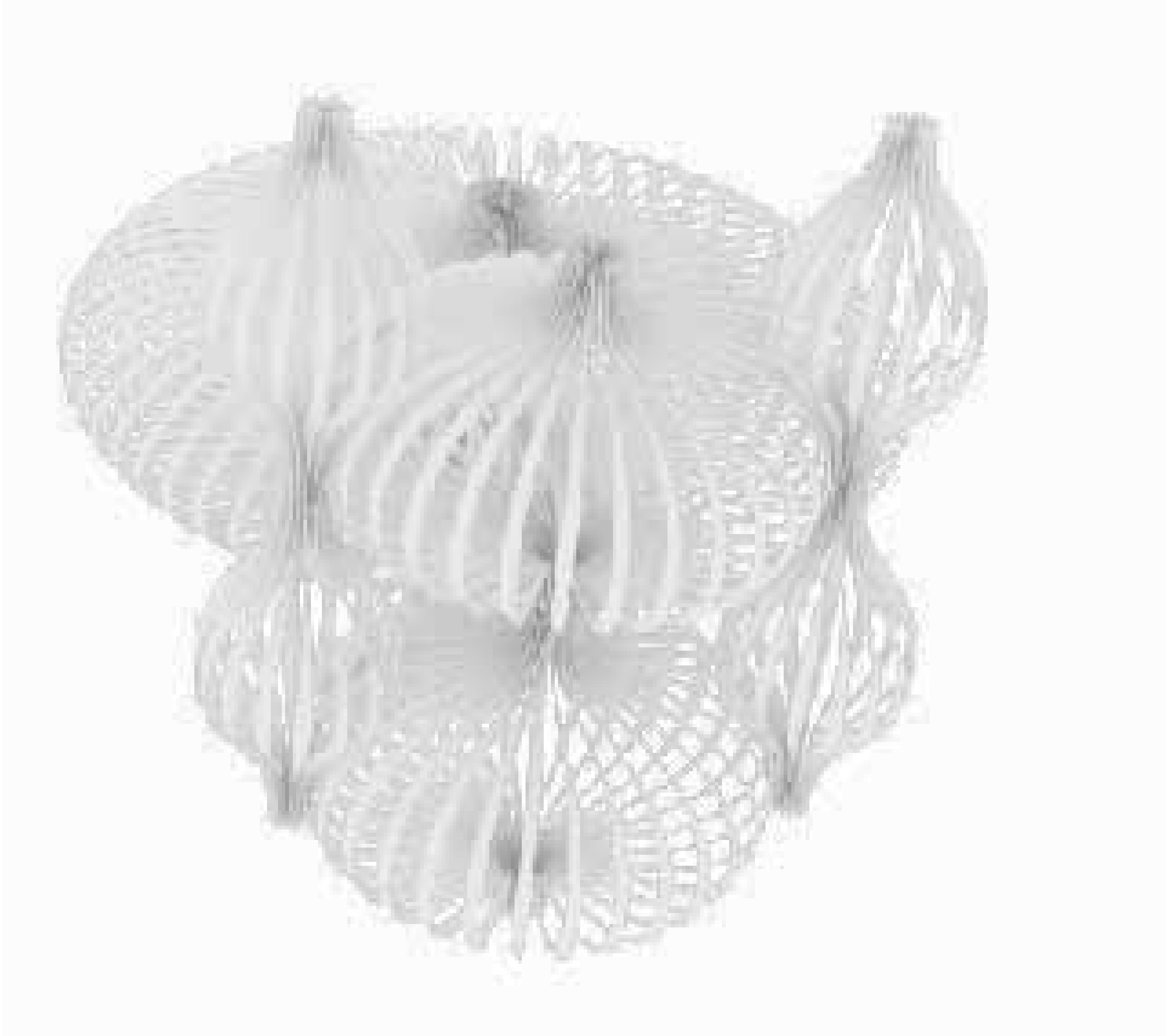








Interior system



cellular parameters

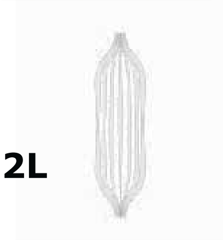
S

M

L

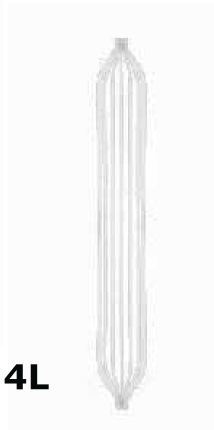
1L

2L



3L

4L



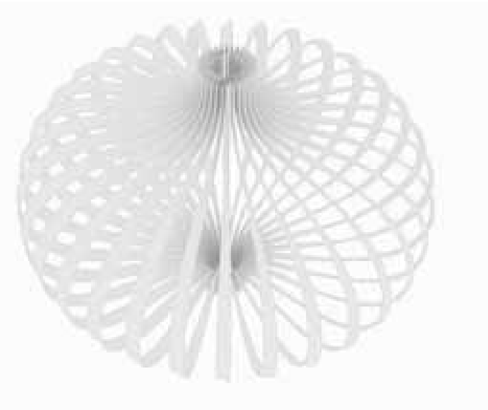
the interior system of the building is also a celular system that inharates its geometric not functional qualities from the facades cellular system ,
in the inner system the cells must adabt themself to a new set of Terms so they can grant the building archeticual qualities , Terms such as cerculation , space , rooms , scales , function .

by determinding a set of parameters that changing them can help me adapt the the cells to any function was my starting point Encountering the interior planing of the building.

O1

O2

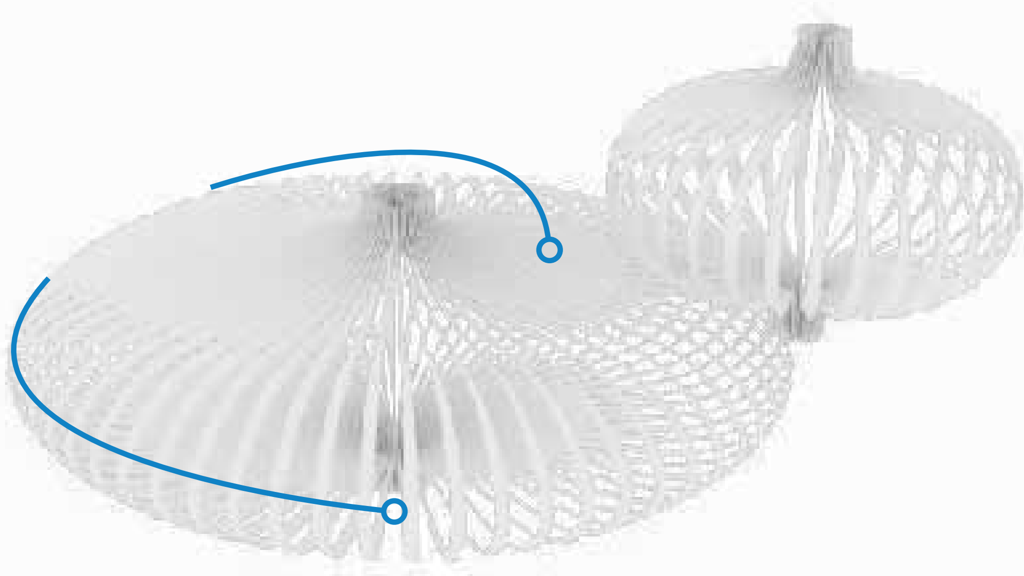
O3



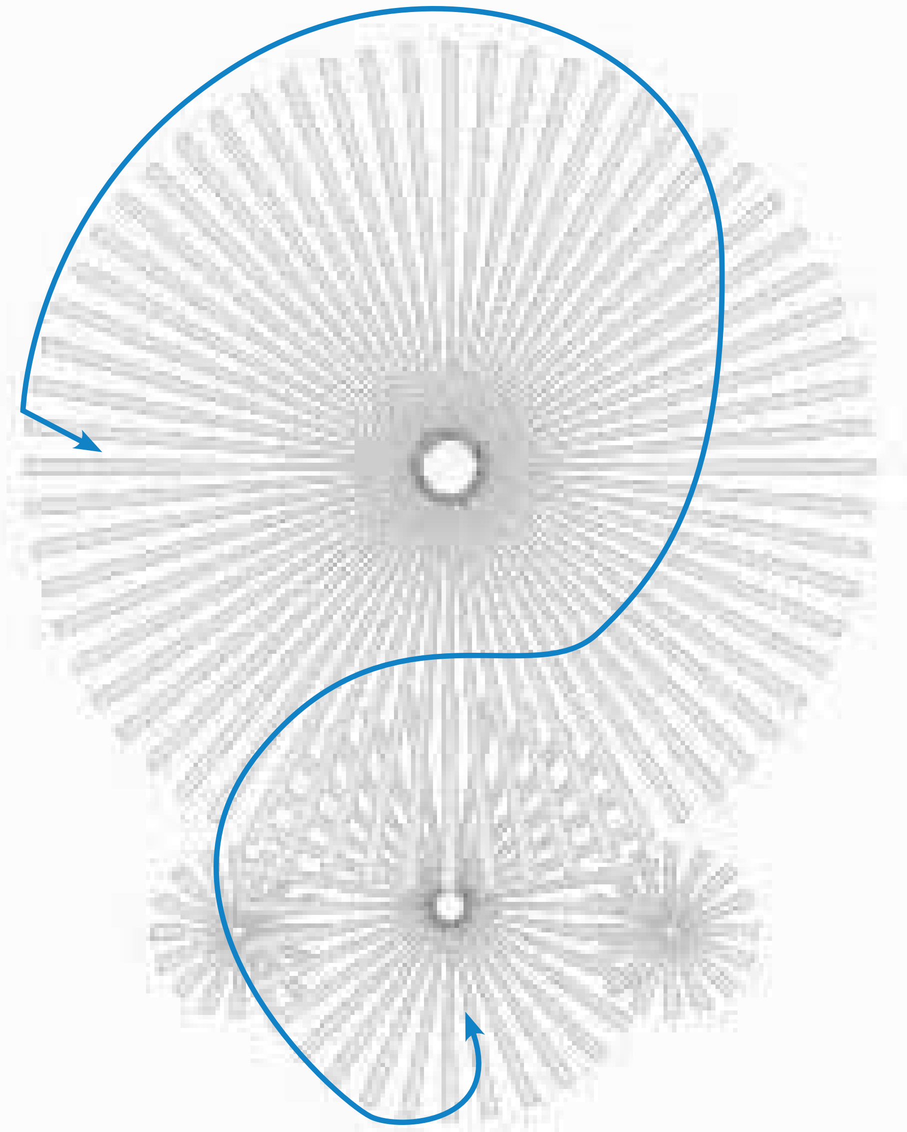
Openings

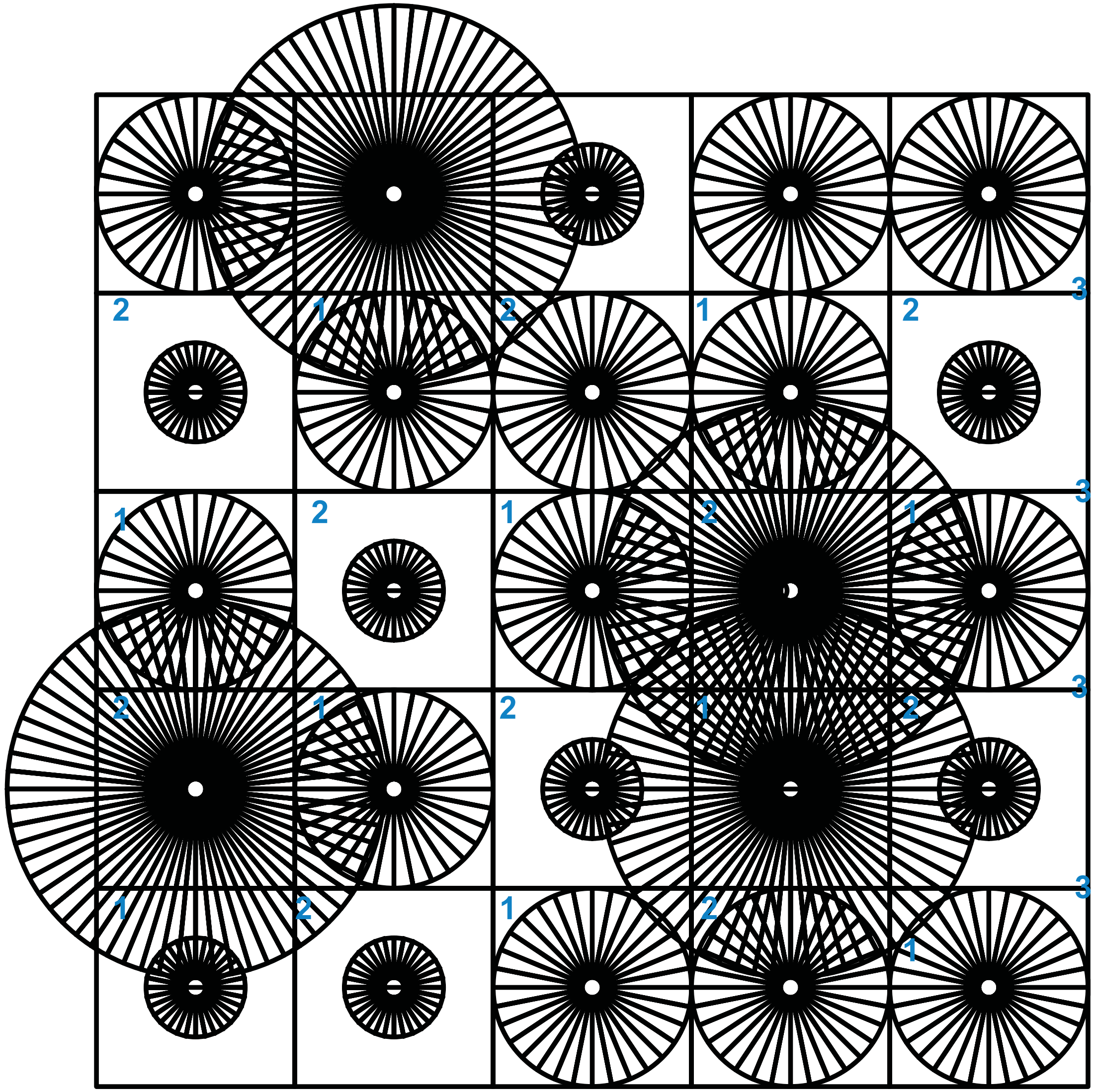
the cells opening level was another parameter and its levell was canged by controling the number of wood strips creating the cell , controling the twist angle and controling its orientation along the cell .
this could lead to varios posebeties of openings in the cell

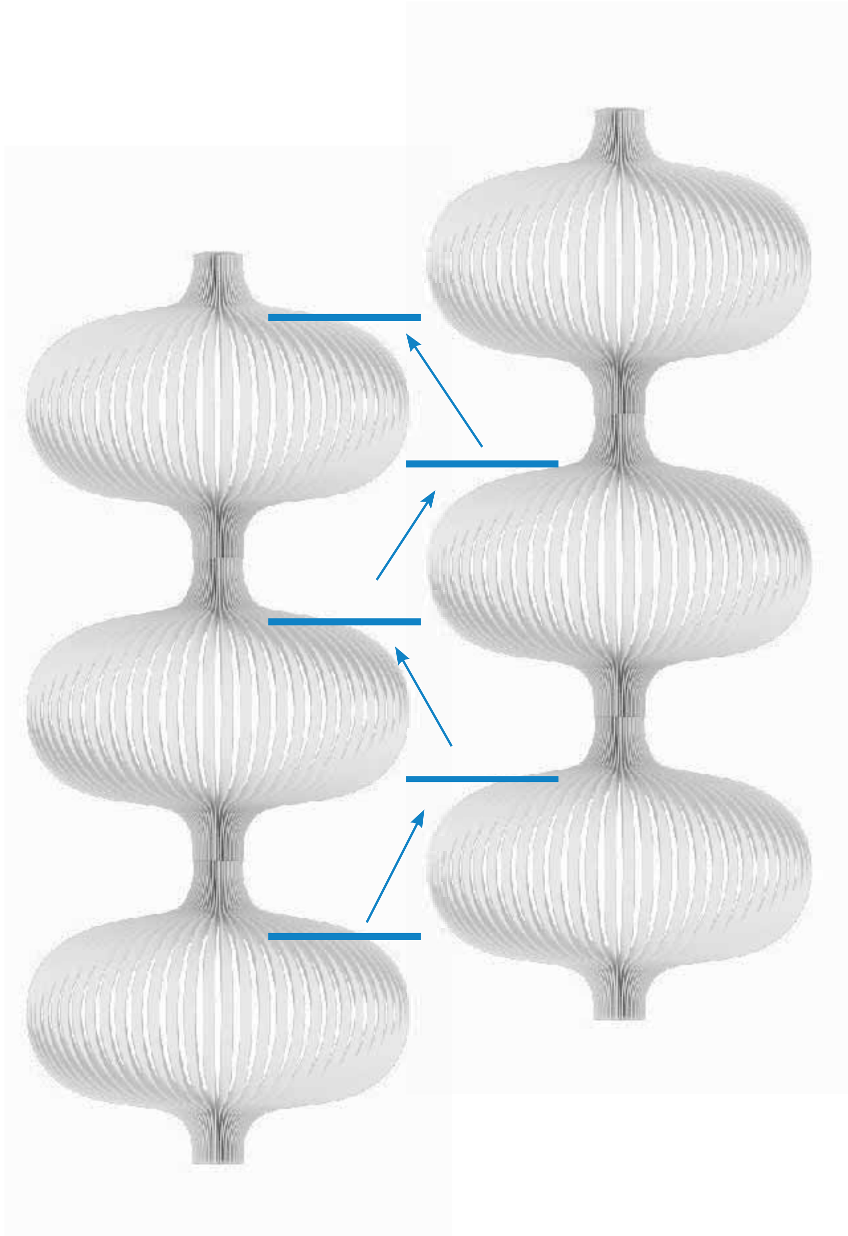
Cerculation

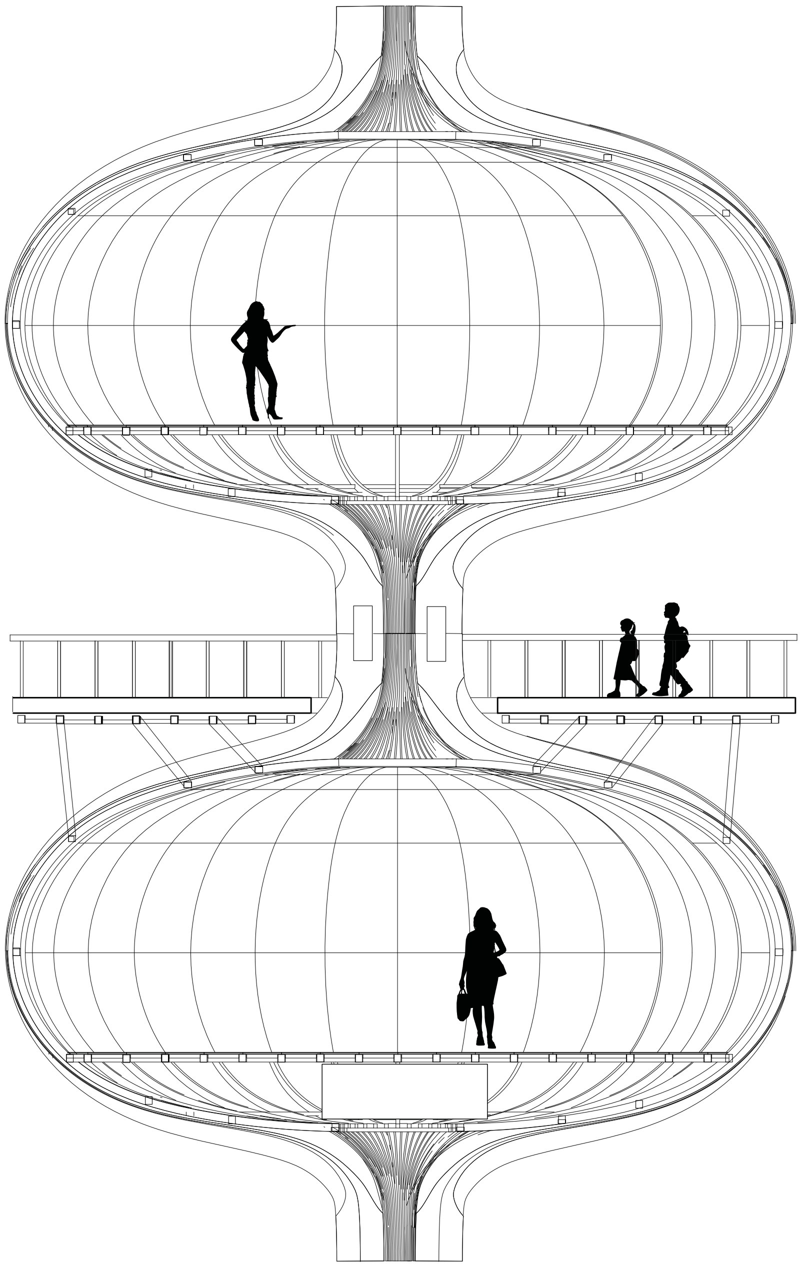


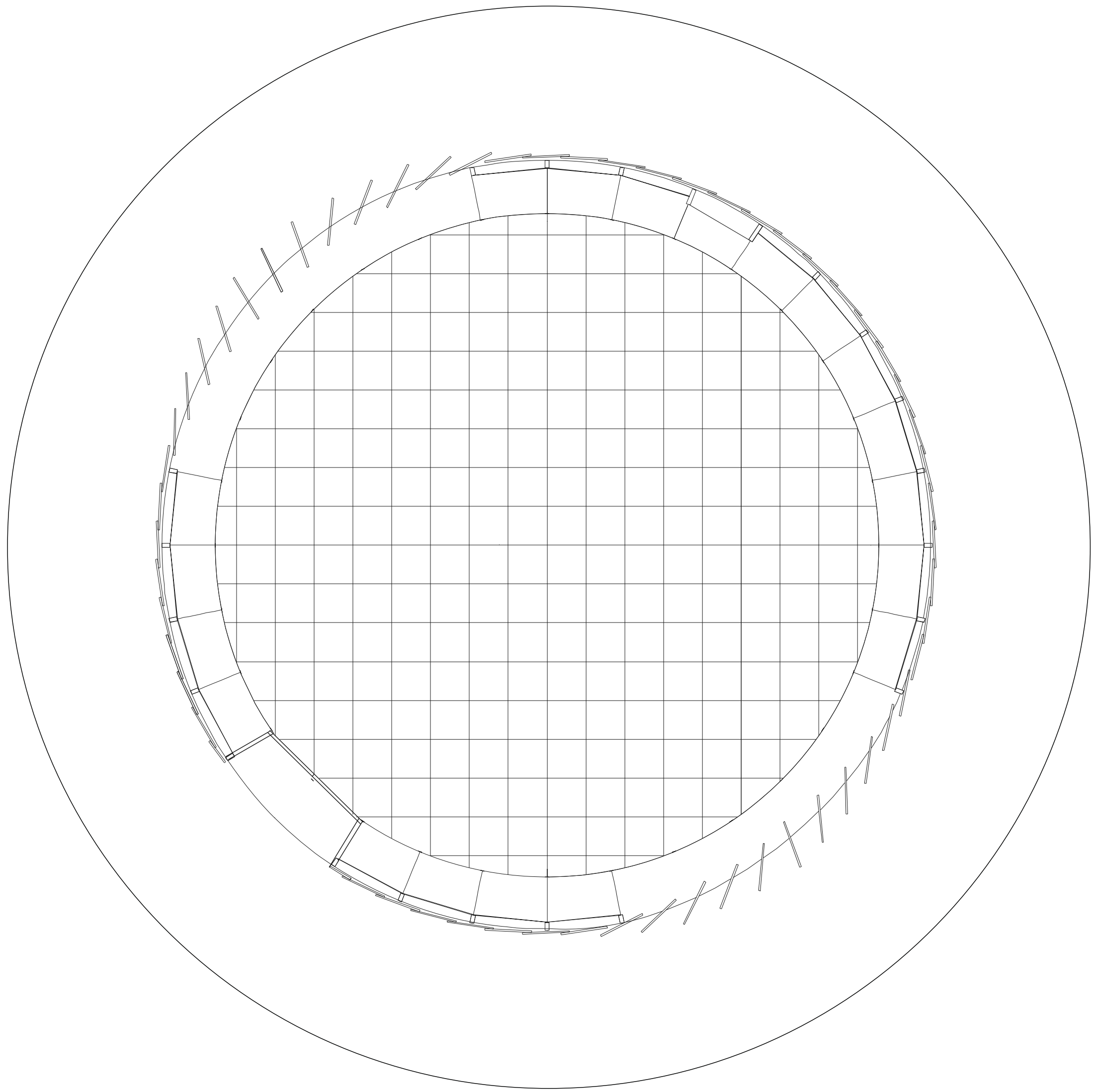
the interior of the building is made of two systems the cells system and the cerculation system that spreads around the cells and connecting them together creating a complex system of ramps all around the building making it a dinamic building

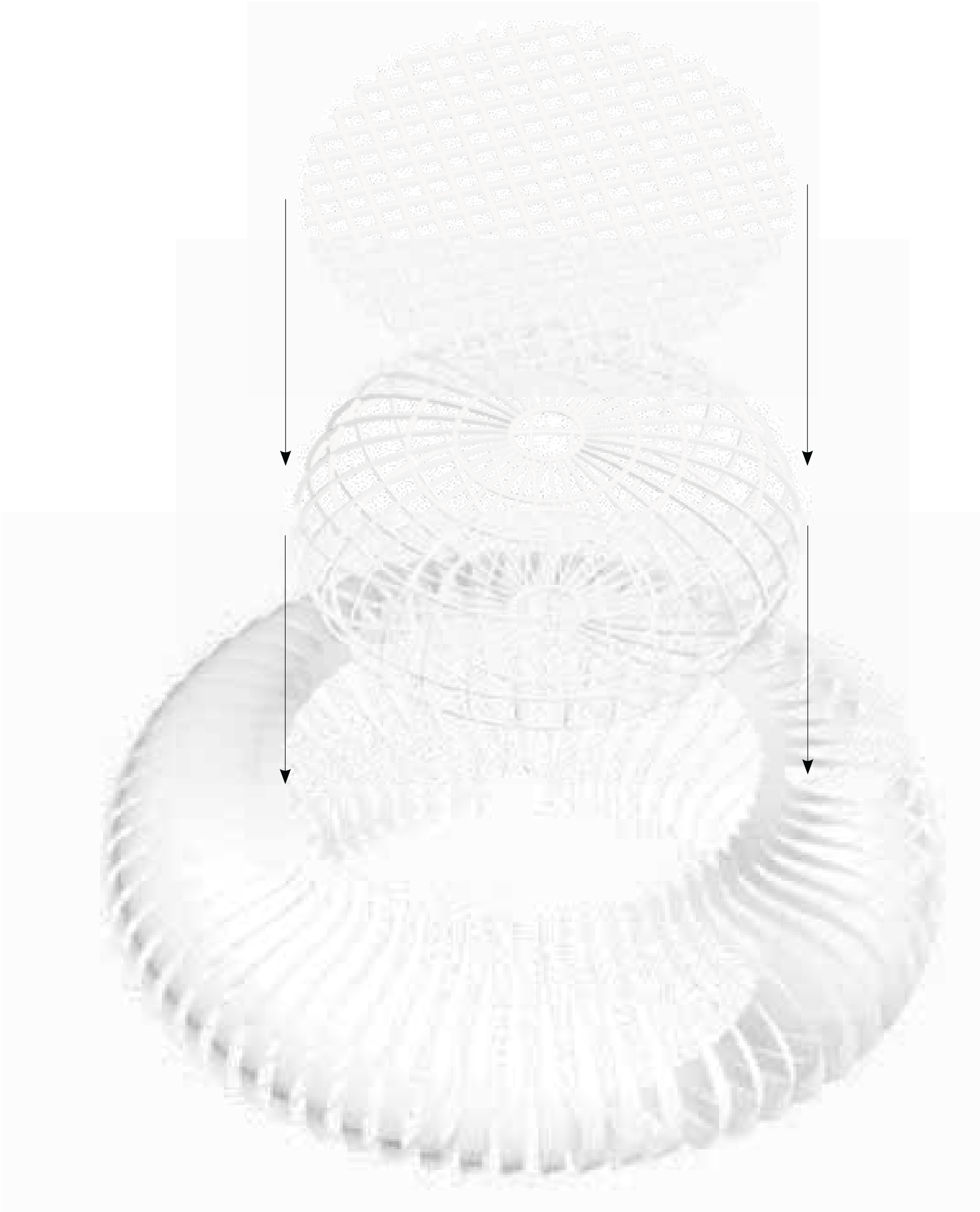


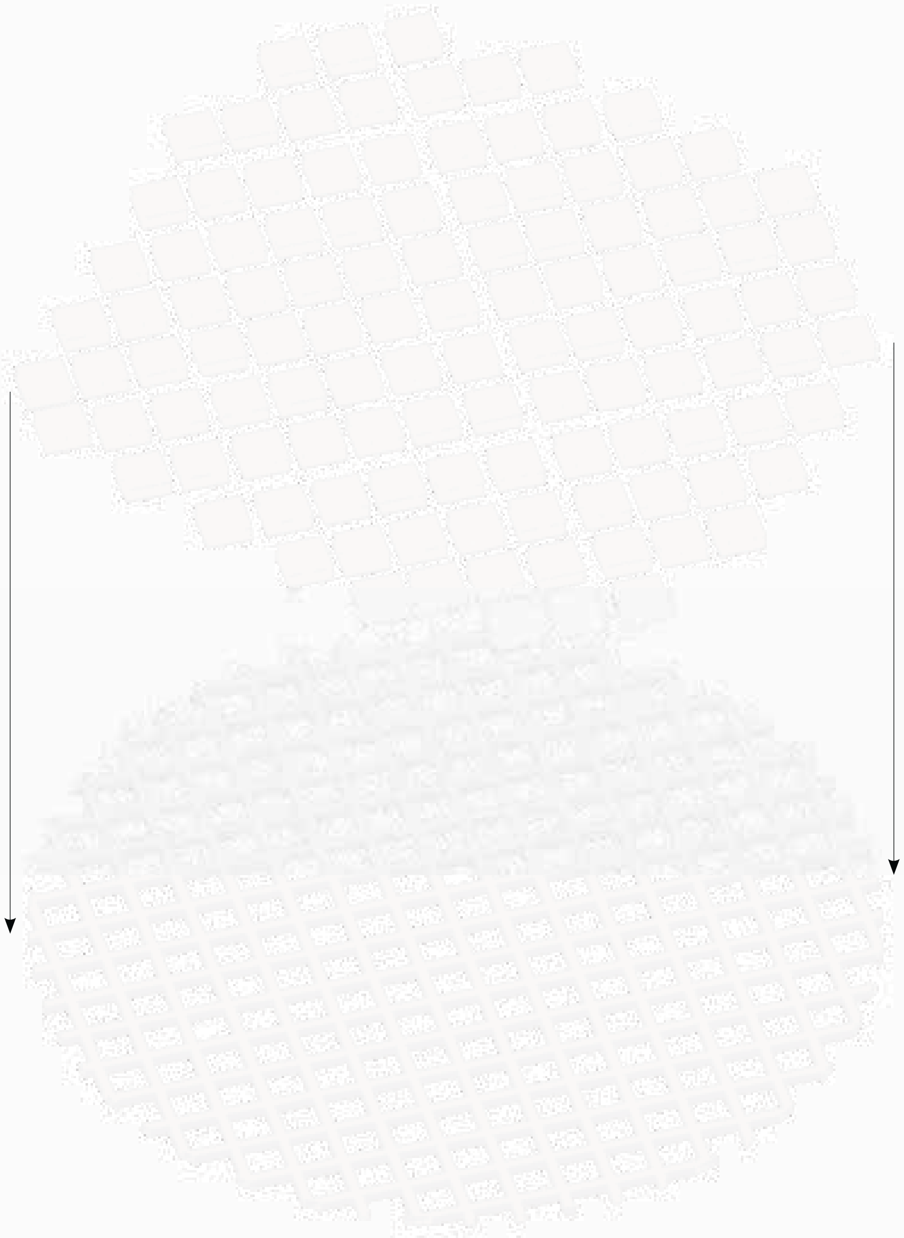

2
1
2
1
2
3
1
2
1
2
1
3
2
1
2
1
2
3
1
2
1
2
1
3

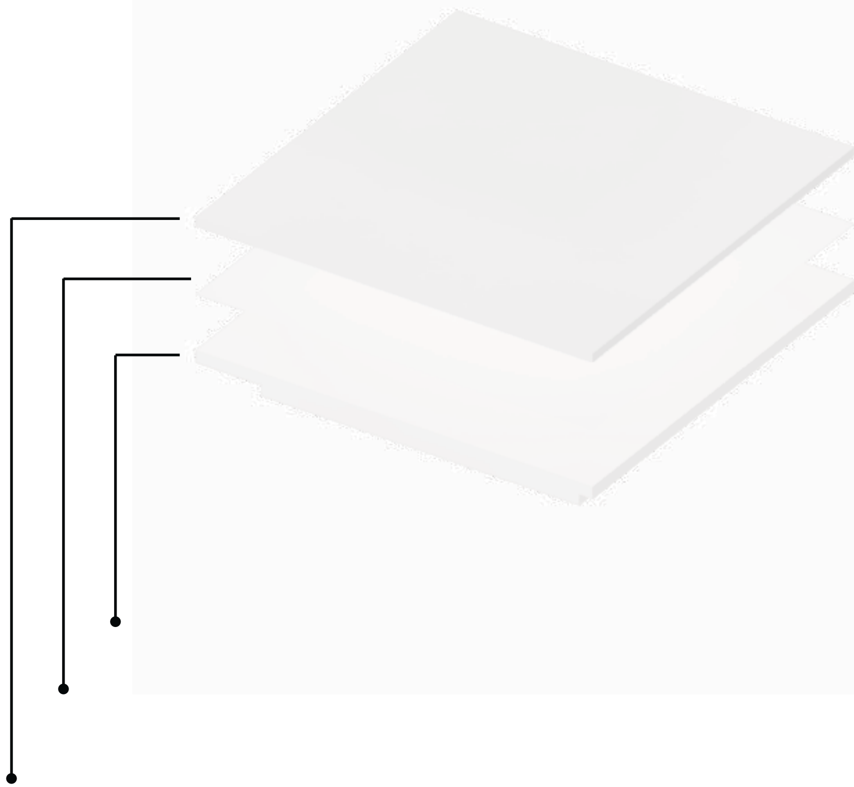


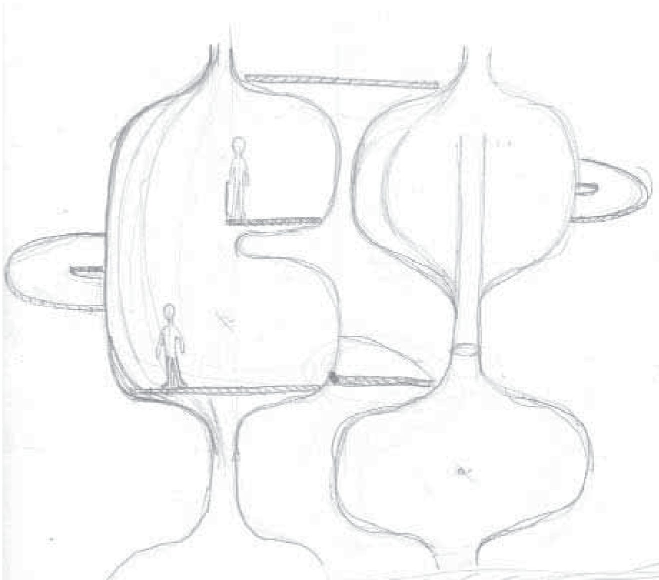


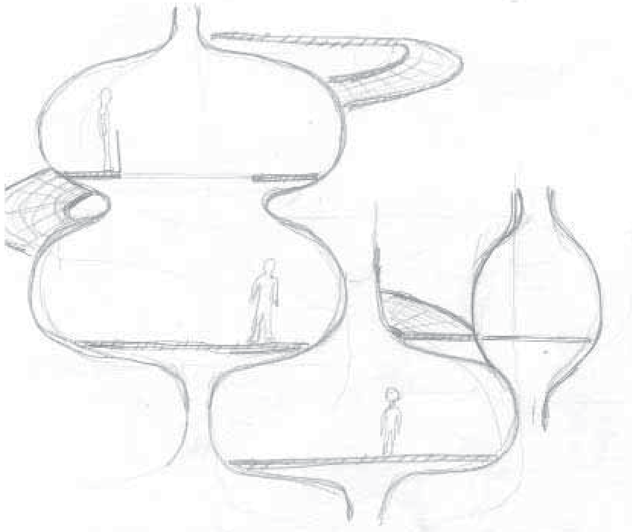




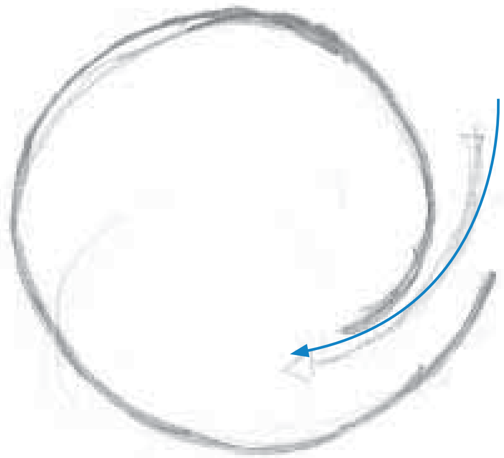


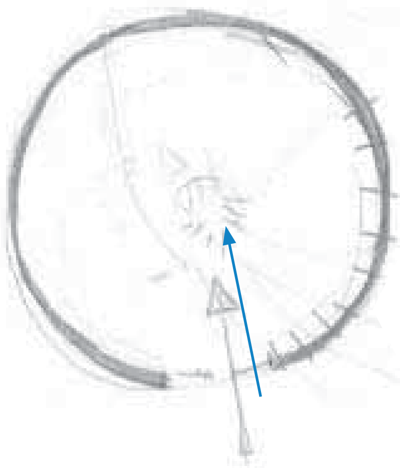




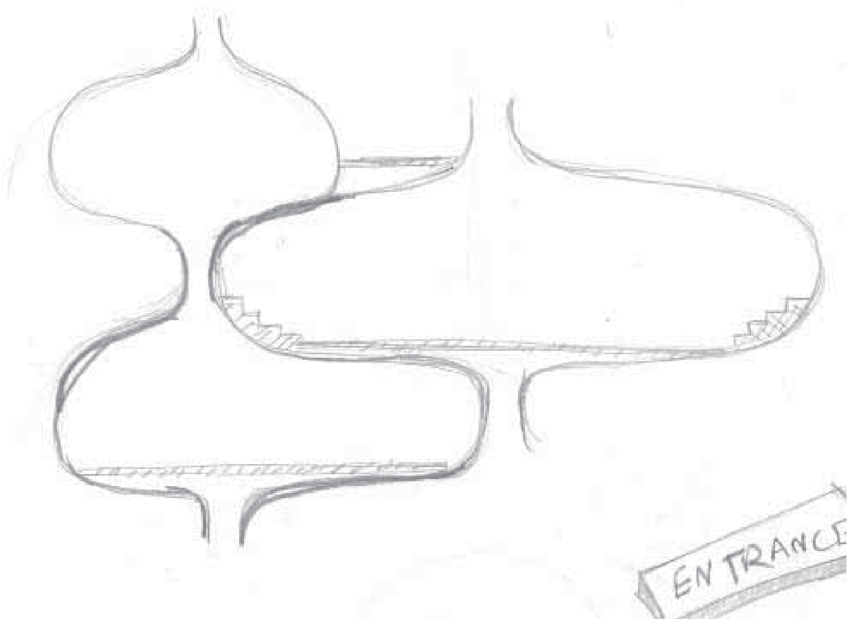


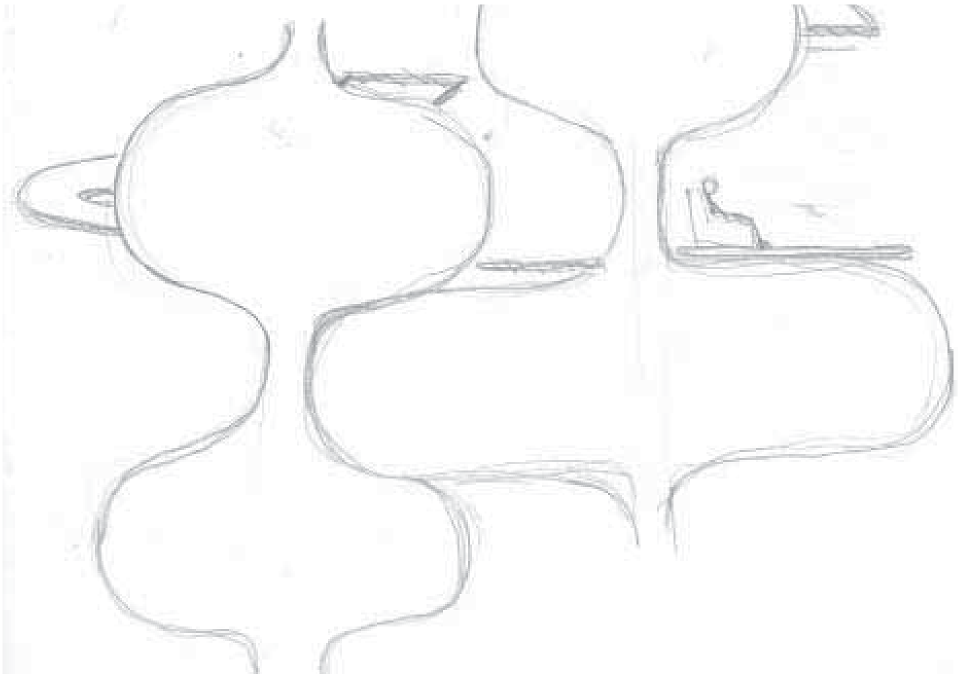
Accesses

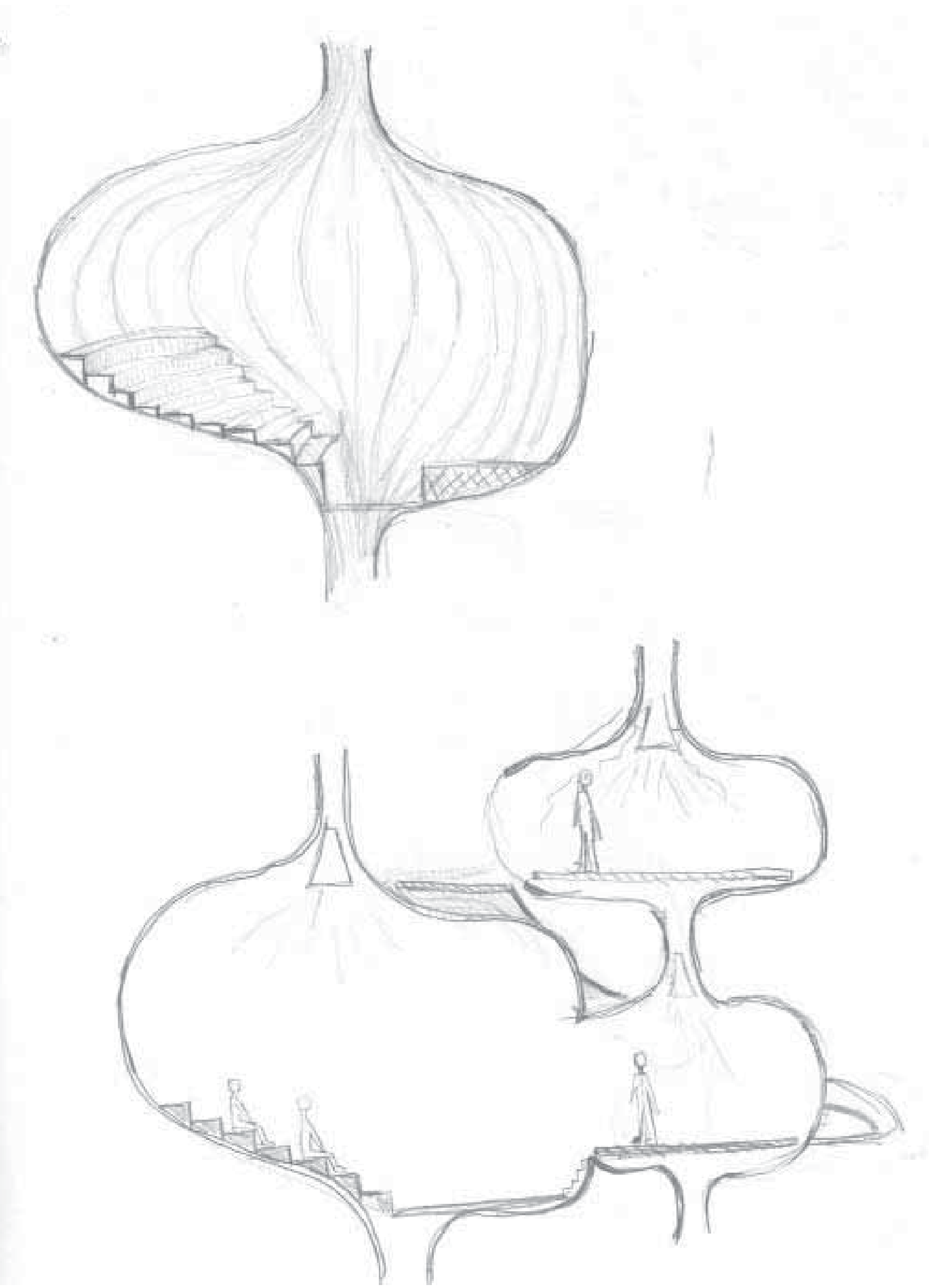


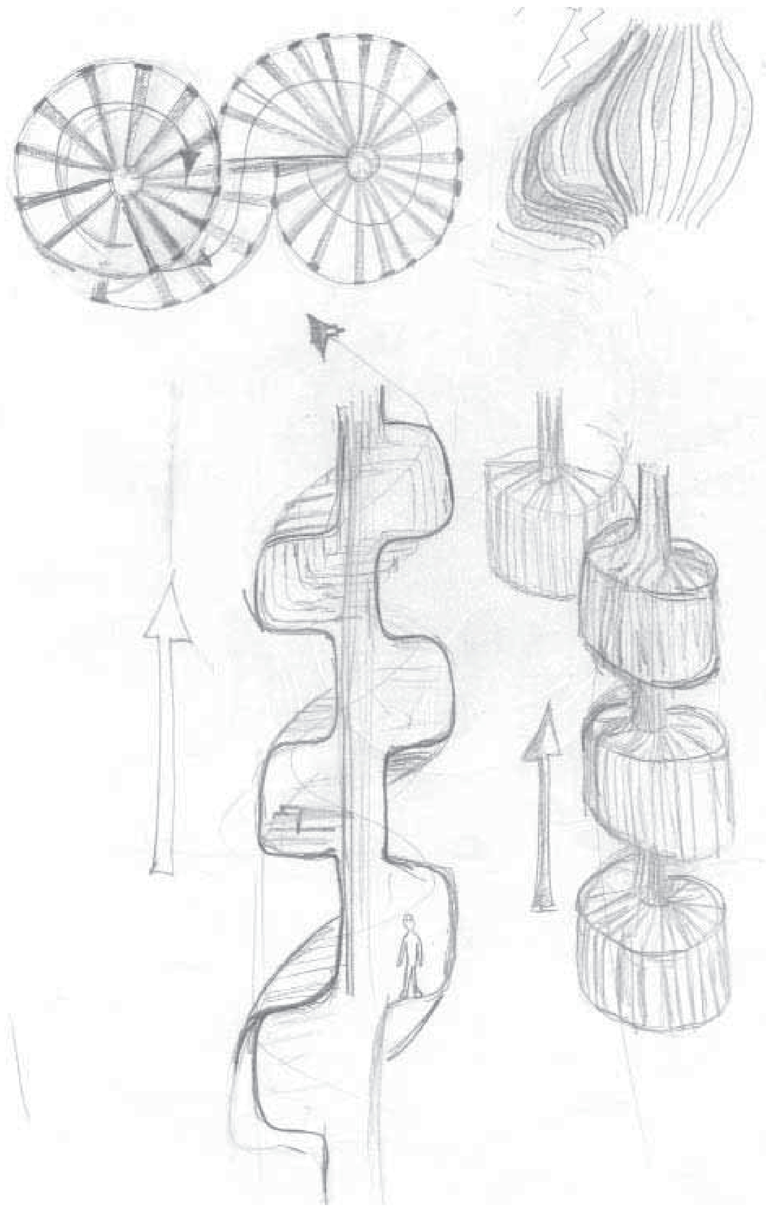


Accesses

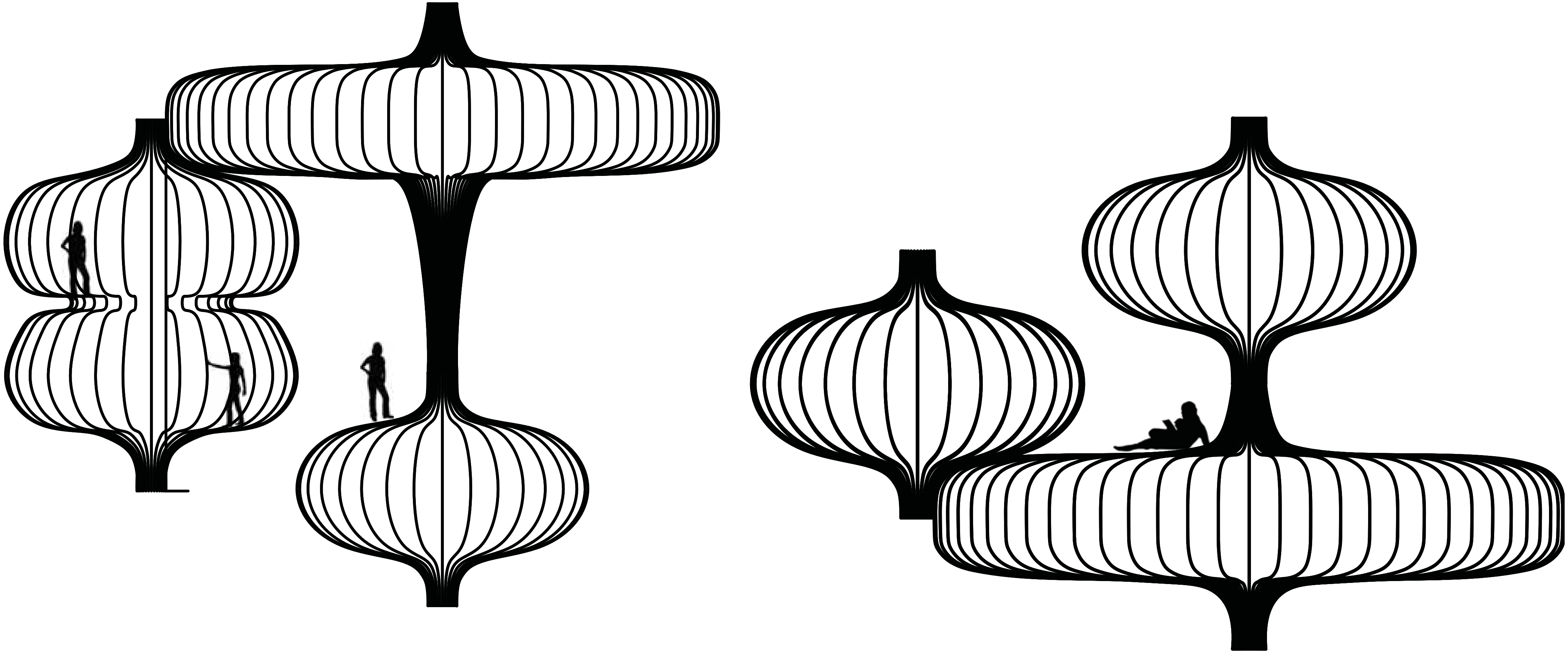


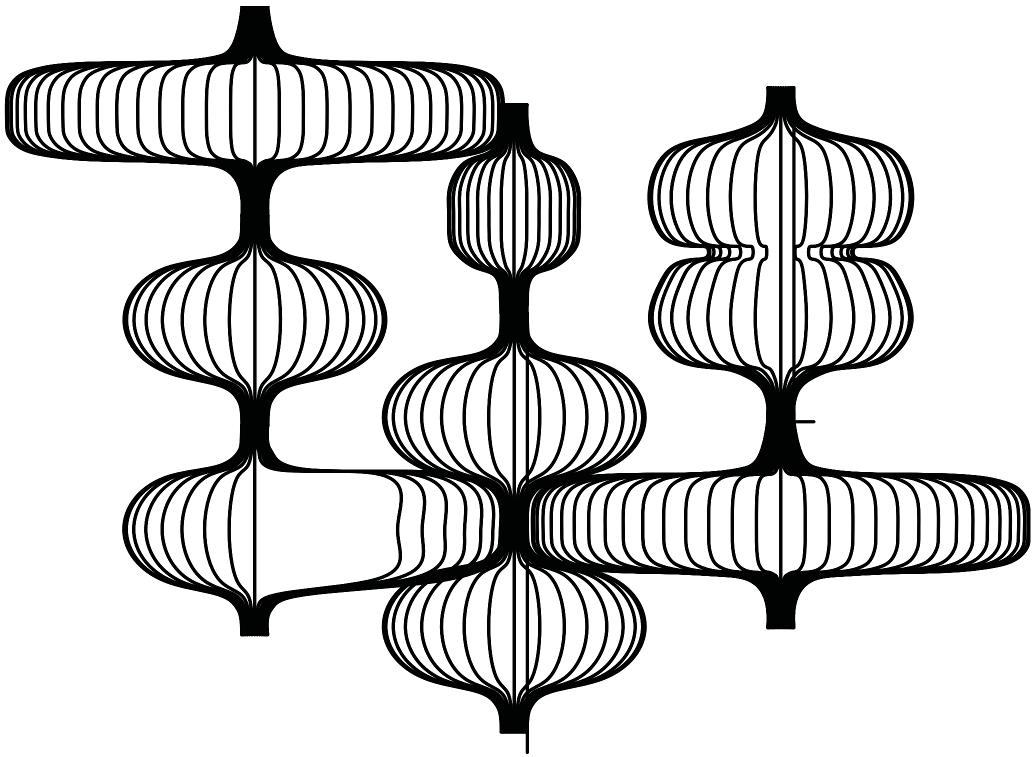


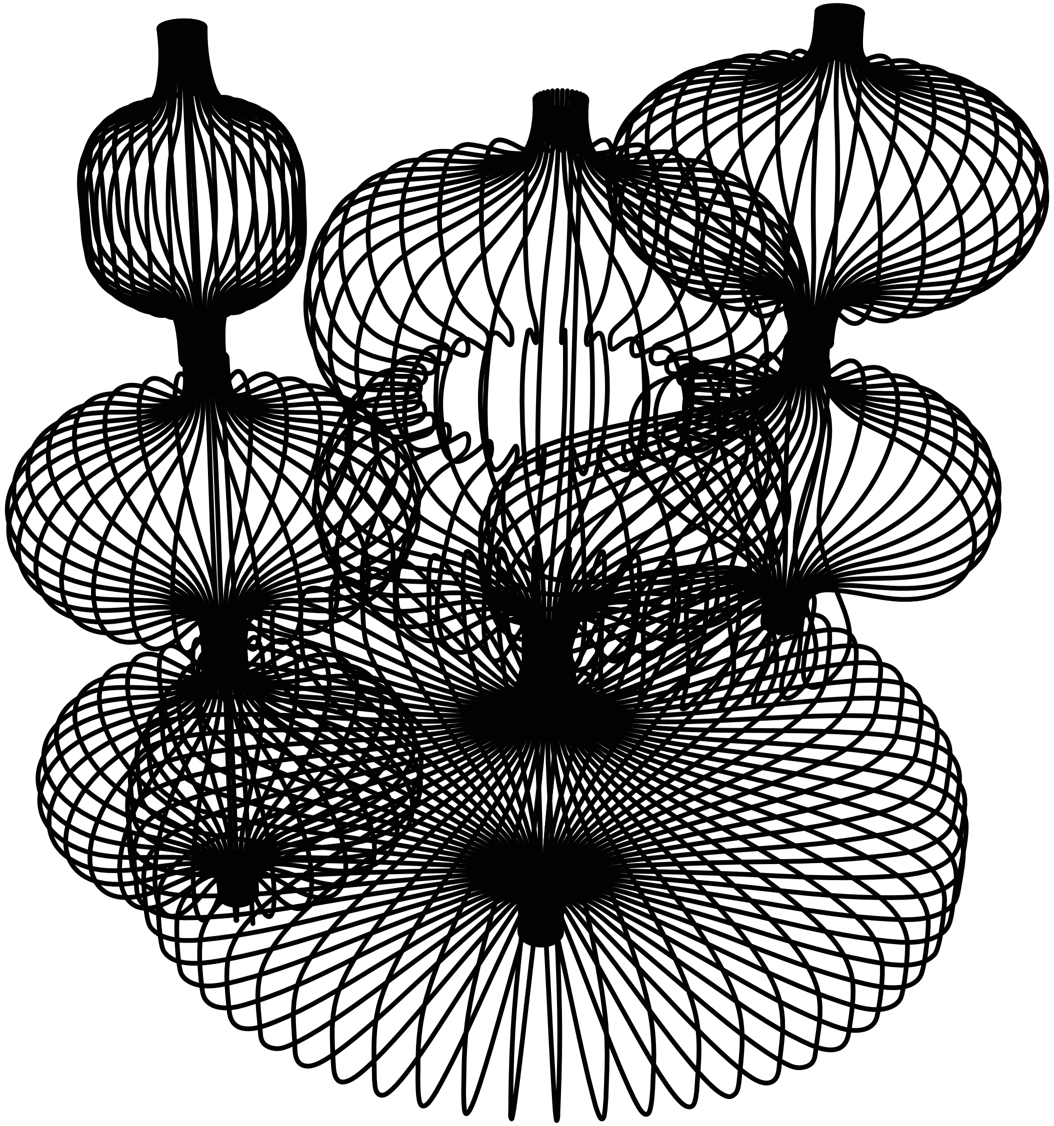


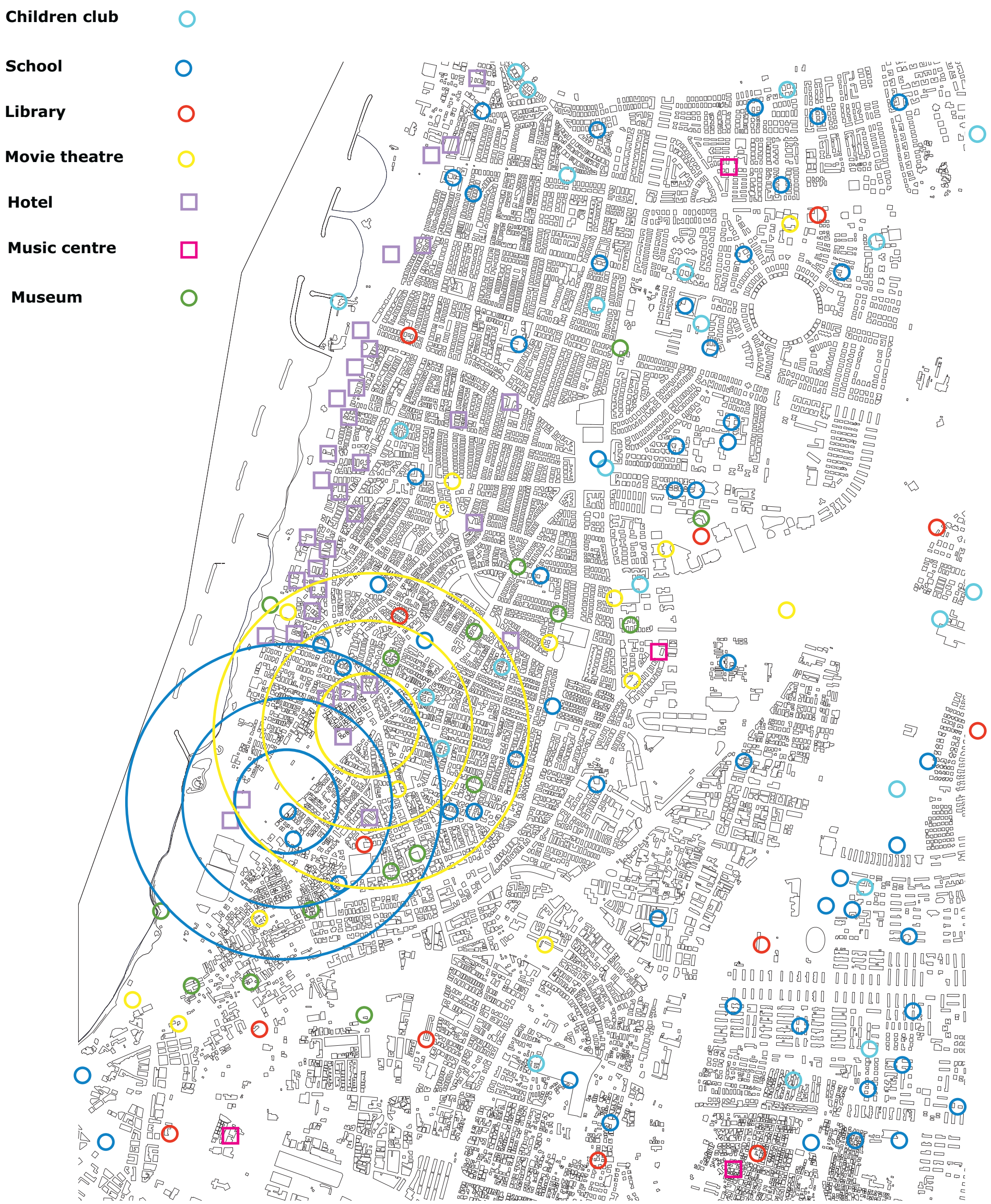


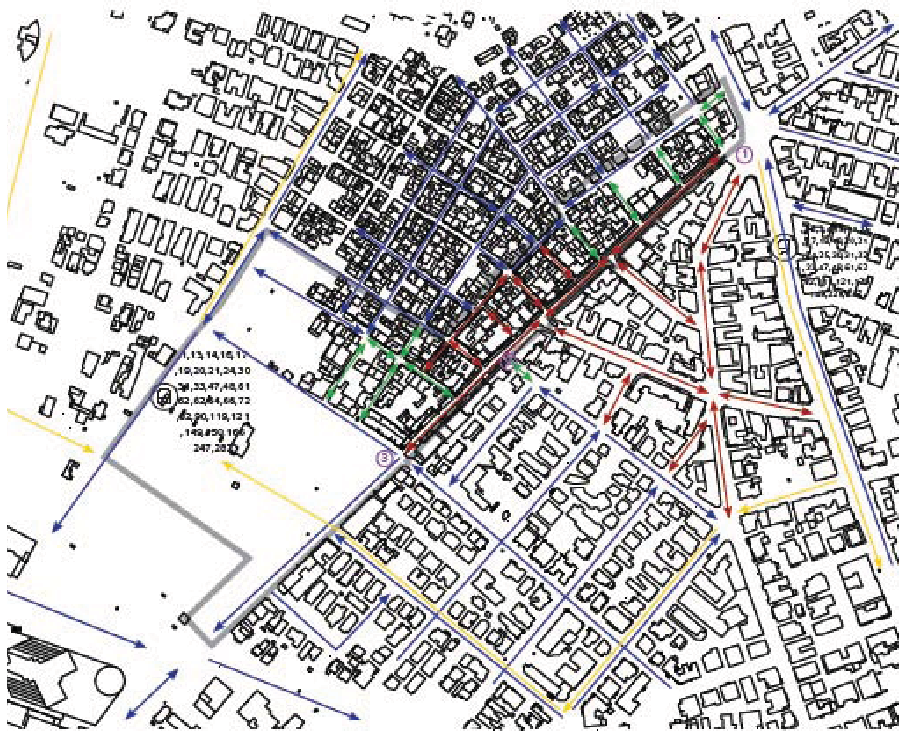
interior catalog



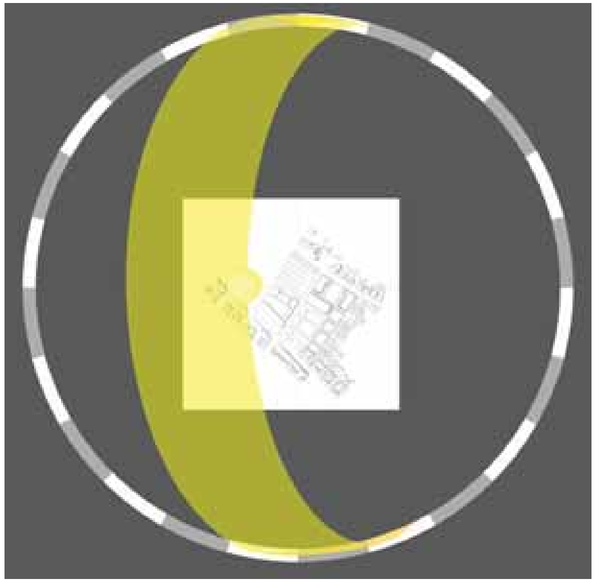




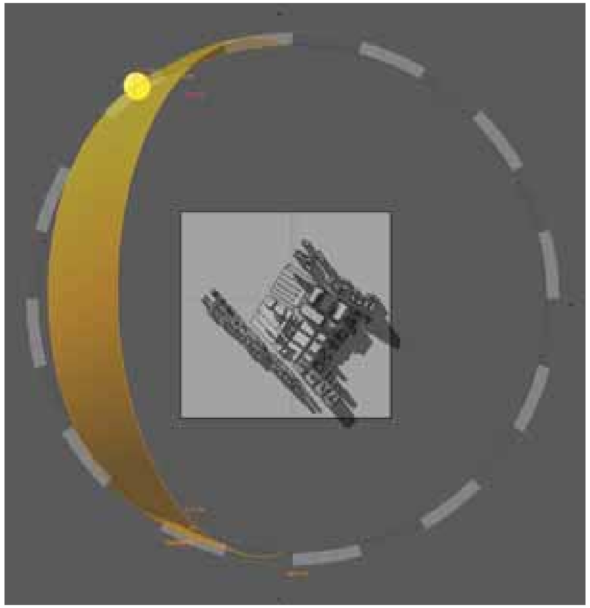

Children club
School
Library
Movie theatre
Hotel
Music centre
Museum



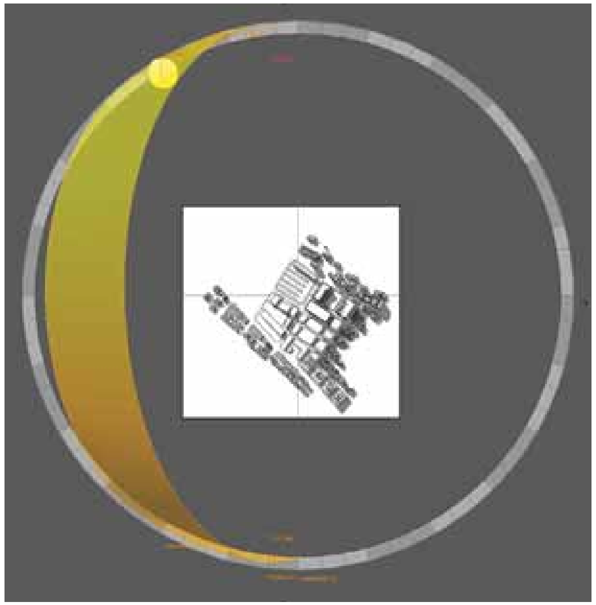
summer



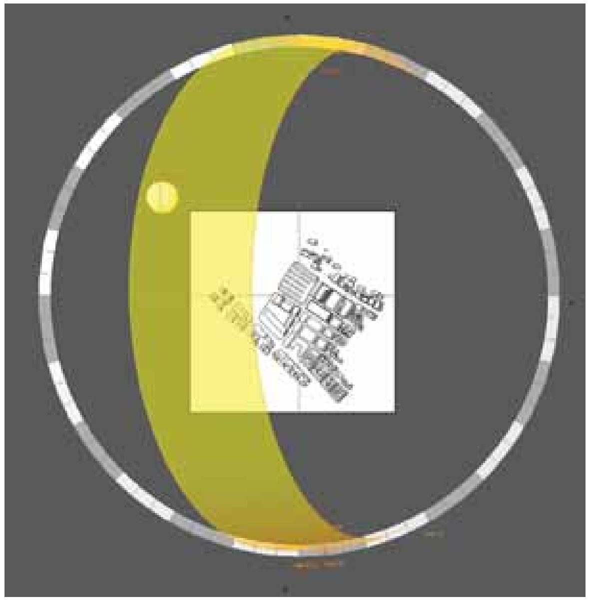
winter

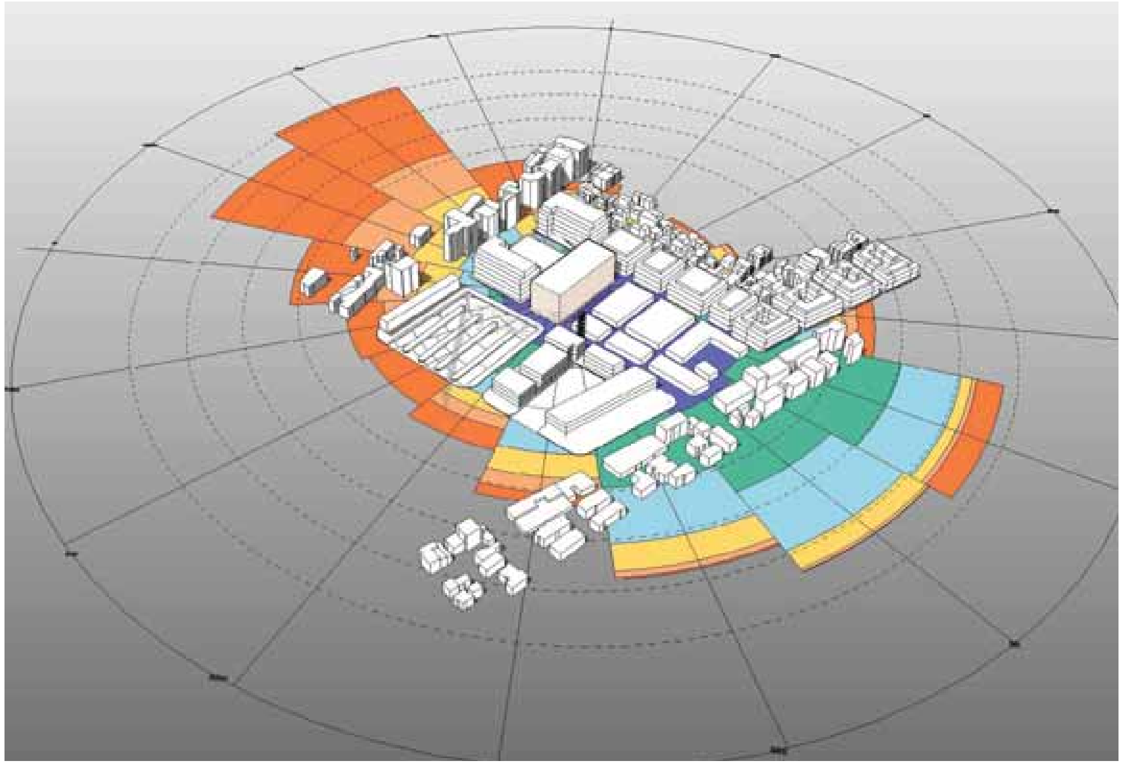


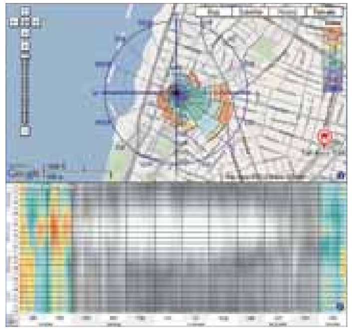
fall



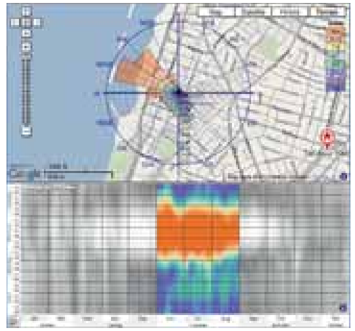
spring



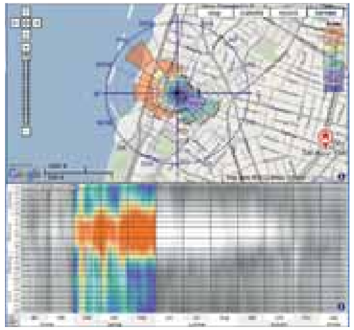




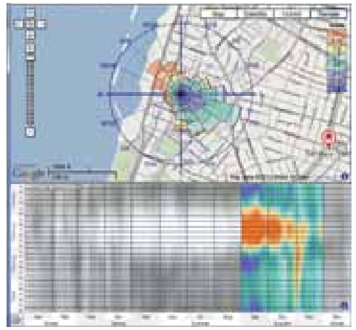
winter



summer



spring

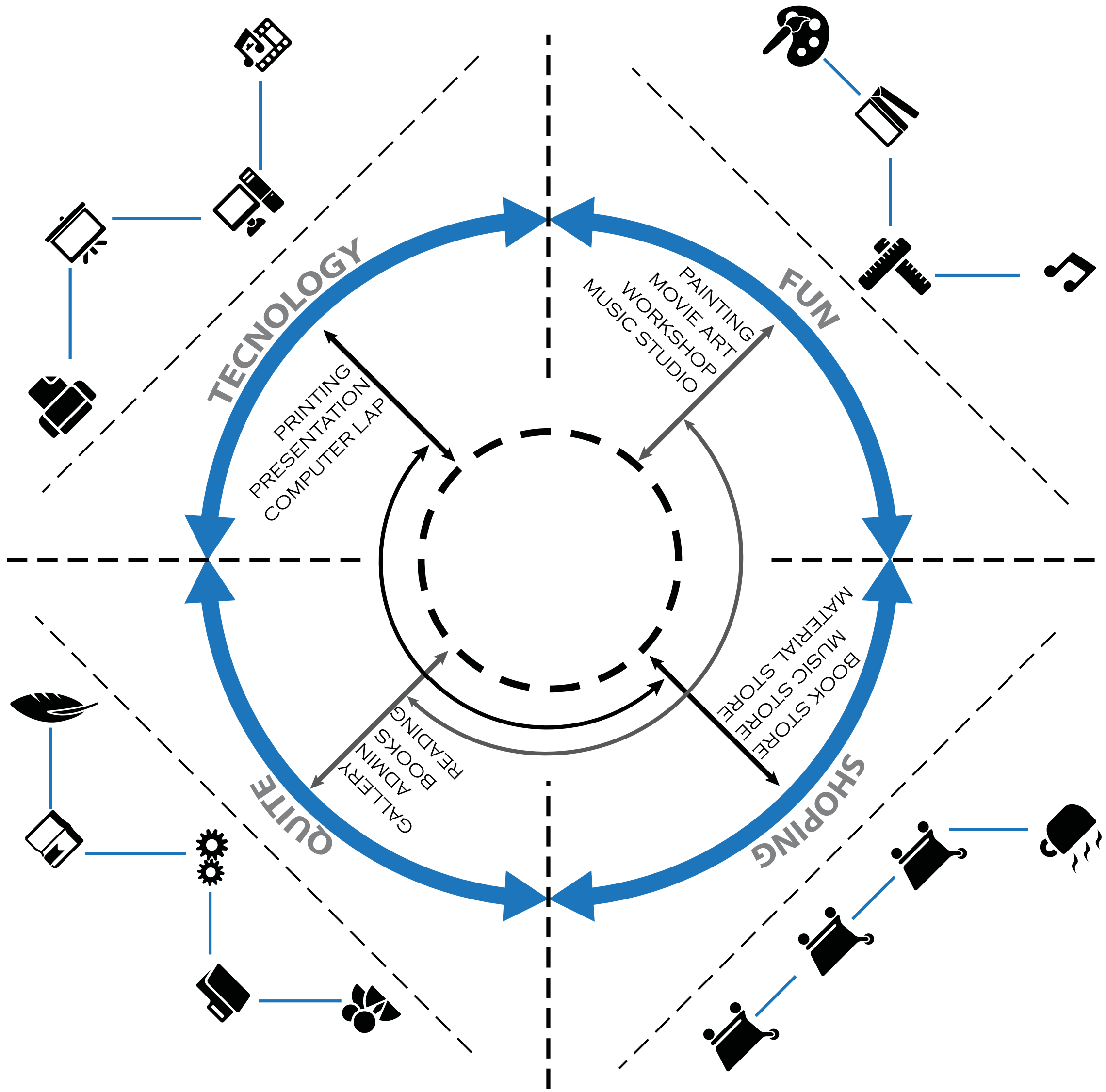


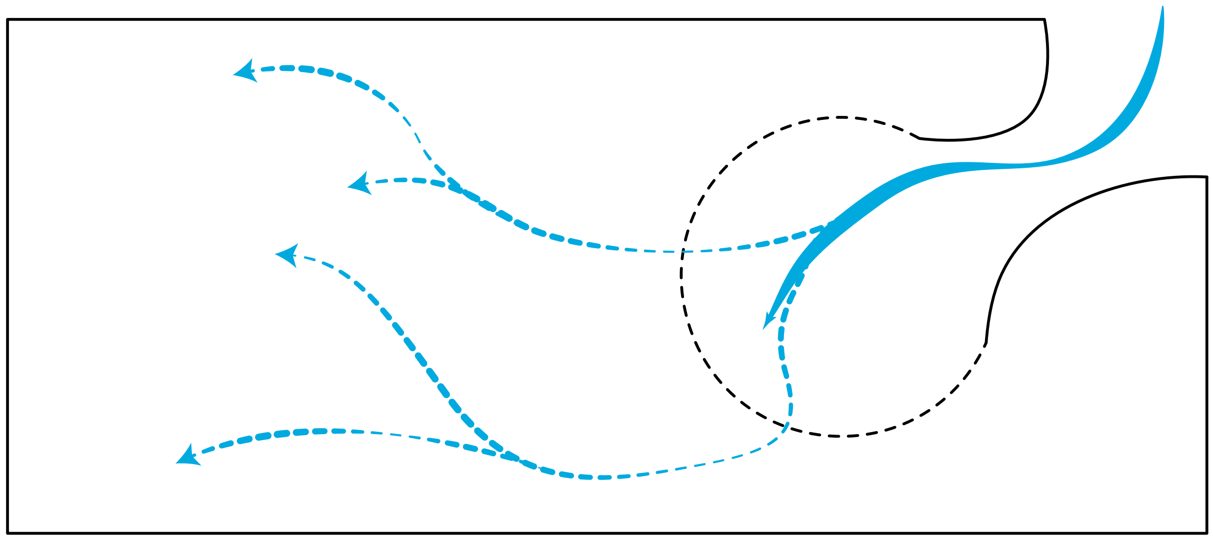
fall

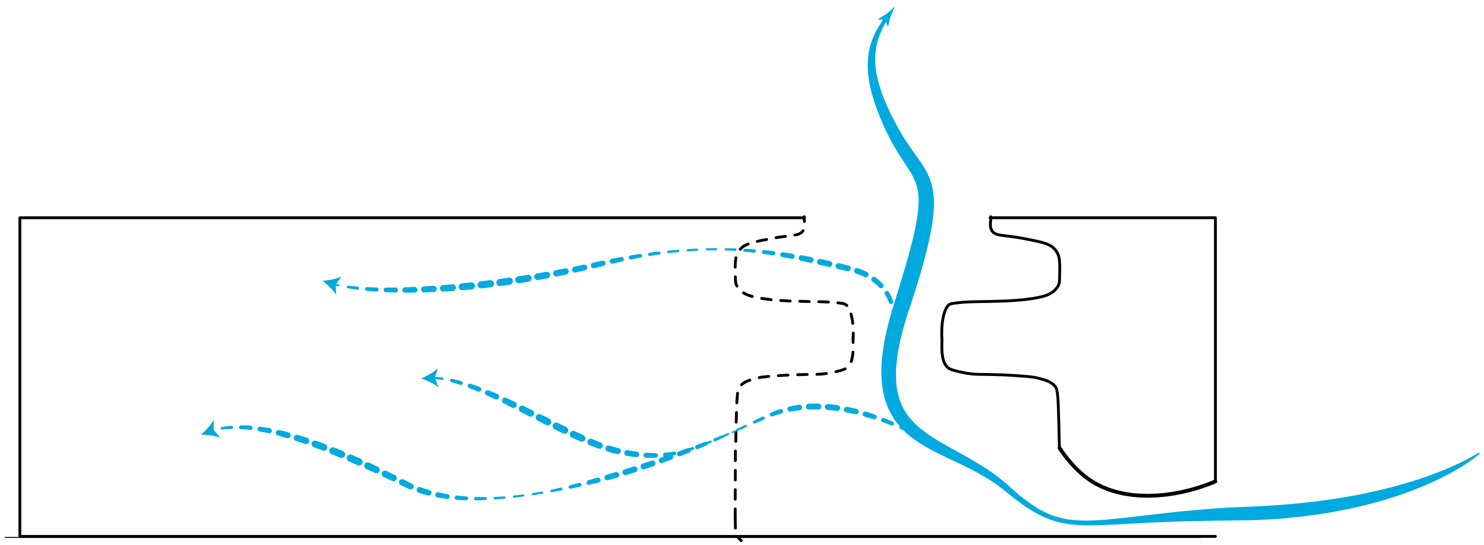
building program

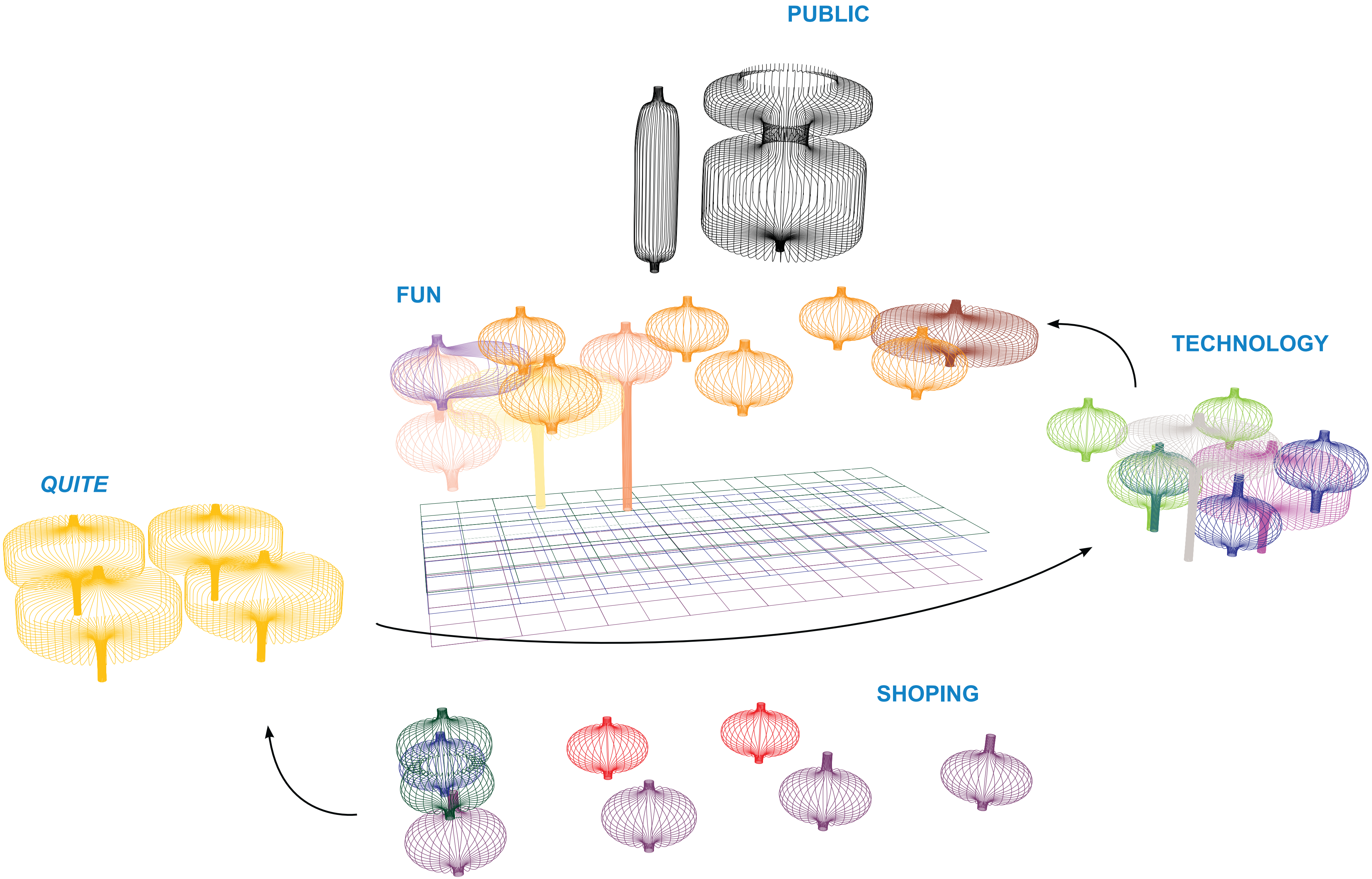
QUITE	
book stack	1200
reading	
letrature	
administration	300
FUN	
music studio	120
photography studio	350
workshop	500
paint studio	200
general studio	90
TECHNOLOGY	
computer lap	260
presentation rooms	100
printing	300
media rooms	120

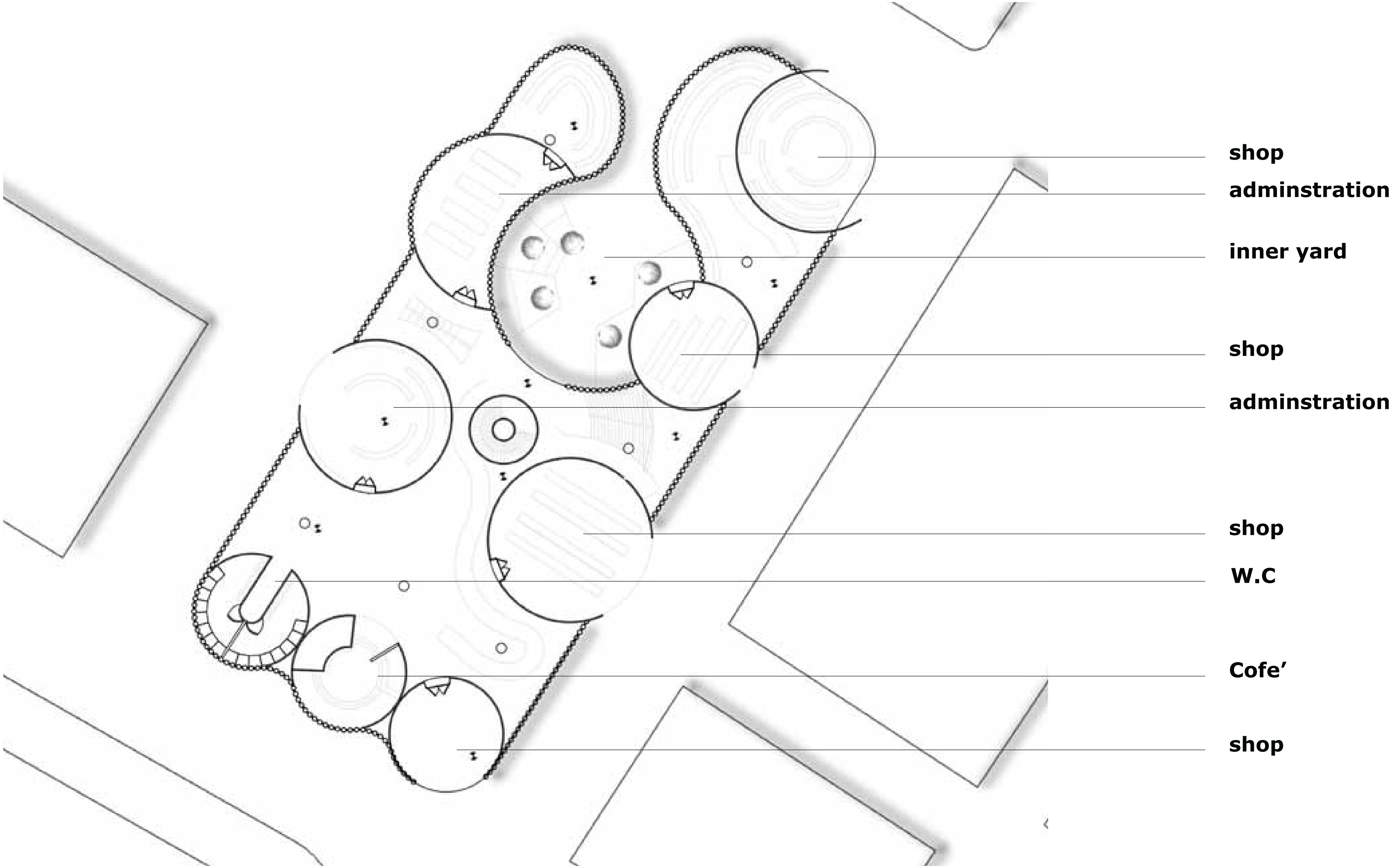
SHOPING	
media shop	90
material shop	90
book shop	90
cafe house	70
PUBLIC	
open space	
theatre	
gallery	600

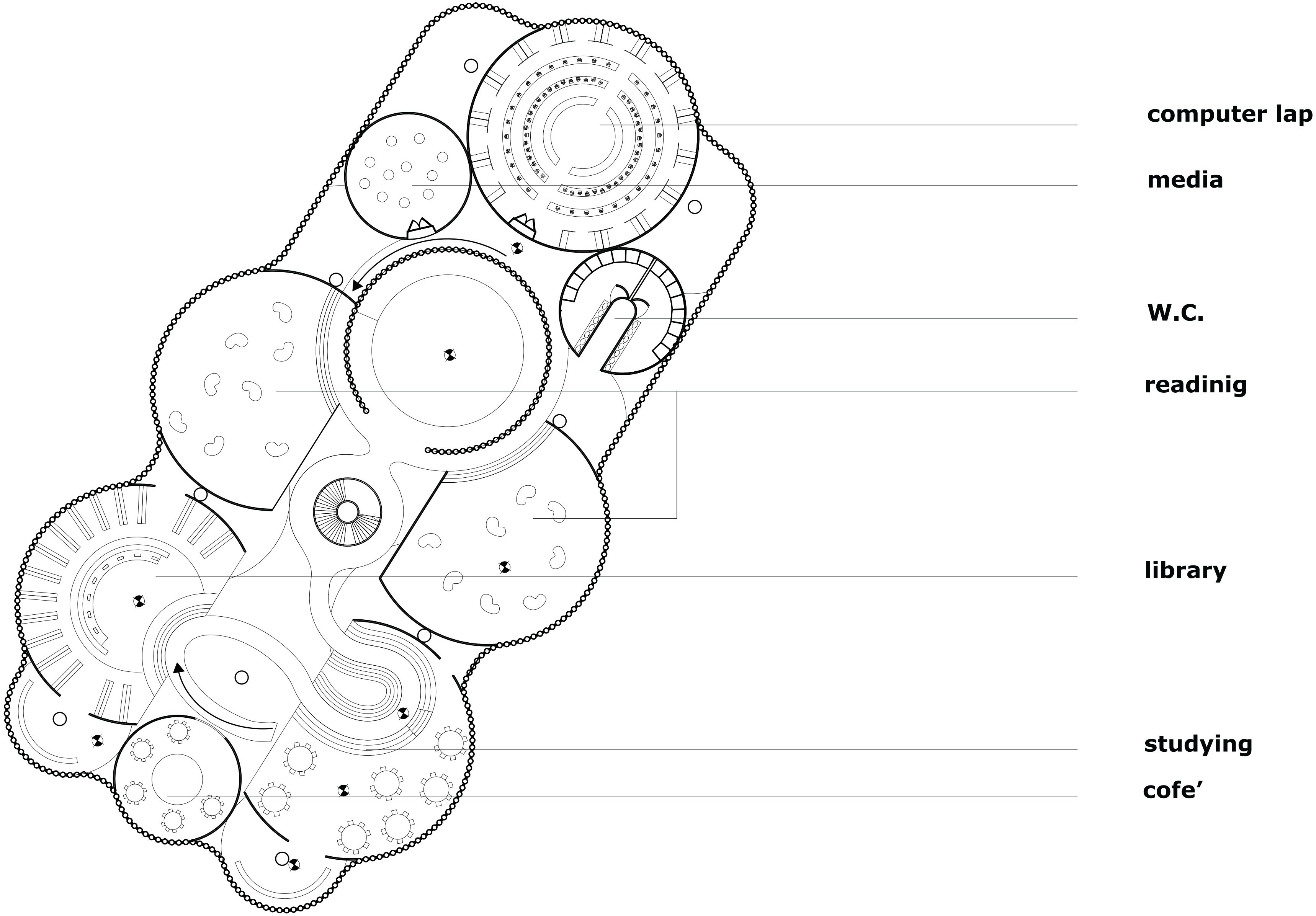


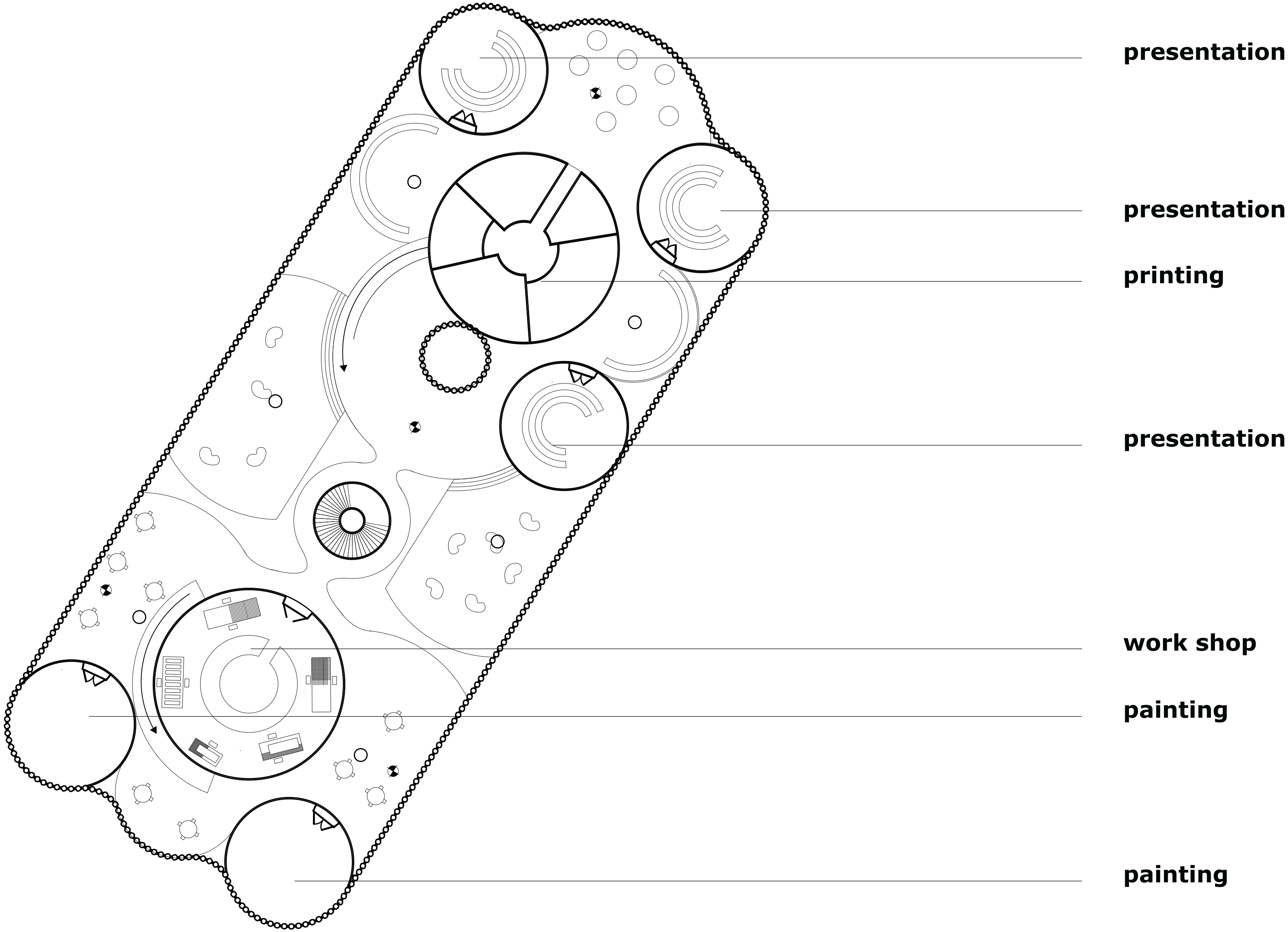


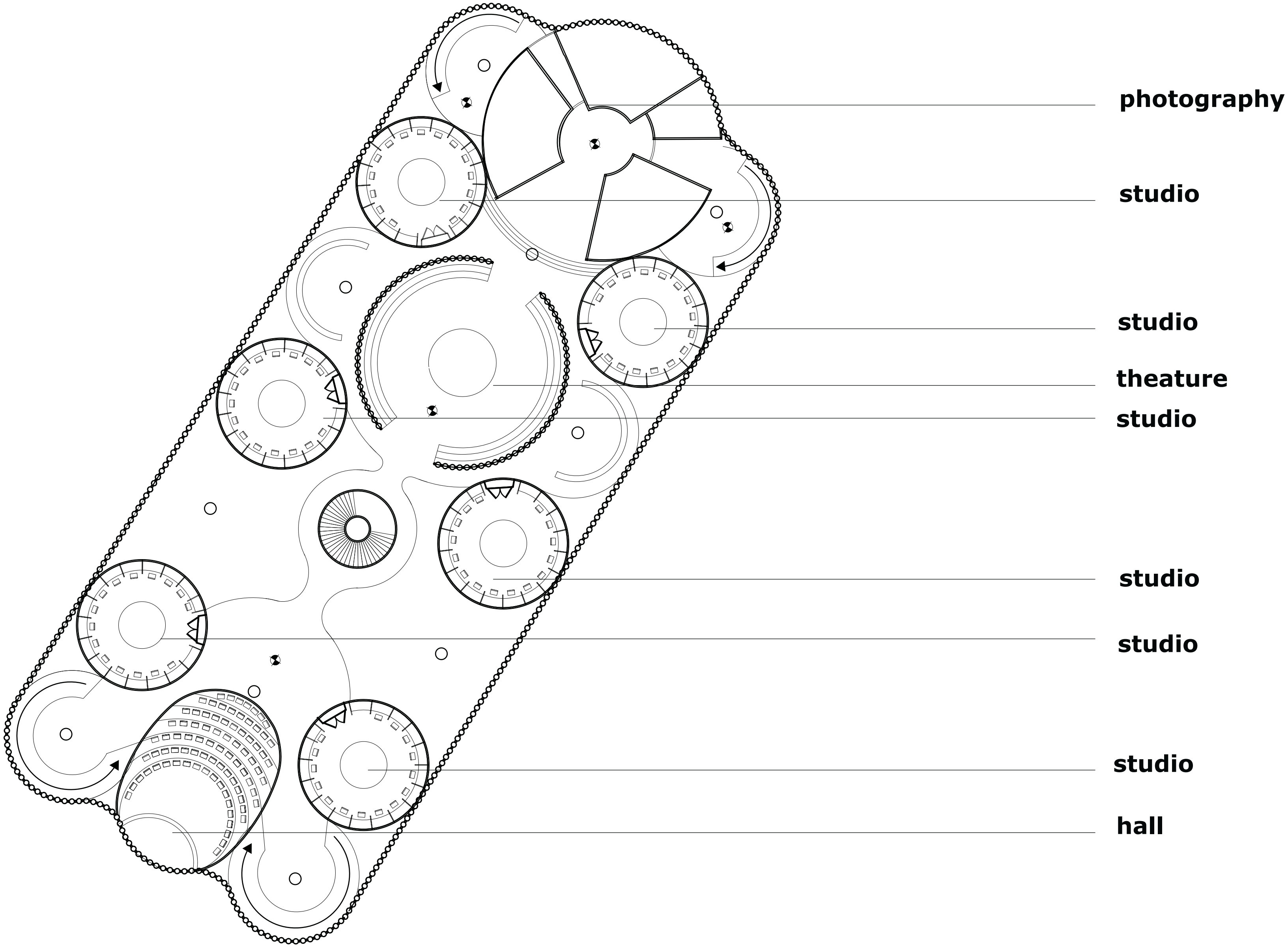


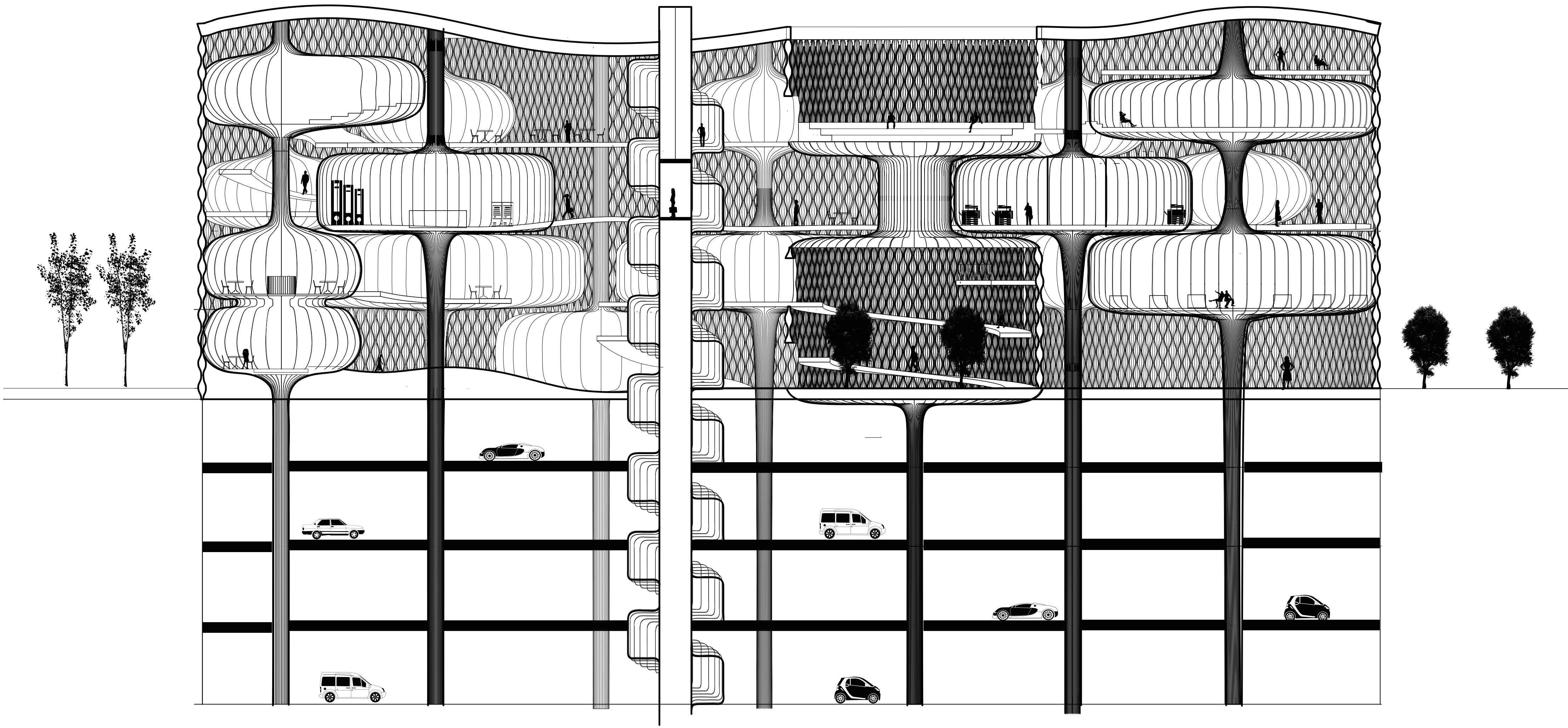

PUBLIC
FUN
TECHNOLOGY
QUITE
SHOPING

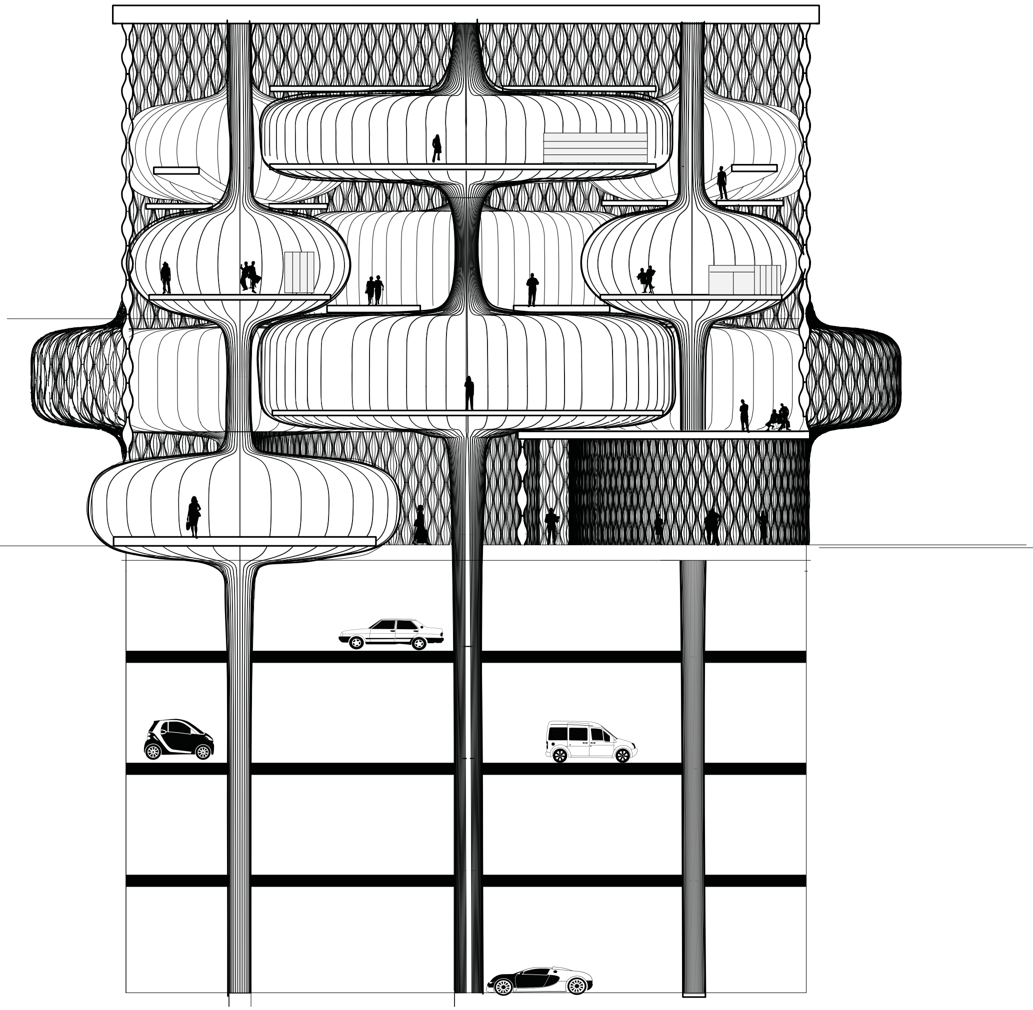

shop
adminstration
inner yard
shop
adminstration
shop
W.C
Cofe'
shop

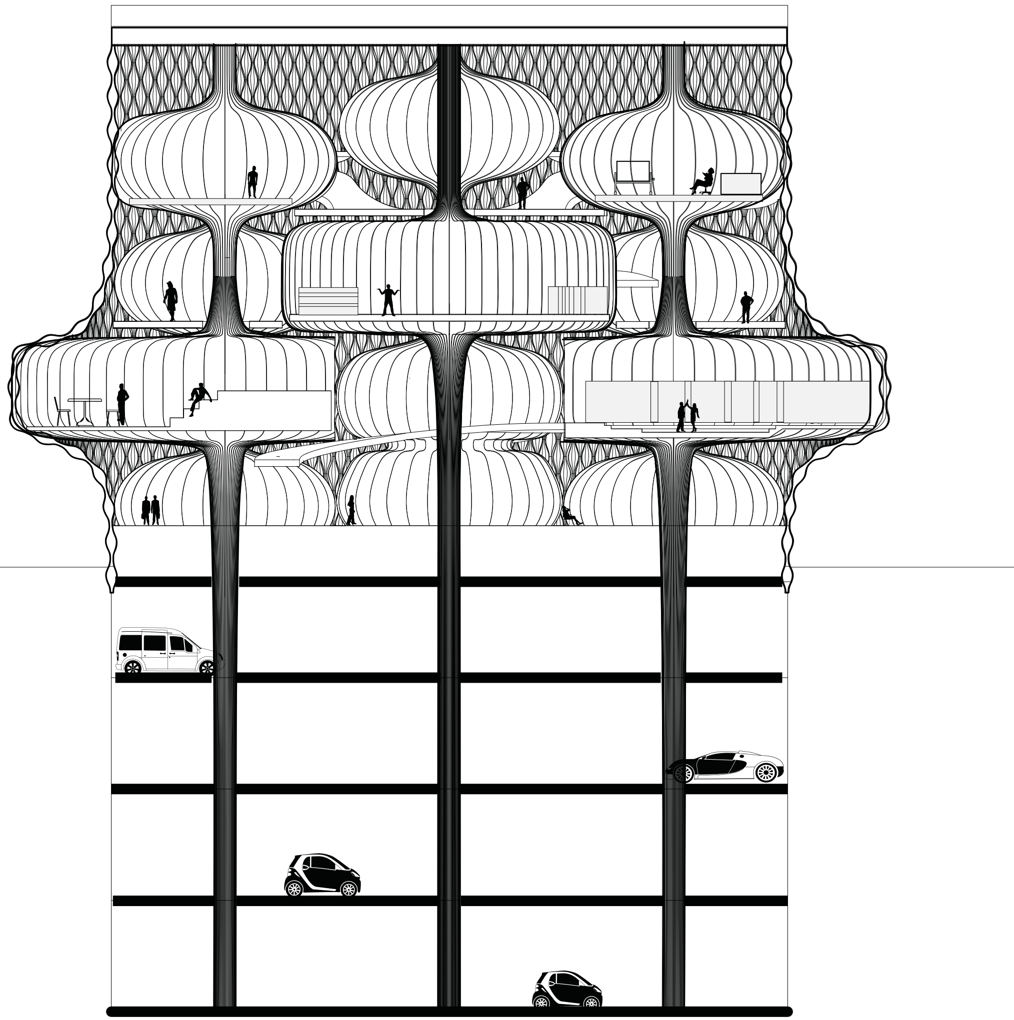

computer lap
media
W.C.
readinig
library
studying
cofe’

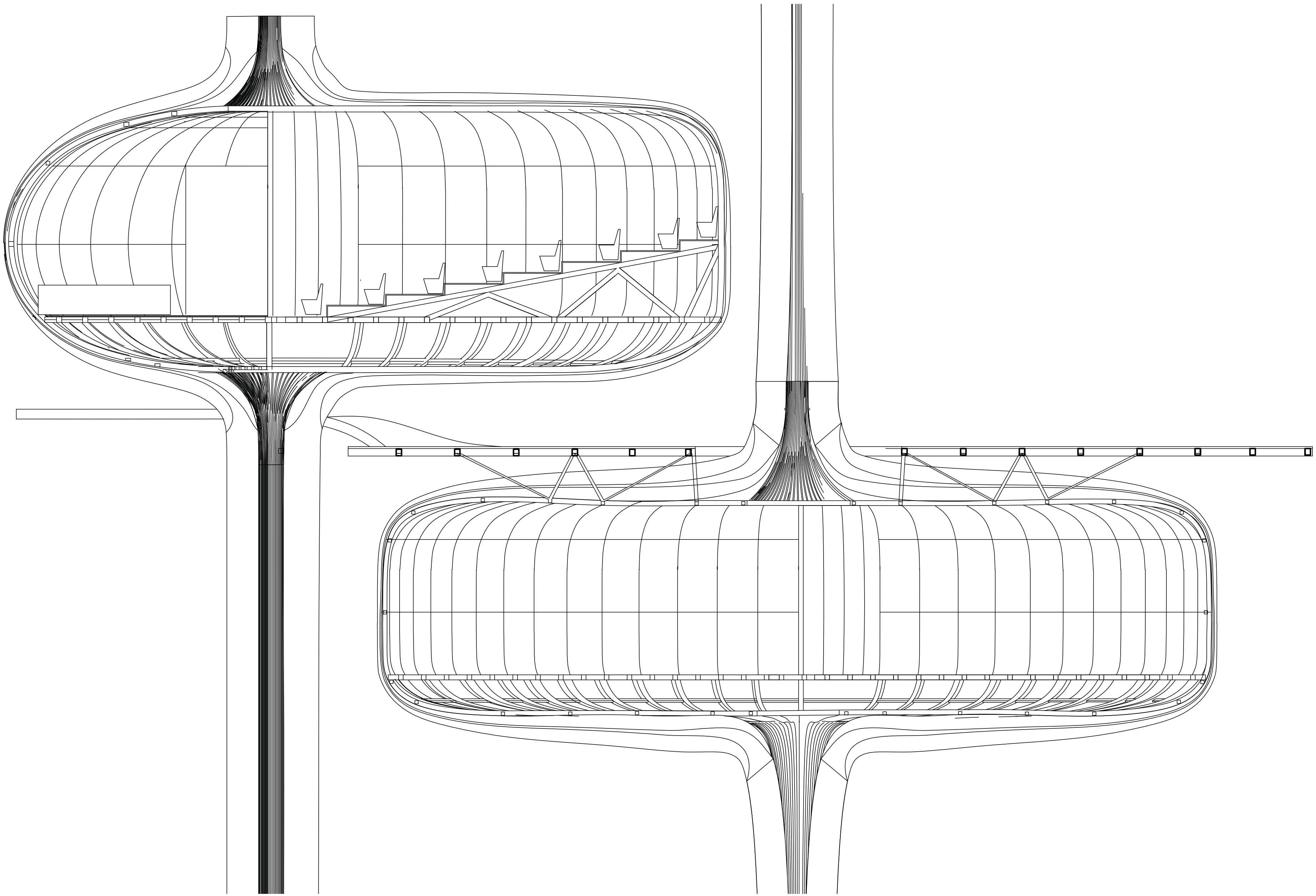

presentation
presentation
printing
presentation
work shop
painting
painting

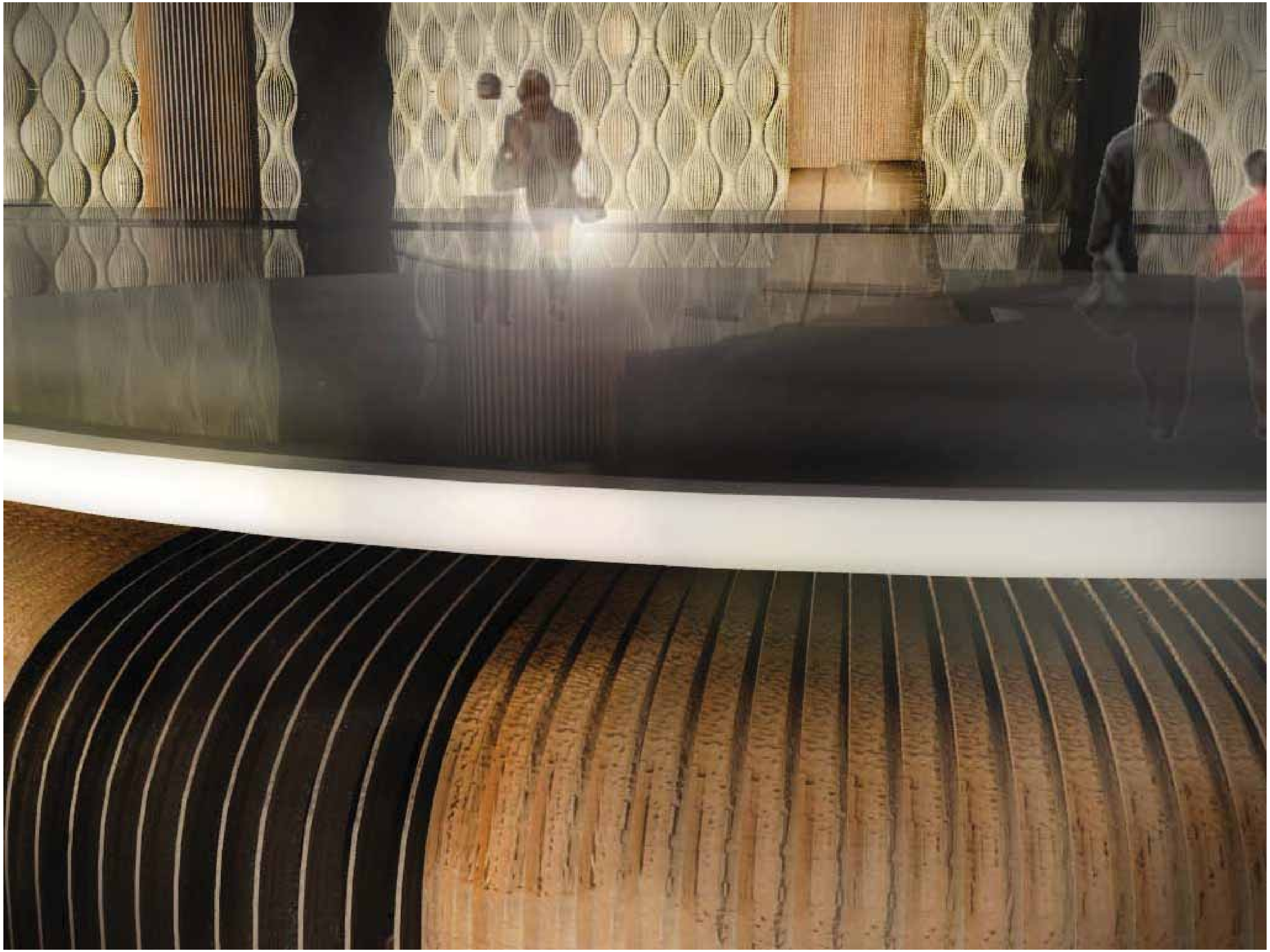

photography
studio
studio
theatre
studio
studio
studio
studio
hall

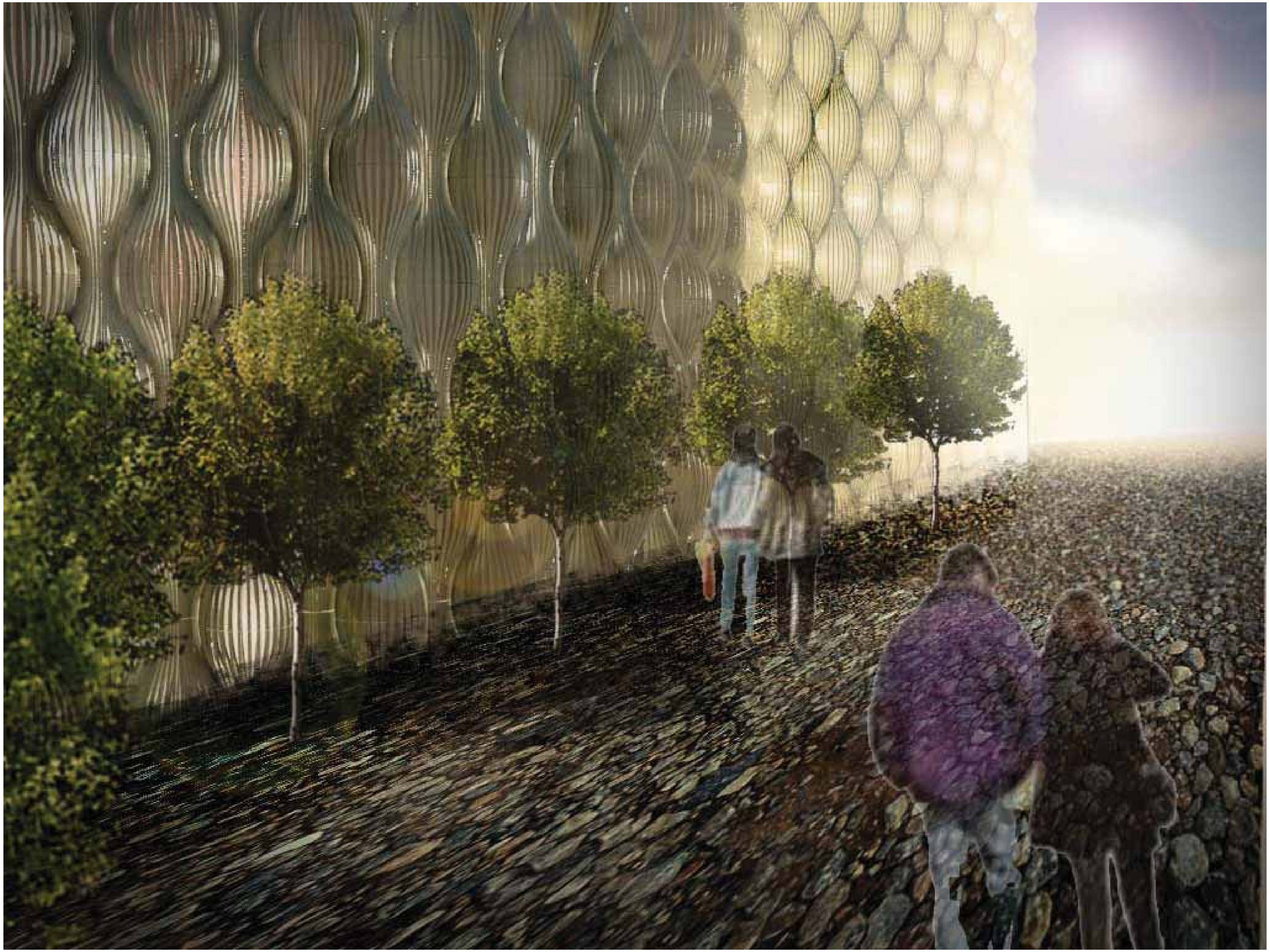




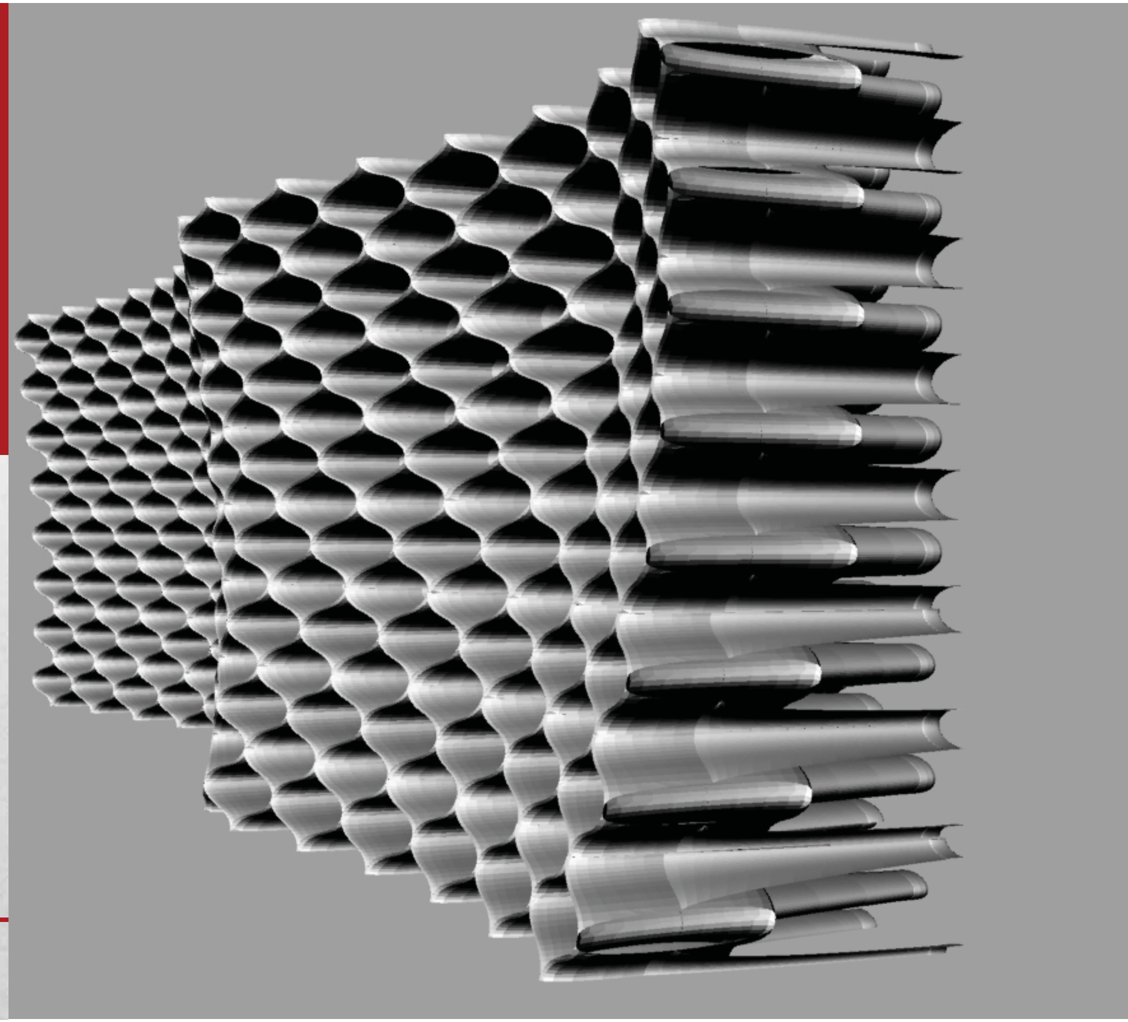






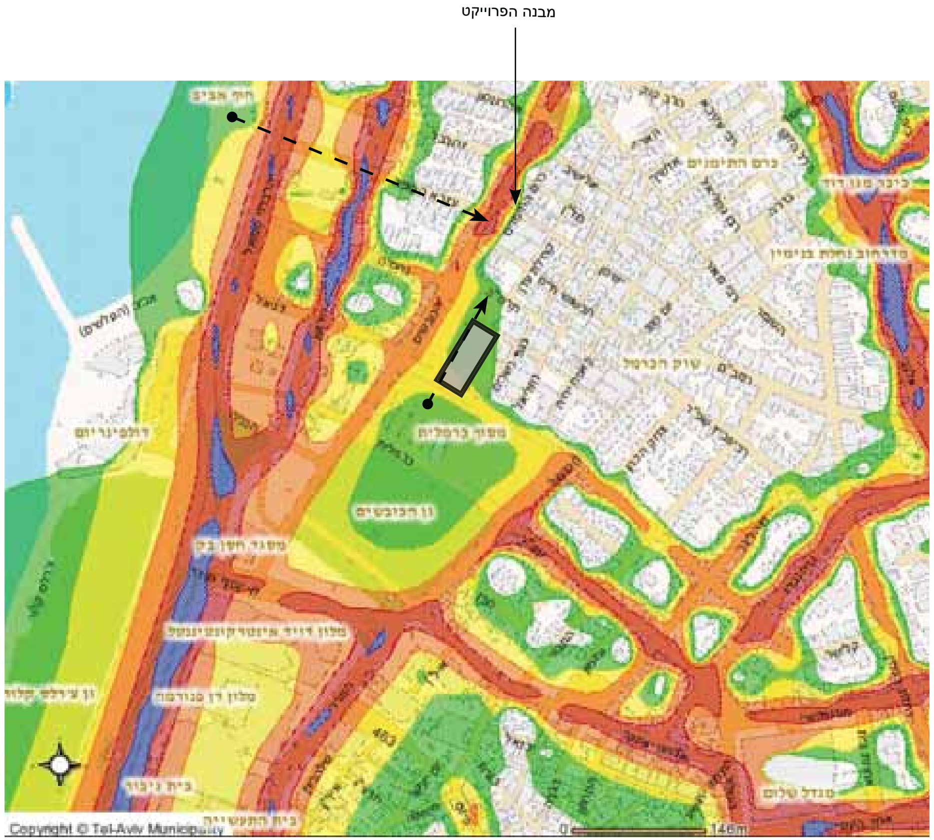


Cellular Structure Planning - Optic & Energetic Performance



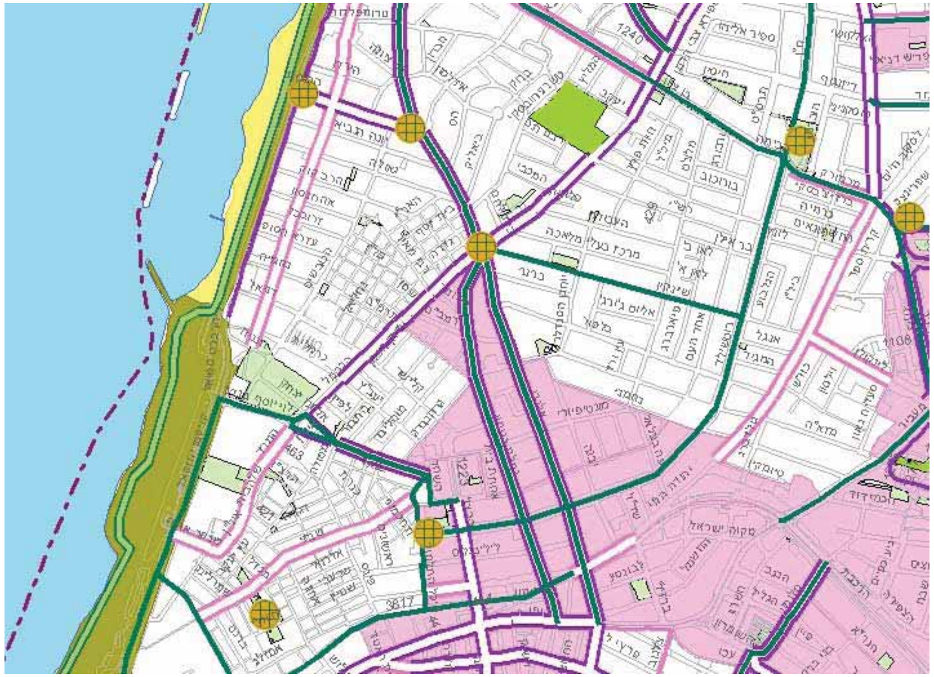
Gem model of the facade

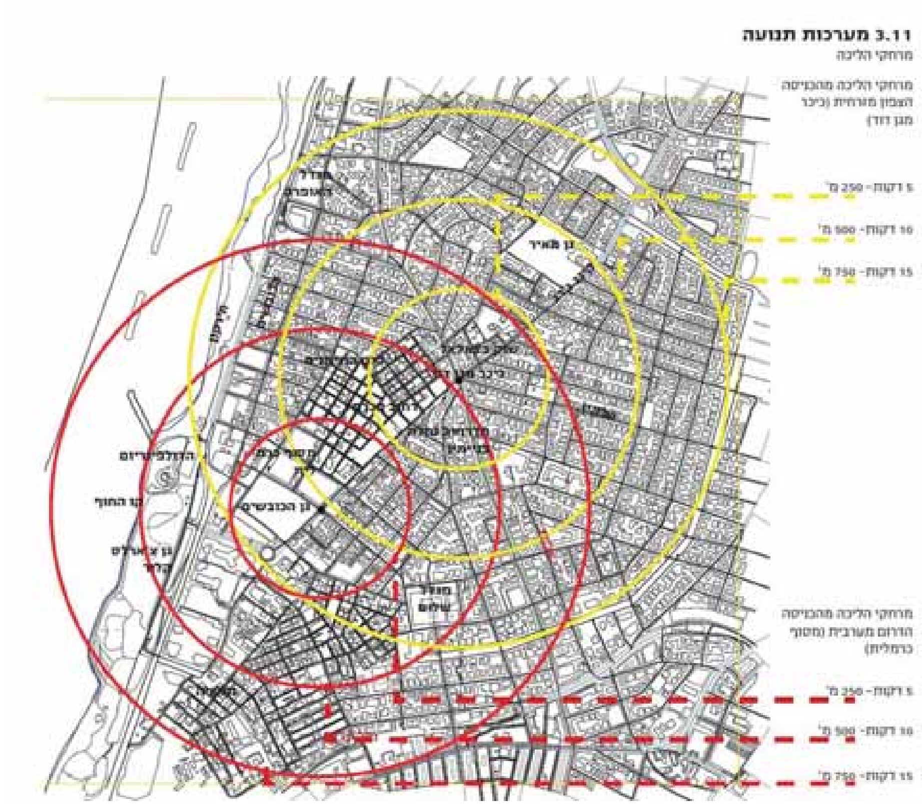
Areal *Hongmin Kim . Suvin Ju*

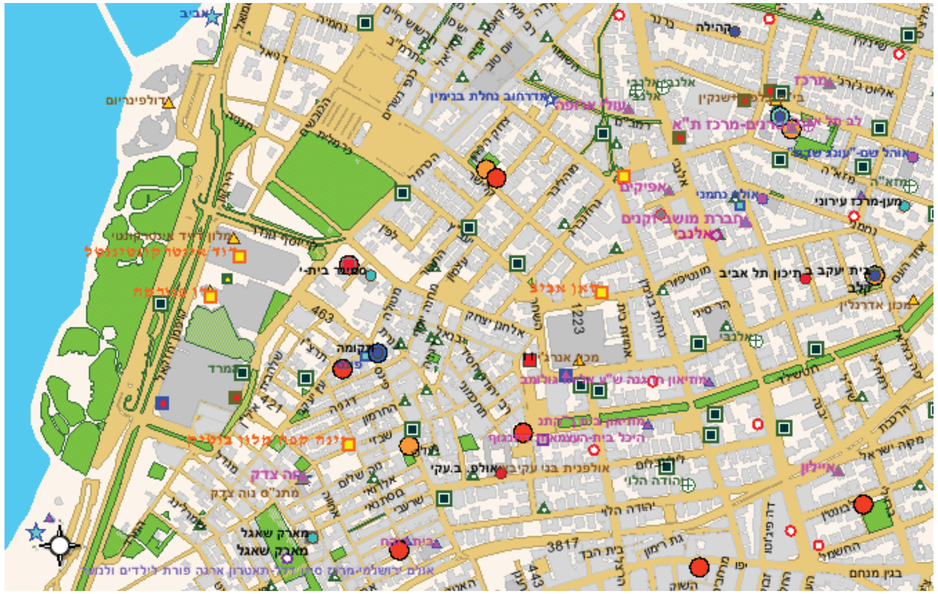


Section west-east through the project building and the endored market
(Yasha Groberman office)

Section west-east through the project building and the endored market
(Yasha Groberman office)

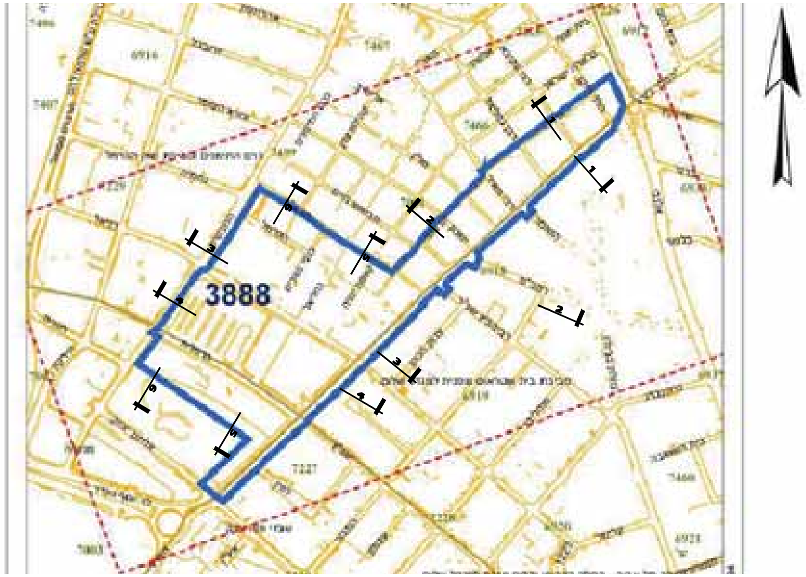




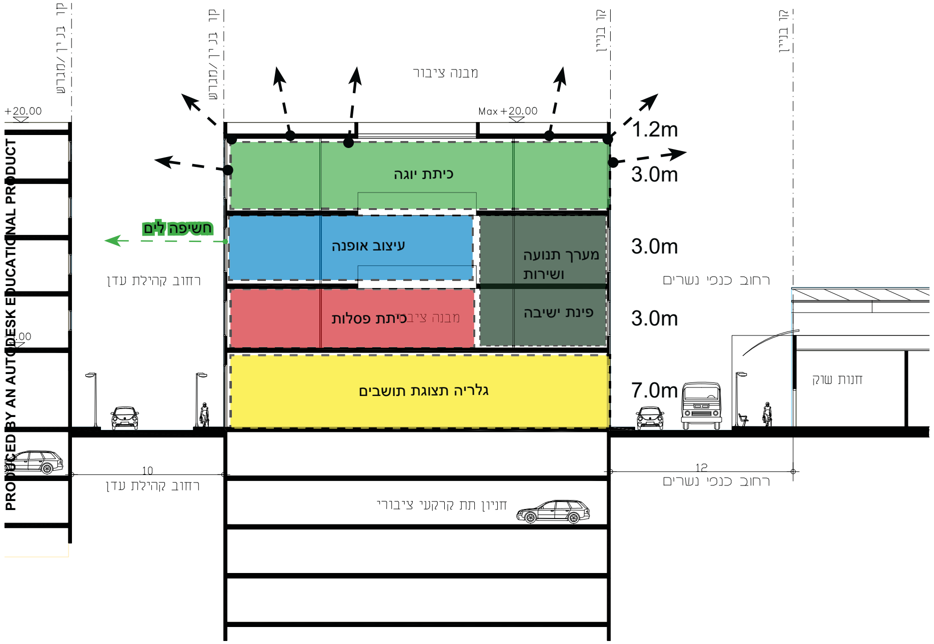


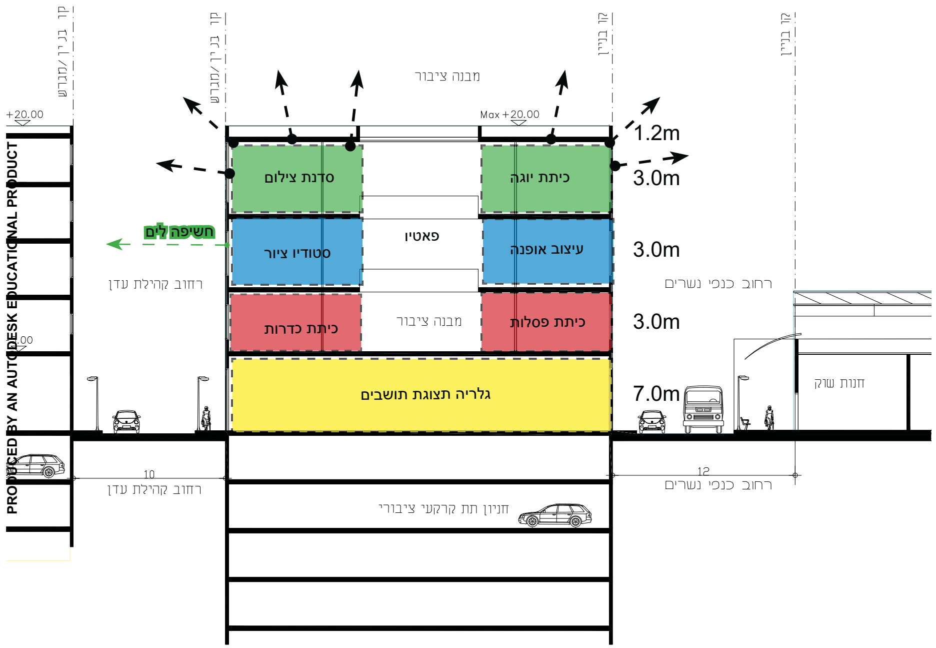
(Yasha Groberman office)

Project area
Carmel market, Tel-Aviv

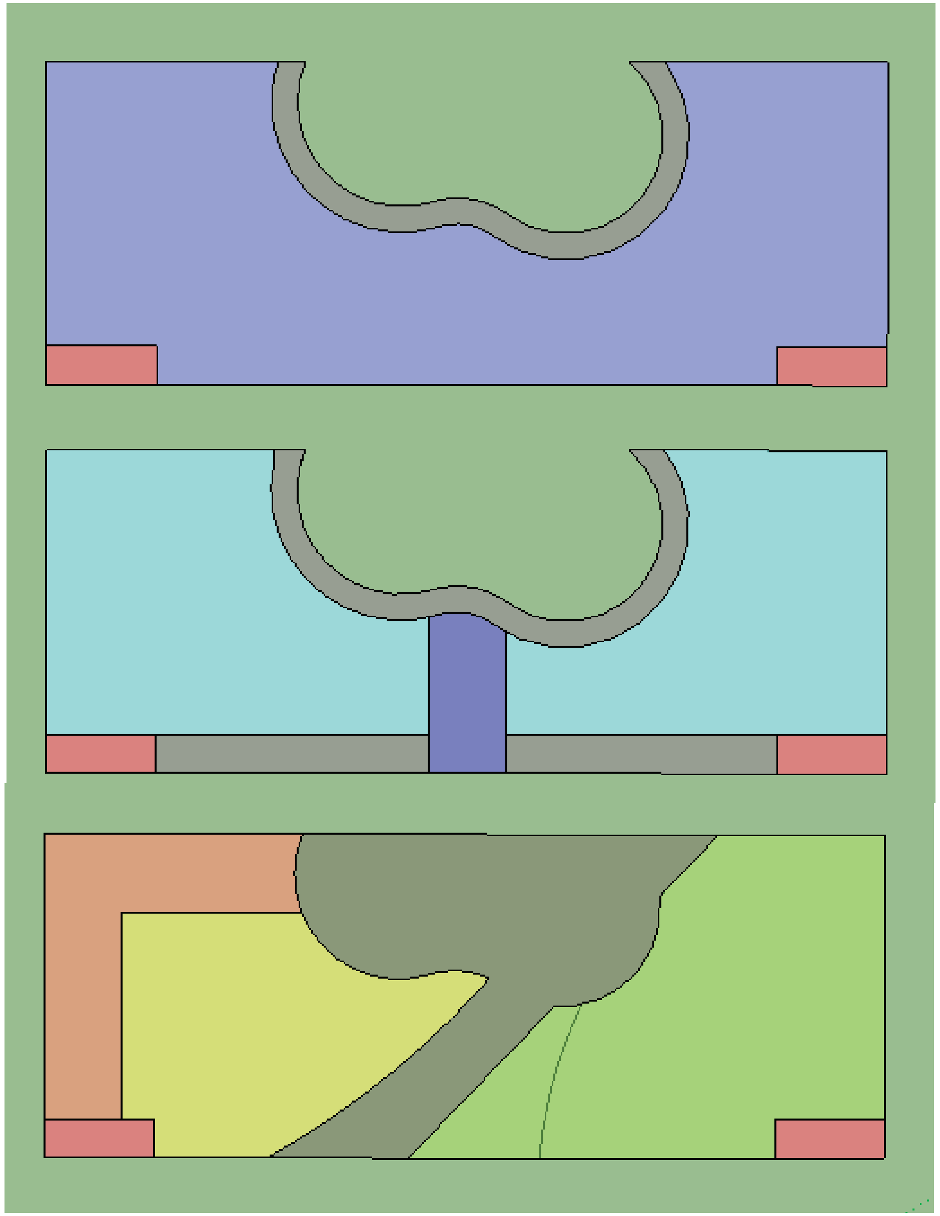


Setlite view

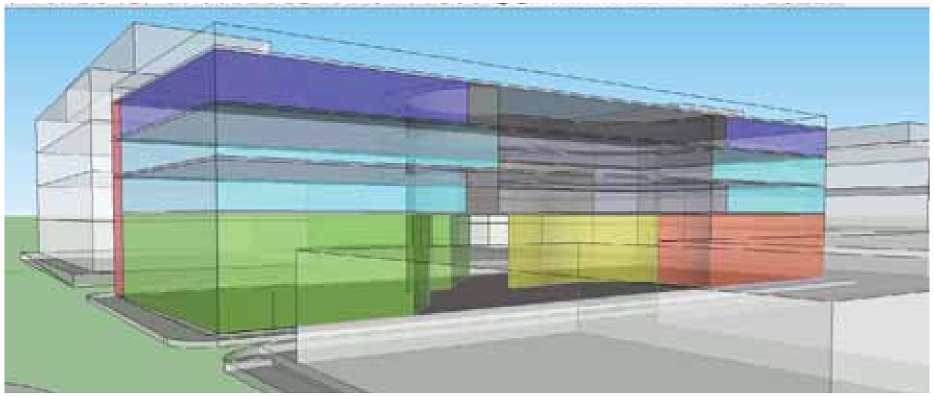


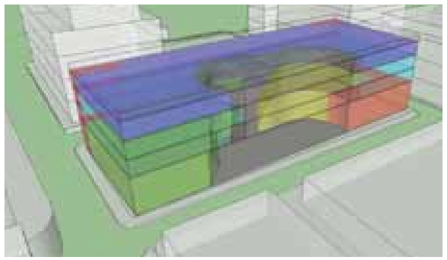


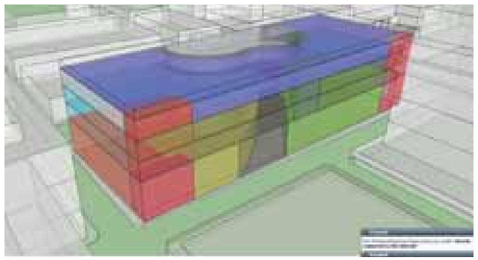
Section west-east through the project building and the endored market (Yasha Groberman office)



|Initial program - Masses



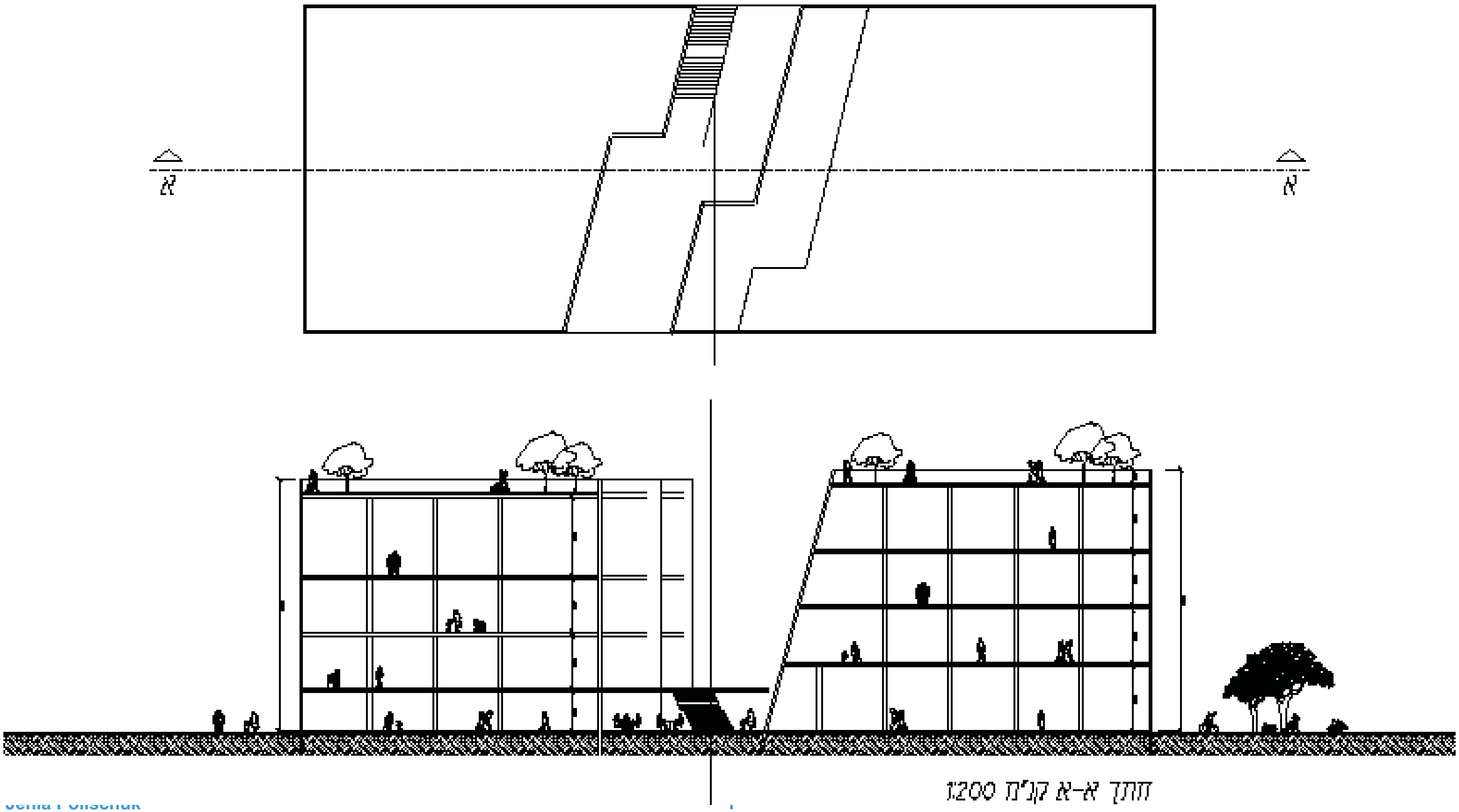




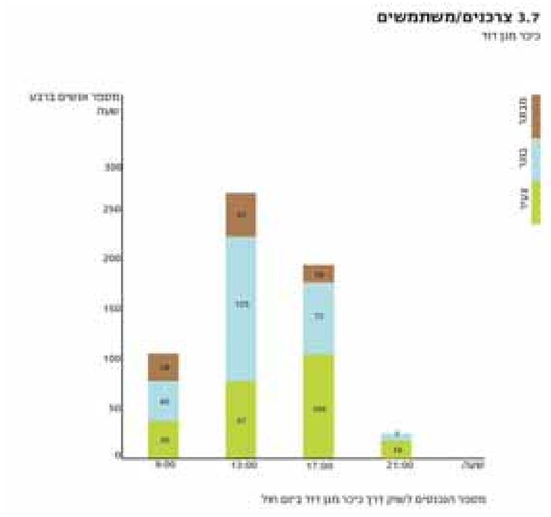
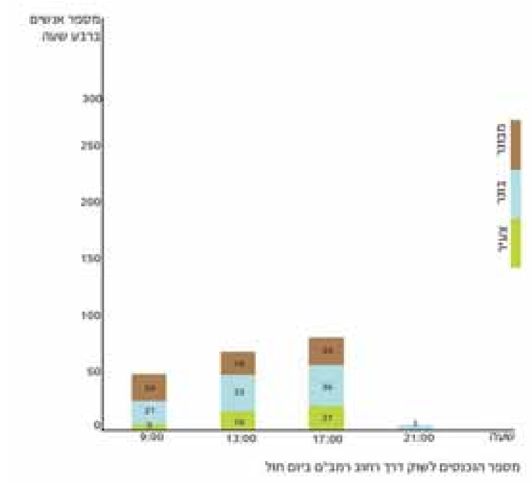
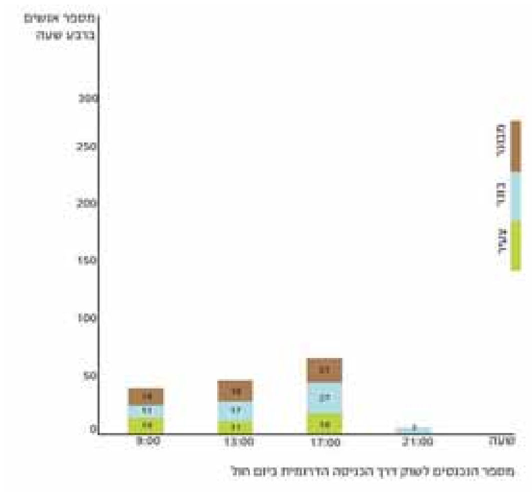
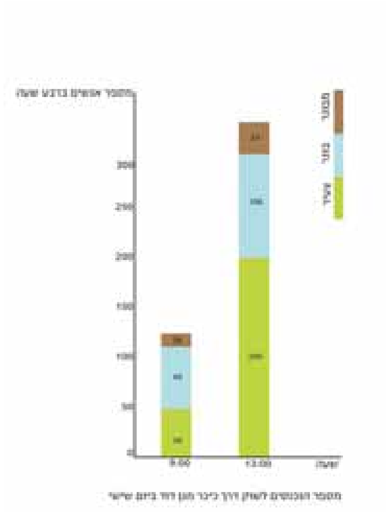
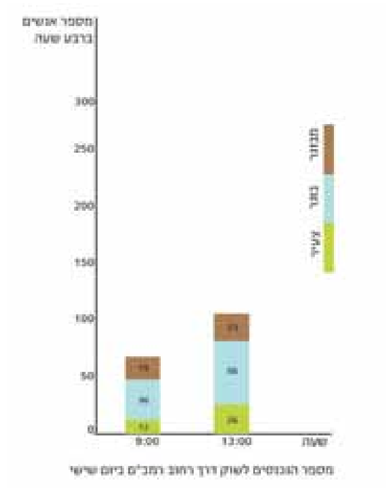
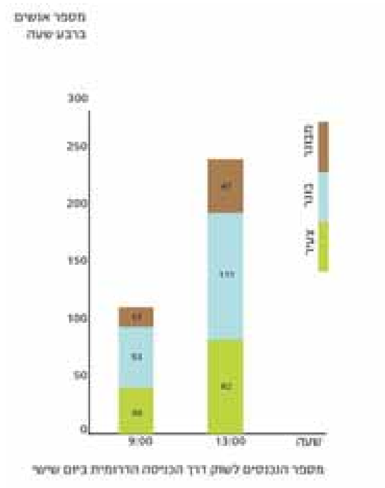
3D views on the proggram of the whole building - each color reffers to a different function

Initial Plan an Section

A public street which pentrates into the building and creating a whole new dynamic environment.



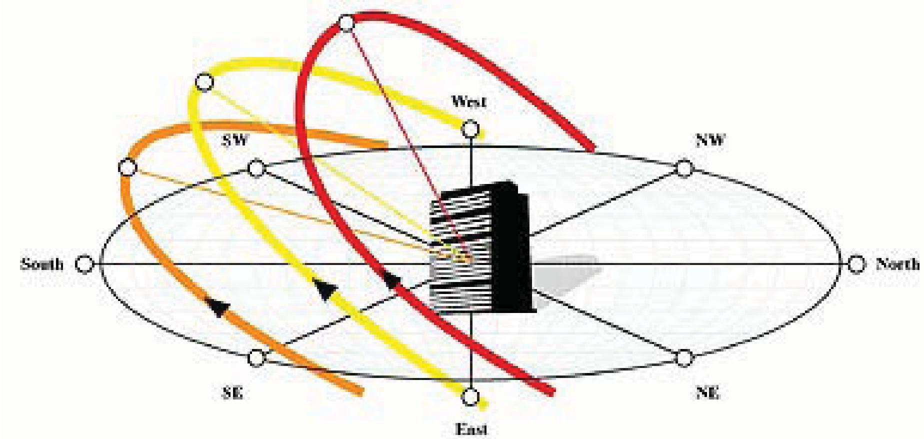
Users and Needs

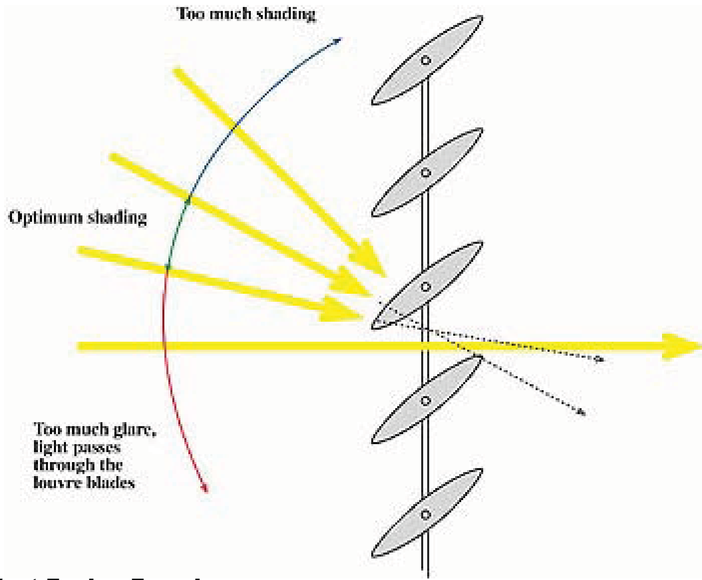







Diagrams which show the age and the ammount of people in the area thro
 (Yasha Grobman)

Solar Principles
Angles and shading elements

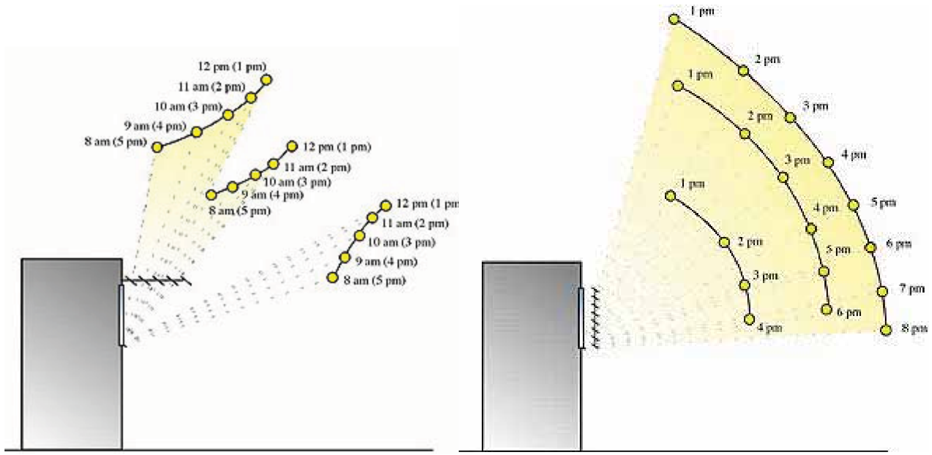
Orange Line - Solar Altitude for 21st December
Yellow Line - Solar Altitude for 21st September
Red Line - Solar Altitude for 21st June





South Facing Façades

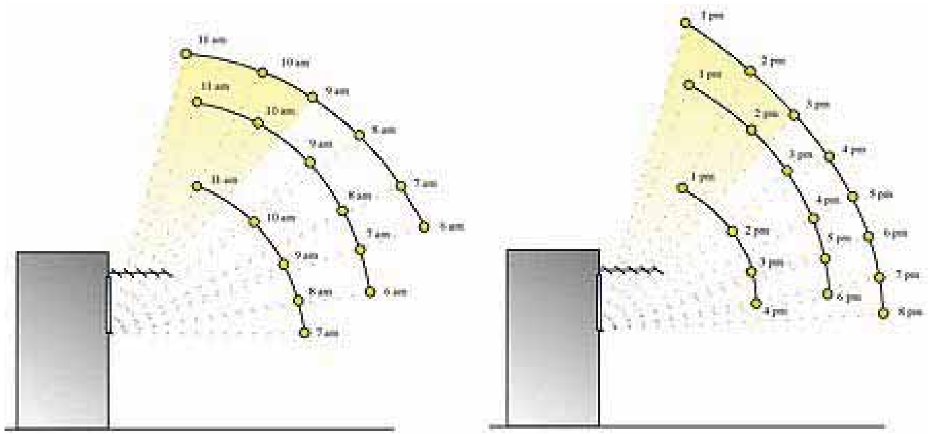
For a predominately South facing façade, a small amount of solar shading can be achieved using a fixed horizontal brise soleil. In the mornings and winter such a device cannot stop direct rays of the sun penetrating the building since the sun is much lower. However the heat gain and solar glare is greatly reduced in winter and therefore this may not considered to be a major problem.



(http://www.shadinglouvres.com)

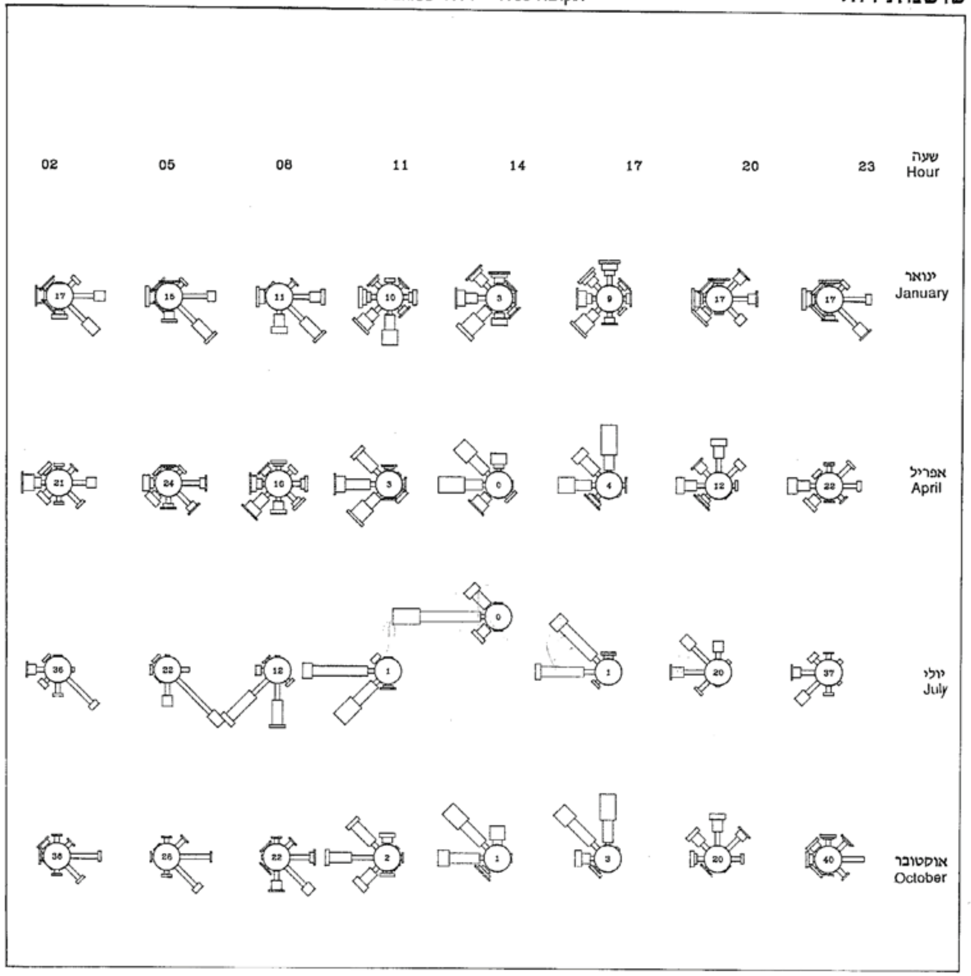
East or West Facing Façades

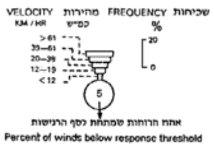
With a predominantly East or West facing façade, a fixed system will not perform well throughout the whole day as the altitude of the sun is much lower. Sunlight will pass directly under most horizontal shading systems as shown in the illustration below.
To overcome this problem, effective solar shading can be achieved using a movable solar shading system.



Section through the green roof

WIND ROSES PERIOD 1971 — 1980 תקופה **שושנות רוח**





רוחות ששכיחותן נמוכה מ-0.5% אינן מופיעות בשושנת הרוח.

SEASONAL WIND REGIME משטר הרוחות העונתי

חודש Month	שעה Hour	מהירות ממוצעת קמ"ש Average velocity km/hr	כיוון שליט Most frequent direction: כיוון Dir.	%	מהירות ממוצעת קמ"ש Average velocity km/hr	כיוון שליט משני Second most frequent direction: כיוון Dir.	%	מהירות ממוצעת קמ"ש Average velocity km/hr	Velocity מהירות קמ"ש 20-28 km/hr: %	כיוון שליט Most frequent direction: כיוון Dir.	%	Velocity מהירות קמ"ש 29-38 km/hr: %	כיוון שליט Most frequent direction: כיוון Dir.	%	Velocity מהירות קמ"ש 39-49 km/hr: %	כיוון שליט Most frequent direction: כיוון Dir.	%	Velocity מהירות קמ"ש > 49 km/hr: %	כיוון שליט Most frequent direction: כיוון Dir.	%	מהירות מקסימלית Maximal Velocity: קמ"ש km/hr	כיוון Dir.
ינואר — January	02	13	SE	29	12	E	22	11	7	S	3	6	W	3	3	SW	1	0	—	—		
	05	13	SE	32	12	E	23	10	7	S	2	5	W	1	2	W	1	1	W	1		
	08	14	SE	32	14	E	23	13	12	S	4	4	W	2	1	W	1	1	W	1		
	11	17	E	24	20	SW	20	21	20	S	8	8	S	3	3	W	2	2	W	1		
	14	20	SW	27	26	W	21	19	23	SW	8	10	SW	5	3	SW	2	1	W	1		
	17	17	SW	22	23	N	15	18	20	SW	6	6	SW	4	3	NW	2	1	W	1		
	20	14	E	17	12	NE	16	15	10	W	3	6	SW	3	4	W	2	1	W	0.5		
	23	13	SE	26	12	E	22	10	8	W	2	4	SW	1	4	W	3	2	SW	1		
אפריל — April	02	12	E	18	12	W	17	21	12	W	7	3	W	2	1	W	1	0	—	—		
	05	11	E	17	11	SE	16	11	12	W	4	3	W	1	0	—	—	0	—	—		
	08	14	SW	20	20	S	12	18	16	SW	5	4	SW	1	2	SW	1	0	—	—		
	11	19	W	31	18	SW	28	22	26	SW	10	5	SW	2	3	SW	2	0	—	—		
	14	21	W	34	21	NW	33	19	40	W	15	10	W	4	1	SW	1	0	—	—		
	17	19	N	34	22	W	24	20	38	N	19	6	W	3	1	SW	1	0	—	—		
	20	13	N	23	14	W	30	17	12	N	5	3	W	1	1	SW	1	0	—	—		
	23	11	W	30	19	NE	14	12	10	W	6	2	W	1	1	W	0.5	0	—	—		
יולי — July	02	7	SE	28	9	W	12	13	1	W	1	0	—	—	0	—	—	0	—	—		
	05	8	SE	44	10	S	16	11	1	W	0.5	0	—	—	0	—	—	0	—	—		
	08	12	SW	43	18	S	32	13	7	SW	4	0	—	—	0	—	—	0	—	—		
	11	17	W	51	16	SW	39	19	24	SW	17	0	—	—	0	—	—	0	—	—		
	14	18	W	67	18	NW	19	19	29	W	20	0	—	—	0	—	—	0	—	—		
	17	16	NW	45	17	W	44	16	14	NW	8	1	NW	0.5	0	—	—	0	—	—		
	20	9	NW	37	11	W	23	11	2	W	1	0	—	—	0	—	—	0	—	—		
	23	7	SW	21	11	W	16	11	1	W	1	0	—	—	0	—	—	0	—	—		
אוקטובר — October	02	7	E	22	8	SE	15	9	4	W	1	0	—	—	0	—	—	0	—	—		
	05	8	SE	24	10	E	24	9	2	W	1	0	—	—	0	—	—	0	—	—		
	08	9	SE	27	10	E	19	9	4	S	1	0	—	—	0	—	—	0	—	—		
	11	15	W	34	14	NW	28	13	12	SW	4	2	W	1	1	SW	0.5	0	—	—		
	14	19	NW	42	18	W	35	18	33	NW	16	4	N	1	2	SW	1	0	—	—		
	17	18	NW	40	17	N	37	22	30	N	14	6	N	4	1	N	0.5	0	—	—		
	20	11	N	24	14	NE	18	11	10	N	4	1	NW	1	0	—	—	0	—	—		
	23	7	E	16	8	SE	9	10	7	W	2	1	SW	1	0	—	—	0	—	—		

		Relative comfort			
Activity	**Areas applicable**	**Perceptible**	**Tolerable**	**Unpleasant**	**Dangerous**
Walking fast	Pavements	**B5** (8.0 - 10.7 m/s)	B6 (10.8 - 13.8 m/s)	B7 (13.9 - 17.1 m/s)	B8 (17.2 - 20.7 m/s)
Strolling	Parks, entrances	**B4** (5.5 – 7.9 m/s)	B5	B6	B8
Standing, sitting:					
short exposure	Parks, plazas	**B3** (3.4 – 5.4 m/s)	B4	B5	B8
long exposure	Street cafes, theatres	**B2** (1.6 - 3.3 m/s)	B3	B4	B8
Acceptable is speed occurs less than:			once/week	once/month	once/year

אופי הפעילות:
חשיפה קצרה\שיעור

מהירות רוח
רצויה

מהירות רוח
נסבלת

17	14	11	08	שעה / חודש
23	26	20	14	ינואר
22	21	19	20	אפריל
17	18	16	15	יולי
17	18	14	10	אוקטובר

17	14	11	8	שעה / חודש
				ינואר
				אפריל
				יולי
				אוקטובר

Beaufort Scale	Description	Mean wind speed range (m/s) at 10 m	Mean wind speed range (m/s) at 2 m	Effects
B0	Calm	0 - 0.2	0.0 - 0.15	
B1	Light air	0.3 - 1.5	0.22 - 1.1	No noticeable wind.
B2	Light breeze	1.6 – 3.3	1.2 - 2.5	Wind felt on face.
B3	Gentle breeze	3.4 – 5.4	2.6 - 4.0	Wind extends light flag.
B4	Moderate breeze	5.5 – 7.9	4.1 - 5.9	Raises dust and loose paper. Hair disarranged, clothing flaps.
B5	Fresh breeze	8.0 – 10.7	6.0 - 8.0	Limit of agreeable wind.
B6	Strong breeze	10.8 – 13.8	8.1 - 10.4	Umbrellas used with difficulty. Force of the wind felt on the body. Wind noisy, frequent blinking.
B7	Near gale	13.9 – 17.1	10.5 - 12.8	Inconvenience felt when walking; difficult to walk steadily. Hair blown straight.
B8	Gale	17.2 – 20.7	12.9 - 15.5	Generally impedes progress; walking difficult to control. Great difficulty with balance in gusts.
B9	Strong gale	20.8 – 24.4	15.6 - 18.3	People blown over by gusts. Impossible to face wind; ear ache, headache, breathing difficult. Some structural damage occurs: falling roof tiles, tree branches etc, hazardous for pedestrians.
B10	Storm	24.5 – 28.4	18.4 - 21.3	Seldom experienced inland. Trees uprooted; considerable structural damage occurs.

		Relative comfort			
Activity	**Areas applicable**	**Perceptible**	**Tolerable**	**Unpleasant**	**Dangerous**
Walking fast	Pavements	**B5** (8.0 - 10.7 m/s)	B6 (10.8 - 13.8 m/s)	B7 (13.9 - 17.1 m/s)	B8 (17.2 - 20.7 m/s)
Strolling	Parks, entrances	**B4** (5.5 – 7.9 m/s)	B5	B6	B8
Standing, sitting:					
short exposure	Parks, plazas	**B3** (3.4 – 5.4 m/s)	B4	B5	B8
long exposure	Street cafes, theatres	**B2** (1.6 – 3.3 m/s)	B3	B4	B8
Acceptable is speed occurs less than:			once/week	once/month	once/year

נוסחה לחישוב עוצמת הרוח בגבהים שונים באותם תנאי שטח (על אותו פרופיל רוח)

$$\frac{V_H}{V_{met}} = \left(\frac{H}{H_{met}}\right)^a$$

כאשר:

V_H = מהירות הרוח בגובה כלשהו H.

V_{met} = מהירות הרוח בגובה נתון (בד"כ גובה 10 מ').

H = גובה החישוב.

H_{met} = הגובה הנתון (בד"כ 10 מ').

a = מקדם בהתאם לתנאי השטח לפי הטבלה להלן.

	תנאי שטח	a
City	מרכזי ערים בהם בניינים מעל 7 קומות.	0.33
Urban	שטחים עירוניים, פרברים, יערות ושטחים אחרים צפופים עד 7 קומות	0.25
Country	שטח פתוח עם מכשולים מפוזרים לא גבוהים מ- 10 מ'.	0.20
Open	שטח פתוח חשוף לרוח הזורמת חופשית.	0.17

Height (m)	Open	Country	Urban	City
2	0.76	--	--	--
3.5	0.83	0.66	--	--
6	0.92	0.74	0.55	--
10	**1**	**0.82**	**0.62**	**0.45**
20	1.13	0.95	0.74	0.56
30	1.21	1.03	0.82	0.64
40	1.27	1.09	0.88	0.71
50	1.32	1.14	0.93	0.76
100	1.48	1.3	1.1	0.96

Height (m)	Open	Country	Urban	City
6	1			
10	**1.09**	0.82 * 1.09 **0.89**	0.62 * 1.09 **0.67**	0.45 * 1.09 **0.49**

תיקון עבור גובה תחנת המדידה:

תחנת המדידה נמצאת בגובה של 6 מ' בשטח חופשי.

בגובה 10 מ' מהירות הרוח גבוהה יותר מאשר בגובה 6 מ', לפי:

$$\frac{V_{10}}{V_6} = \left(\frac{10}{6}\right)^{0.17} \rightarrow \frac{V_{10}}{1} = \left(\frac{10}{6}\right)^{0.17} \rightarrow V_{10} = 1.09$$

גבול עליון B3 : מהירות רוח מכסימאלית של 5.4 מ/ש, גובה 10 מ' באזור המתוכנן:

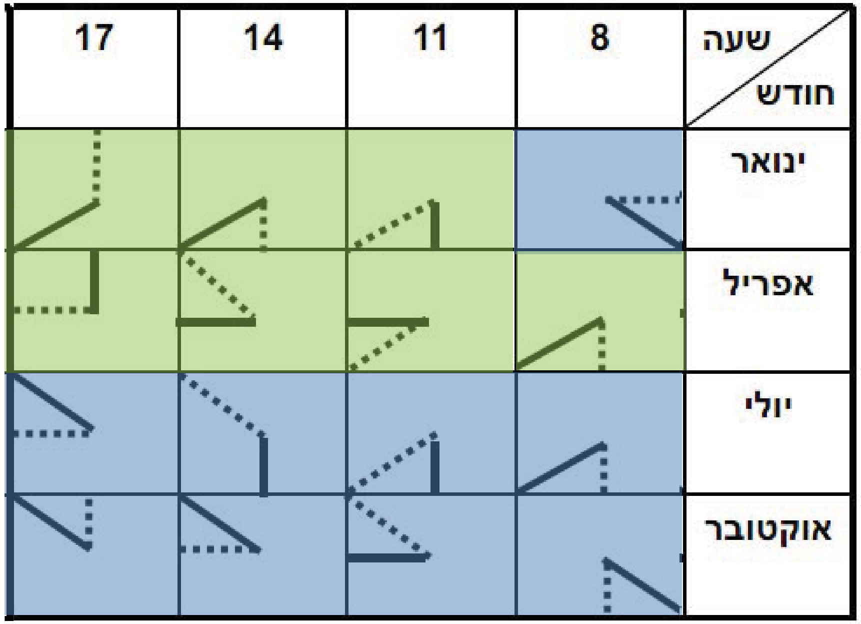
$$\underbrace{\frac{1*5.4}{0.67} = 8.05\ \mathrm{m/s}}_{\text{תיקון מהירות}} * \underbrace{\frac{3600}{1000}}_{\text{מעבר יחידות}} = \boxed{29.01\ \mathrm{Km/Hr}}$$

מהירות הרוח המכסימאלית לפי הנתונים האקלימיים של תל אביב היא 26 קמ"ש
הגבול העליון של המהירות הרצויה שקיבלנו גבוה יותר ולכן מהירות הרוח לא גבוהה מדי.
יש צורך לבדוק את הגבול התחתון של התחום B3 כדי לוודא שעוצמת הרוח הקיימת אינה חלשה מידי:

גבול עליון B3 : מהירות רוח מכסימאלית של 3.4 מ/ש, גובה 10 מ' באזור המתוכנן:

$$\frac{1*3.4}{0.67} = 5.07\ \mathrm{m/s} * \frac{3600}{1000} = \boxed{18.26\ \mathrm{Km/Hr}}$$

<B3   B3 תחתון <   < B3 עליון



Level of Activity (met)

The level of Metabolism depends on the
Level of Activity (met)
1 met = A person resting
Increse of 1 met – Affects temperature by 3-4°c
High level of Activity (2-3 met) => 4°c
Low level of Activity (1-2 met) => 3°c

Activity	met
sleeping	0.8
resting	1.0
seating office work	1.2
light work	1.6
medium work	2.0
hard work	3.0
walking 6 km/h	4.0

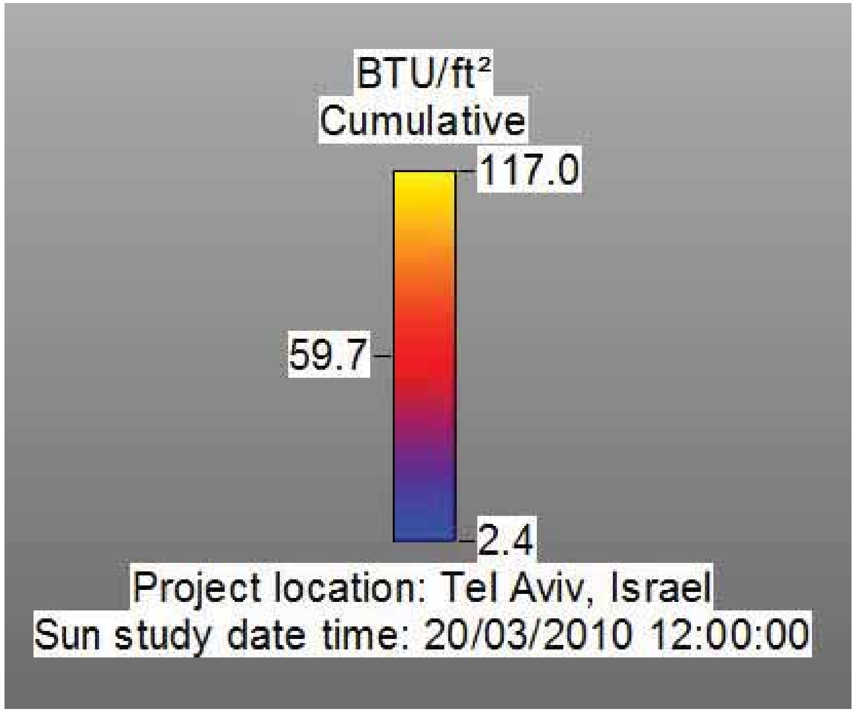
Level of Clothing (clo)

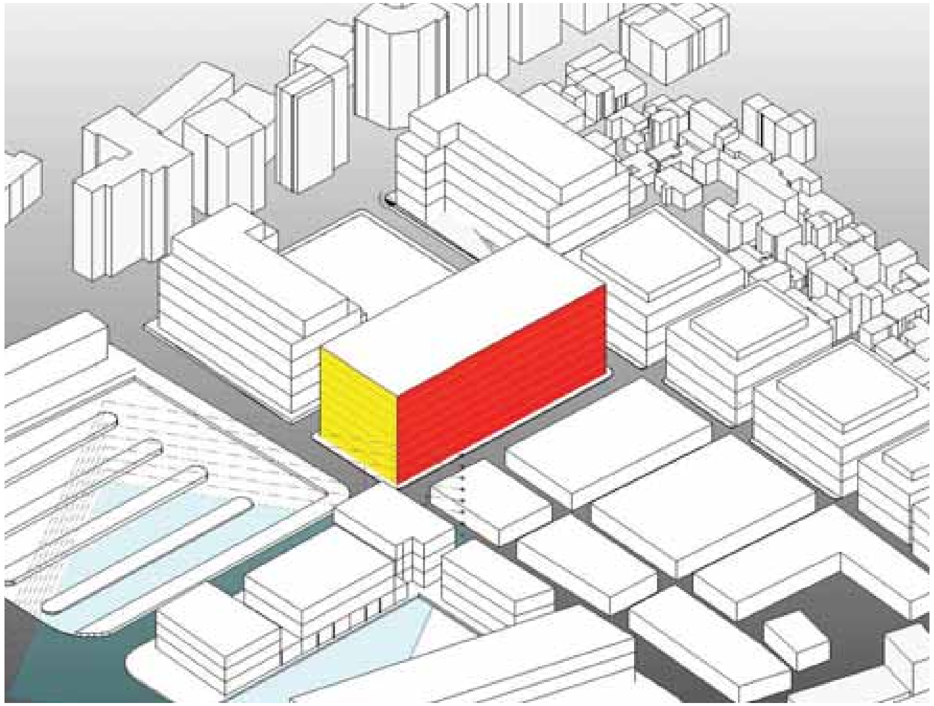
1 clo unit = Insolation of A Buisnes Suit
Or approximately 3 Kg of clothing.
Increse of 1 clo – Affects temperature
around the body by ~ 2-5°c
winter => 2°c   summer => 5°c

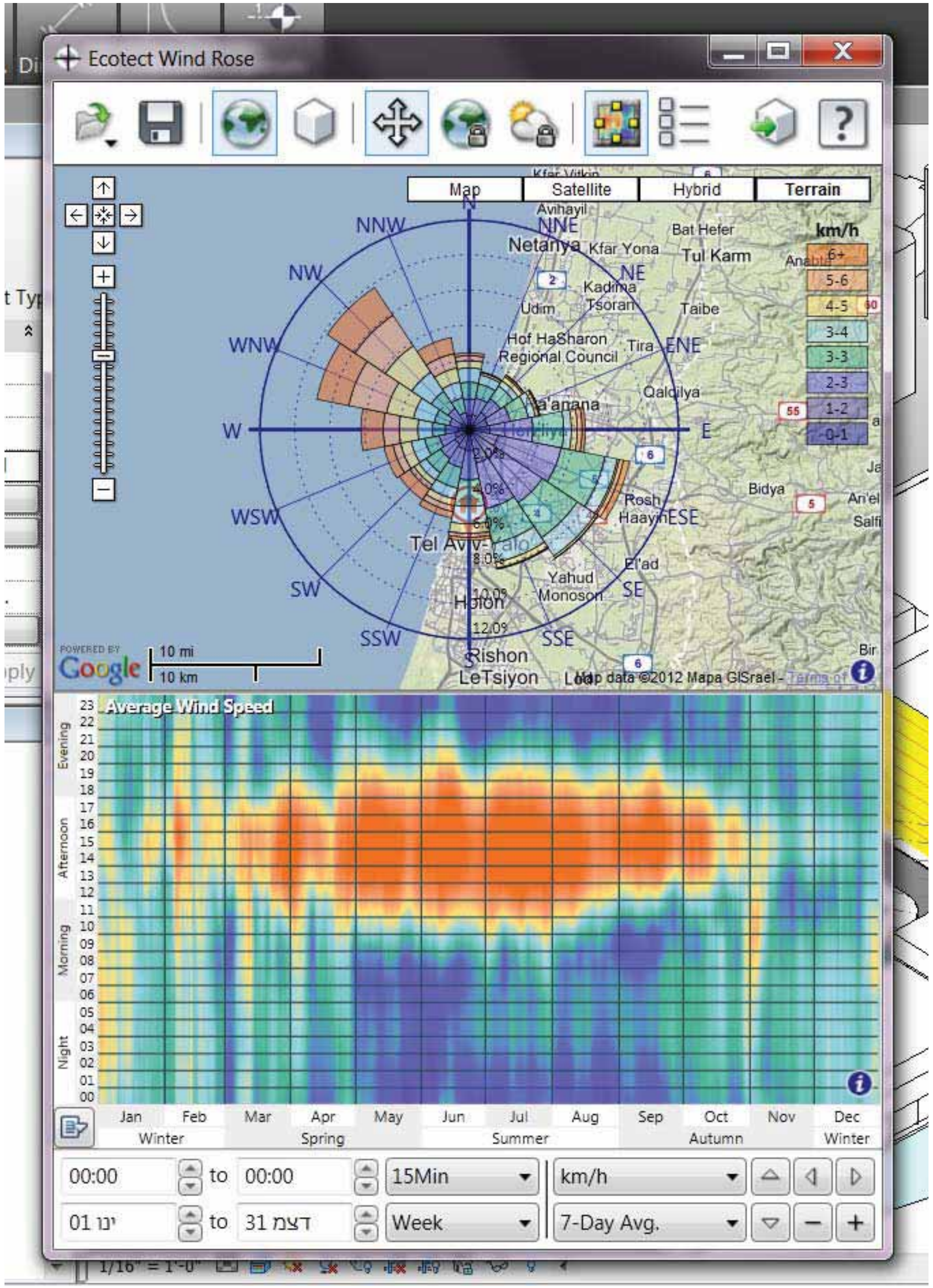
Type of clothing	clo
no clothes	0.0
summer outfit(shorts+Tshirt)	0.3
summer outfit(pants+Tshirt)	0.5
buisnes suit	1.0
light winter outfit(suit+sweater)	1.5
medium winter outfit(suit+coat)	2.5
heavy winter outfit or thick blanket	3.0

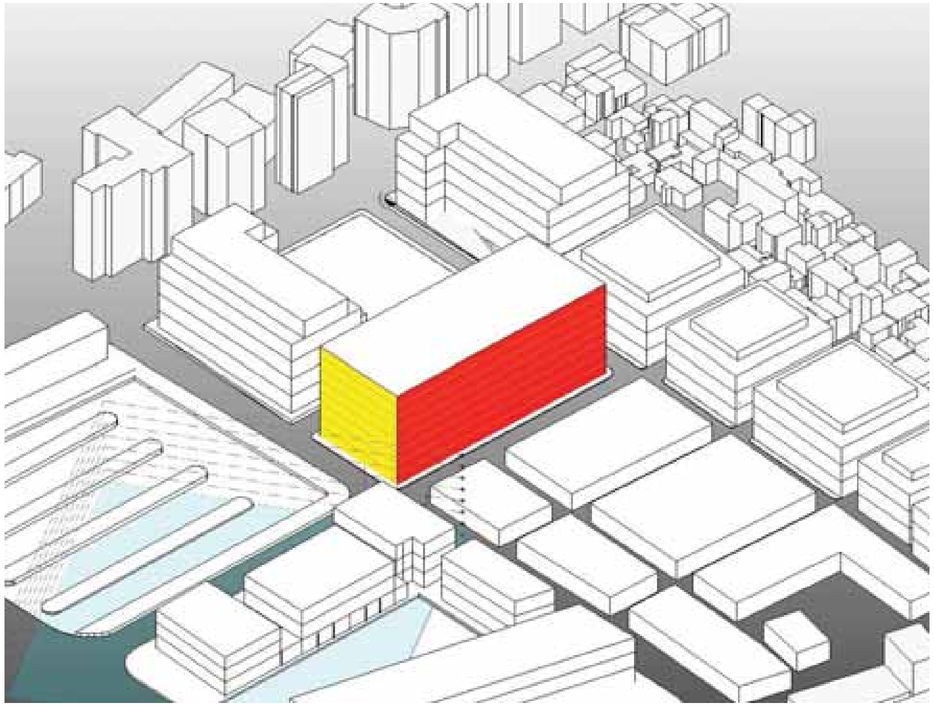
MET	CLO	(שטח חוץ)
1.6	0.3	יולי
1.6	2.5	ינואר
1.6	1.0	אפריל
1.6	0.7	אוקטובר

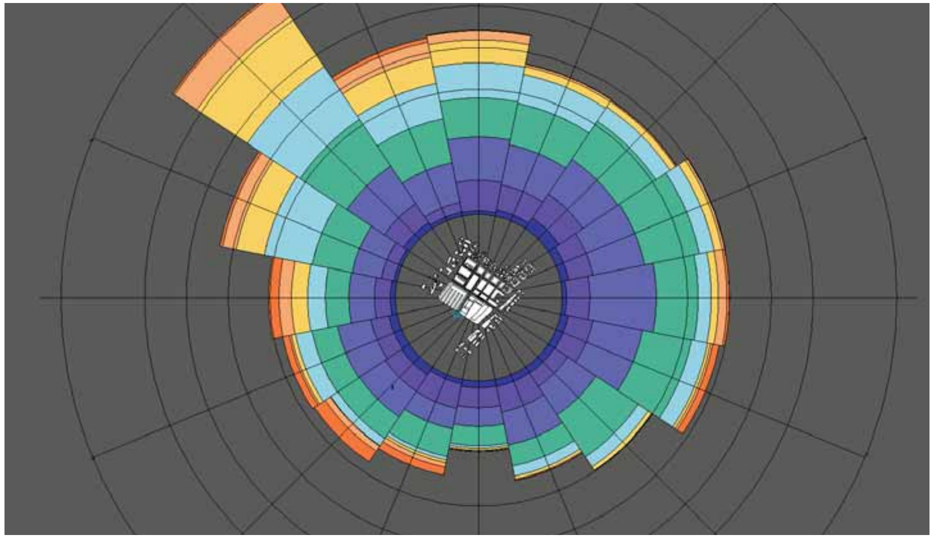
MET	CLO	(חללי פנים)
1.6	0.3	יולי
1.6	1.5	ינואר
1.6	0.8	אפריל
1.6	0.5	אוקטובר

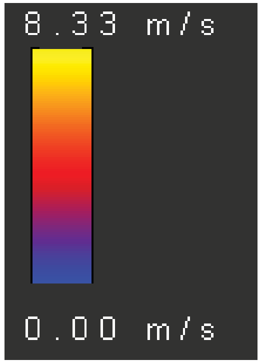

BTU/ft²
Cumulative
117.0
59.7
2.4
Project location: Tel Aviv, Israel
Sun study date time: 20/03/2010 12:00:00

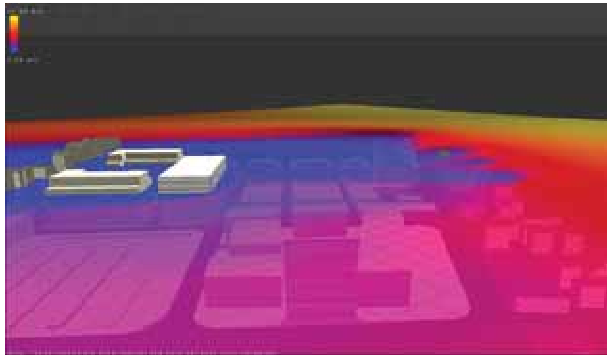



Ecotect Wind Rose
Map
Satellite
Hybrid
Terrain
km/h
6+
5-6
4-5
3-4
3-3
2-3
1-2
0-1
N
NNE
NE
ENE
E
ESE
SE
SSE
SSW
SW
WSW
W
WNW
NW
NNW
Netanya
Tel Aviv
Rishon LeTsiyon
10 mi
10 km
Average Wind Speed
Evening
Afternoon
Morning
Night
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Winter
Spring
Summer
Autumn
00:00
to
00:00
15Min
km/h
Week
7-Day Avg.





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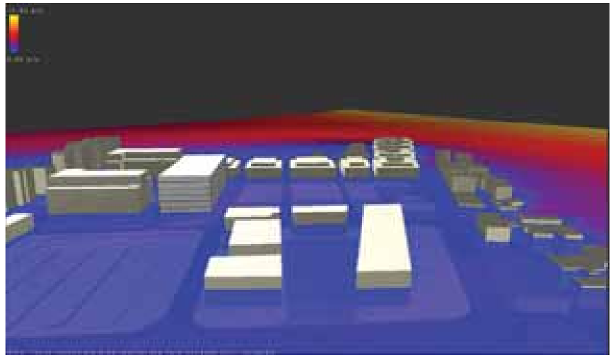
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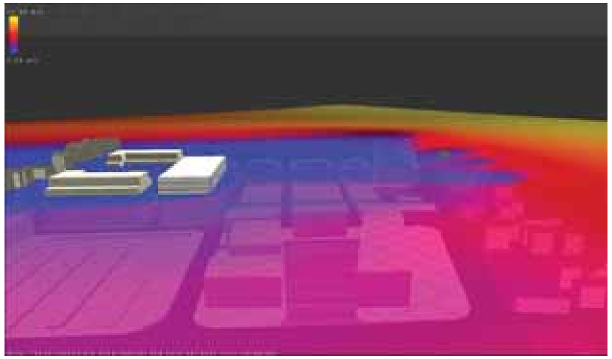
25m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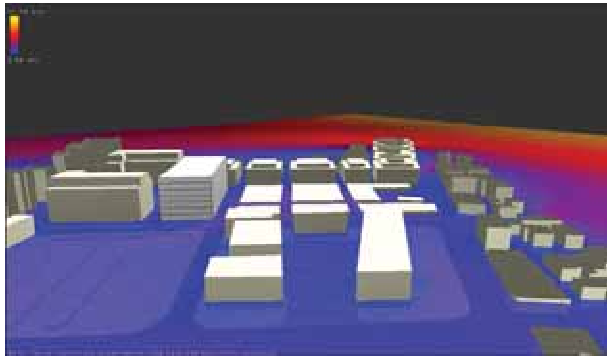
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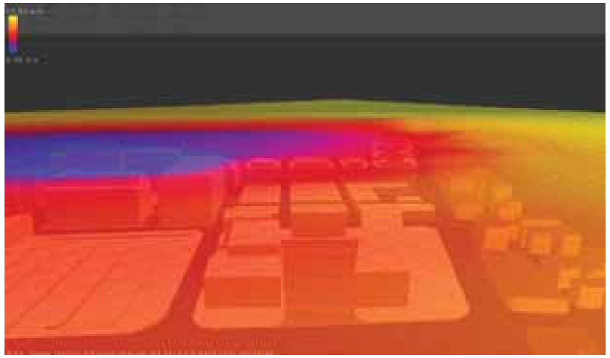
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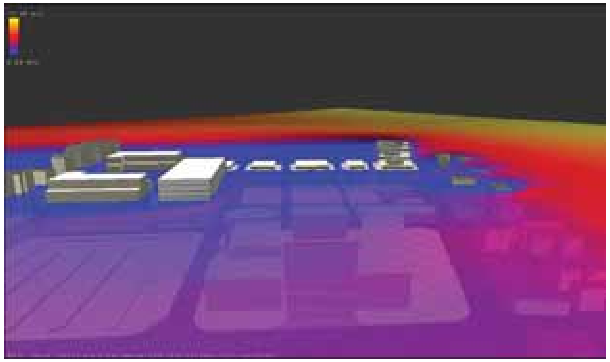
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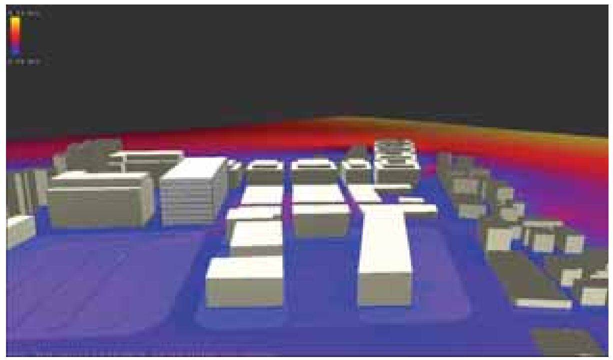
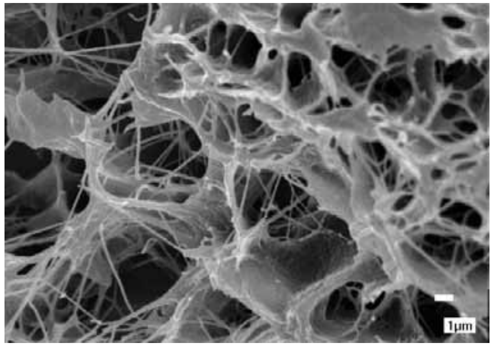
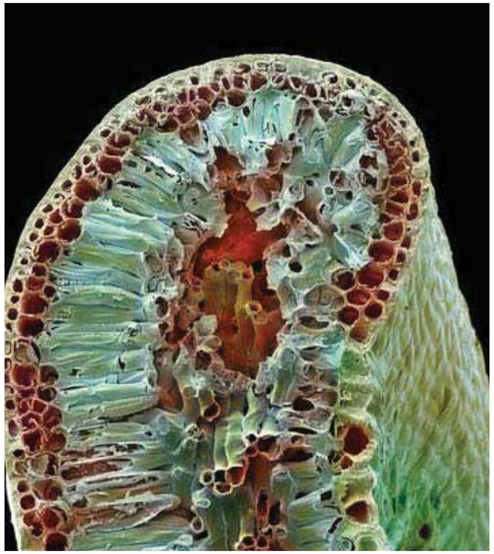

2m

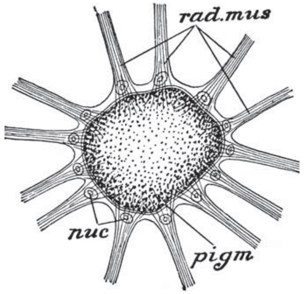
Bones Structure - Case study

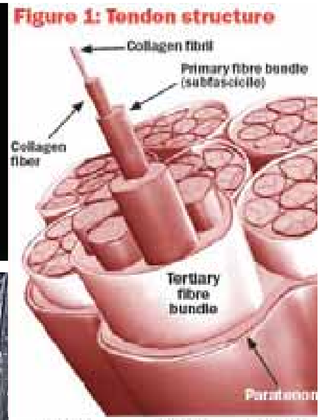


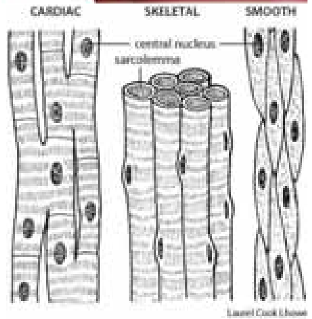
Connecting Tissue
(http://podolnymd.com)



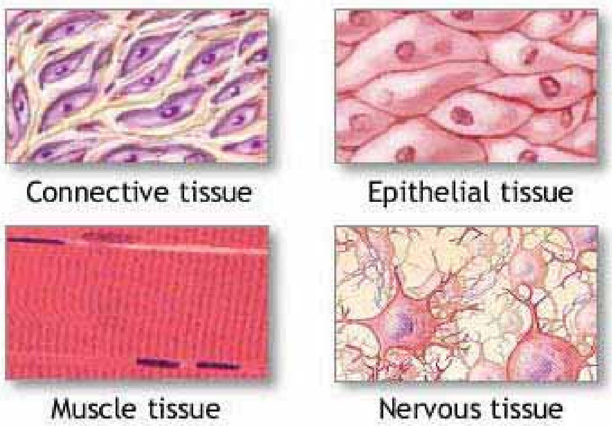
Leafe Tussue X200
(http://www.sciencephoto.com)

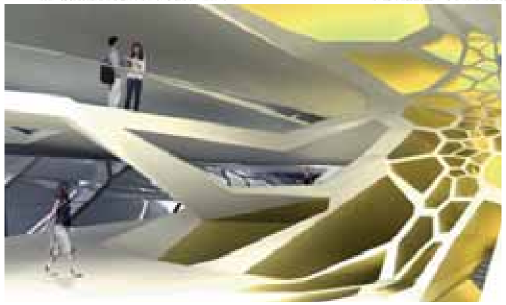






http://notesofranvier.blogspot.com/

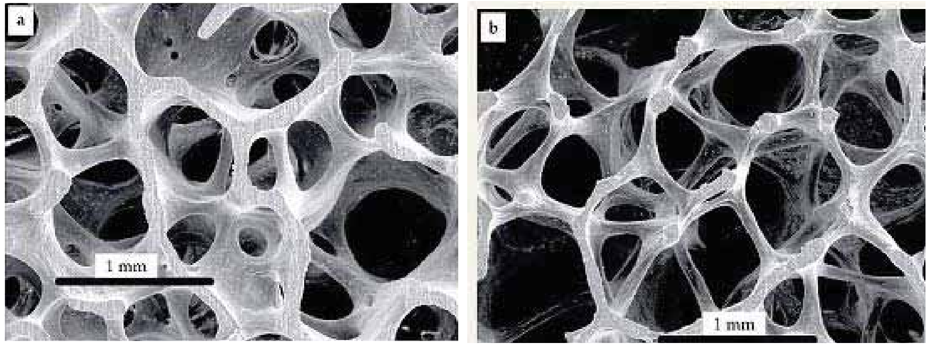




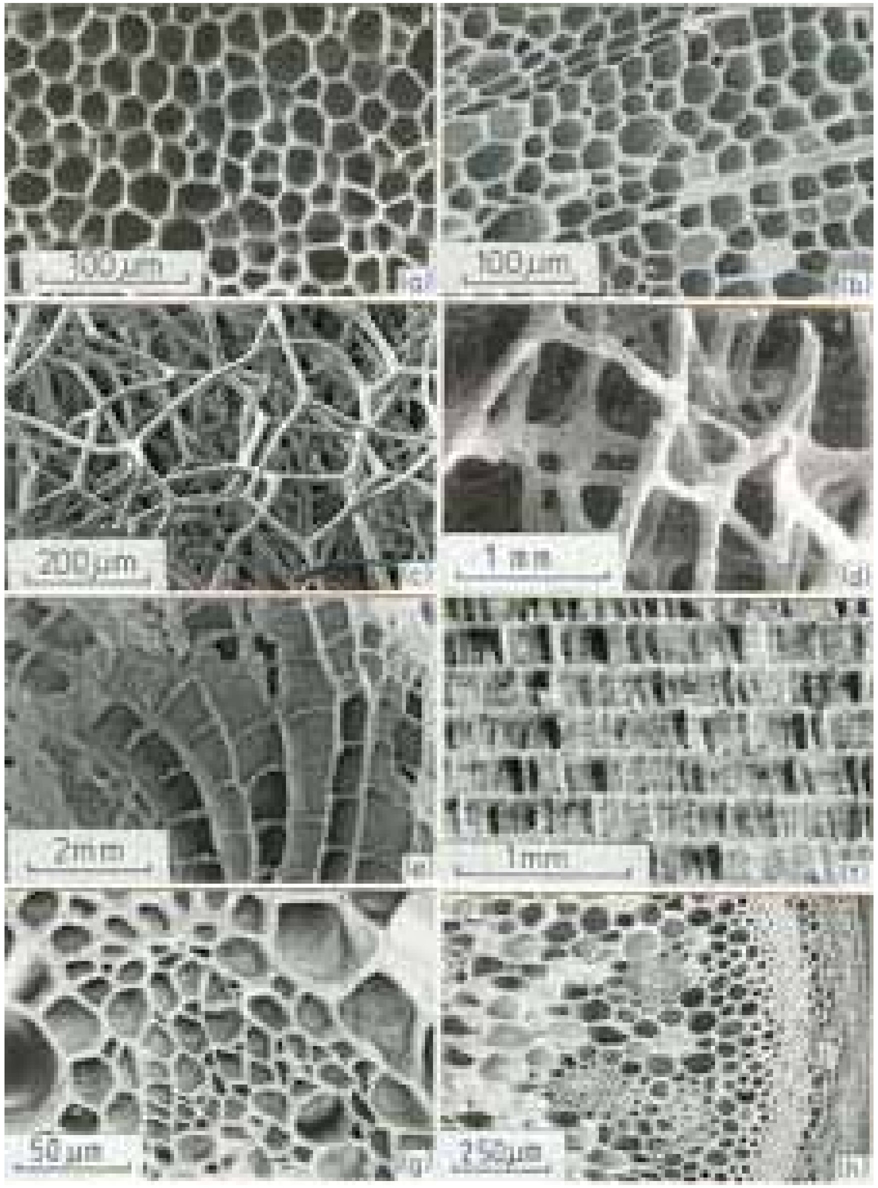
Bones Structure - Case study

רקע מדעי

השלד מורכב בעיקר מהעצמות, וכולל גם את הסחוסים ואת המפרקים. העצמות הן החלקים הקשים ביותר בגוף, וקשיותן נובעת משקיעת מלחים בתוך הרקמה החיבורית של העצם. תפקיד השלד לשמור על מבנה הגוף, להגן על הרקמות הרכות והאיברים הפנימיים, ולשמש נקודת משען ומנוף לשרירים. כמו כן מהווה מערכת העצמות מרכיב חשוב במשק הסידן בגוף. בתוך העצמות מצוי מוח העצמות, שתפקידו ליצור את מרכיבי הדם.
מחלקים את העצמות לפי הצורה והמבנה לעצמות ארוכות, קצרות, שטוחות ובעלות מבנה לא סדיר. עצם ארוכה בנויה מגוף העצם וקצה העצם. בגיל הצמיחה מופרד קצה העצם מגוף העצם ברקמה סחוסית פעילה, הגורמת לצמיחת העצם.

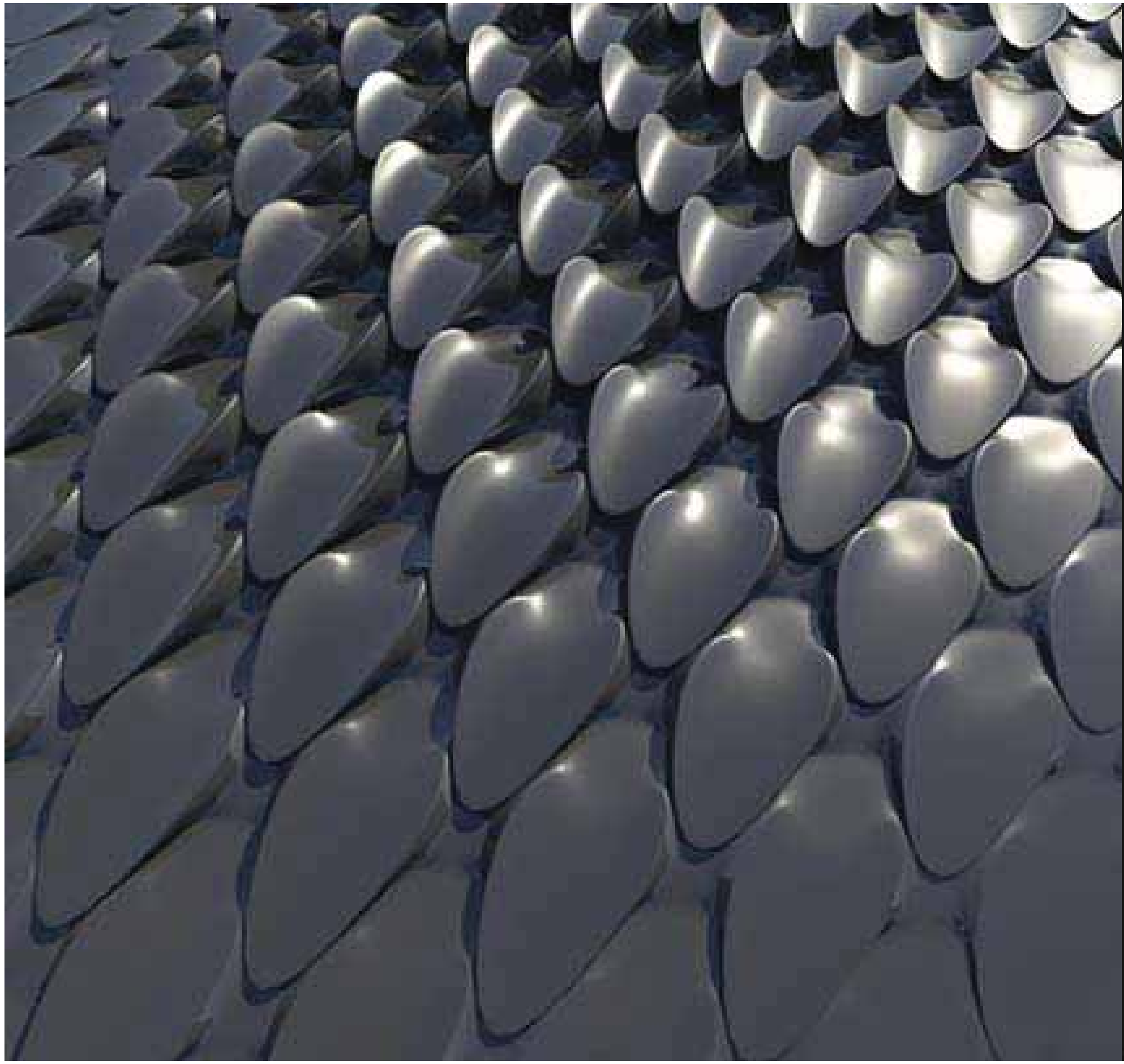


Human bone - a-25, b-65 (http://blogs.physicstoday.org)



Cellular Materials in Nature
(http://web.mit.edu)

מקור הרקמה הגרמית היא רקמת החיבור. יש שהרקמה החיבורית הופכת לעצם במישרין (כגון בעצמות הפנים ובחלק מעצמות הגולגולת), ויש שהיא הופכת לסחוס, וממנו מתפתחת רקמה גרמית (זהו המצב ברוב העצמות הארוכות).
בעובר מתפתחת מערכת השלד מהשכבה המסודרמלית החל מהשבוע השמיני להפריה.
השלד של אדם מבוגר מורכב מ- 206 עצמות לפי החלוקה הבאה: גולגולת ופנים – 22; עצם הלשון – 1; עצמות השמע – 6; עמוד שדרה – 26; צלעות ועצם החזה – 25; גפה עליונה – 64; גפה תחתונה – 62. העצמות מחוברות ביניהן באמצעות מפרקים שונים. סוג המפרק וצורת העצם קובעים את טיב התנועות באותו מפרק.



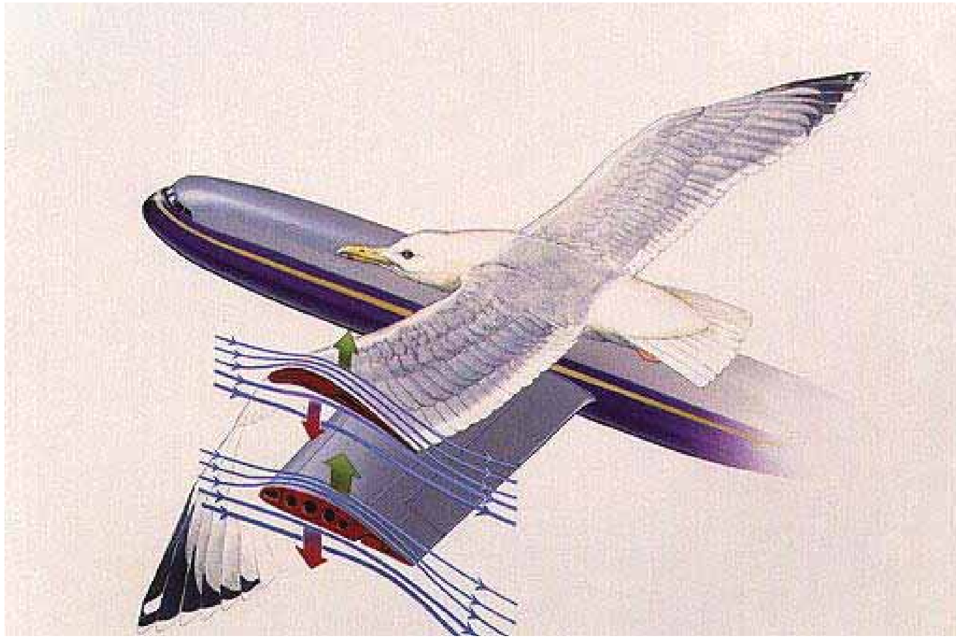
(http://vagueterrain.net)

http://kadampalife.org

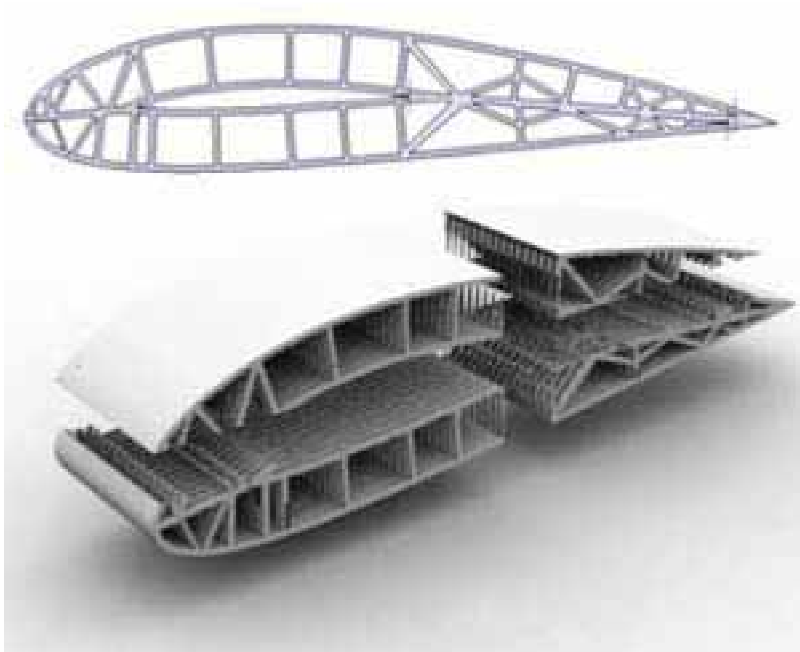
http://www.dvinfo.net

http://aak92.wordpress.com

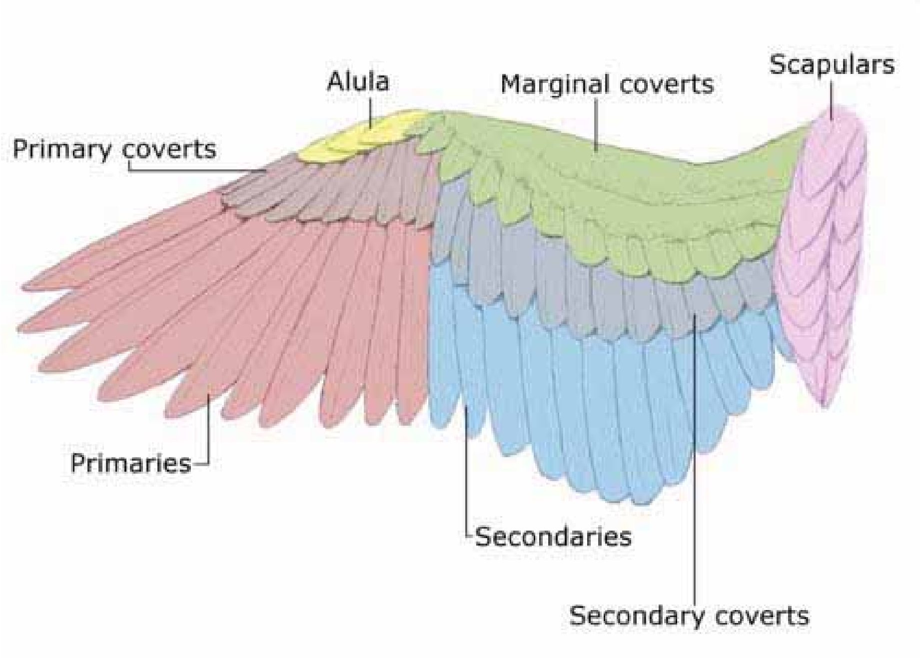
http://indianapublicmedia.org



Cross section through one barb of a feather (www.sciencedaily.com)

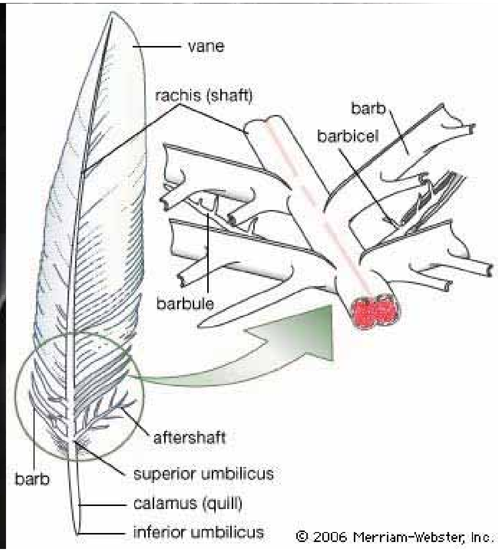


Wing Manufacturing (http://www.me.utexas.edu)



Wing Structure (http://hippie.nu)

Micro Bird Feathers (http://blotta.com)

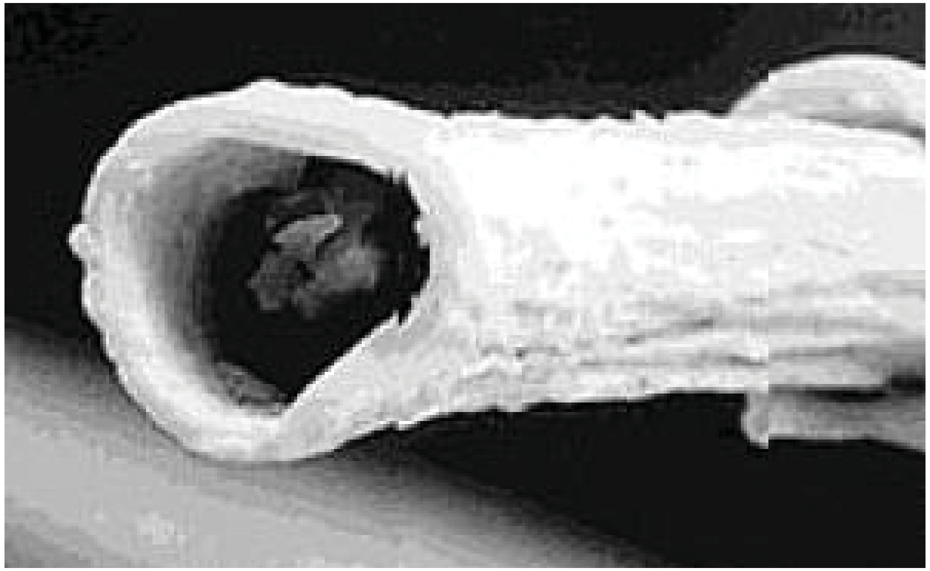


Cross section through one barb of a feather
(www.sciencedaily.com)

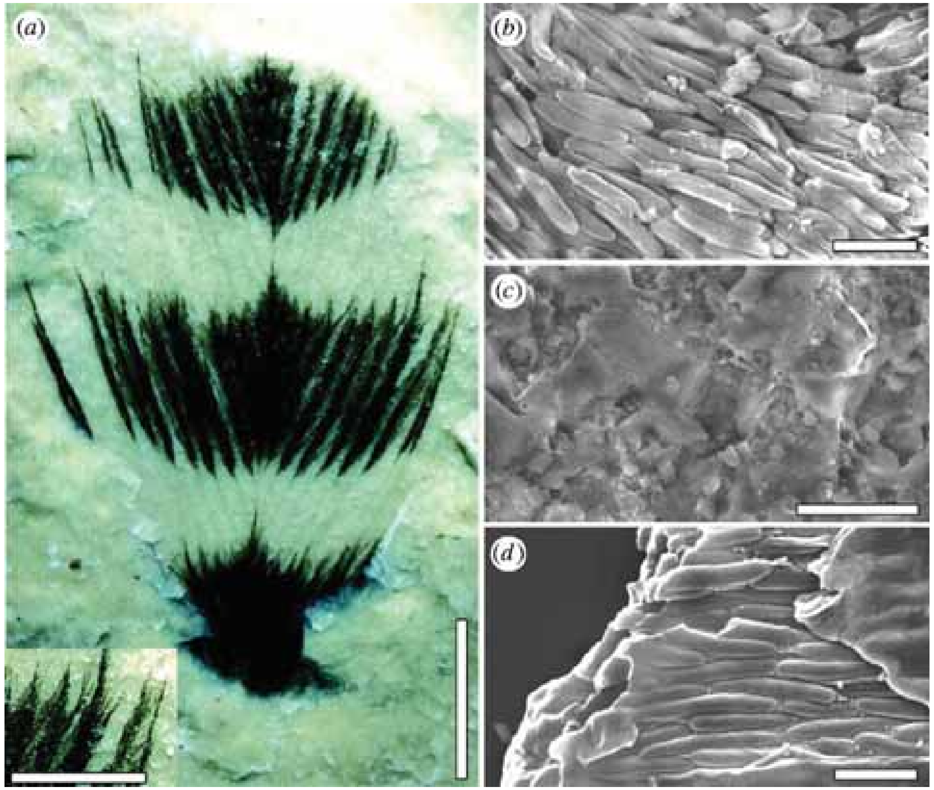
Feather

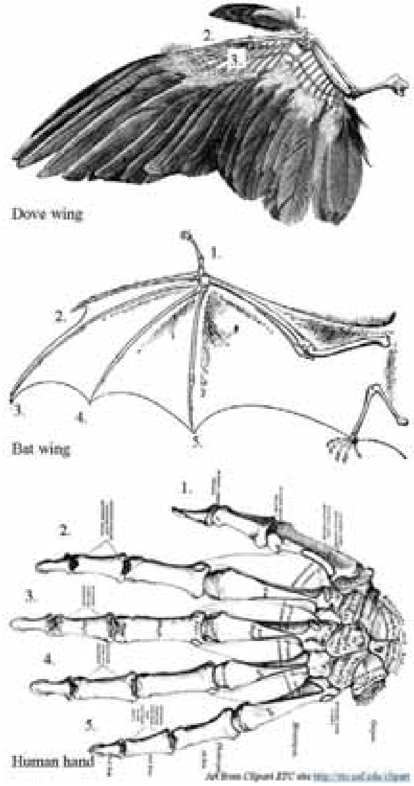
Component structure of the outer covering and flight surfaces of all modern birds. Unique to birds, feathers apparently evolved from the scales of birds' reptilian ancestors. Like hair, feathers are made of keratin, a fibrous protein. They are variously specialized for insulation, flight, formation of body contours, display, and sensory reception. Contour feathers form most of the surface of the bird, streamlining it for flight and often waterproofing it. The basal portion may be downy and thus act as insulation. The major contour feathers of the wing (remiges) and tail (rectrices) function in flight. Contour feathers grow in tracts (pterylae) separated by bare areas (apteria) and develop from follicles in the skin. Down feathers have loose-webbed barbs, all rising from the tip of a very short shaft. Their function is insulation, and they may be found in both pterylae and apteria in adult birds. They also constitute the first feather coat of most young birds. Filoplumes are hairlike feathers with a few soft barbs near the tip. They are associated with contour feathers and may be sensory or decorative in function. Bristlelike, vaneless feathers occur around the mouth, eyes, and nostrils of birds. Some bristles function as eyelashes on ground-dwelling birds; bristles over the nostrils may serve as filters.

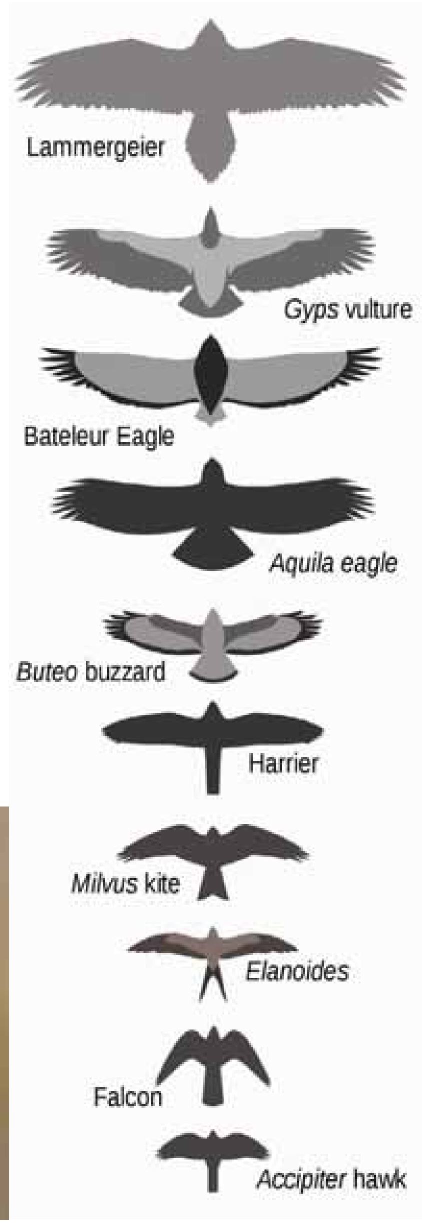
http://www.britannica.hk



Cross section through one barb of a feather (www.sciencedaily.com)

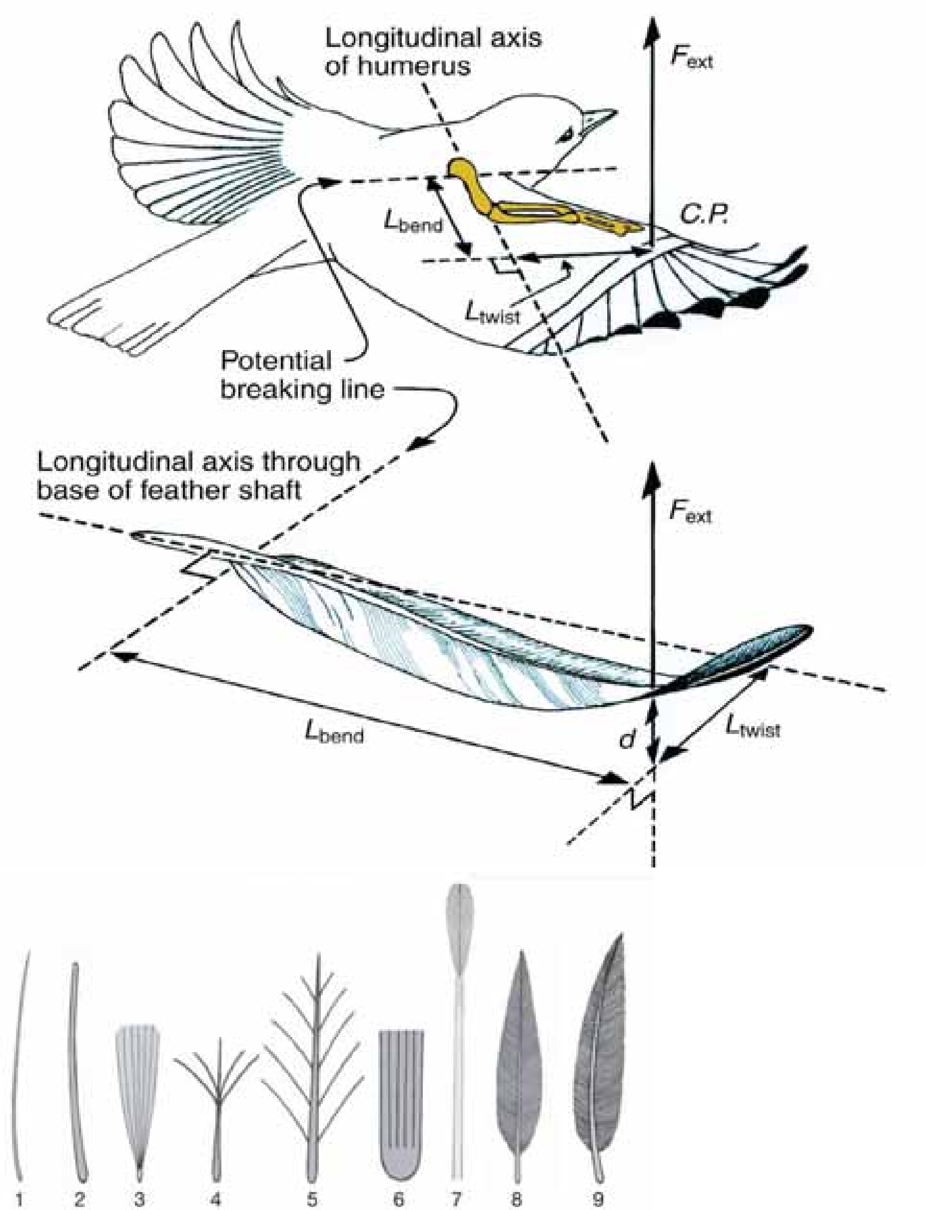




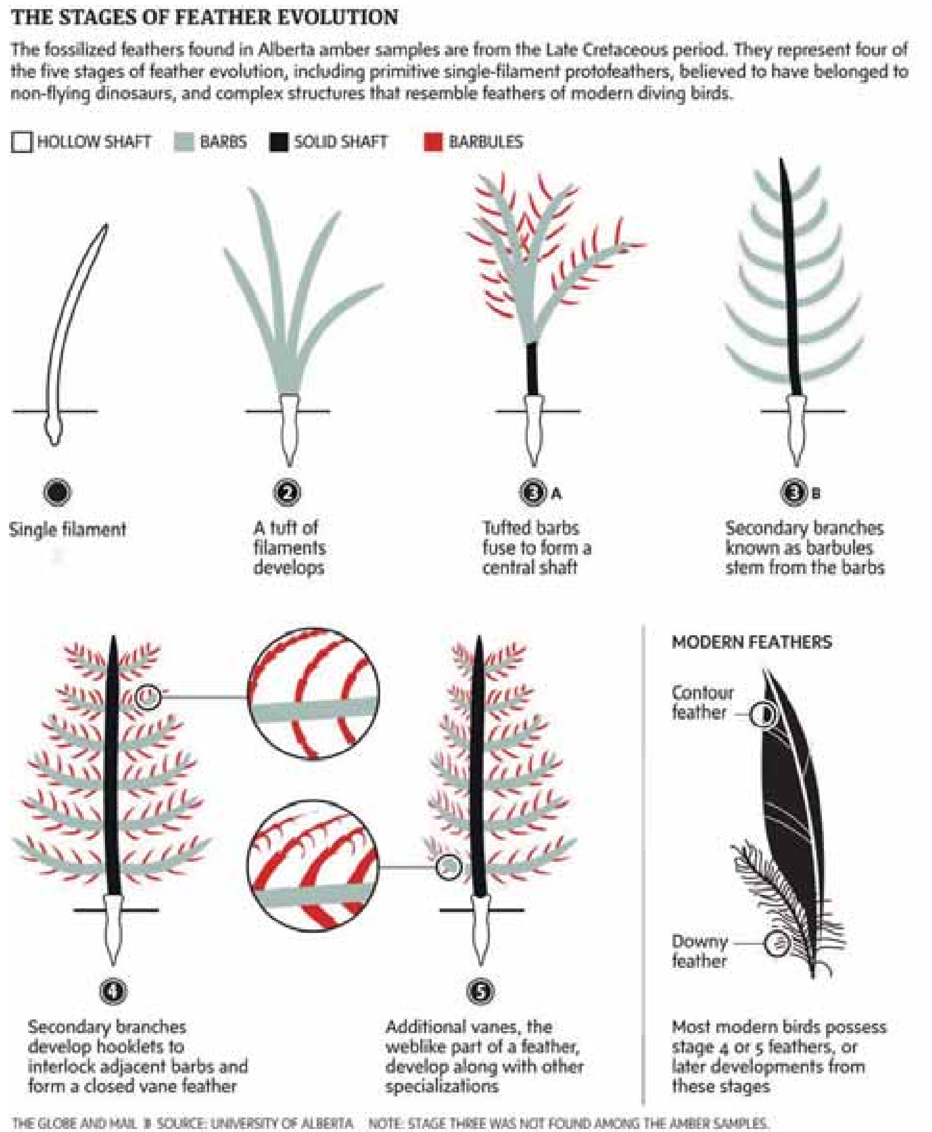


(http://comenius.susqu.edu)

(http://lansingwbu.blogspot.com)



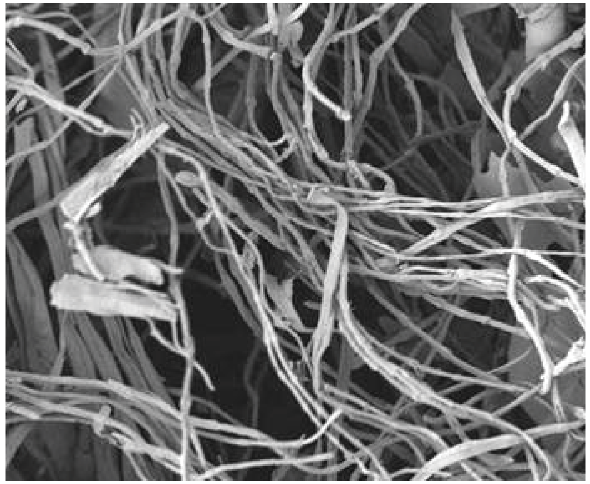
(http://jeb.biologists.org/content/213/16/2873/F3.large.jpg)



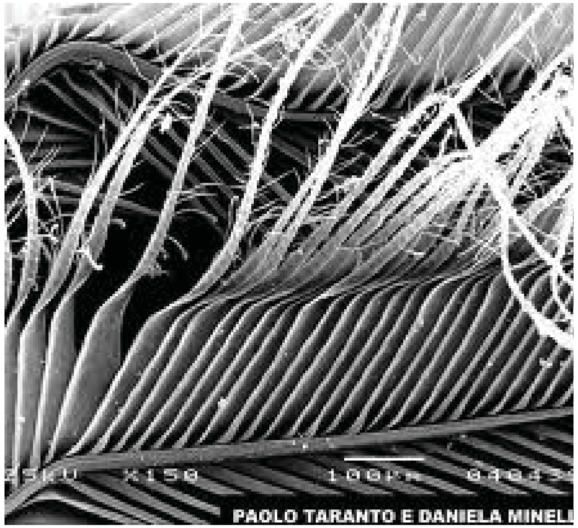
(http://evolutioncourse.blogspot.com)

Duck Flat Feathers
(http://www.redbubble.com)

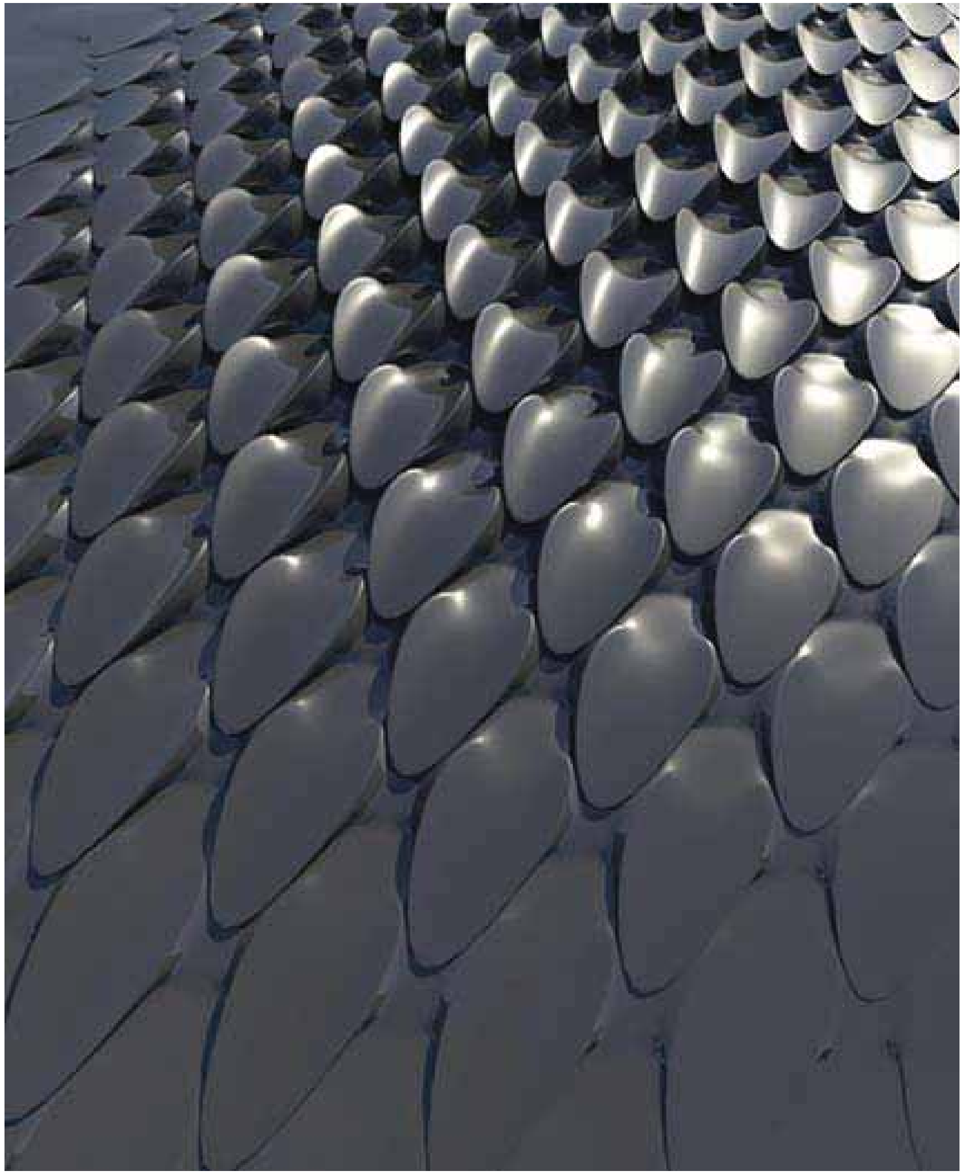
http://www.msnbc.msn.com



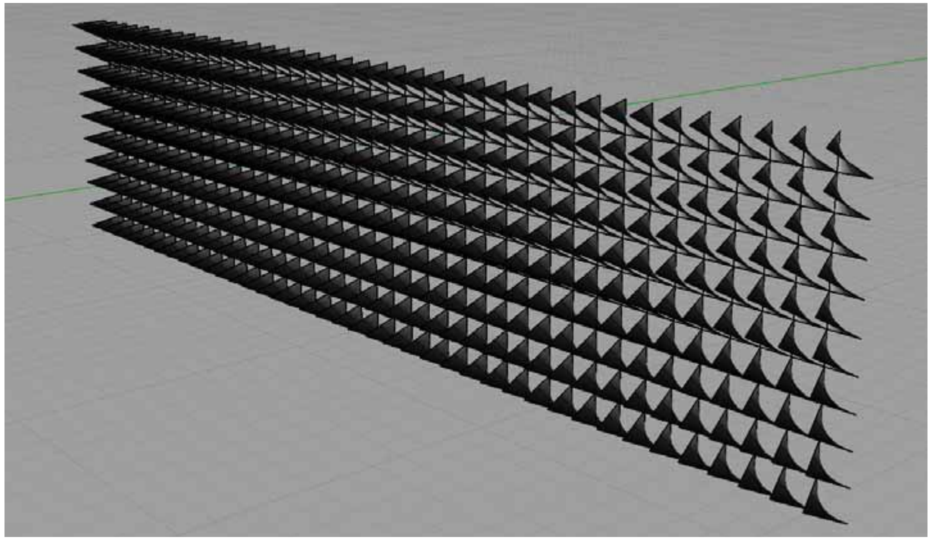
http://www.owlpages.com

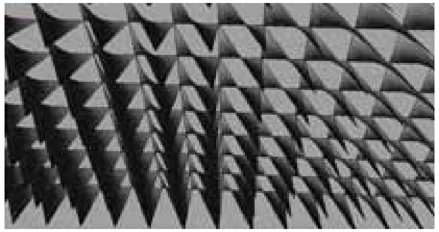


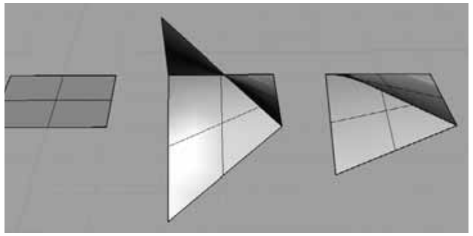
http://photography.
nationalgeographic.com/

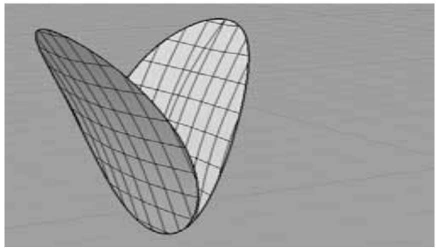


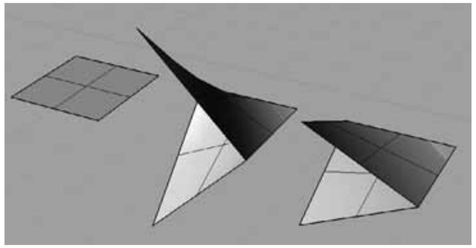
(http://vagueterrain.net)

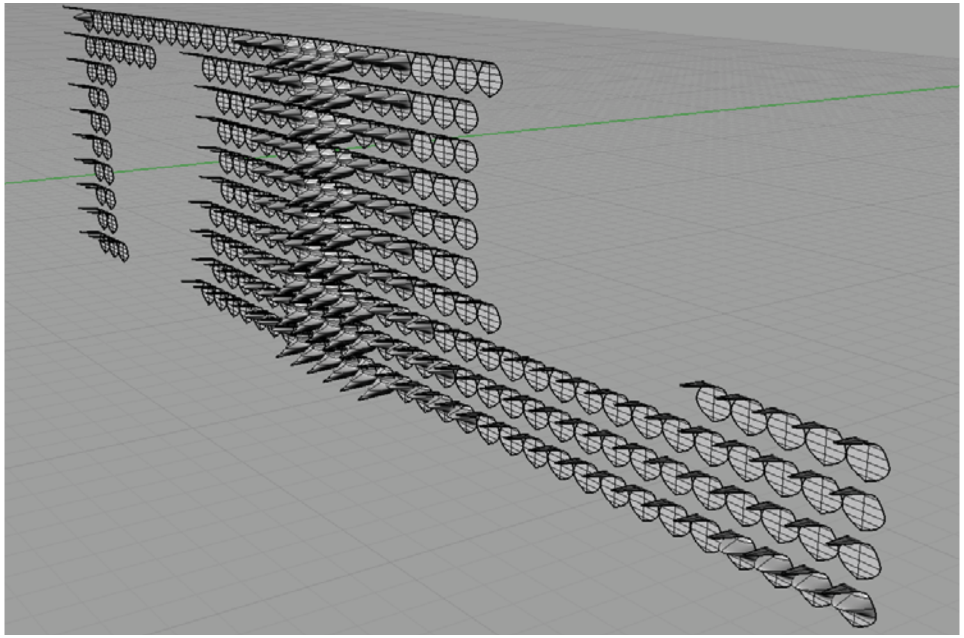


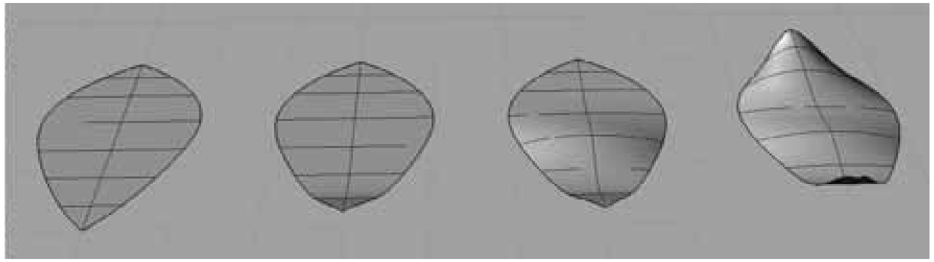


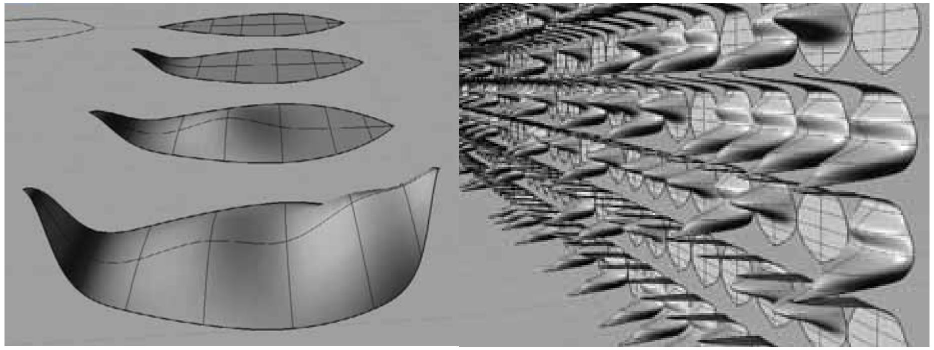


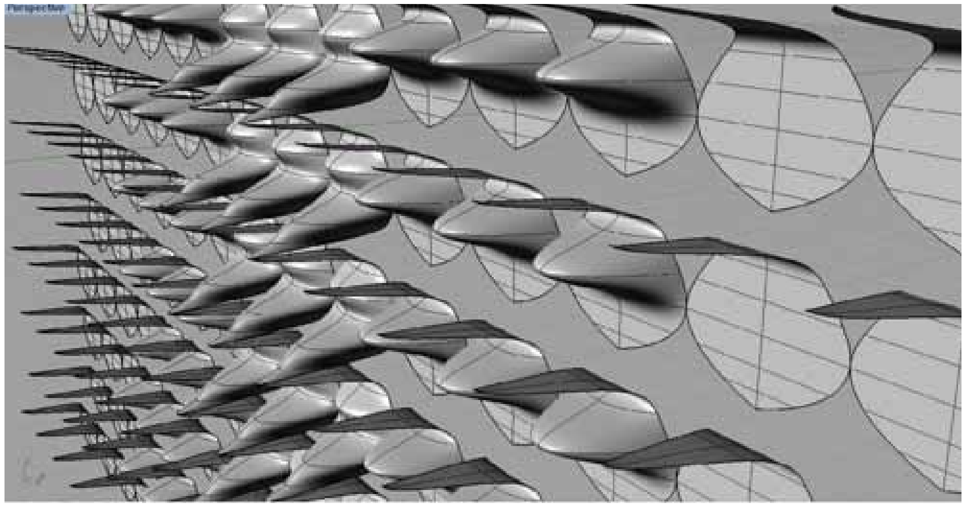


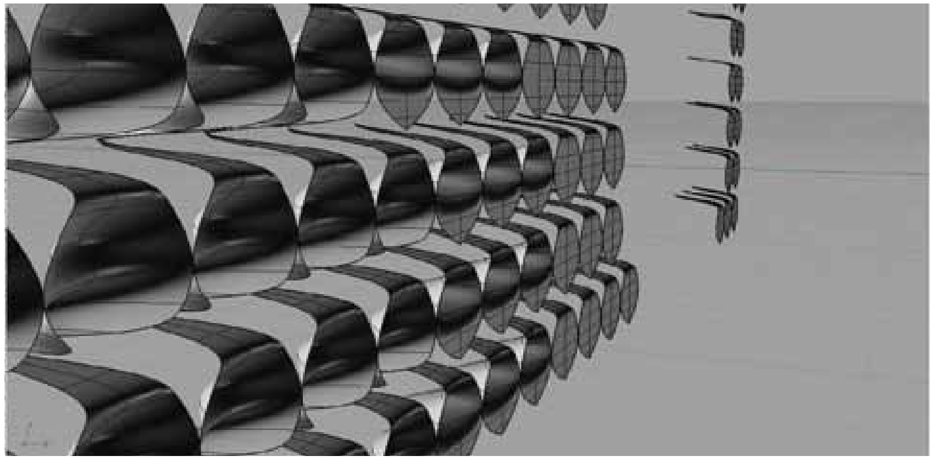






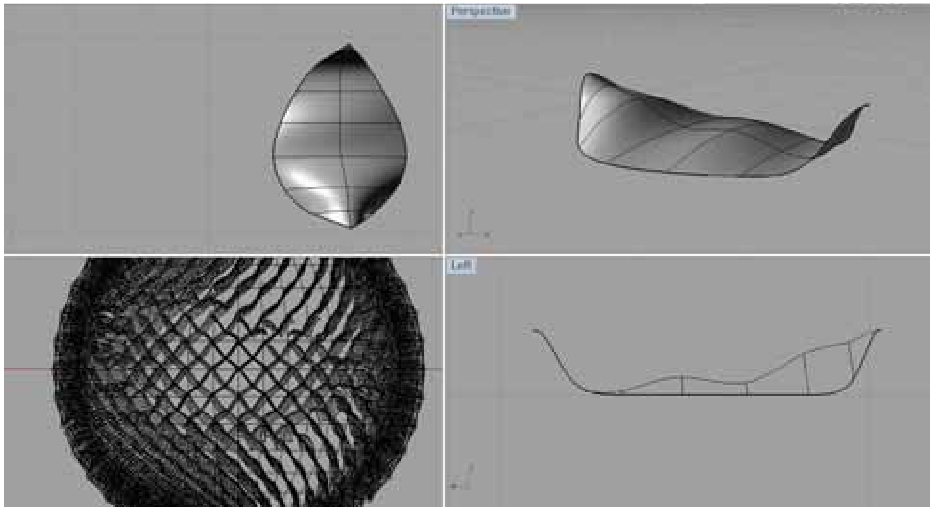




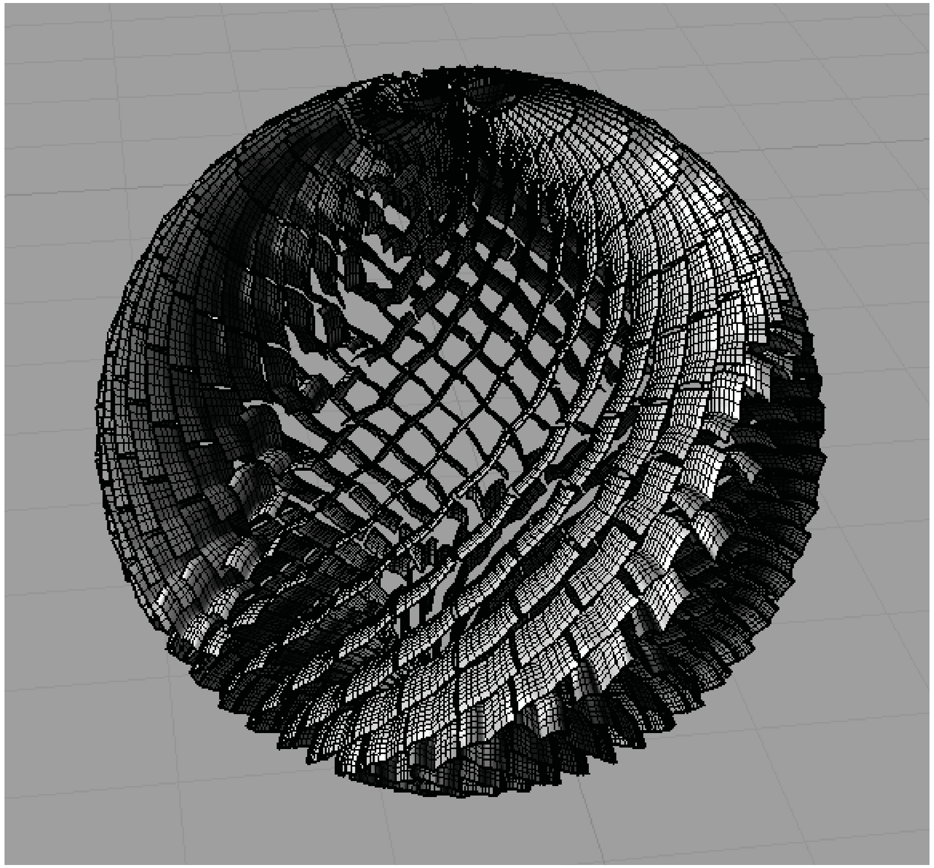


Organic form module

Gradually openning of the basic module



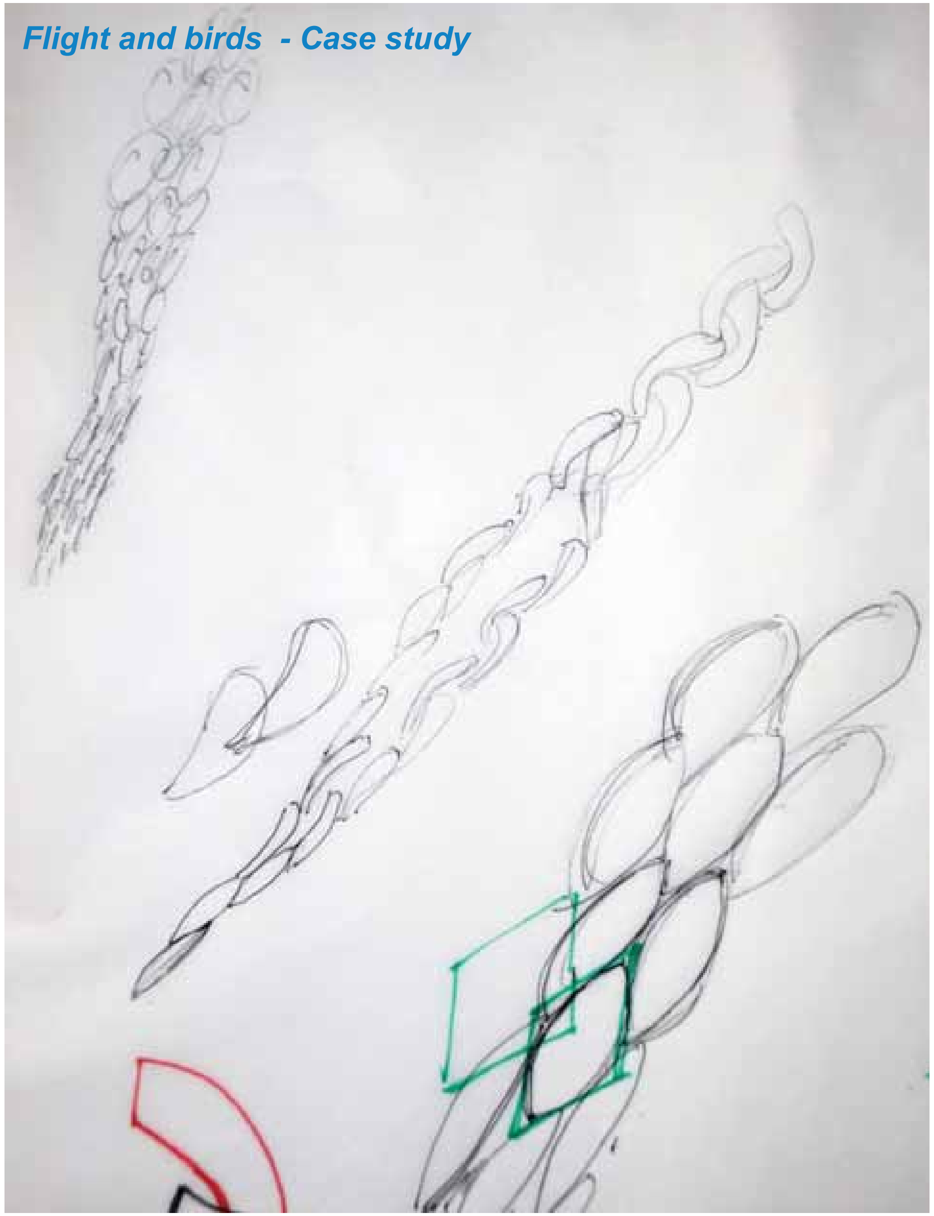
Basic Module and the whole form



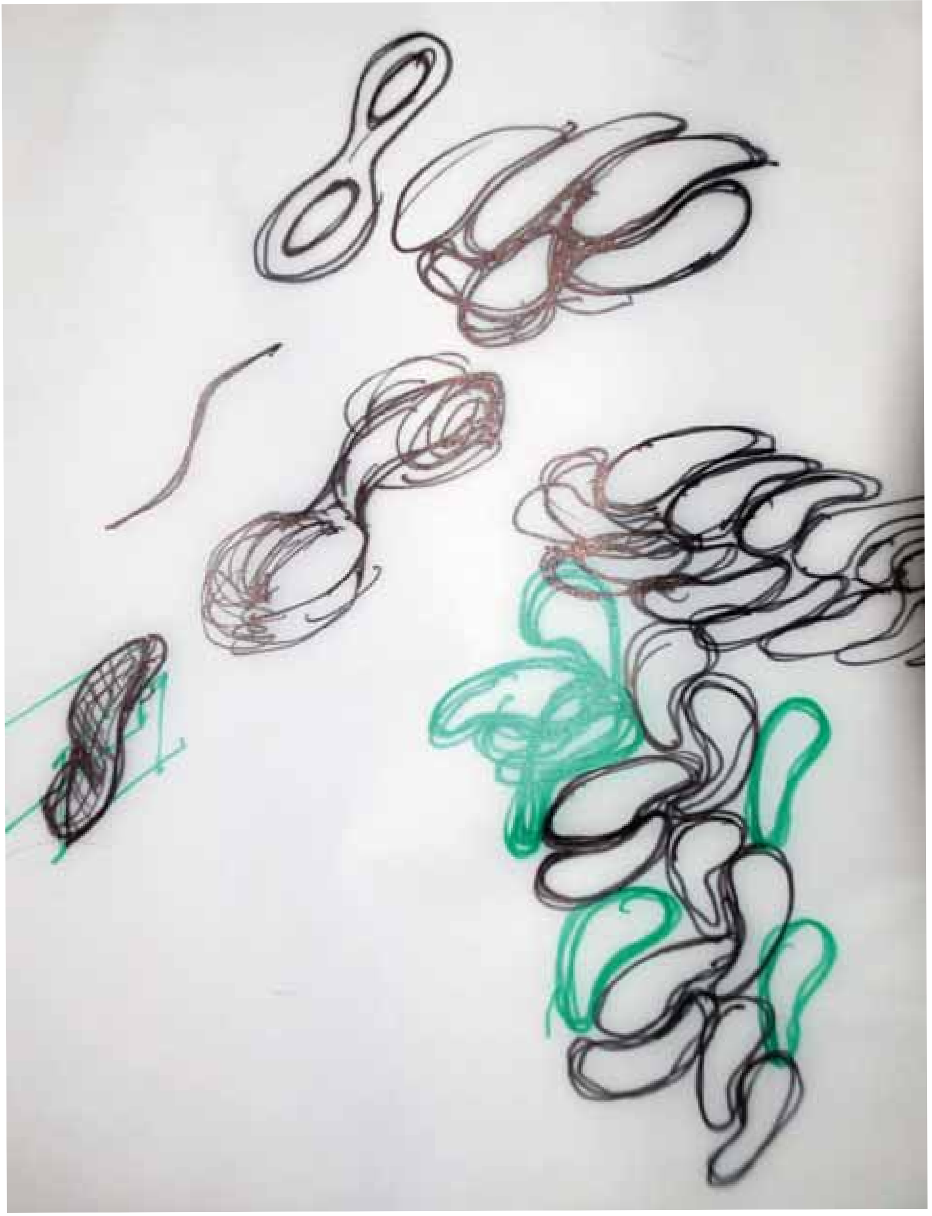
Module Placed on a sphere

Flight and birds - Case study

Flight and birds - Case study

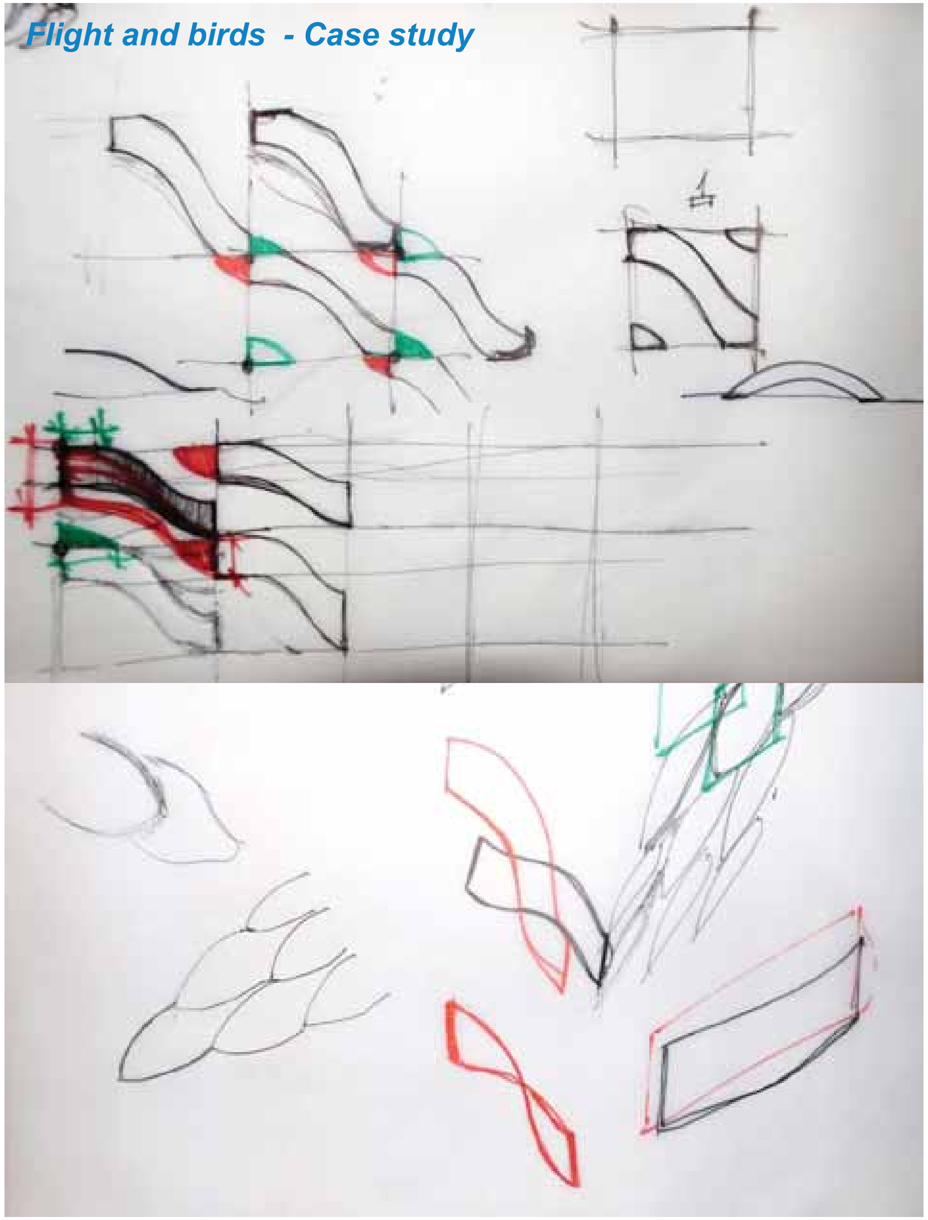


Parametric Pattern



Searching Pattern

Flight and birds - Case study

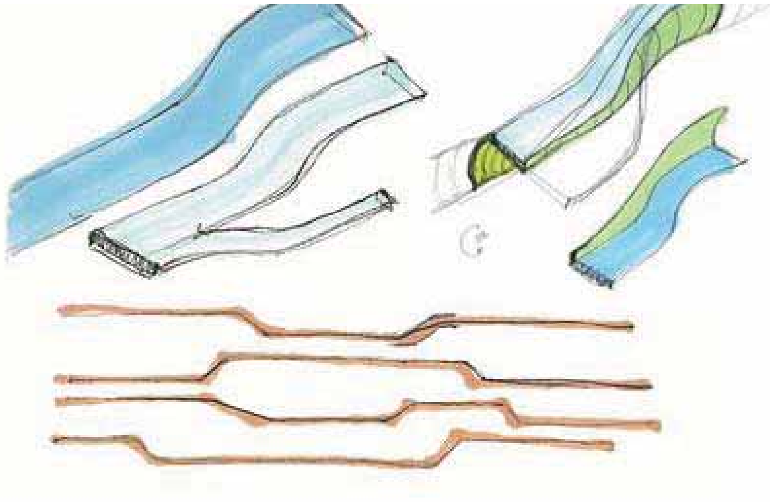


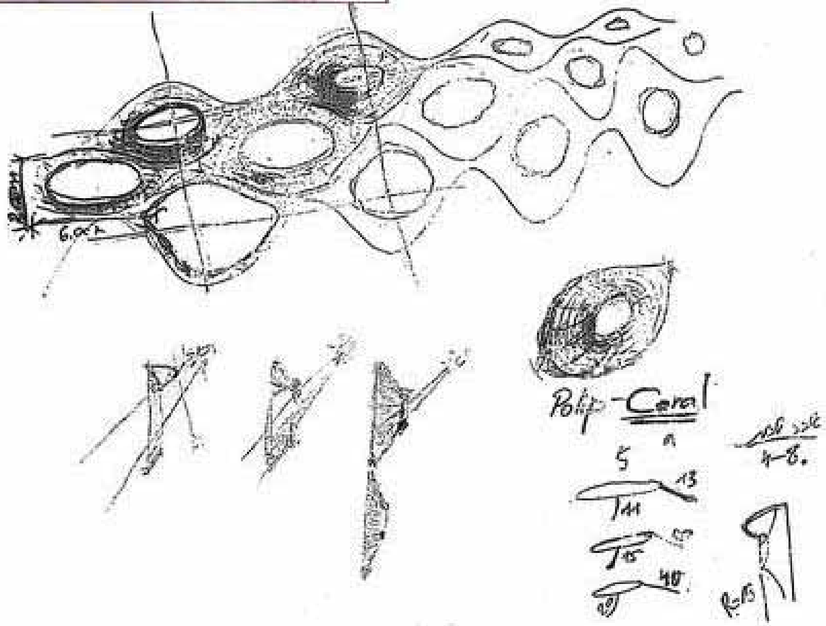
3d Module searching

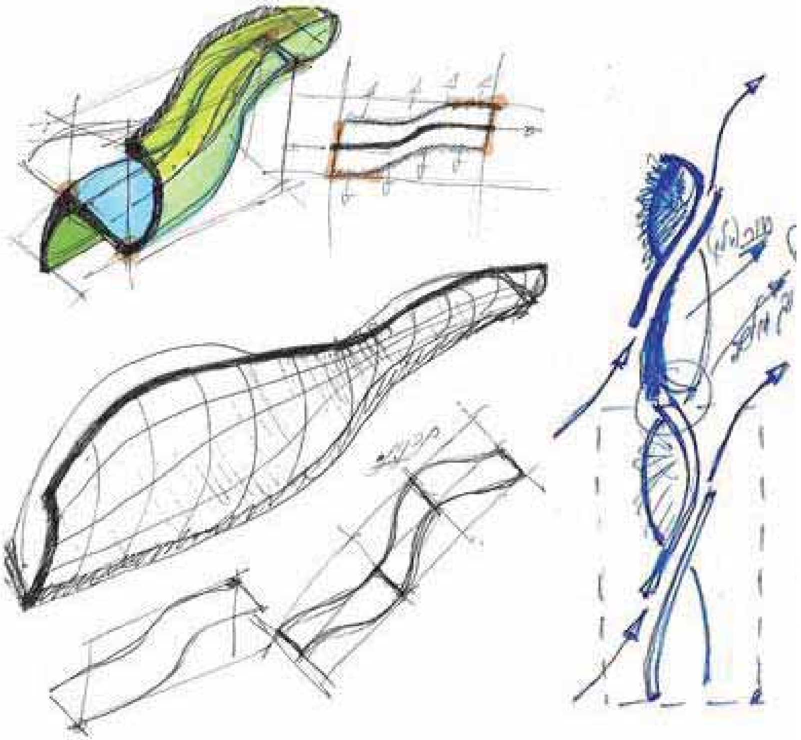
http://www.petsfoto.com

http://www.tevahadvarim.co.il

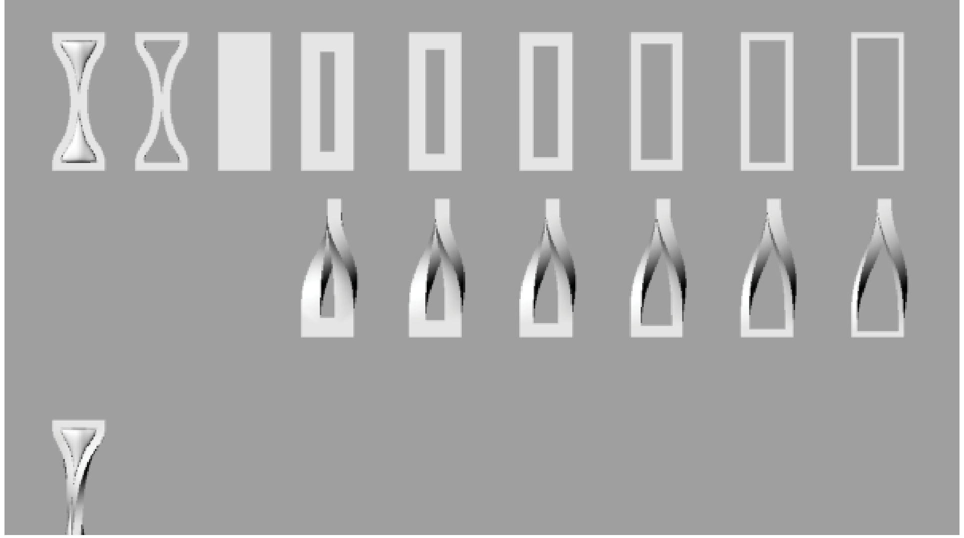
Flight and birds - Skizas

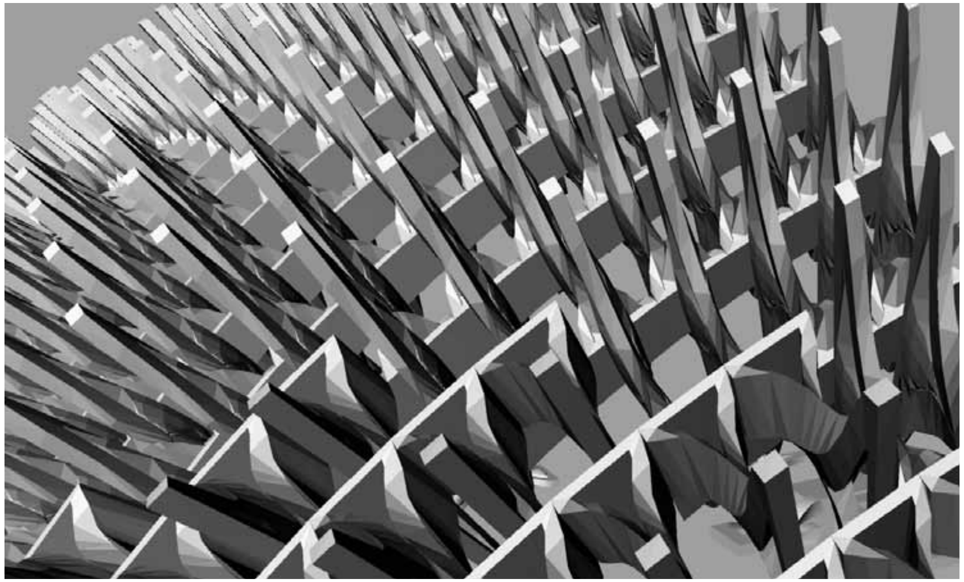


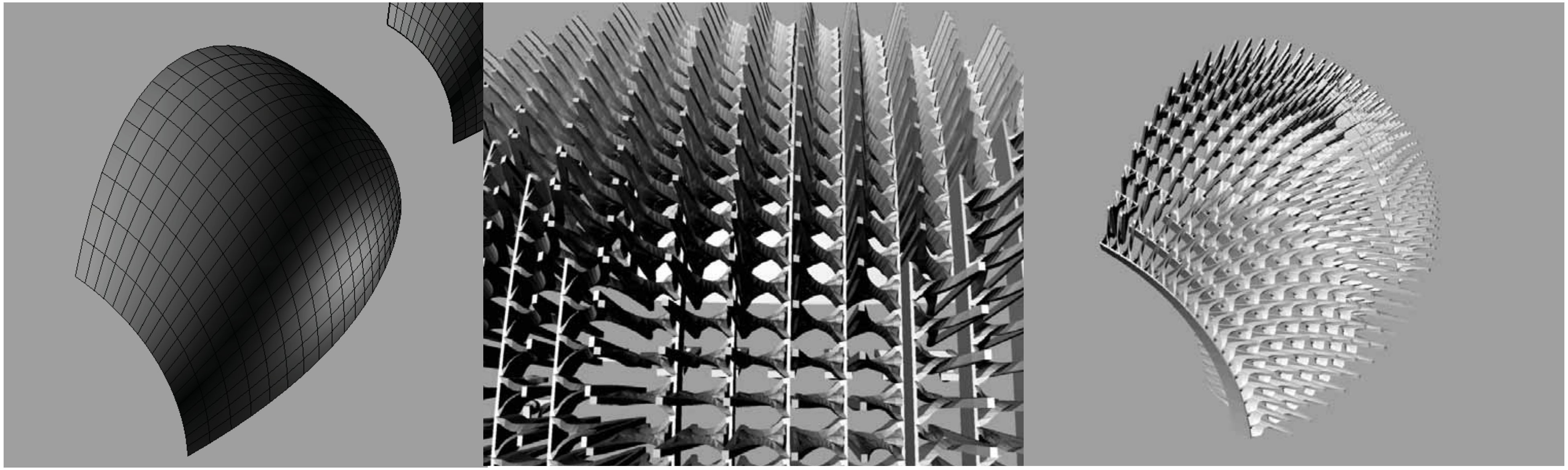




Flight and birds - Rhino attempts of form finding

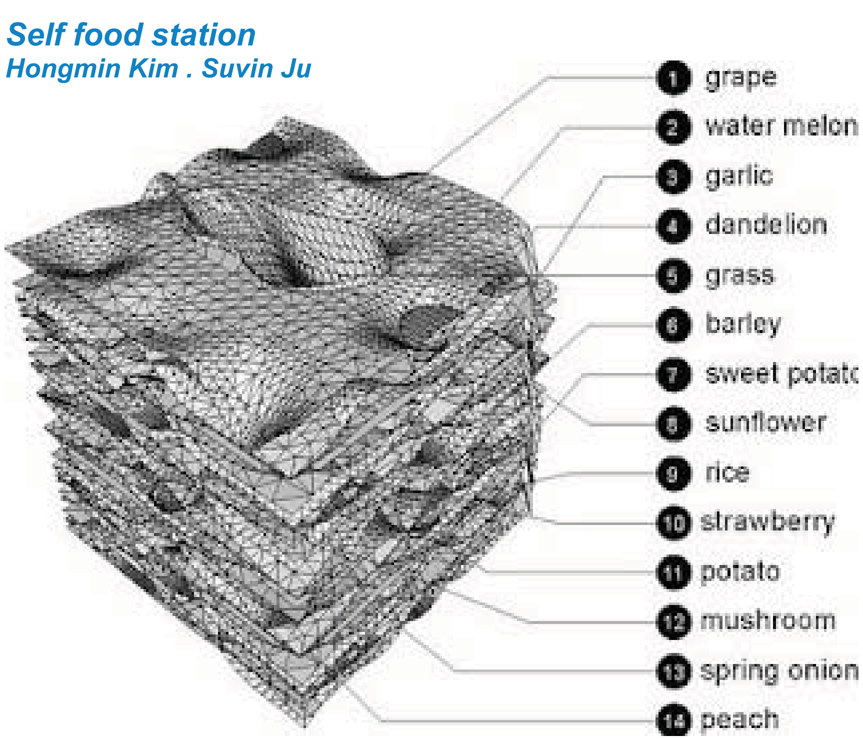




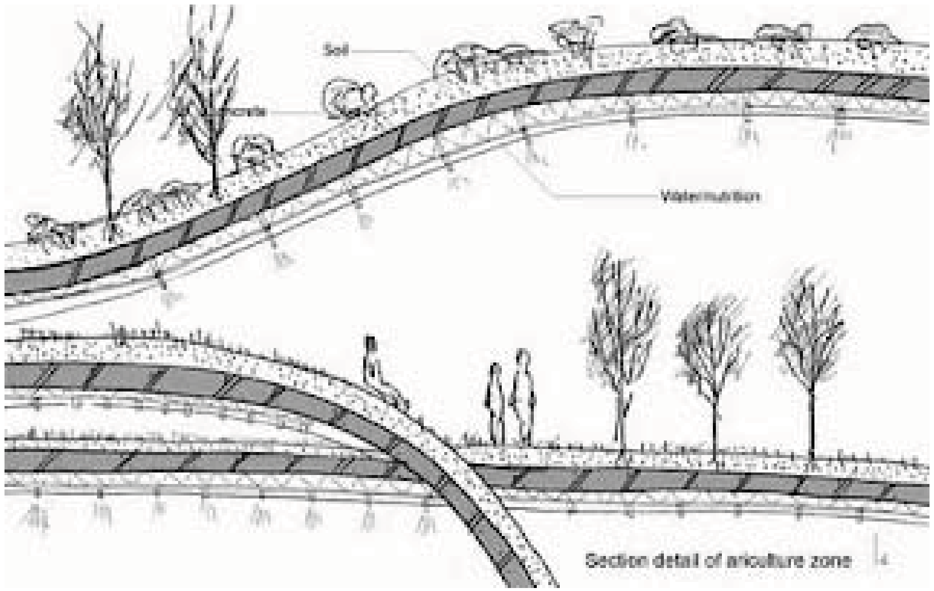


Fotrm finding - twisted form wich makes a pointy facade with climatic filter.

Self food station
Hongmin Kim . Suvin Ju



(http://afasiaarq.blogspot.com)



Section through the green roof

Section through the green roof

BIG
TED Cube Building

Aptly named, this BIG creation in Taiwan looks like a cube-shaped black hole out of a sci-fi movie. Recessions throughout the building might give the impression of a portal to another world but in actuality lead to open areas that allowing people to walk through. BIG's futuristic creation will not be barren: on top of the 57-m-high building will be a grove of trees encircling a rooftop performance area, which will provide a naturally cooled public park.

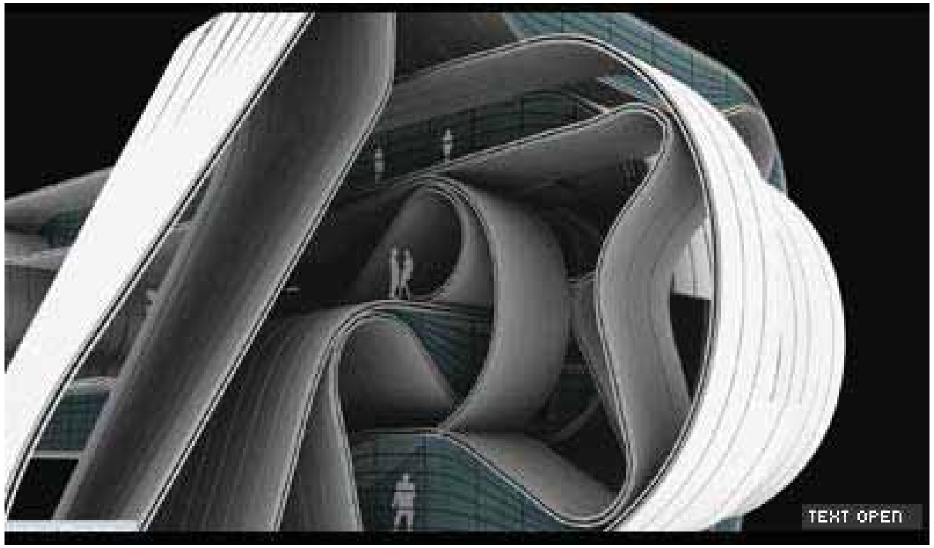

Views on the natural cooled public areas (http://buildipedia.com)

Renzo Piano
California academy of science

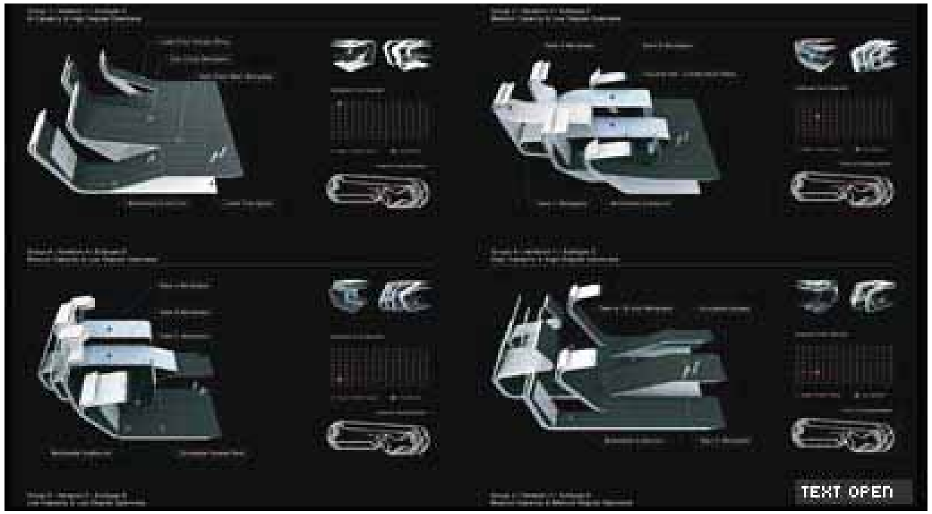
Sky lights lightens the interior garden with natural light (http://buildipedia.com)


The skylughts plays part also atnight towords outside and at day towords inside
(http://buildipedia.com)

AADRL
Razor Bios

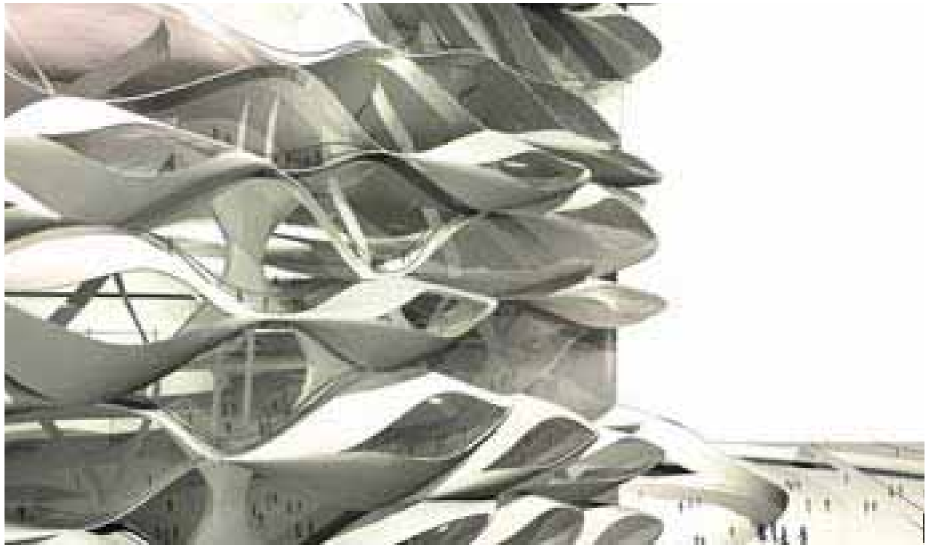


The baundary element can be useful for more than one thing

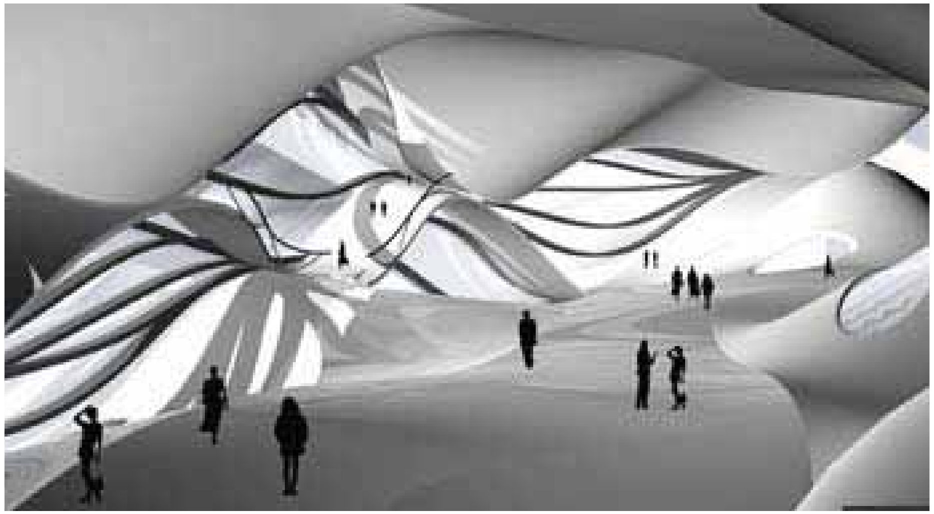


Modules of bended material (http://www.AADRL.com)

AADRL
Micro city

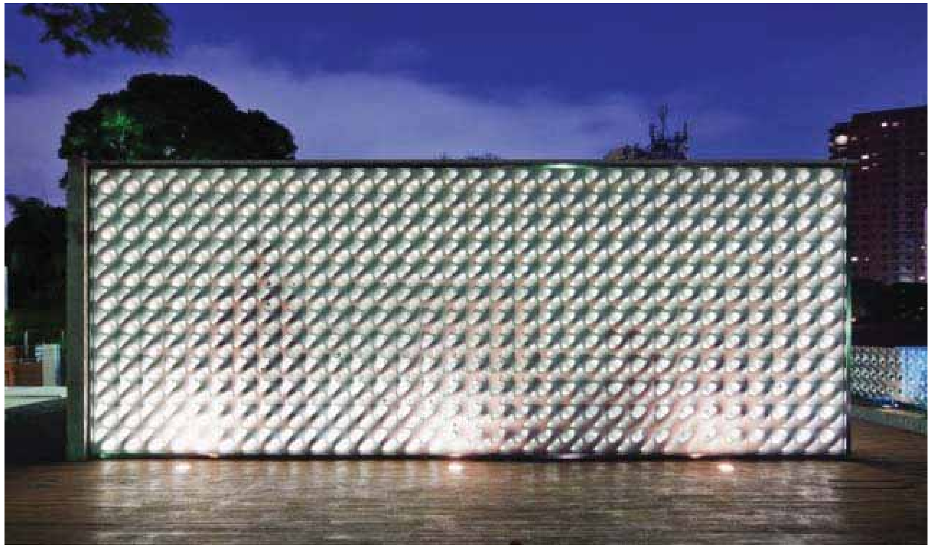


3d developed parametric form

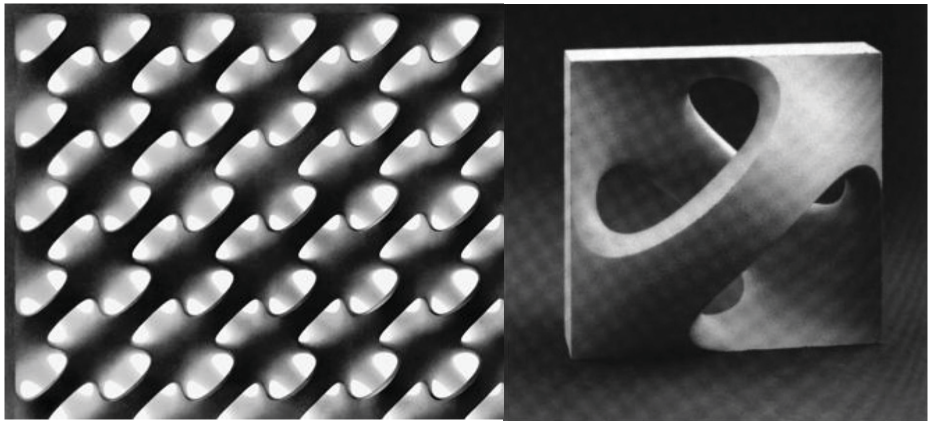


Almost flat surfaces frokm the inside - mostly parametric facade

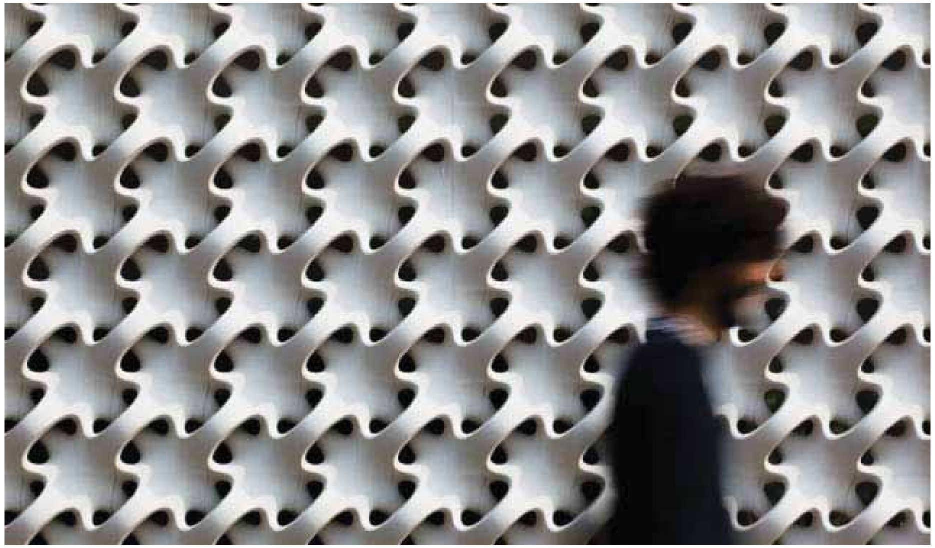
Marcio Kogan
Designed space based on Erwin Hauer designs



Erwin Hauer is an artist exploring 3dimensional surfaces as his canvas. His work is an intersection between sculpture, parametric design, modularity and patterns. His work bonds intimately with the architectural and interior /exterior design, performing a constant dialogue with light and shadow. Marcio Kogan and his studio MK27 did a fantastic job designing an space using Erwin's modules. Check out the images from mk27.



Erwin Hauer - Showroom of Knoll Internacional de Mexico, Mexico City Design 1 (1950)
(http://pytr75.blogspot.com/)



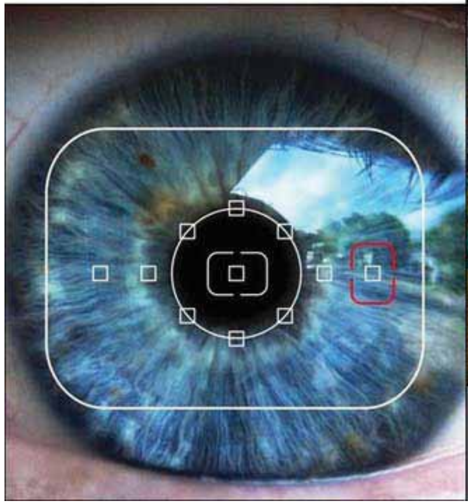
Marcio Kogan and his studio MK24 - space design based on Erwin Heuer's 1950 desugn

(http://sharingisdelicious.wordpress.com)

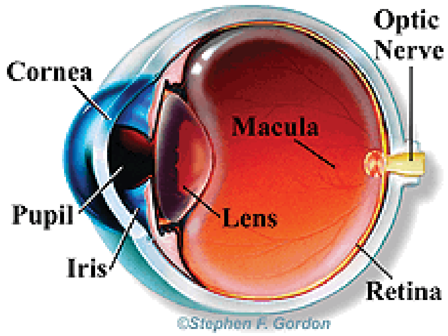
Study & Inspiration

Coral with Polyps inside
(http://www.messersmith.name)

Chameleon Eye (each 180o independent)
((http://www.messersmith.name))



Human Eye((http://www.messersmith.name))

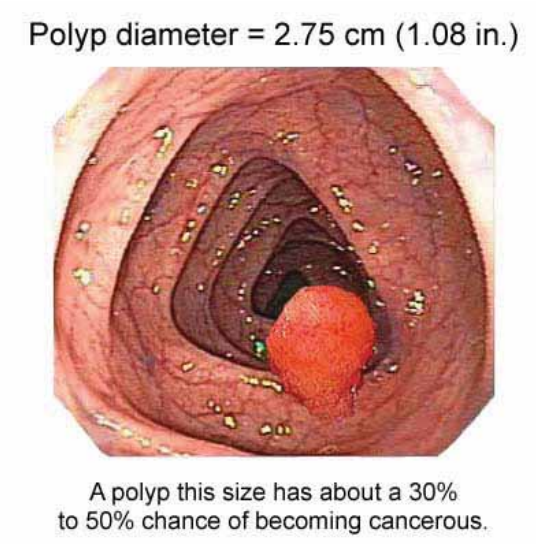


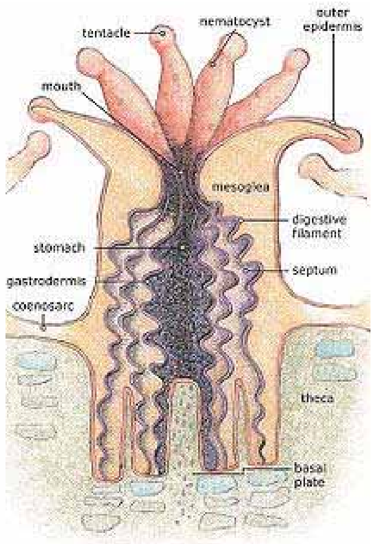
Focusing and Protection of the inside, freedom of movement, sensutivity to the light

Study & Inspiration - Coral Polyp

A polyp in zoology is one of two forms found in the phylum Cnidaria, the other being the medusa. Polyps are approximately cylindrical in shape and elongated at the axis of the body. In solitary polyps, the aboral end is attached to the substrate by means of a disc-like holdfast called the pedal disc, while in colonies of polyps it is connected to other polyps, either directly or indirectly. The oral end contains the mouth, and is surrounded by a circlet of tentacles.

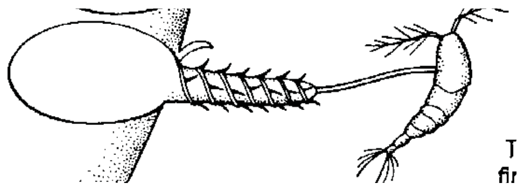
The mesogloea may be a very thin layer, or may reach a fair thickness, and then sometimes contains skeletal elements formed by cells which have migrated into it from the ectoderm. The sac-like body built up in this way is attached usually to some firm object by its blind end, and bears at the upper end the mouth which is surrounded by a circle of tentacles which resemble glove fingers. The tentacles are organs which serve both for the tactile sense and for the capture of food. Polyps extend their tentacles, particularly at night, containing coiled like stinging nettle-cells or nematocysts which pierce and poison and firmly hold living prey paralysing or killing them which include copepods and fish larvae.[1] Longitudinal muscular fibrils formed from the cells of the ectoderm allow tentacles to contract when conveying the food to the mouth. Similarly, circularly disposed muscular fibrils formed from the endoderm permit tentacles to be protract or thrust out once they are contracted. These muscle fibres belonging to the same two systems, thus allows the whole body to retract or protrude outwards.



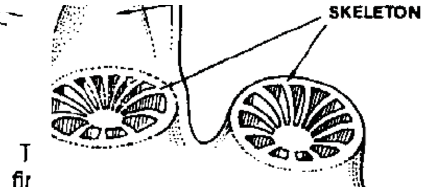


Hyuman Polyp inside a intestine (http://en.wikipedia.org)

Inspirated by coral polyp structure (http://science.nature.nps.gov)



tentacle fired its poisen into a small floating animal



(Coral Reefs in the South Pacific Handbook)

Inspirated by coral polyp structure(http://www.hiren.info)

Study & Inspiration - Chameleon eye

The movements of both eyes and the head were recorded with search coils in unrestrained, freely moving chameleons. As a main result I found that the generation of saccades in the left and the right eye was either independent from each other or was highly correlated according to the behavioural situation. When no prey item was fixated, disconjugate saccades were observed which was in accordance with earlier observations in chameleons. During prey tracking the chameleons switched to a different oculomotor behaviour and pursued the moving prey with synchronous saccades. At higher target velocities, the tracking movement of the head was also saccadic and was synchronised with the two eyes. Binocular coupling affected only the timing of the saccades but not the metrics: the amplitudes of the synchronous saccades were usually different in the two eyes. These observations suggest the existence of two independent premotor neuronal circuits for left and right eye saccadic motor control in the chameleon. Binocular coupling in prey-tracking chameleons is probably achieved by neuronal coupling of these premotor circuits during eye–head coordination. The ability to switch between synchronous and uncoupled saccadic eye movements has not been described for any other vertebrate. This unique ability of the chameleon may help to understand the organisation of the oculomotor system of other vertebrates since evidence for separate left eye and right eye saccade generation and .position control has recently also been reported in primates

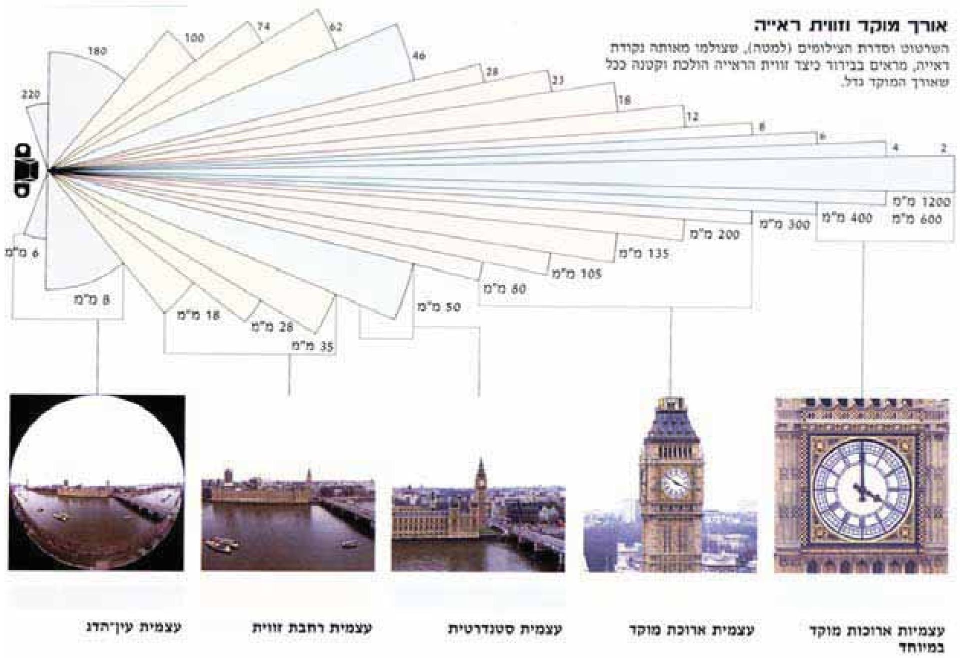
(Coral Reefs in the South Pacific Handbook.
Dr. Michael King) (http://www.springerlink.com)

Both eye work together when focusing on a pray (bleedingroses37.blogspot.com)

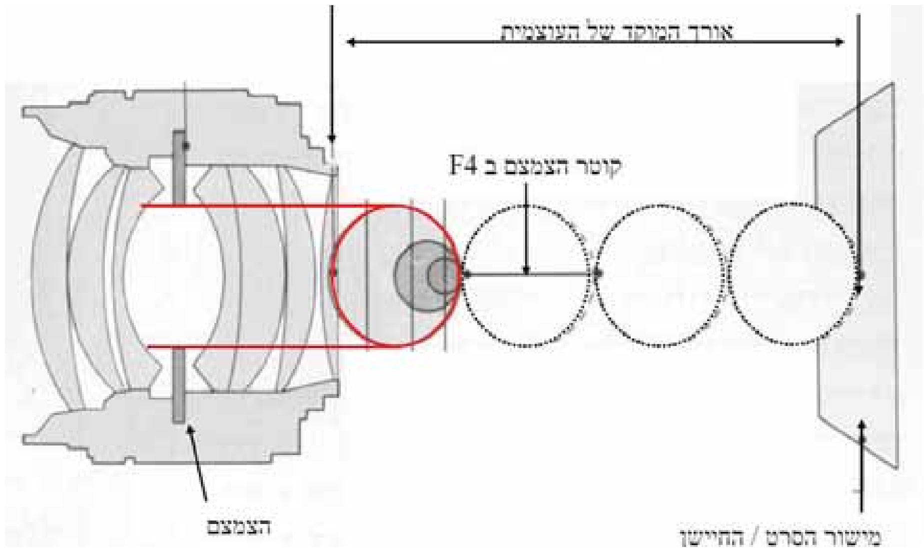
Each eye is an independent 180 degrees telescopic (www.snailtails.com)

Study & Inspiration - Camera

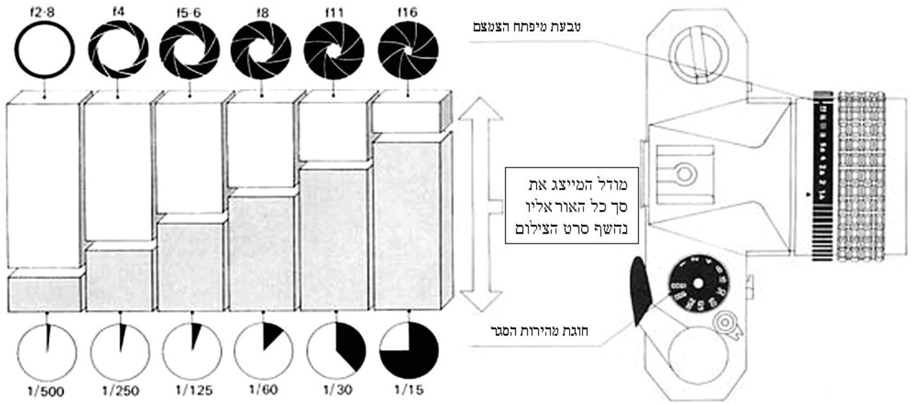
(http://www.mypay-computers-credit.com)



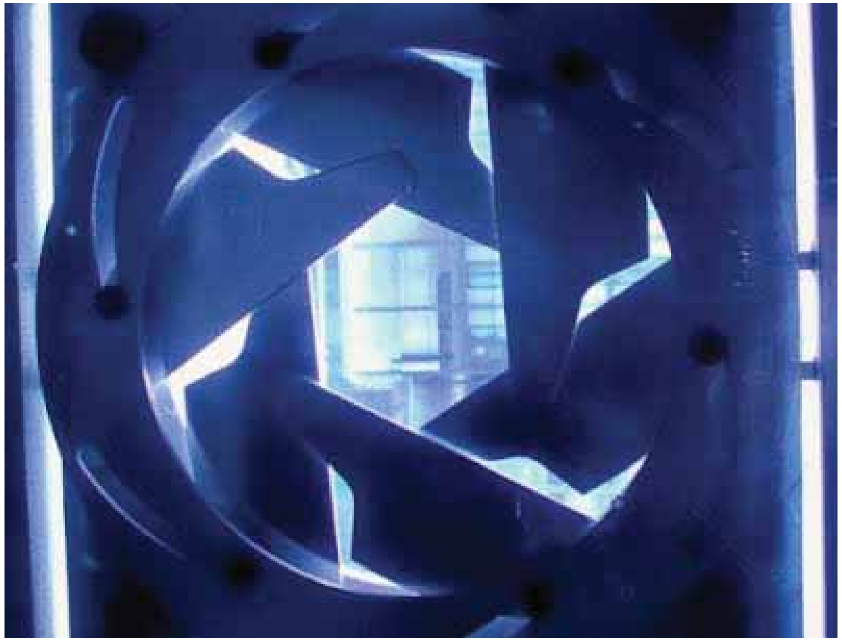
Angle of view is changing according to the lens type - can be used to collect more light through a smaller opening and loosing a miniumal ammount of energy (Koby goffer Presentation)

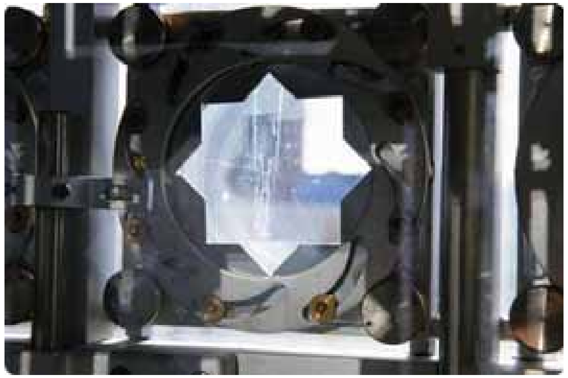


Both eye work together when focusing on a pray (bleedingroses37.blogspot.com)



The eye is like a camera - opens up depending on the ammount of light and picturing the surrounding in the range of sight at the specific moment. ((Koby goffer Presentation)

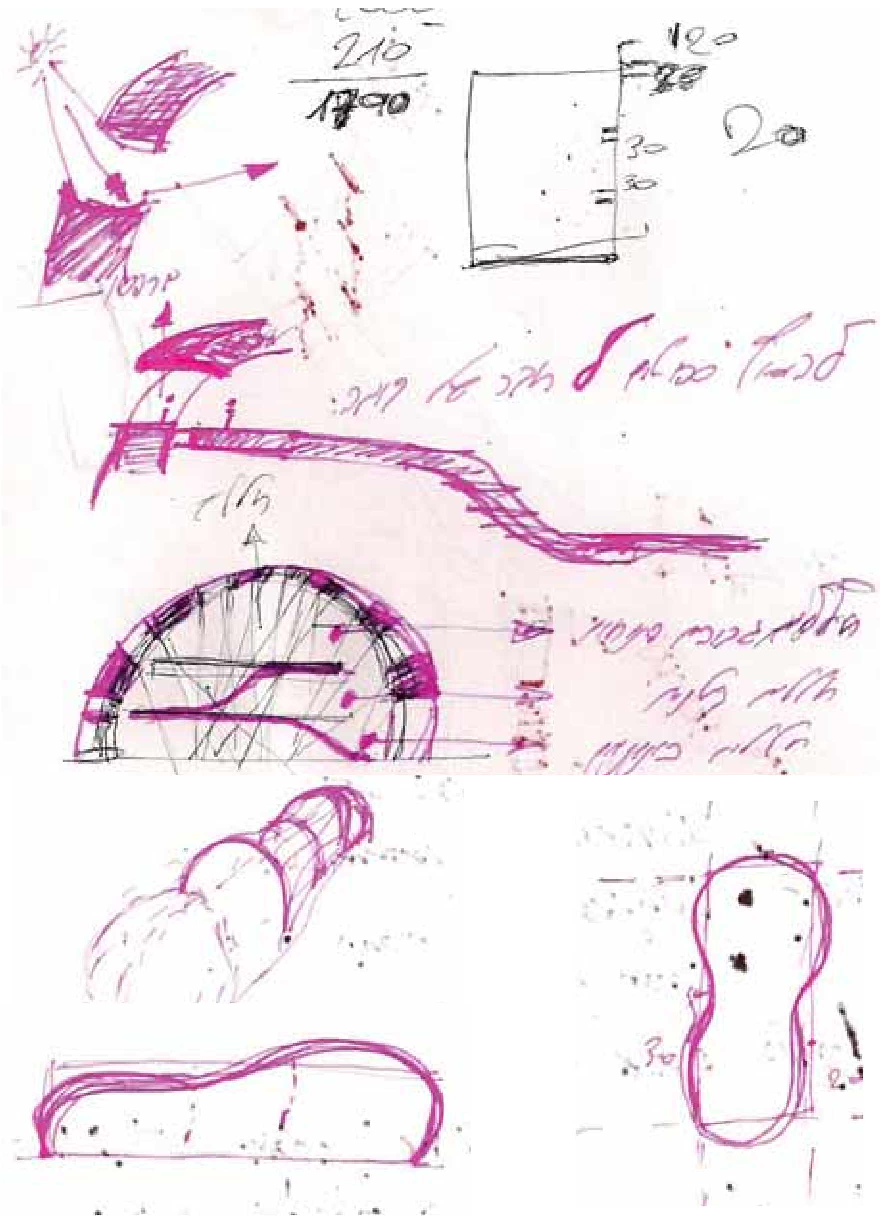


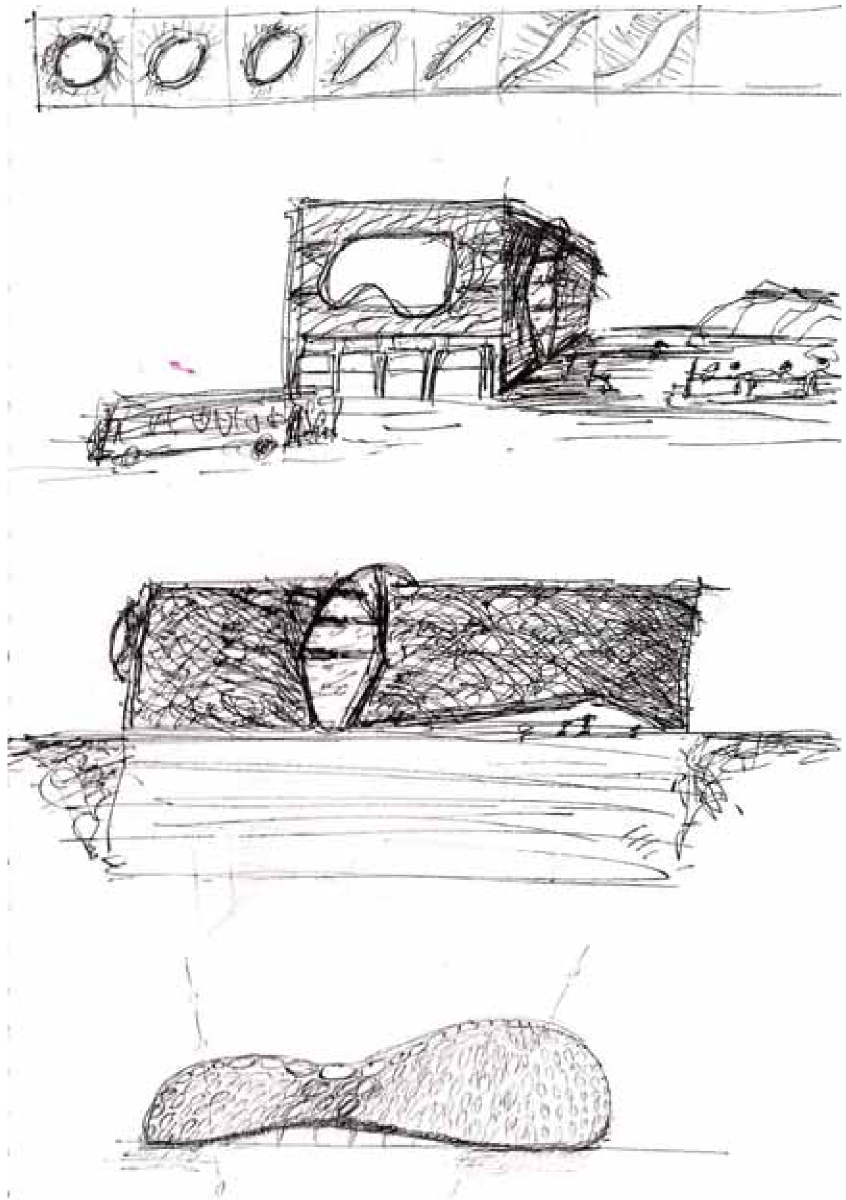


institut-du-monde-arabe (MONDEDEARAB.COM)v

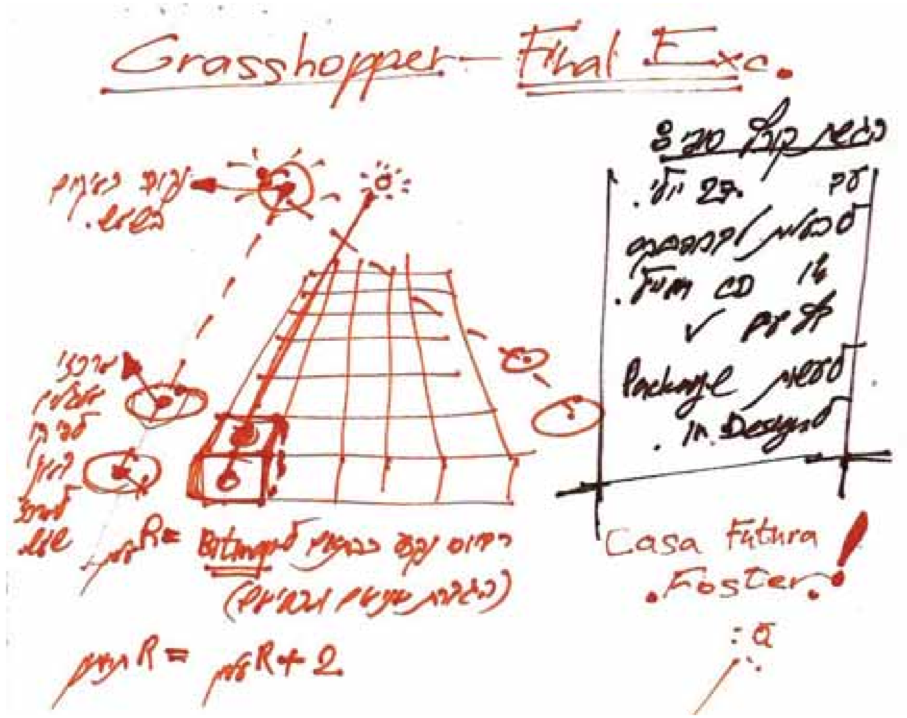
L'Institut du Monde Arabe
(www.3ddreamer.com)

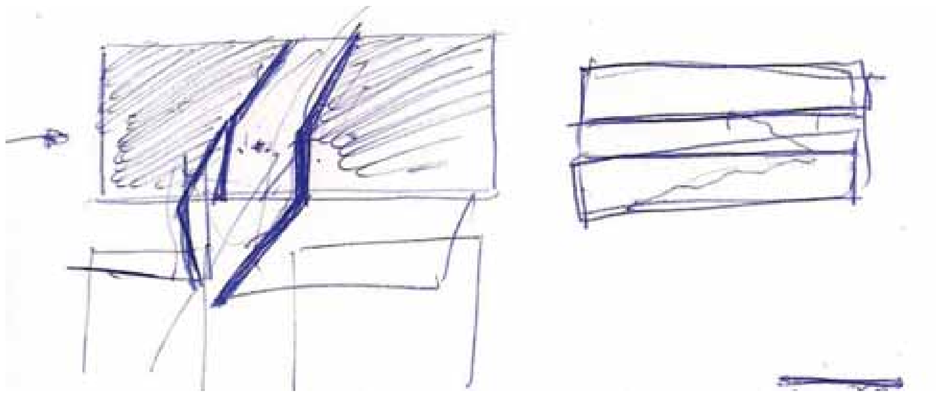
Skizas from diffferent stages iof the project

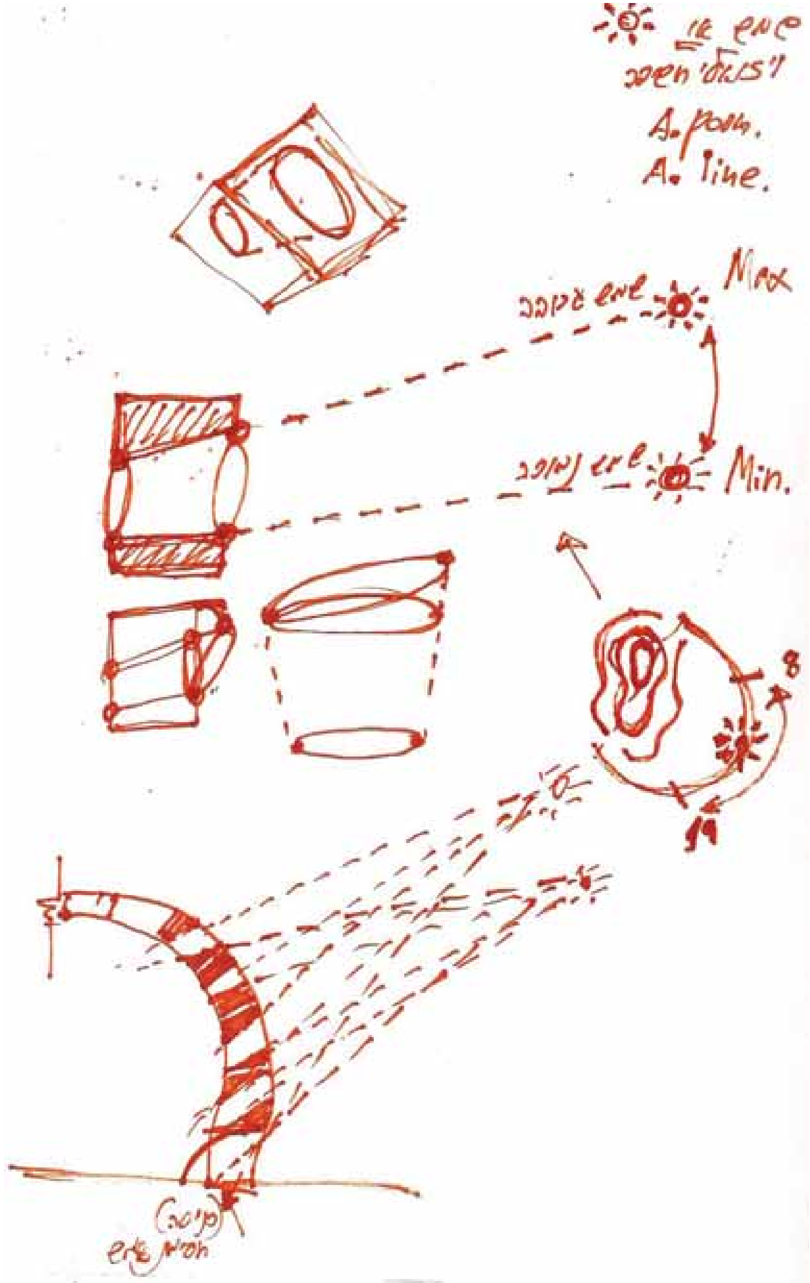




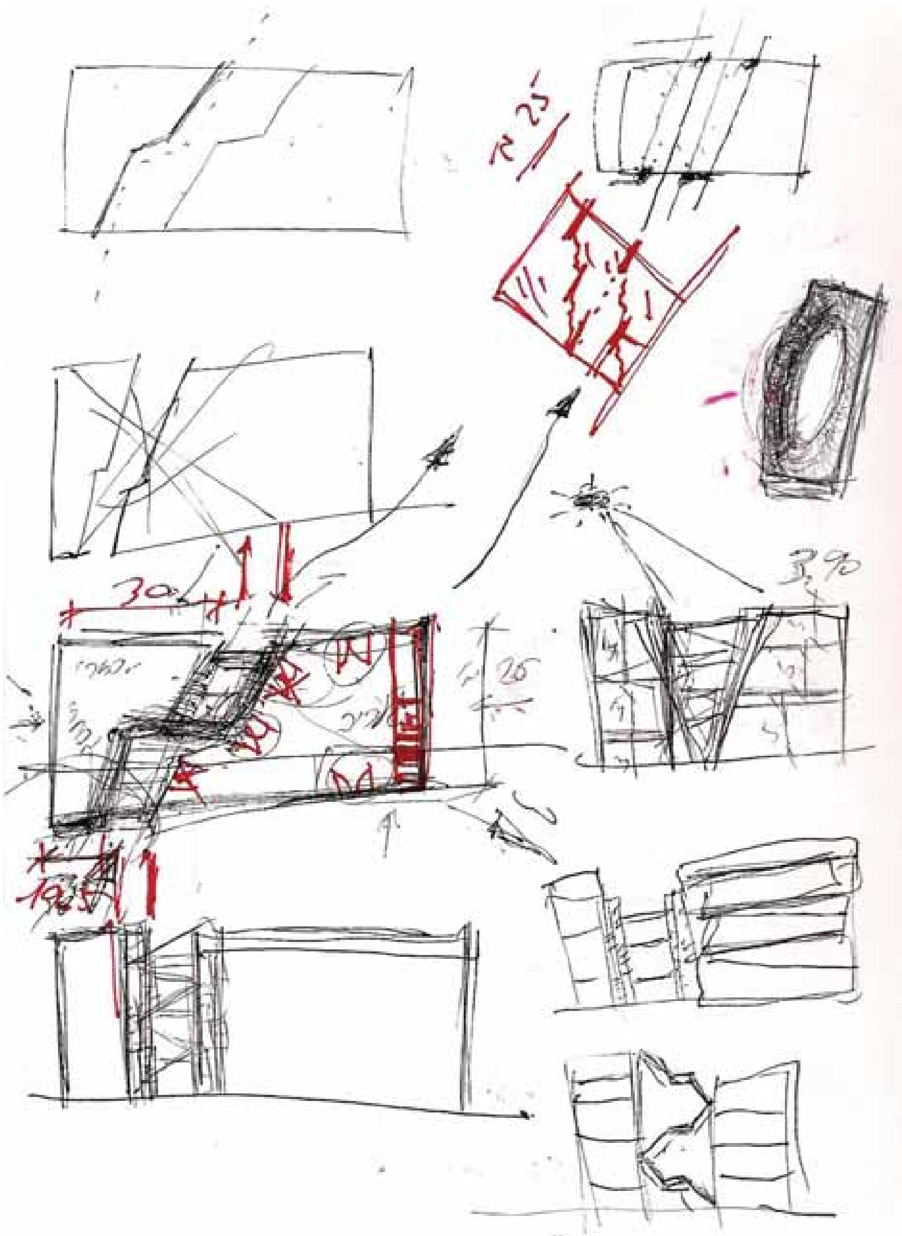
Skizas from diffferent stages iof the project

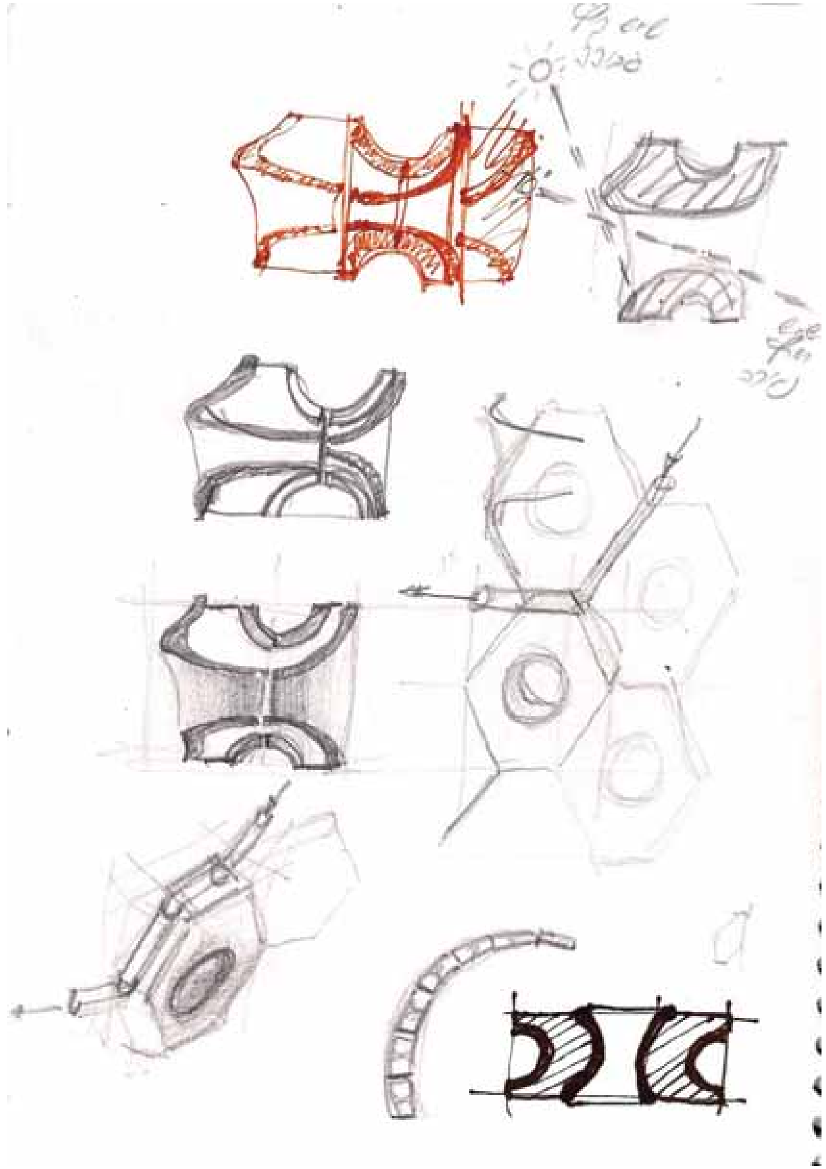






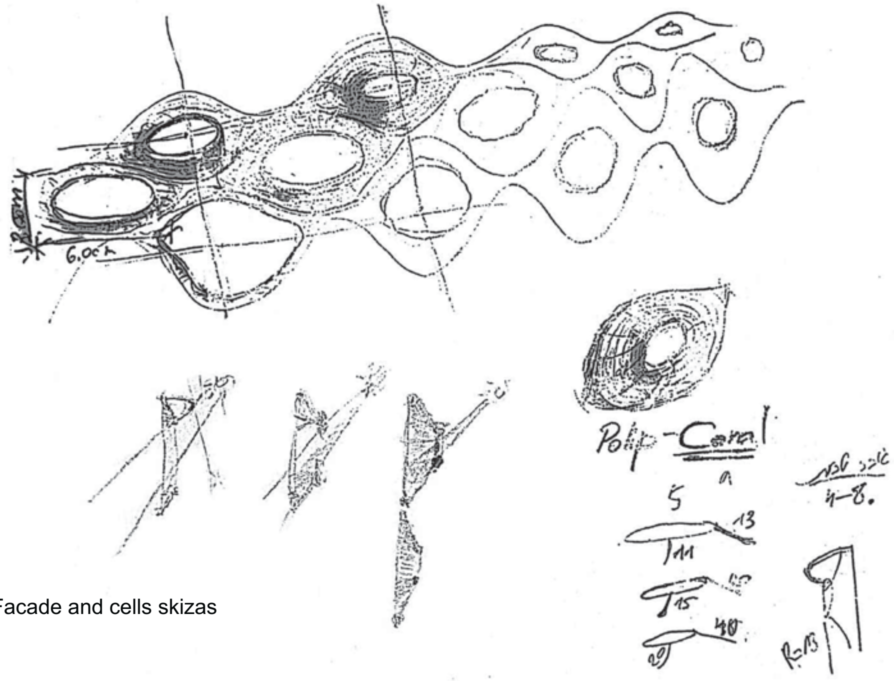
Skizas from diffferent stages iof the project



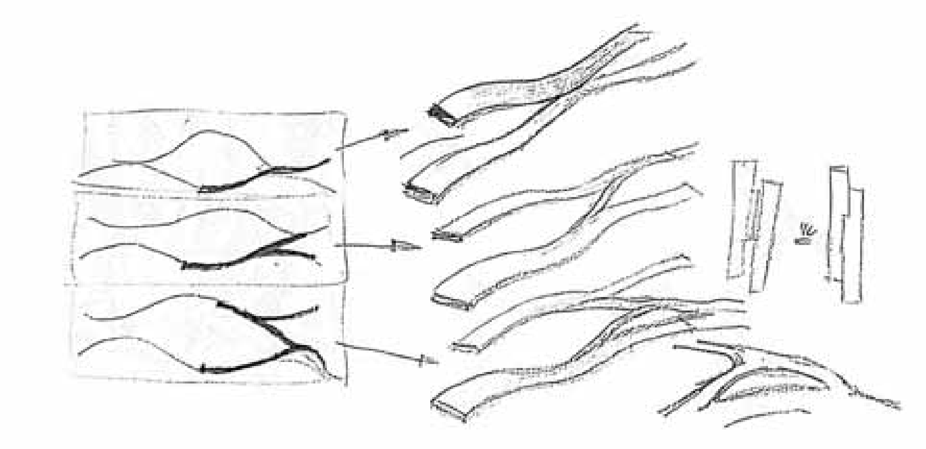


Detail of one element of the facade in section - self shading and diveresed opening's directions according to views desired

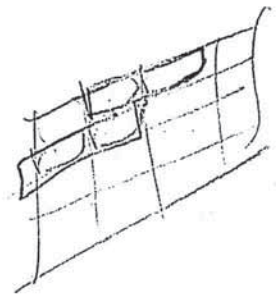
Skizas from diffferent stages iof the project

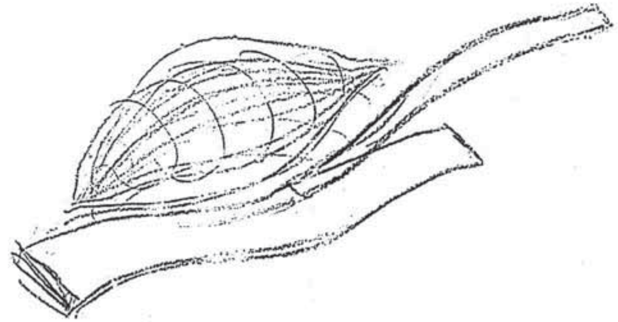


Facade and cells skizas

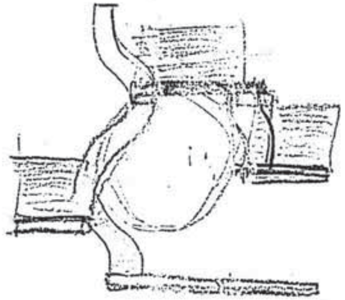


Inner space Skizas - more duplicity when the hight gets bigger

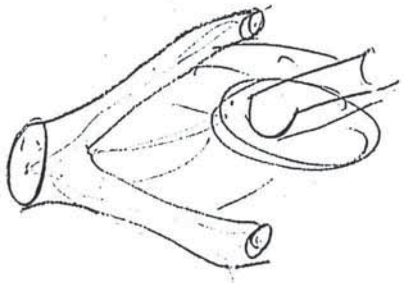




Inner bulb?

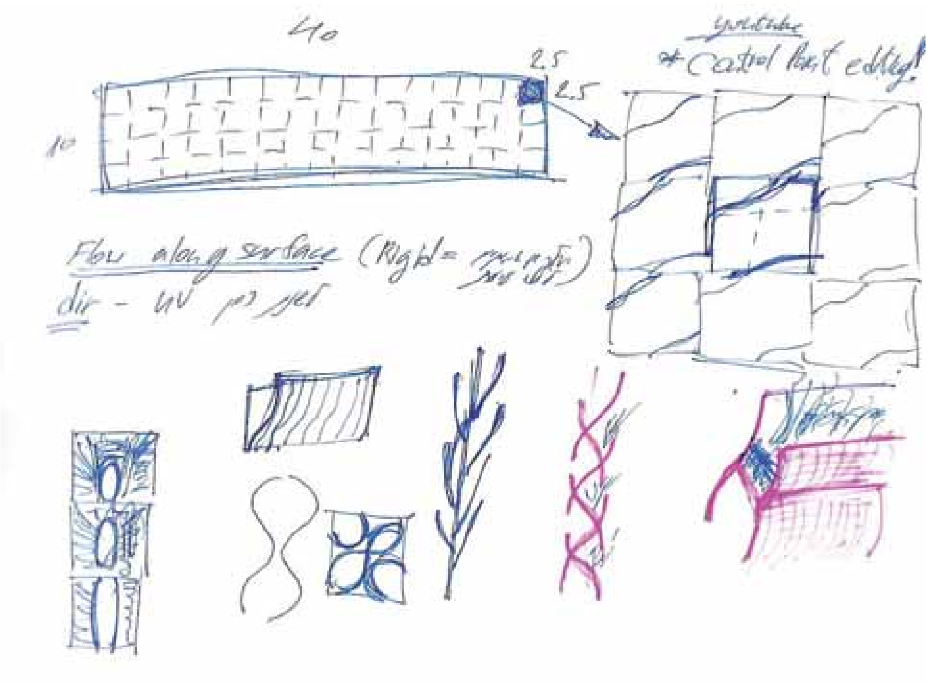


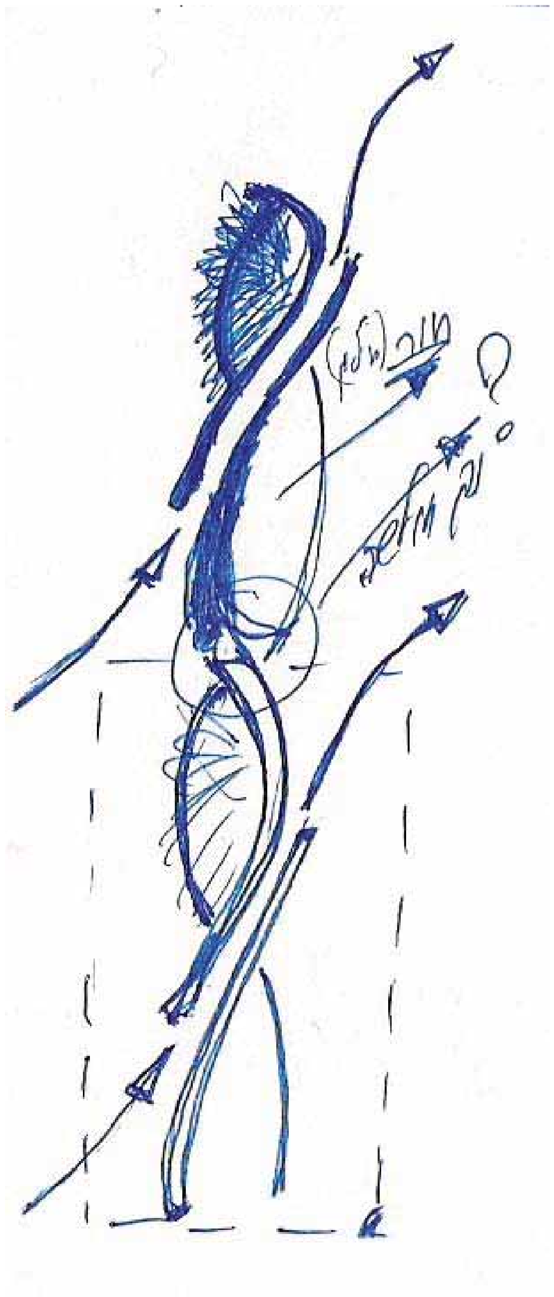
Inner Public Space section



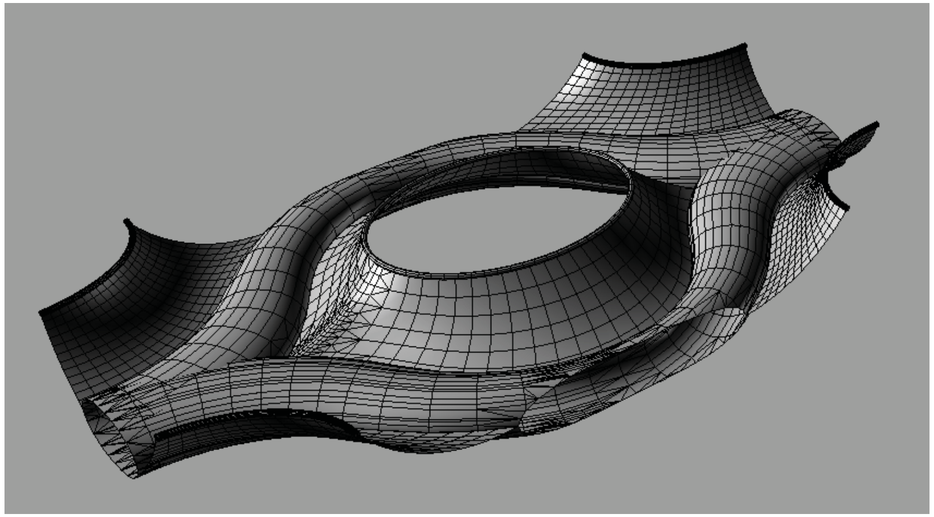
Module Frame

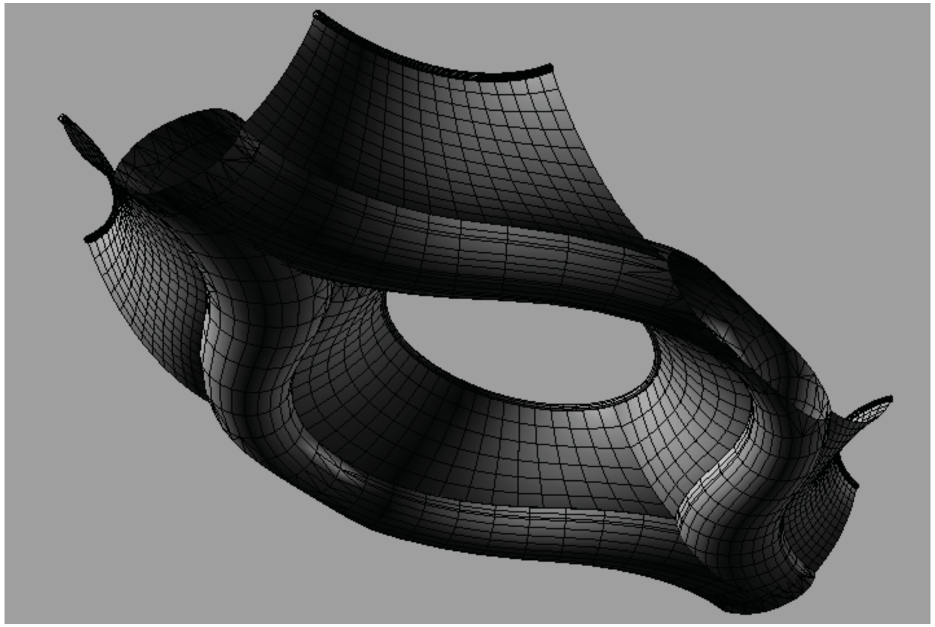
Skizas from diffferent stages iof the project



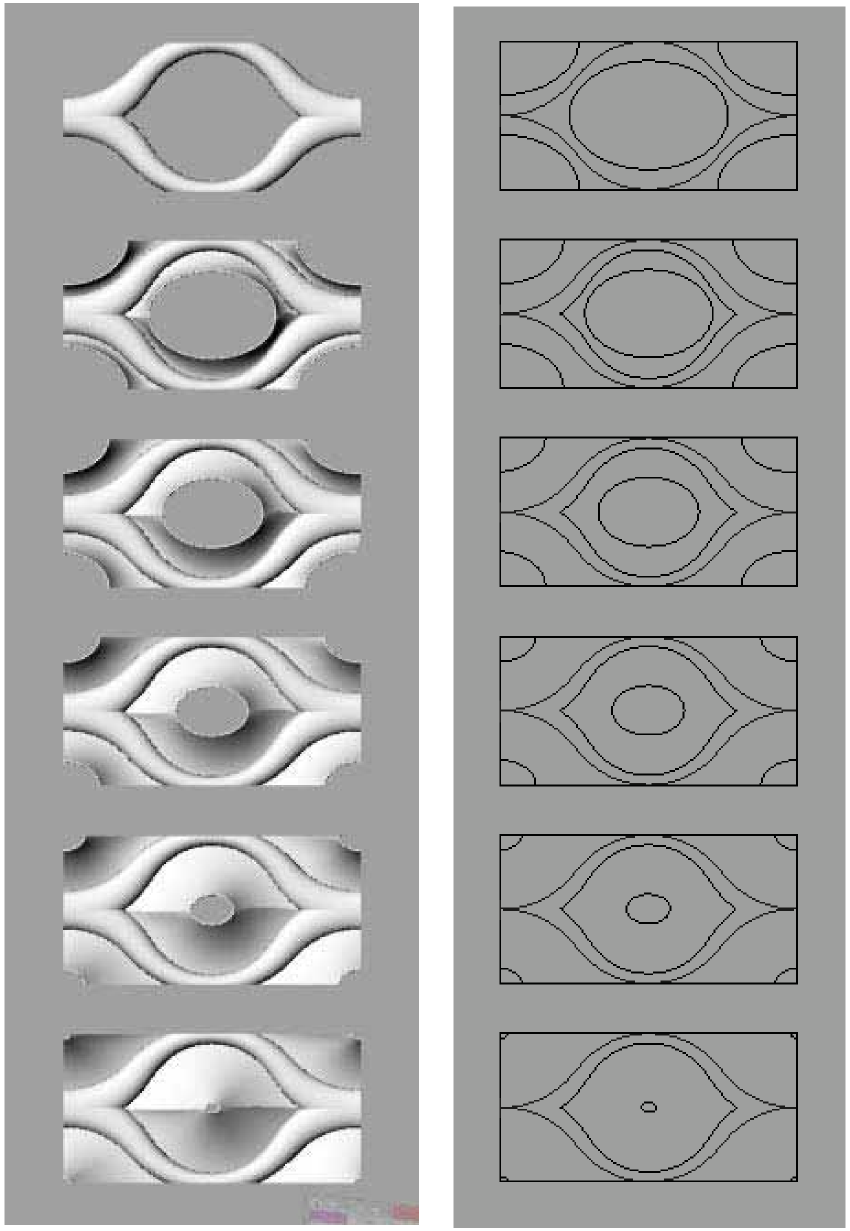


Top Side view - shows how looks the floor in the inner spaces (Face + Spaces intrior)

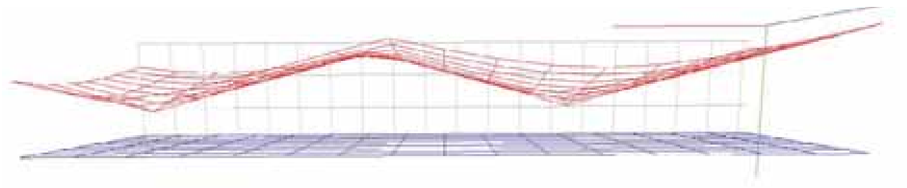




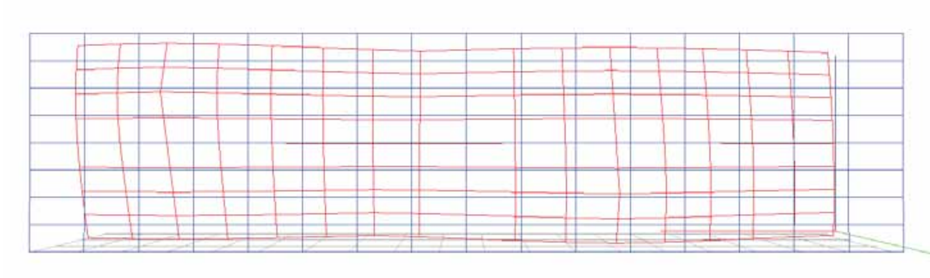
Cell Structure

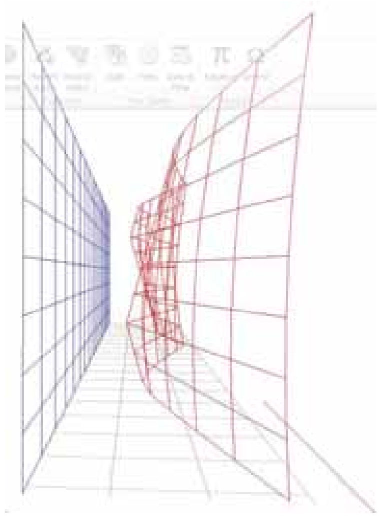


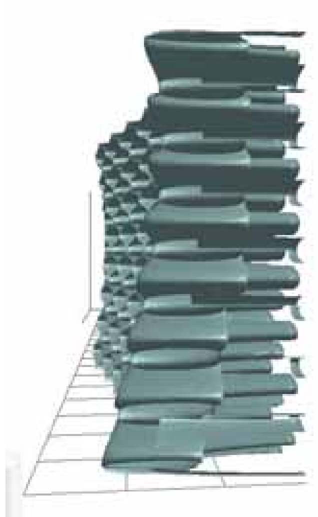
Facade Modules 1-6 - Cell becomes deeper as the hole gets smaller (light control)

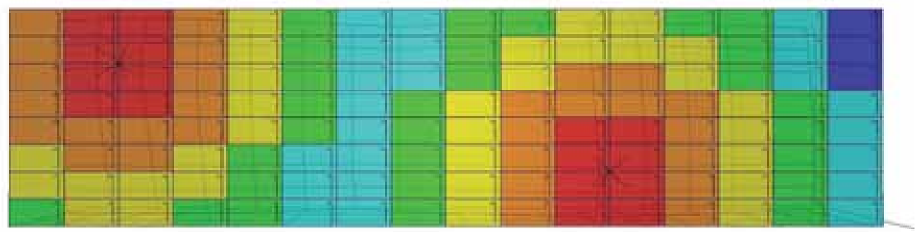


Top view on the facade - thickness increases by attractoor points

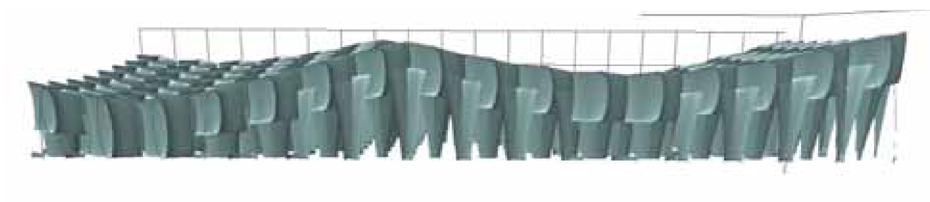




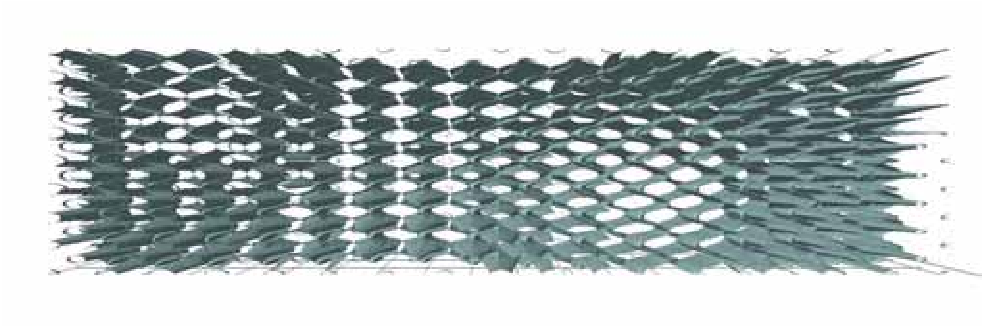




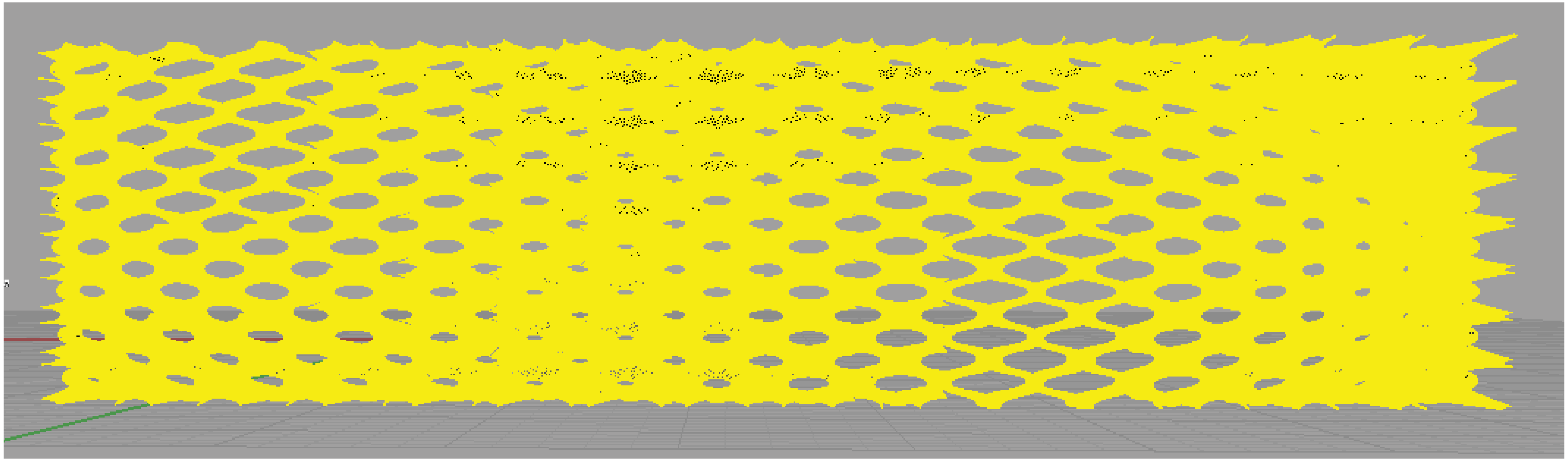
Gem cells distribution bu 2 attractors points



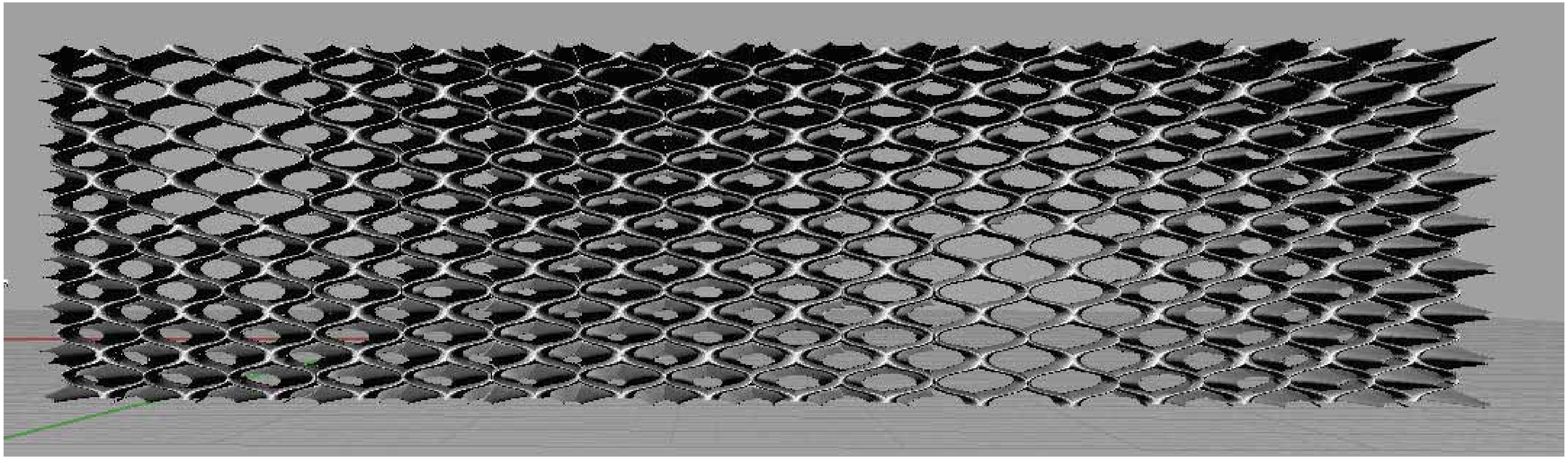
Top view on the facade



Gem Facade by 2 attractors points



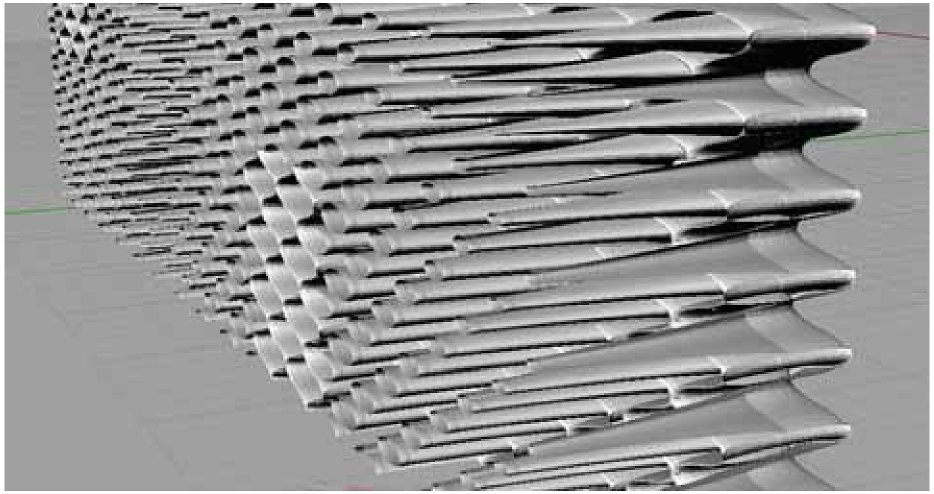
holes in the facade increases in a public areas



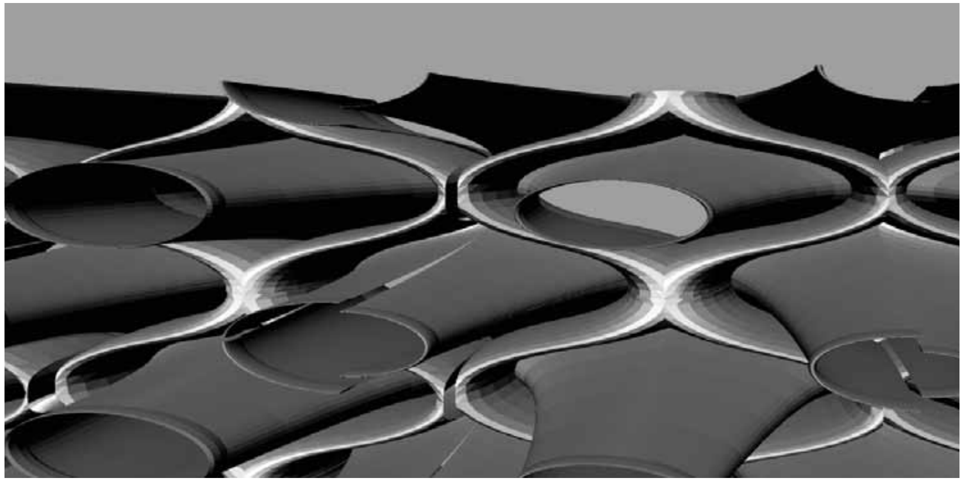
Variable facade by attractor points

The facade was generally successful except the connections between the forms. They need to be in the same margins and position relative to the cell imaginary frame.

The variable part should be inside the module.

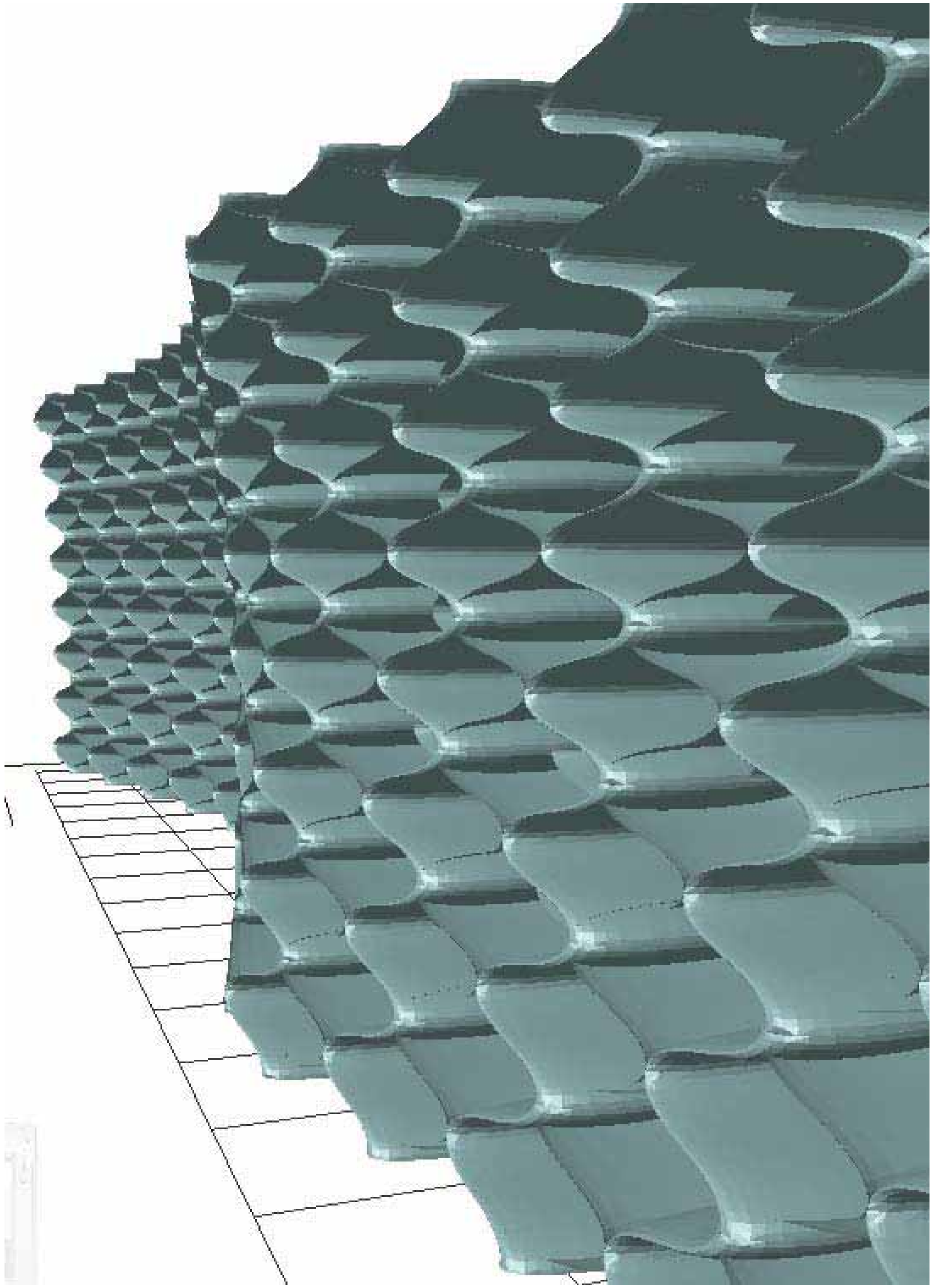


Pointy Facade - stretched because of the thickness

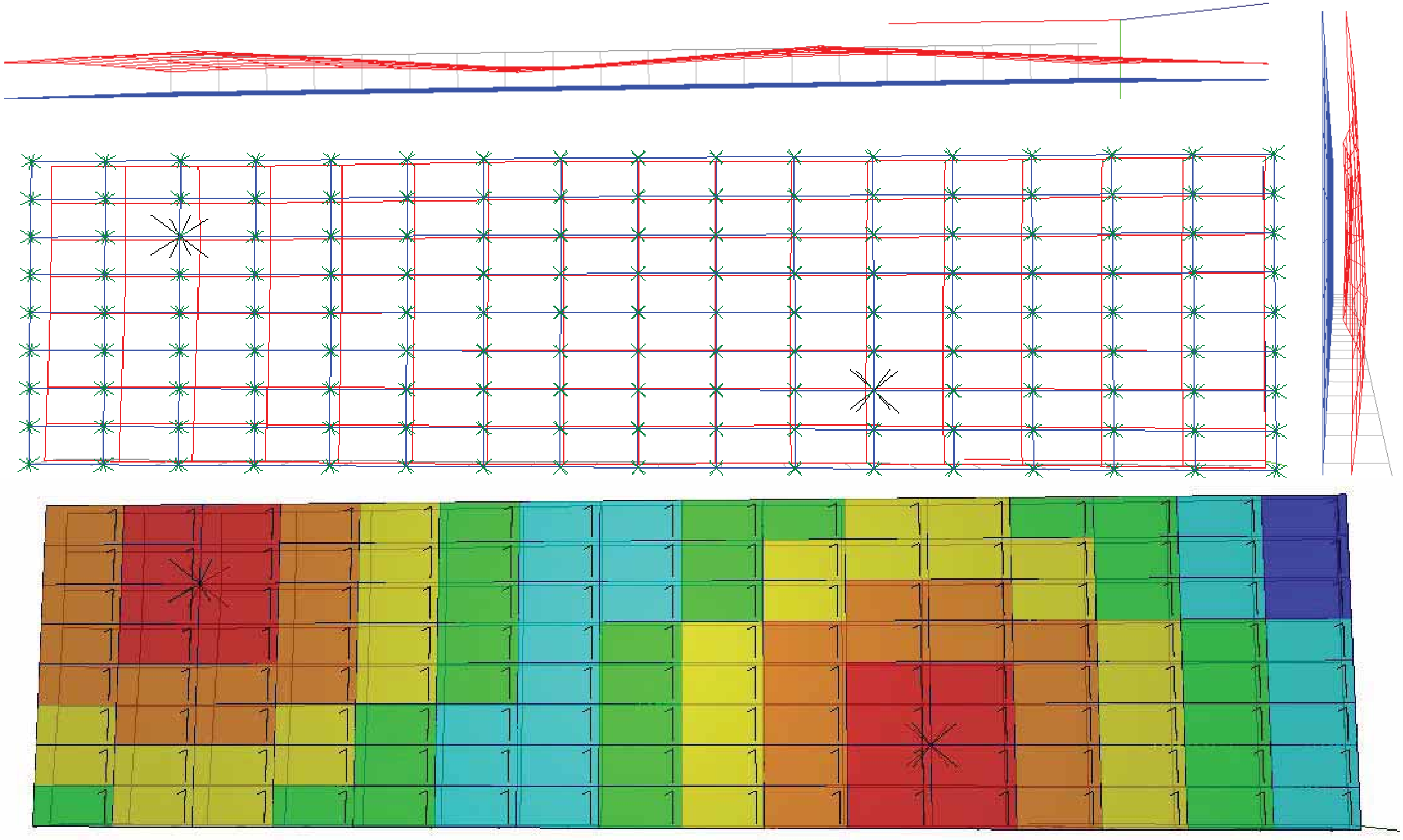


Nice form connecting with each other and the interior spaces

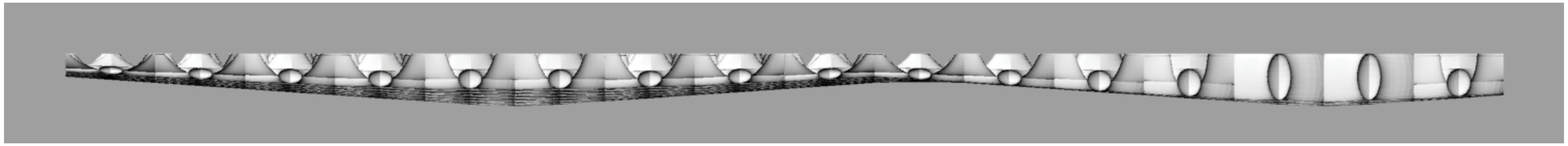
connections between the cells

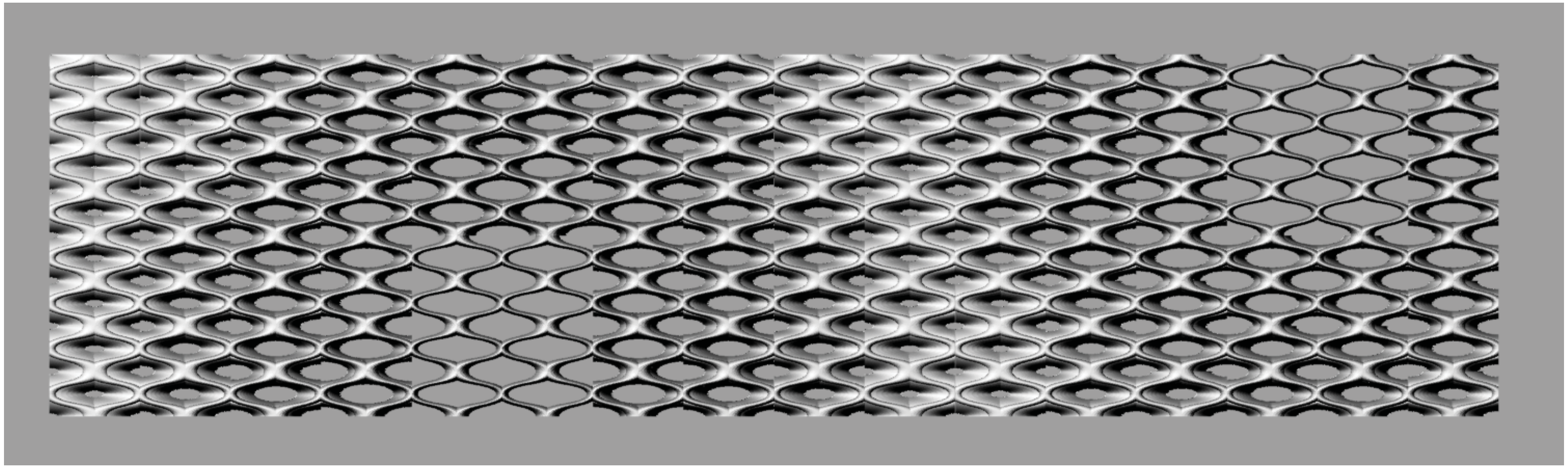


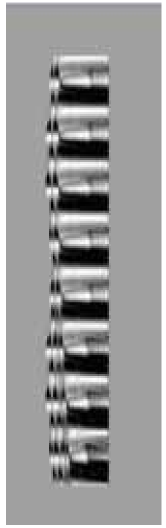
cells as tubes



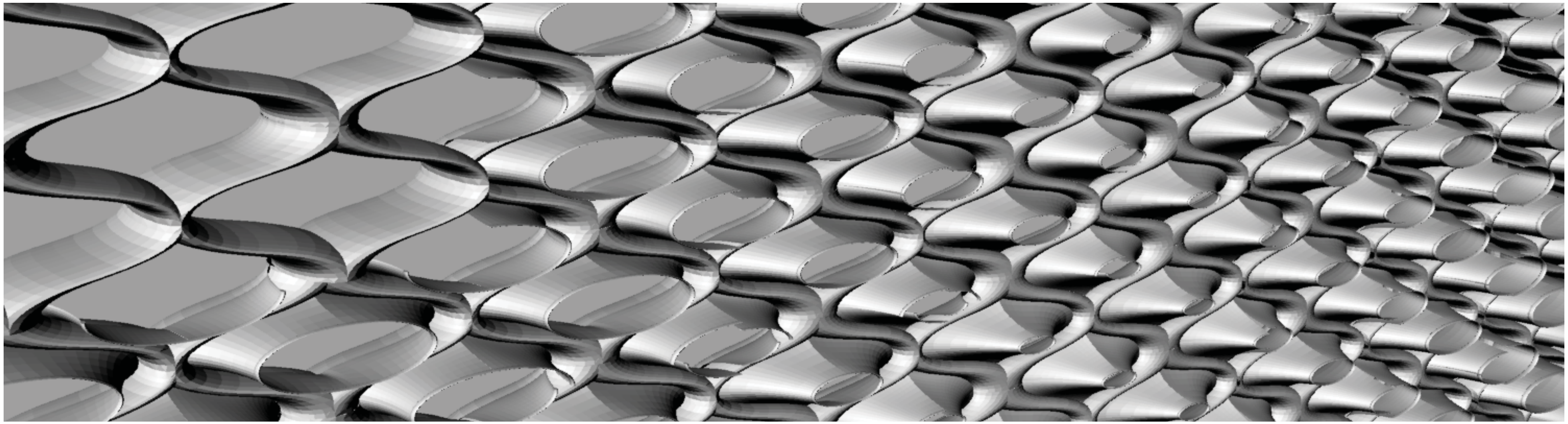
I decreesed the thickness of the facade to 1-50cm to decrees the destortion of the cells





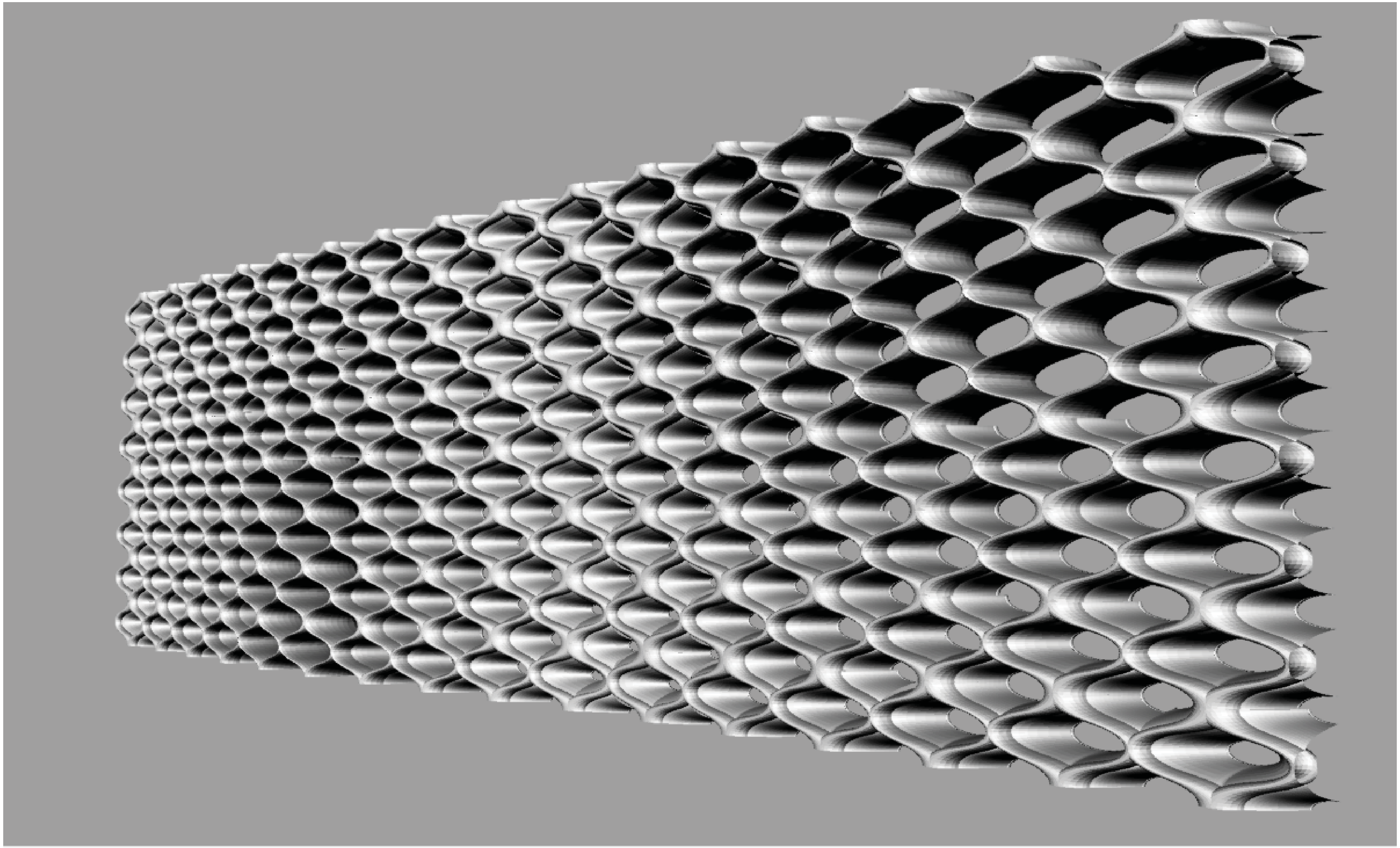


Facade changing according to light and views wanted in public spaces and more privacy in the smaller spaces

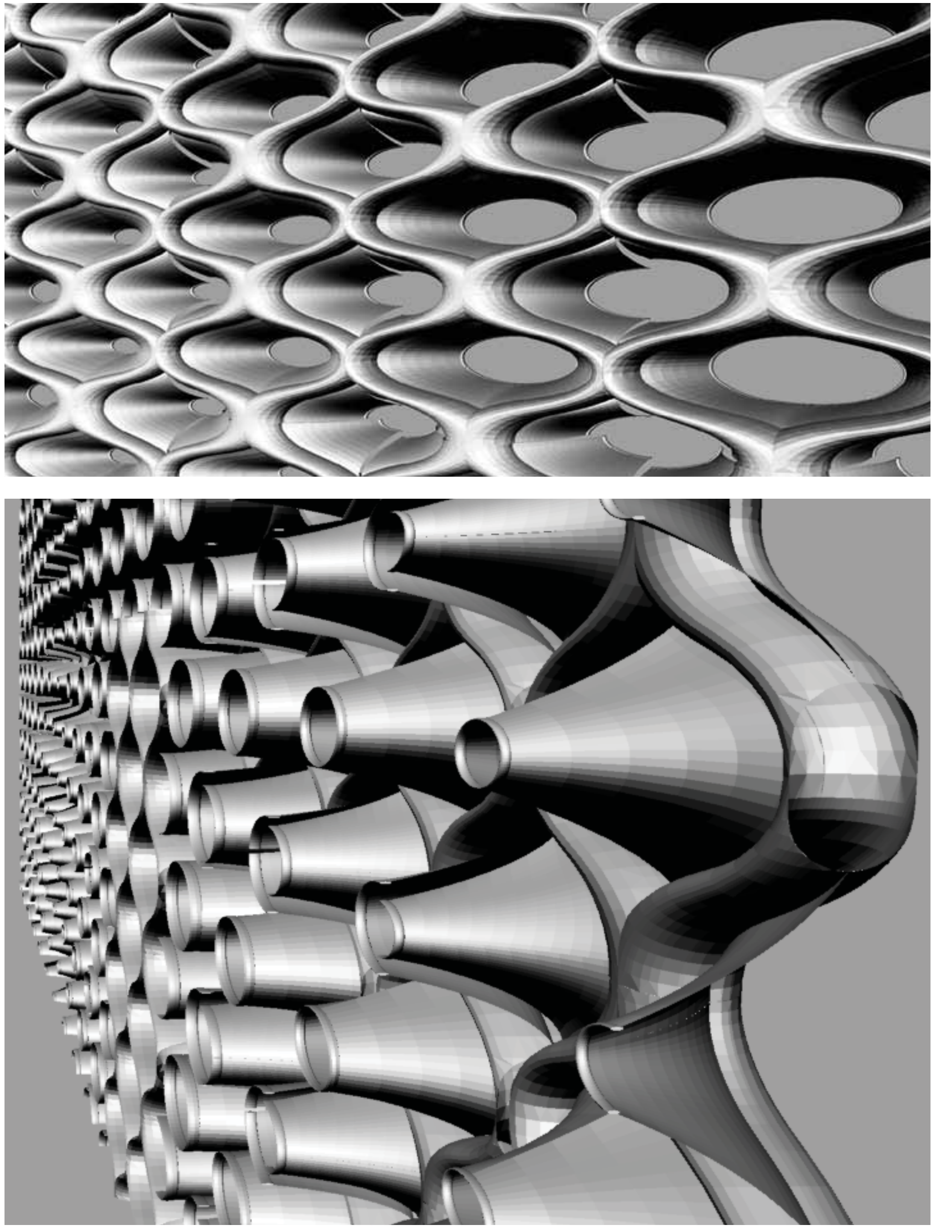


connections between the cells

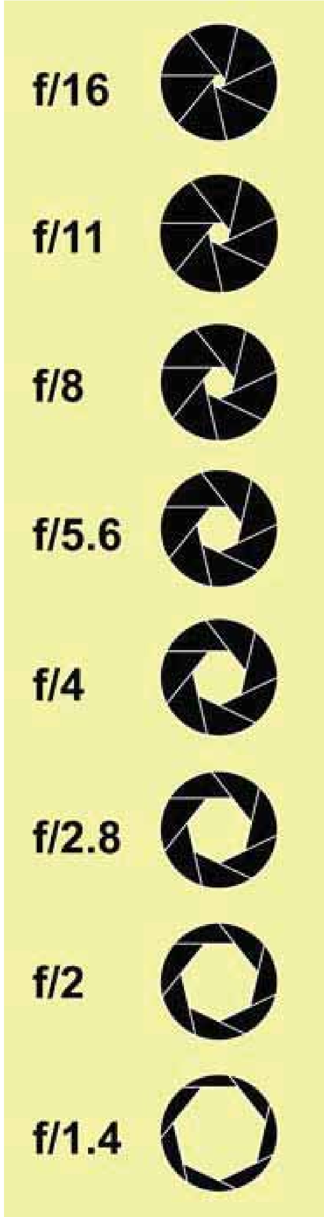
cells as tubes



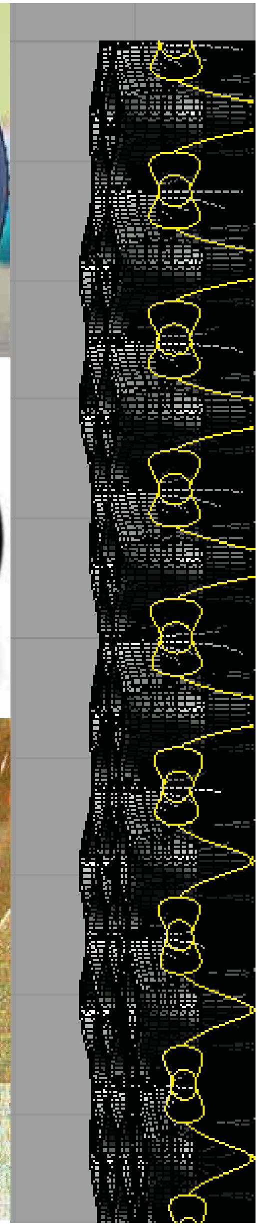
Inner side of the Facade - clear form to connect to the building itself



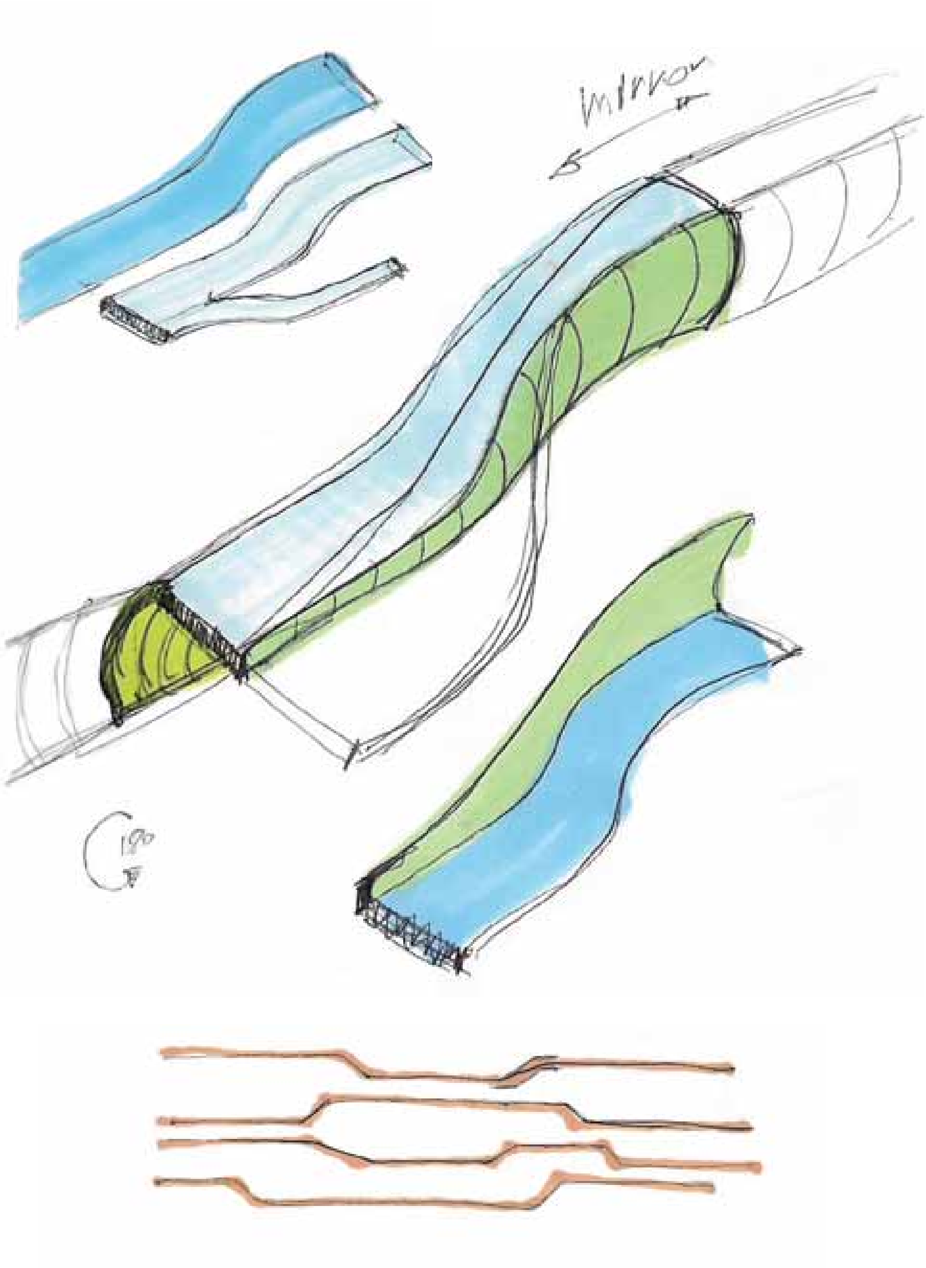
Front facade with the lense openings - small opening but light gets in through lenses.

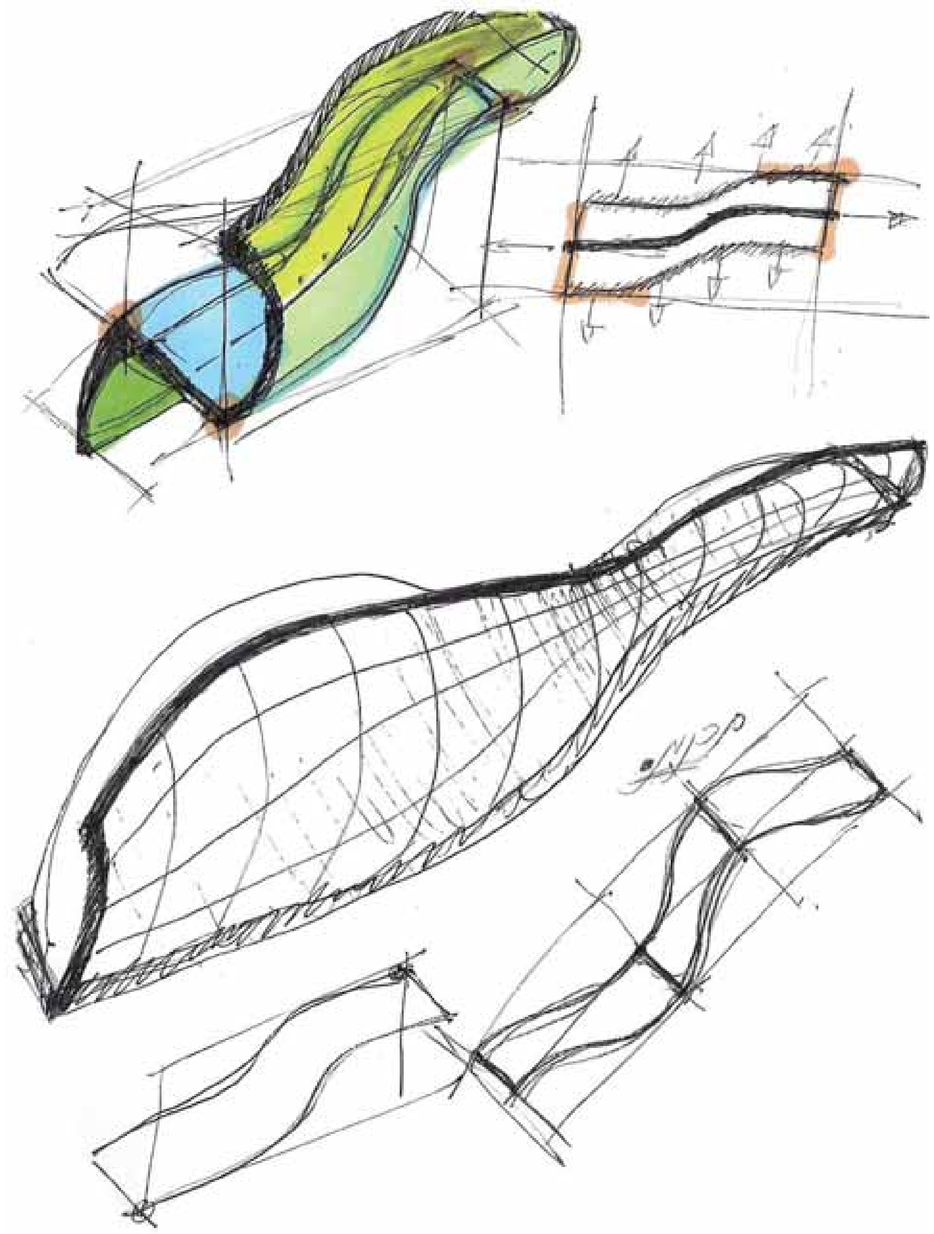


camera aperture (www.basiccameraphotography.com)

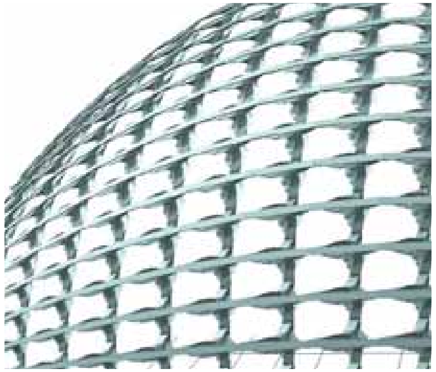


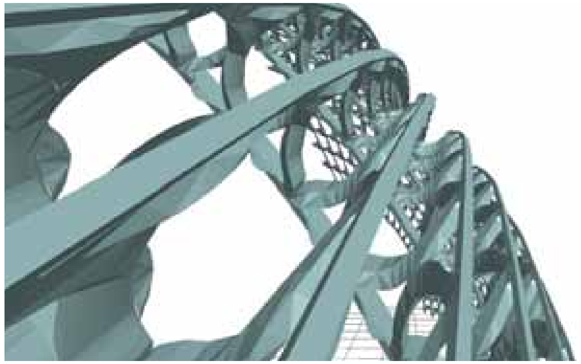
Section thtough narrow cells

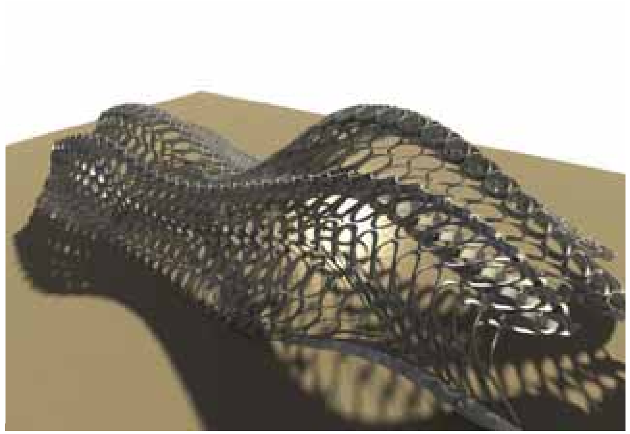


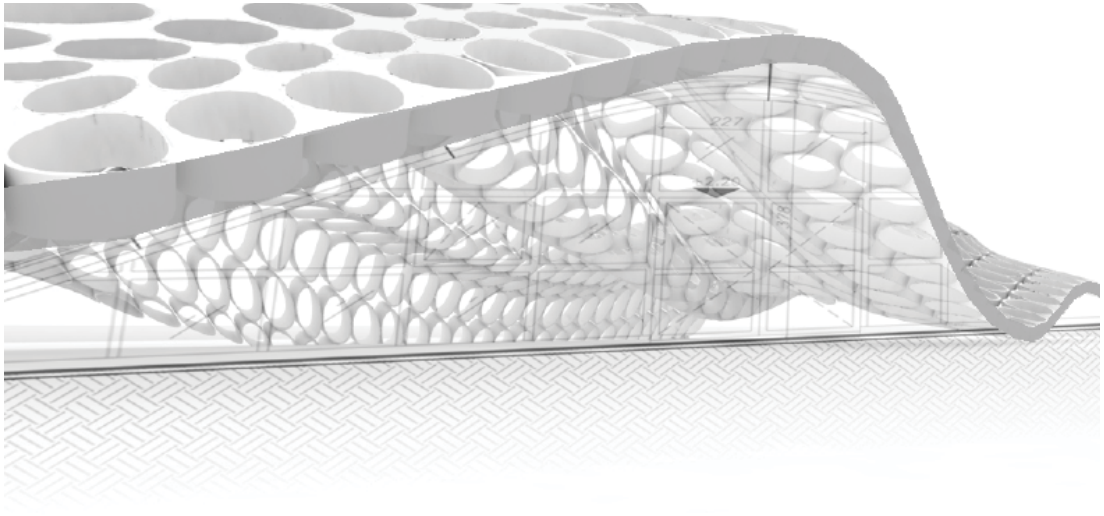


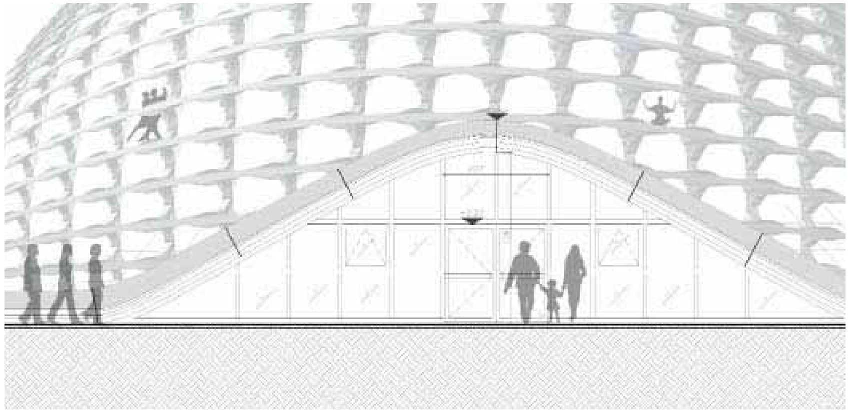
Inner Spaces and the way they may connect to the facade

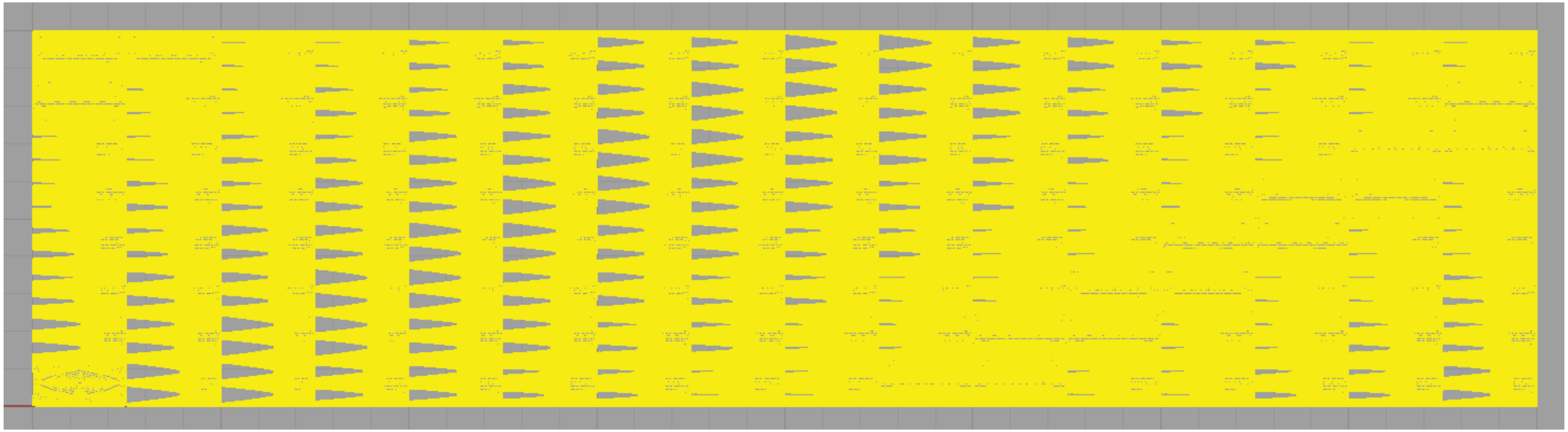




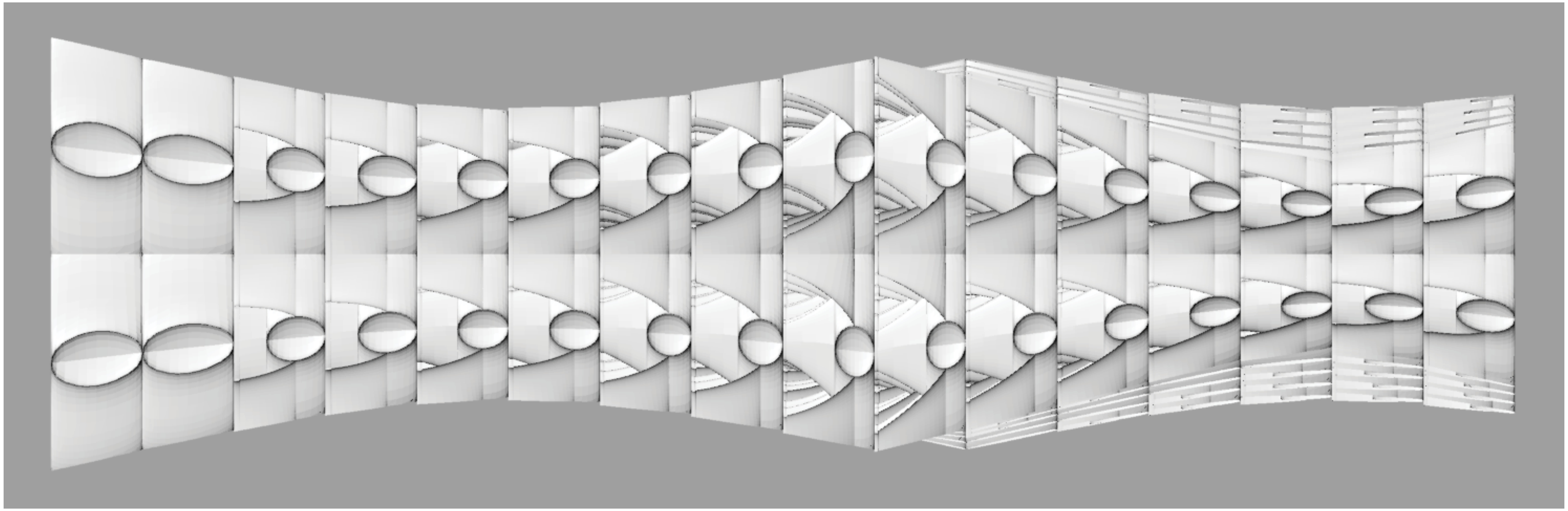




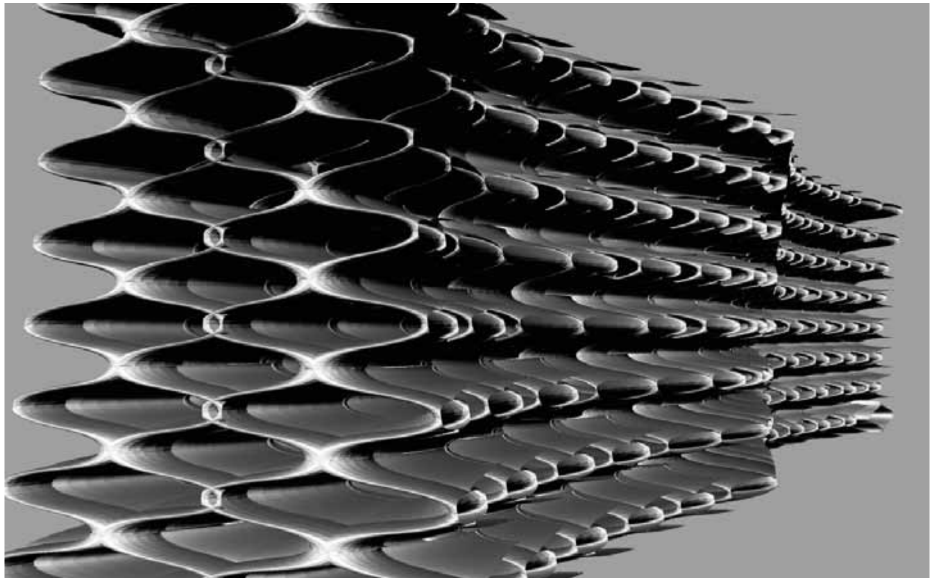


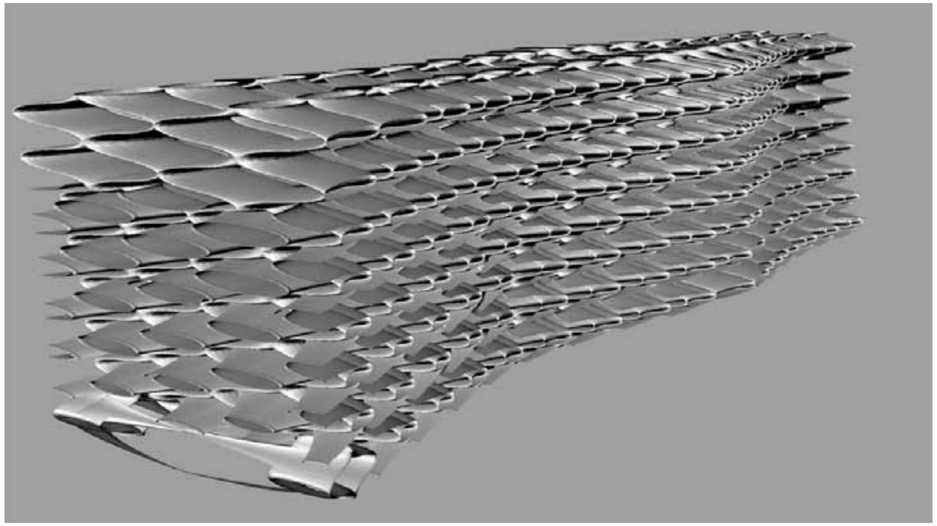


Cross section through the spaces

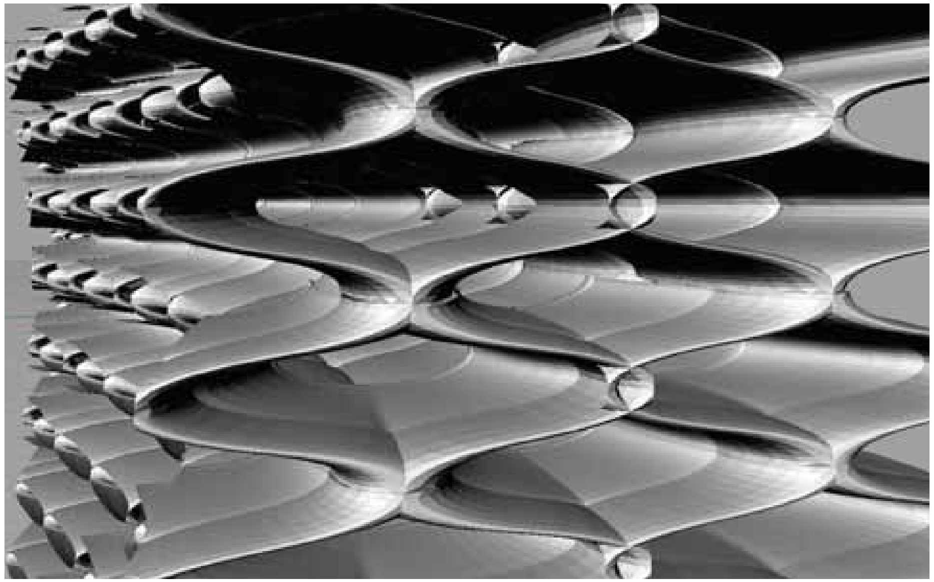


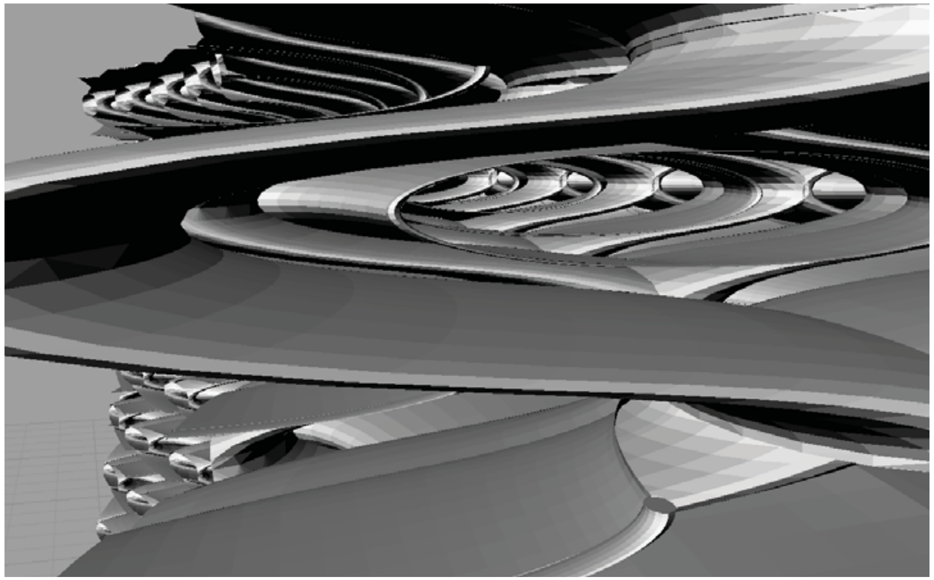
Top view - Duplicated Inner Spaces



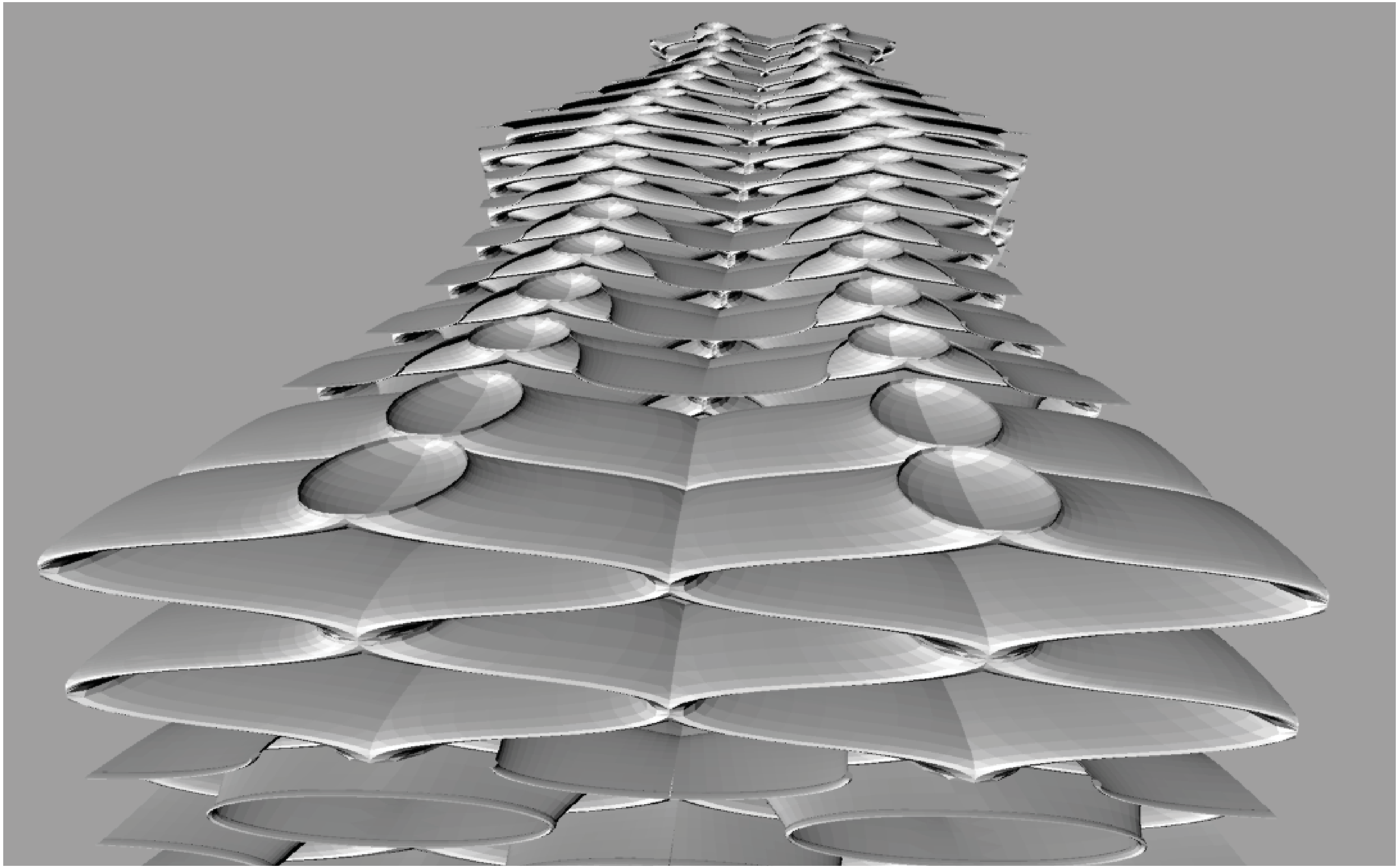


outer covering

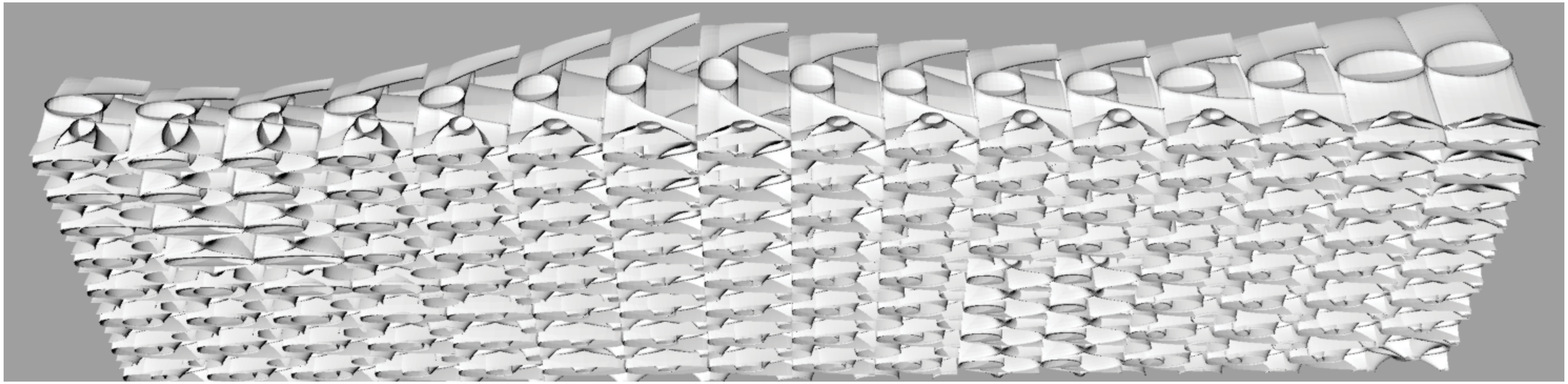


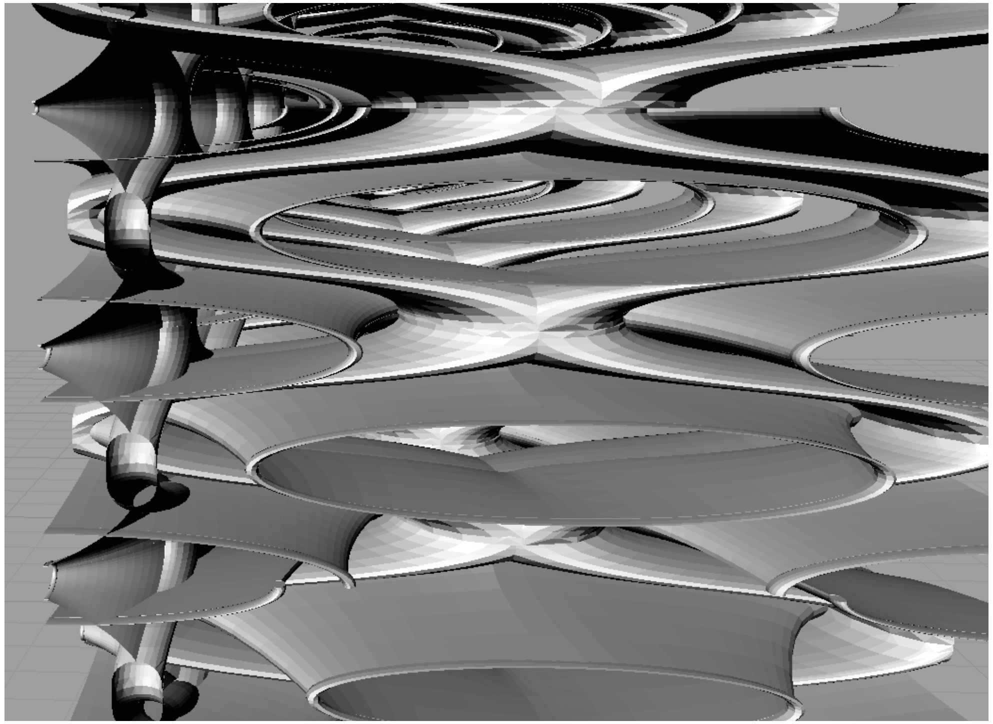


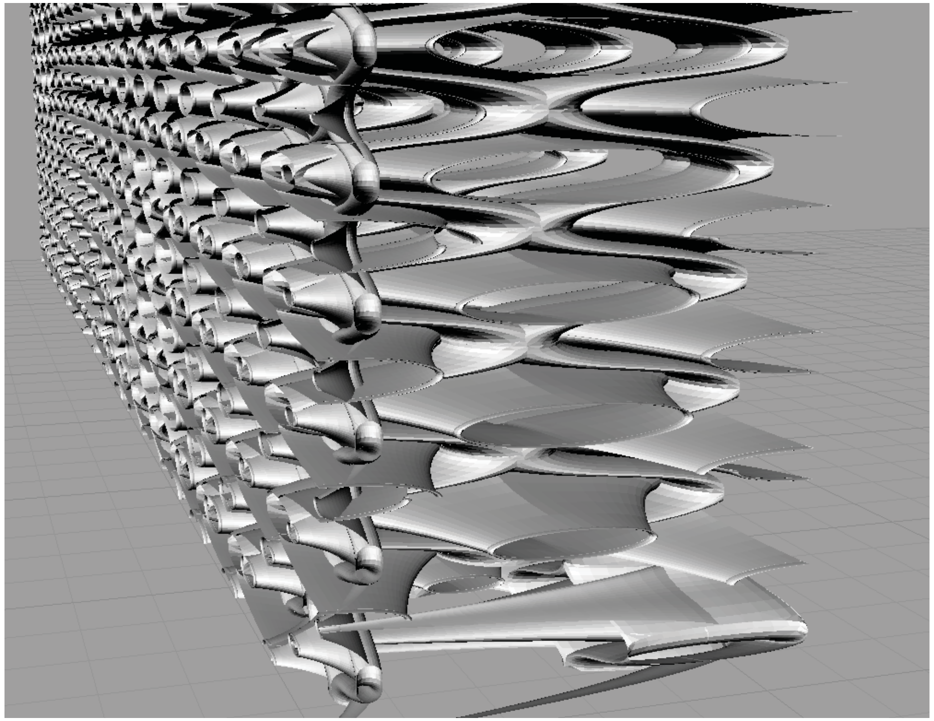
inner spaces makes openings and longual holes



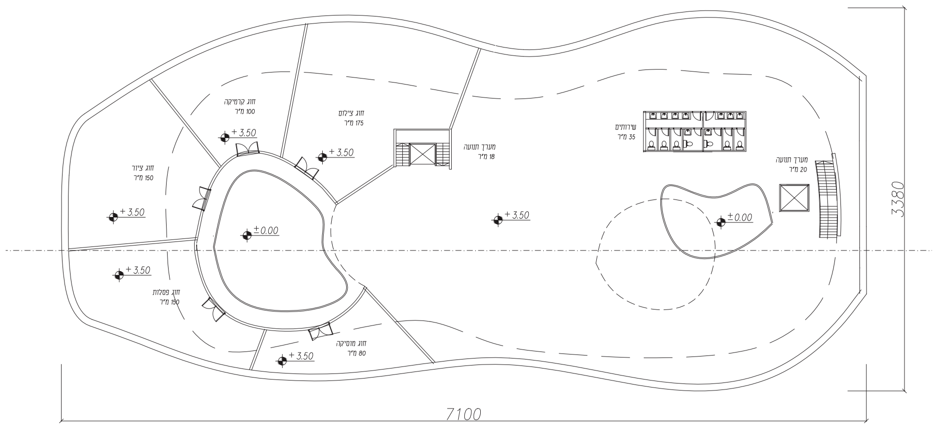
Top Side view - shows how looks the floor in the inner spaces



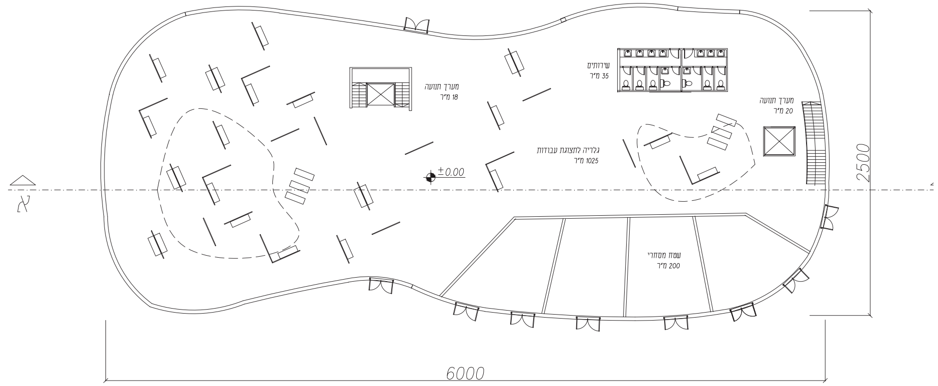




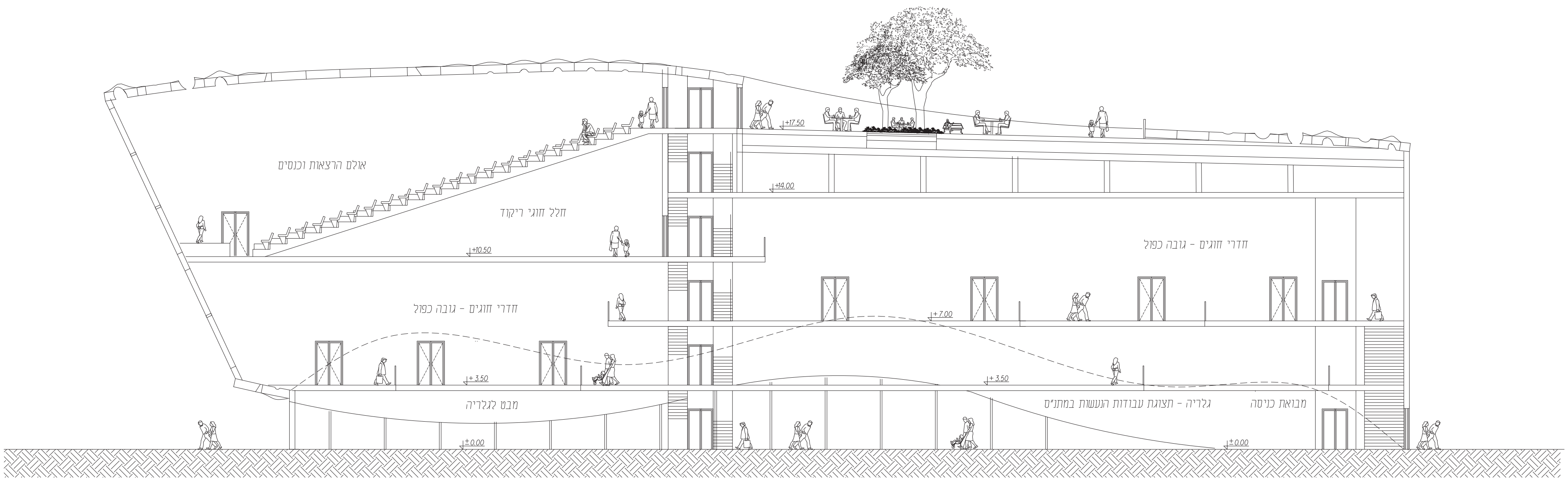
Top Side view - shows how looks the floor in the inner spaces (Face + Spaces intrior)



תכנית קומה שנייה קנ"מ 1:200

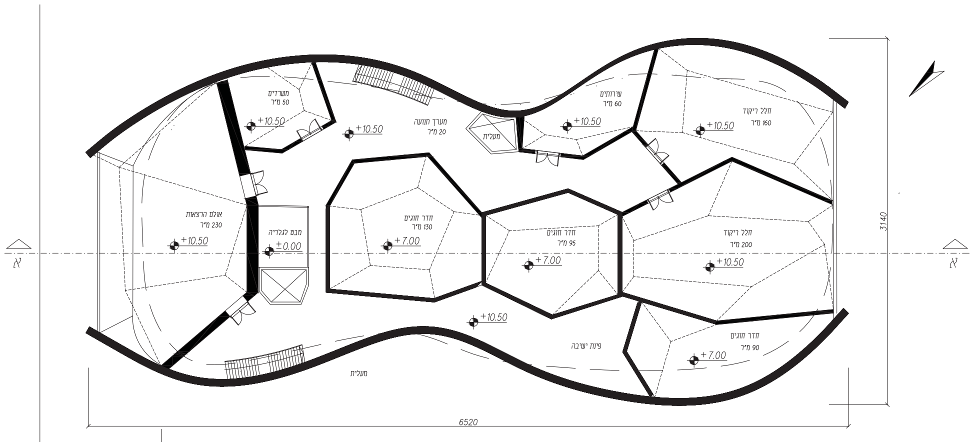


תכנית קומת קרקע קנ"מ 1:200

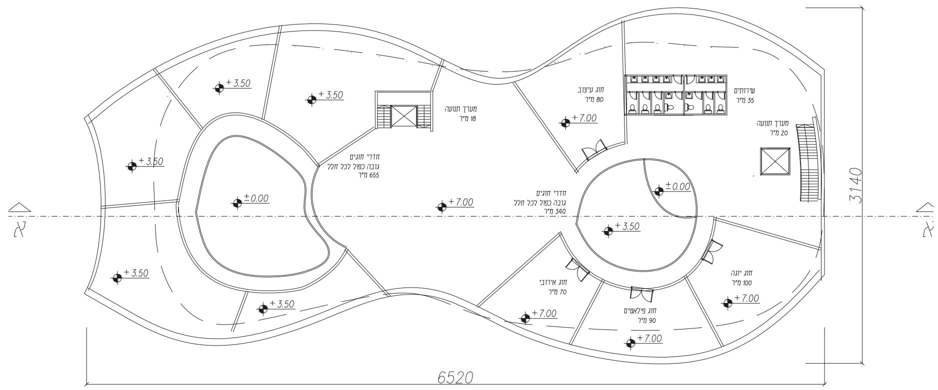


חתך א-א קנ"מ 1:100

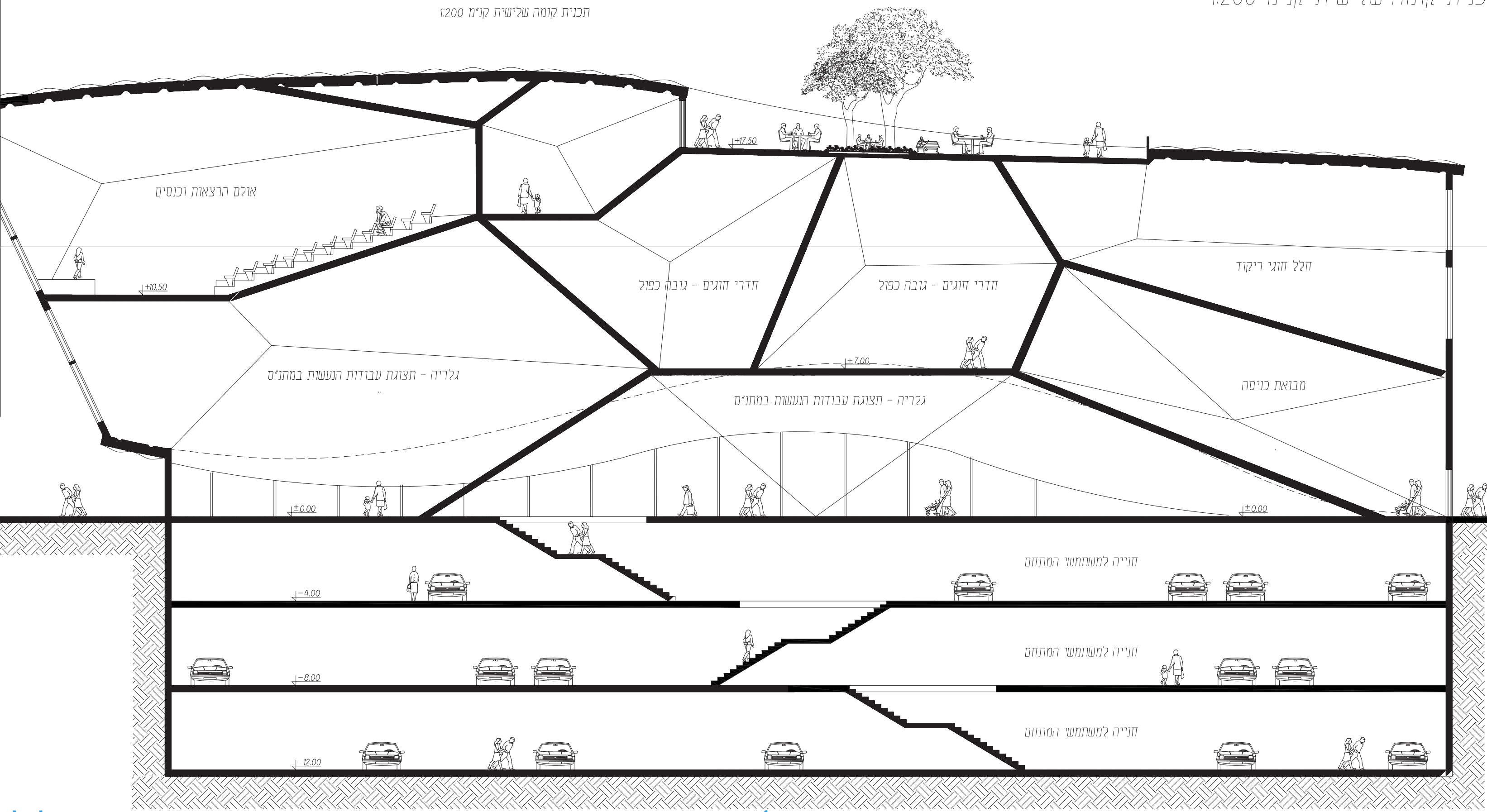
Mid Presentation Plans - Forma finding



1:200 תכנית קומה שלישית קנ"מ

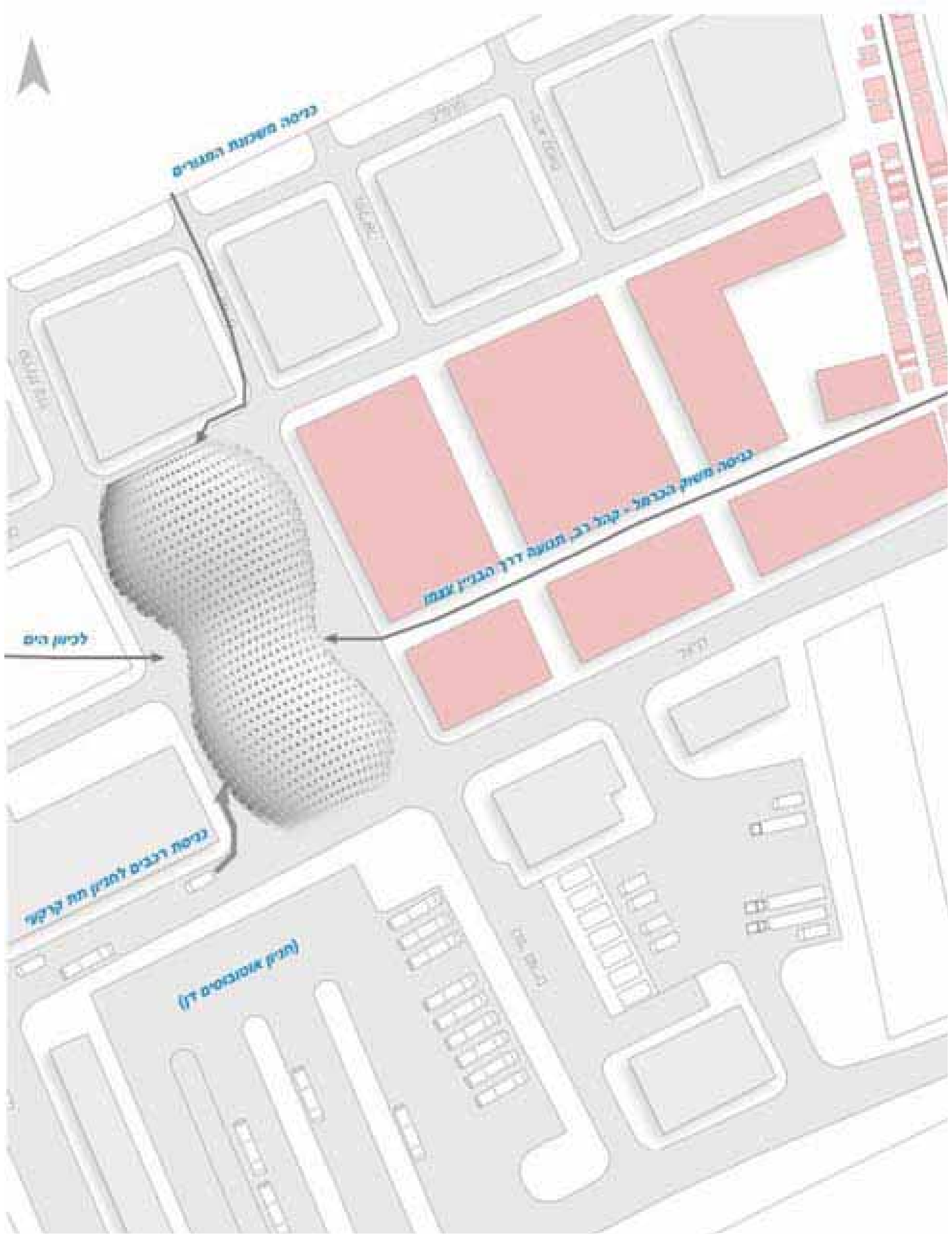


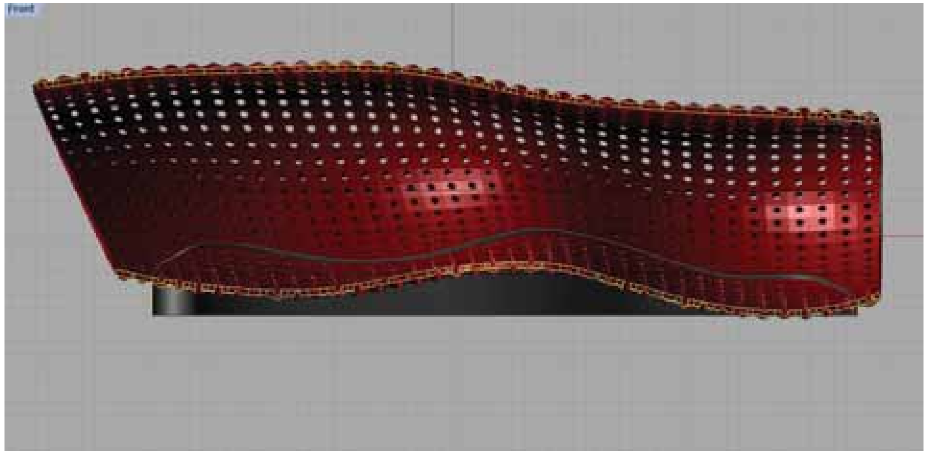
1:200 תכנית קומה שלישית קנ"מ

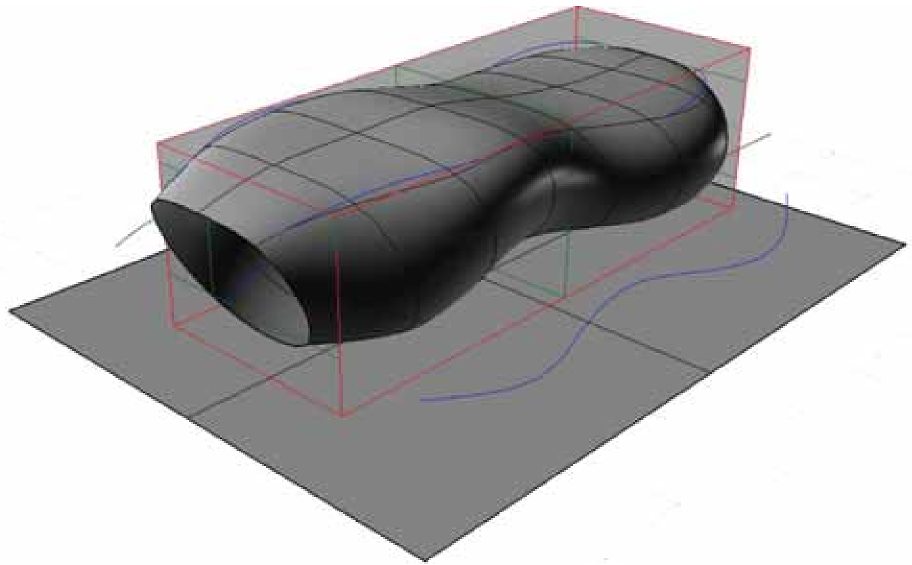


1:100 חתך א-א קנ"מ

Final Plans





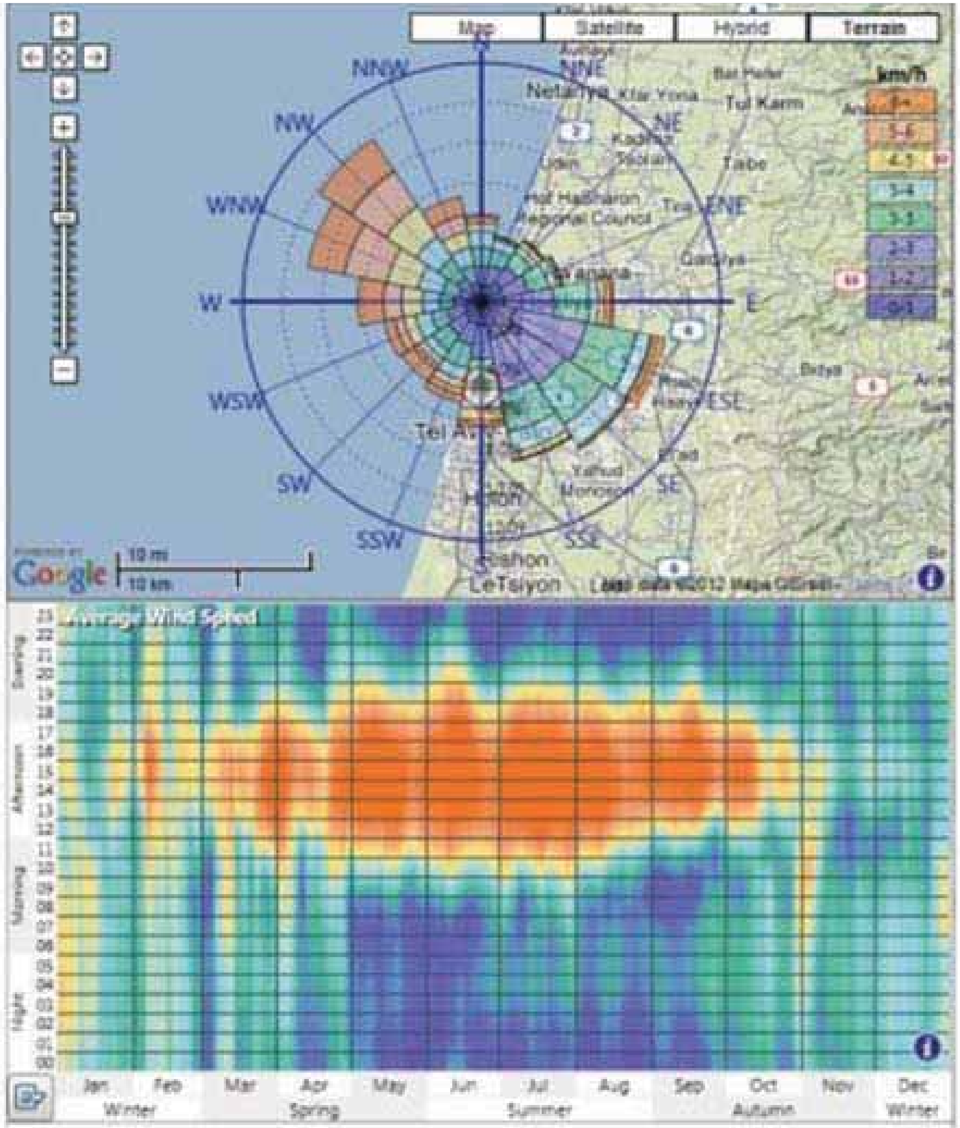


Final Form - Flowein and aerodynamic amorphic shell whitch correlates with the proggram

EYE CONTACT CELLULAR STUDY

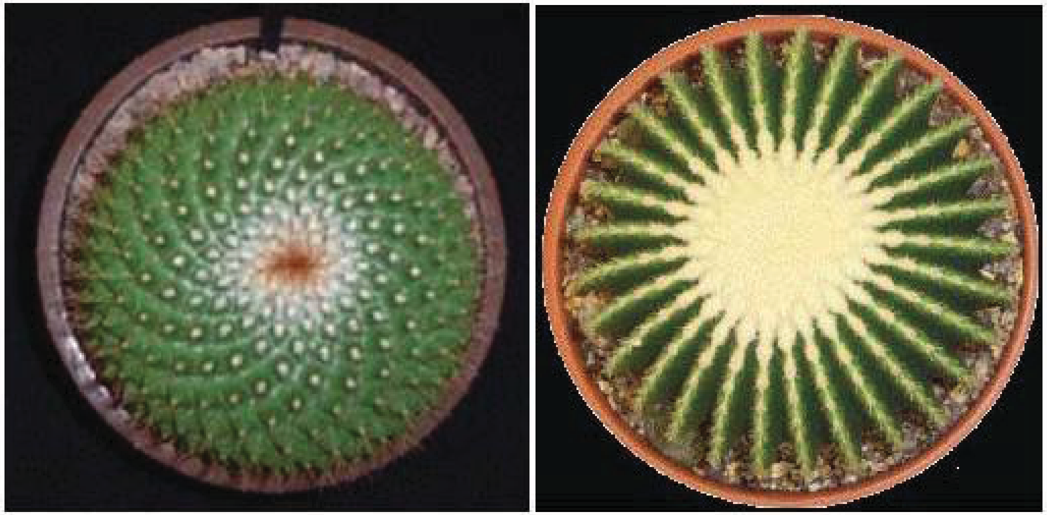
Climatic Study

המבנה
ממוקם בלב
שכונצת
מגורים
אינטימית,
במרחק הליכה
משוק הכרמל,
הים ומסוף
האוטובוסים
של חברת
"דן"

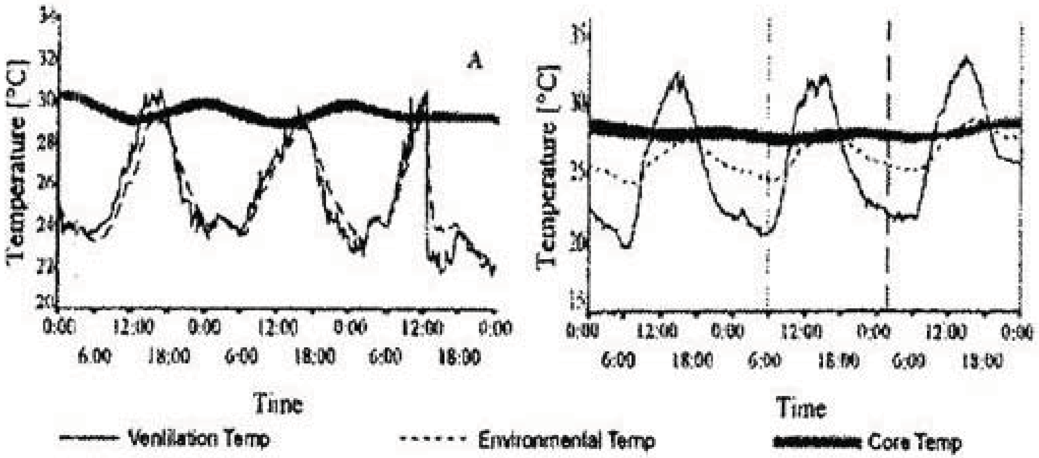


Climatic study of the project area - windy most of the year mostly west wind from the sea and very high humidity. (From the left) the area is in a quiet environment wich close enough to walk.

EYE CONTACT CELLULAR STUDIO INSPIRATION



חתך של קקטוס הנובע מסיבה אקלימית (אסף נבו)



"HIGH PERFORMANCE MASSONARY WALL SYSTEM"

קקטוסים כדוגמא לניצול מירבי של תנאי אקלים והגנה מפניהם בזמנים קשים ע"י מבנה פיסי של הקקטוס.

הצללה עצמית

שימוש במים לפיזור, ניצול מסה תרמית

צבע קוצים

הגדלת שטח מגע ב-80%!

הצללה על 60% מהקקטוס

-טמפרטורת סביבה:

קיץ: 28-37

חורף: 16-18

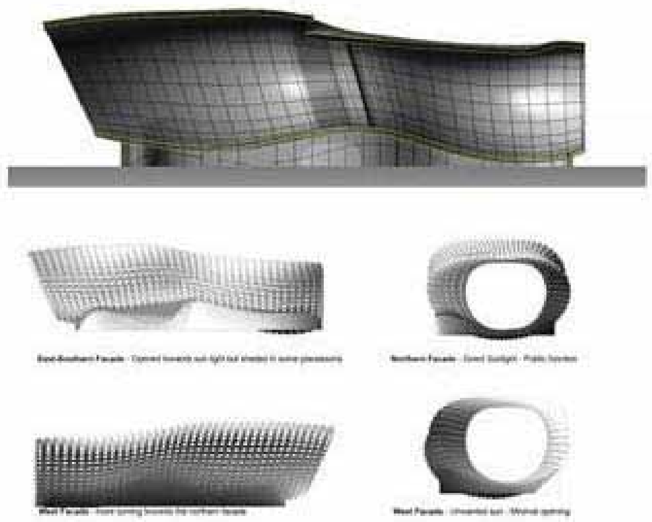
טמפרטורת ליבה - שני שליש

מטמפרטורה חיצונית

אם לחות עולה על 50 אחוז התהליך לא יעיל!


EYE CONTACT
CELLULAR STUDIO
INSPIRATION
Self food station
AADRL
The boundary element can be useful for more than one thing
תקדימים המשתמשים בקליפות כאבן בניין למבנה פרמטרי
Hakovshim st" - The way to the beach"

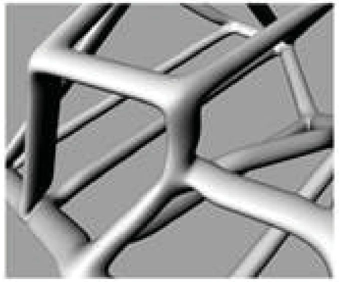
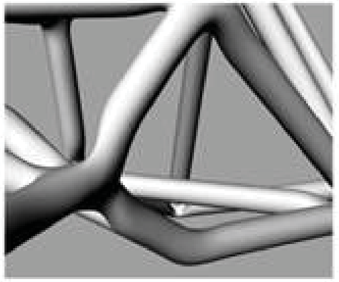
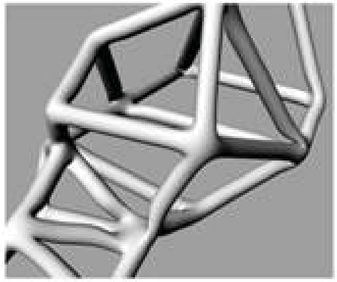
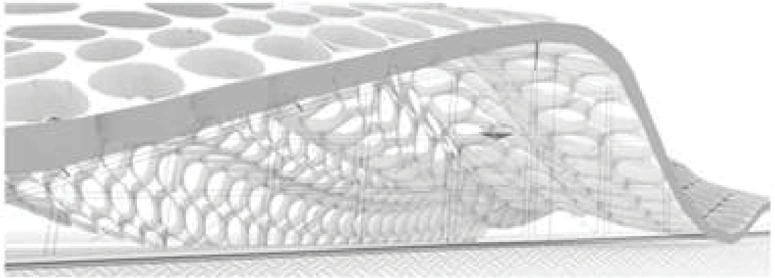

כובשים
24



Study & Inspiration - Chameleon eye

The movements of both eyes and the head were recorded with search coils in unrestrained, freely moving chameleons. As a main result I found that the generation of saccades in the left and the right eye was either independent from each other or was highly correlated according to the behavioural situation. When no prey item was fixated, disconjugate saccades were observed which was in accordance with earlier observations in chameleons. During prey tracking the chameleons switched to a different oculomotor behaviour and pursued the moving prey with synchronous saccades. At higher target velocities, the tracking movement of the head was also saccadic and was synchronised with the two eyes. Binocular coupling affected only the timing of the saccades but not the metrics: the amplitudes of the synchronous saccades were usually different in the two eyes. These observations suggest the existence of two independent premotor neuronal circuits for left and right eye saccadic motor control in the chameleon. Binocular coupling in prey-tracking chameleons is probably achieved by neuronal coupling of these premotor circuits during eye–head coordination. The ability to switch between synchronous and uncoupled saccadic eye movements has not been described for any other vertebrate. This unique ability of the chameleon may help to understand the organisation of the oculomotor system of other vertebrates since evidence for separate left eye and right eye saccade generation and position control has recently also been reported in primates.

EYE CONTACT CELLULAR STUDIO FINALLY

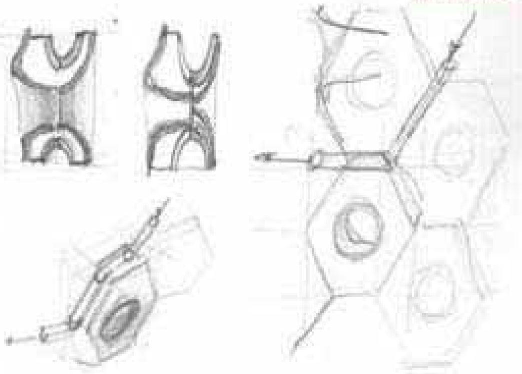
Facade Cell Detail

The facade detail is based on the self shadow and the winds in the sea area where the project is located. However the humidity is very high most of the year and that»s why the cooling effect will be a little bit less segnificant. The essay «high performance masonary wall» by J.Laver,D.Clifford and J.Vollen, suggest the self cooling phenomenon according to physical form of thee openings. The conclution of reading this essay and knowing the climatic data of Tel Aviv is that this method is not the best for this area because the high .humidity through most of the year

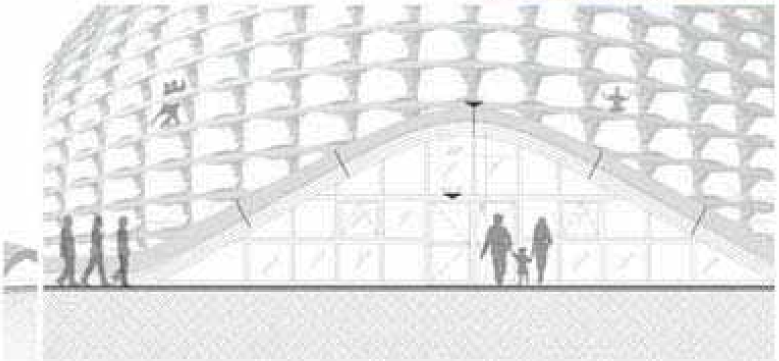
The Hexagonal form of the facade cell allows to use some of the sodes of the cell for pipes of water, collecting of rain water or system .cables of the building

ired ceramic will absorb water. For example, on a 38°C (100°F) day, with
% relative humidity (RH), evaporative cooling will lower the wall surface
ature and immediate surrounding air temperatures by 8–14°C (14–25°F)
When RH rises above 50%, evaporative cooling becomes ineffective. In

פרט אלמנט חזית

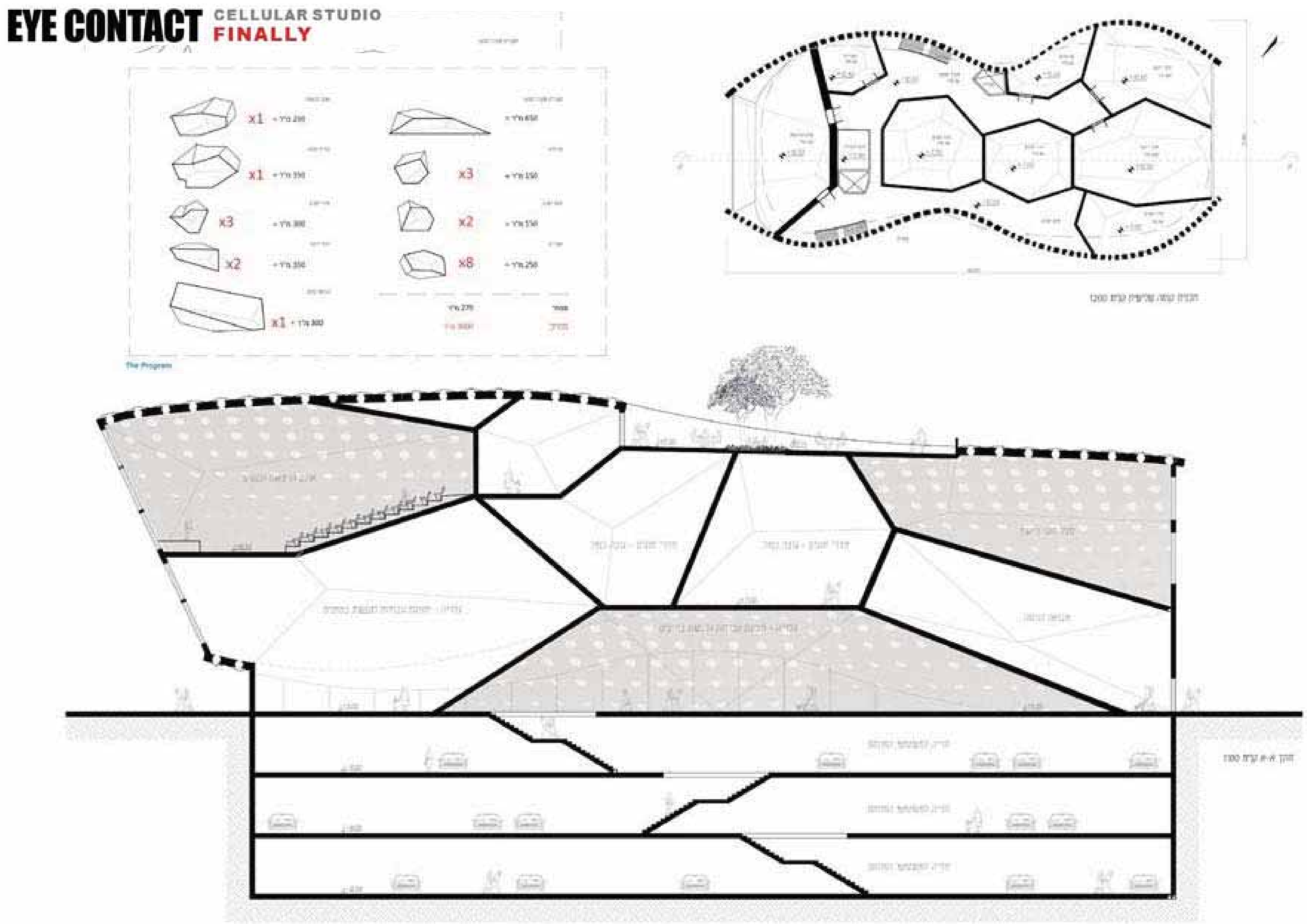


פרט קיר זכוכית (החלק התחתון של המבנה)

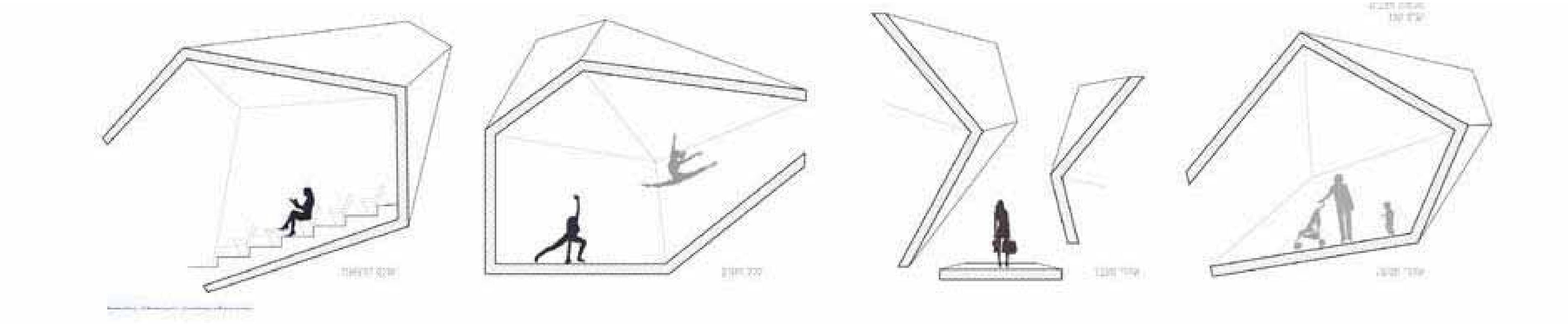


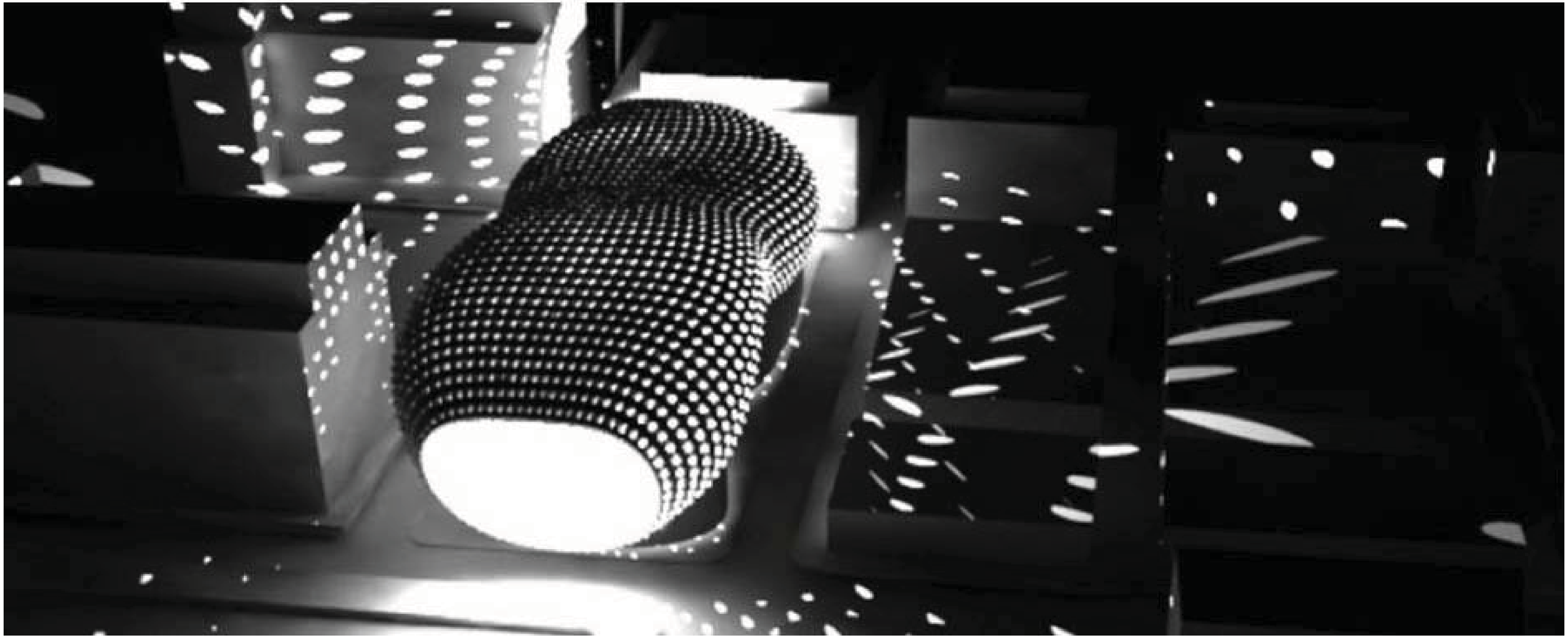
BIG TED Cube Building

APTLY NAMED, THIS BIG CREATION IN TAIWAN LOOKS LIKE A CUBE-SHAPED BLACK HOLE OUT OF A SCI-FI MOVIE. RECESSIONS THROUGHOUT THE BUILDING MIGHT GIVE THE IMPRESSION OF A PORTAL TO ANOTHER WORLD BUT IN ACTUALITY LEAD TO OPEN AREAS THAT ALLOWING PEOPLE TO WALK THROUGH. BIG'S FUTURISTIC CREATION WILL NOT BE BARREN: ON TOP OF THE 57-M-HIGH BUILDING WILL BE A GROVE OF TREES ENCIRCLING A ROOFTOP PERFORMANCE AREA, WHICH WILL PROVIDE A NATURALLY COOLED PUBLIC PARK.


EYE CONTACT
CELLULAR STUDIO
FINALLY
x1
x1
x3
x2
x1
x3
x2
x8
The Program

EYE CONTACT CELLULAR STUDIO FINALLY

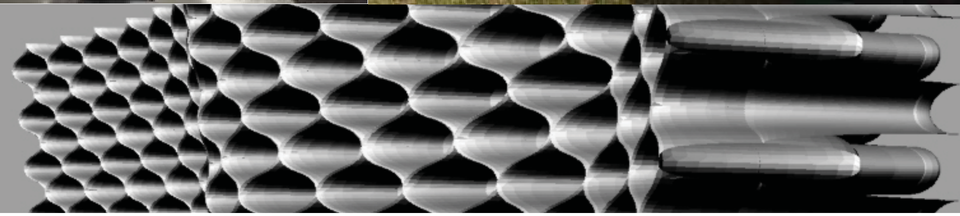






EYE CONTACT

CELLULAR CELL STUDIO 2012



Contemporary egg bedf (http://homedesigninterior.com)

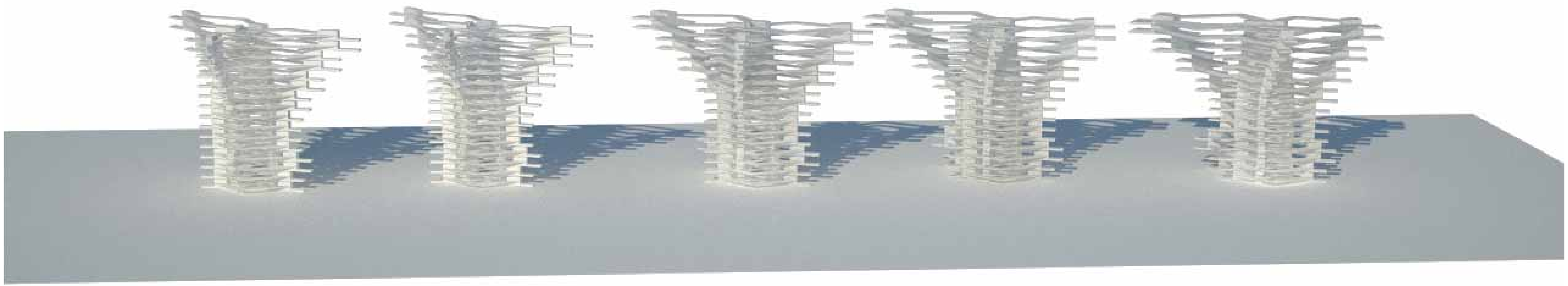
frias-alberto-sleeping-pod (http://mysticmedusa.com)

TWIST MOTION

Final presentation

Keren Feilgut

Instructor: Yasha J. Grobman



Contents

Research

Cellular structures and cell-in-cell structures

Microscope and nanoscopic measurement -

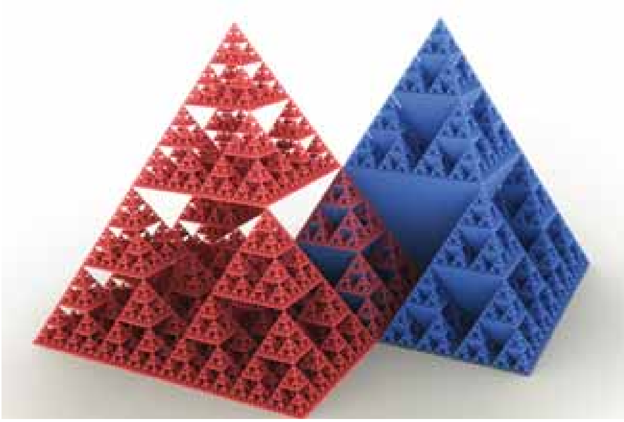
The flora and fauna.

About the research

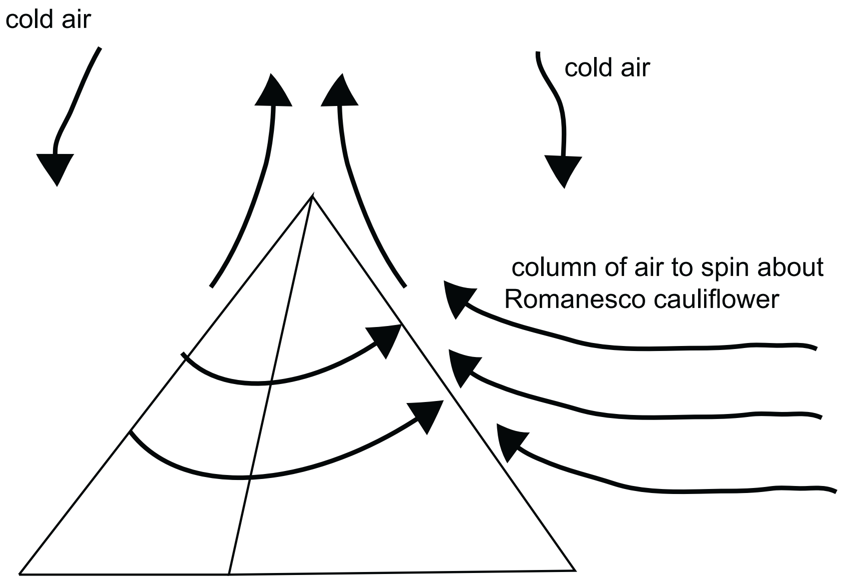
The study examined cellular structures and cell-in-cell structures Microscope and nanoscopic measurement.From this selected topic, human bone and body was chosen as a subject for further study and project.

Fractal objects

Fractal objects that have the property of self similarity, in that the organization of the constituents parts that make up the object reflect that of the whole and overall object



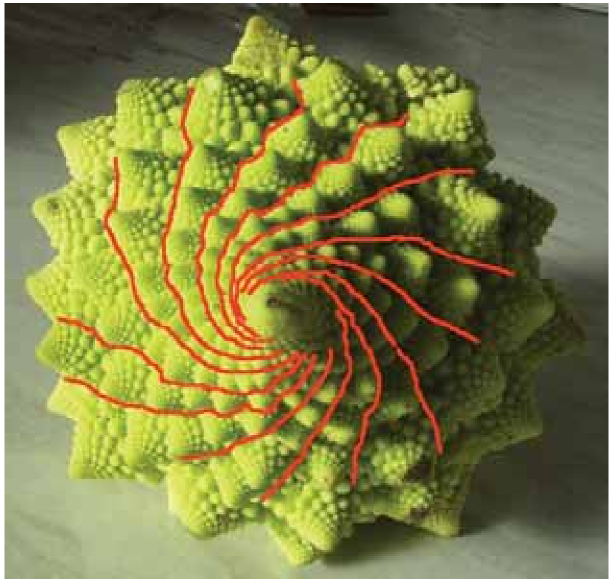
climate model

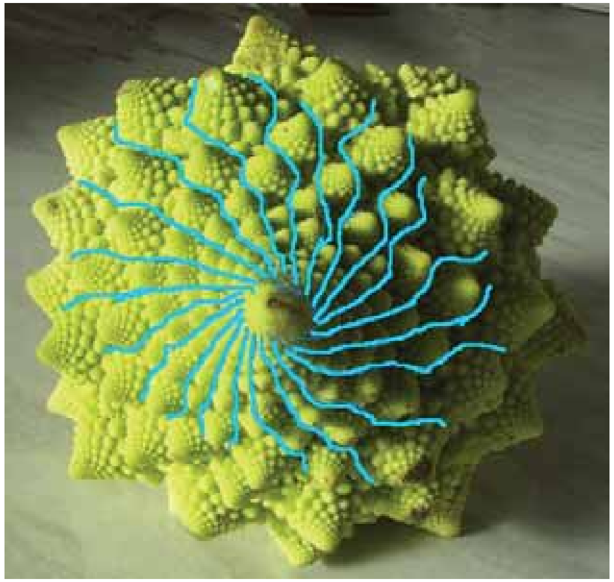


The head of a Romanesco cauliflower

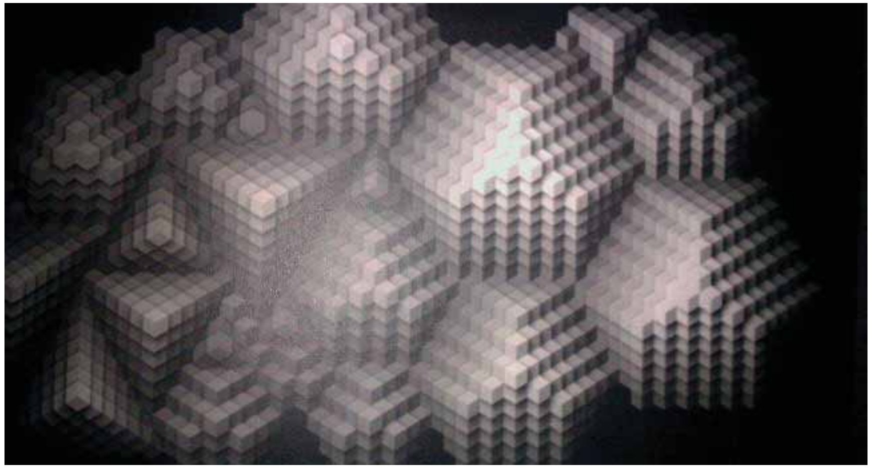
http://www.easybloom.com/plantlibrary/plant/cauliflower-4

http://morrisonworldnews.com/?p=28397





http://davesgarden.com/guides/pf/showimage/176595/

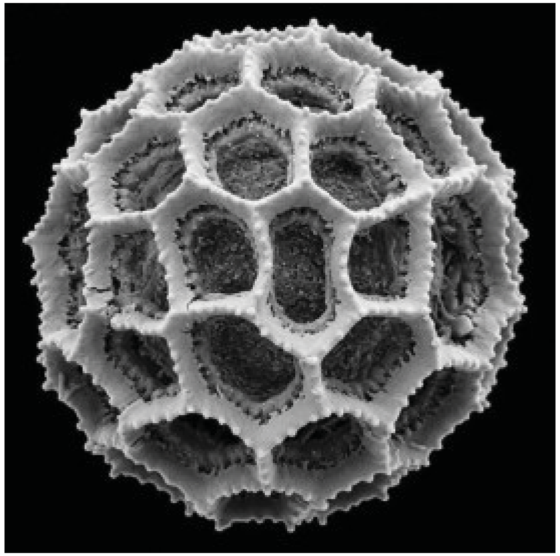


Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.

http://morrisonworldnews.com/?p=28397

The tree- rayed networks pollen

such patterns of the surfaces of the pollen grains are determined, for the most part, by the genetic programming of the plant

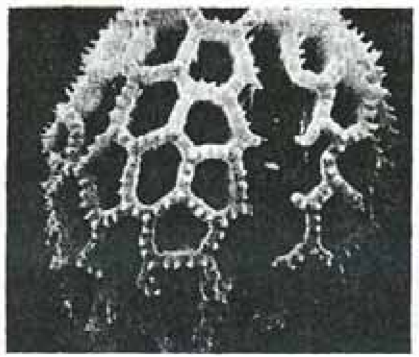


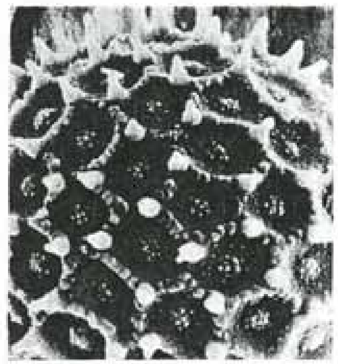
scanning electron microscopy photography by The University of Edinburgh

http://sacrit.blogspot.com/2010/11/epic-art-science-exhibit-exploration.html

naturally occuring tree- rayed hexagonal networks is to be found in giraffe skin.
The extremely uniform reptile skin is a packing of circles in which small triangles appear at the interstices.

Giraffe skin

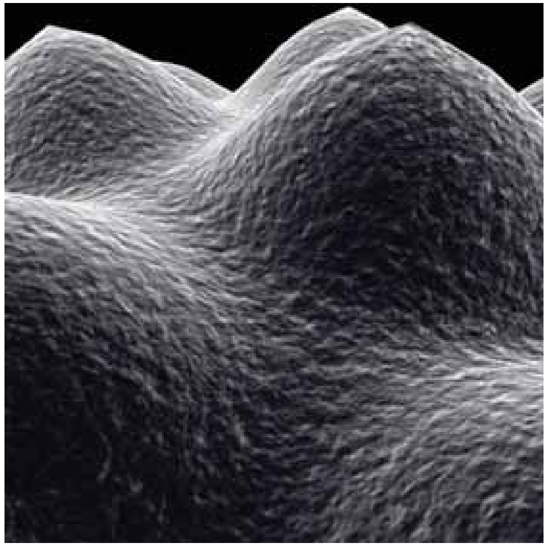


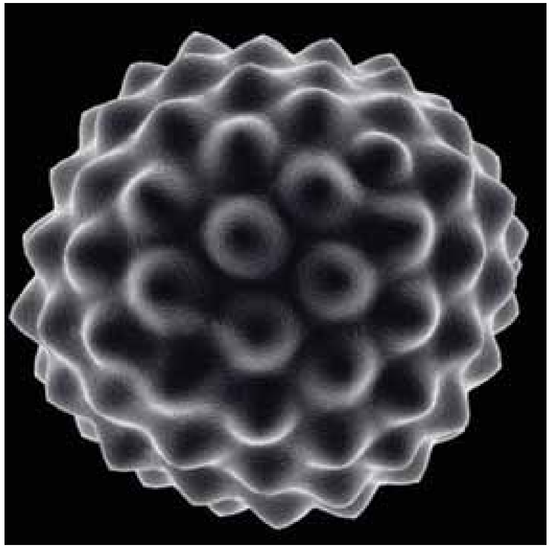


Pollen grain of morning glory and thrift pollen (copyright 1969, patrik echlin & cambridge scientific instruments).

Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

Pollen





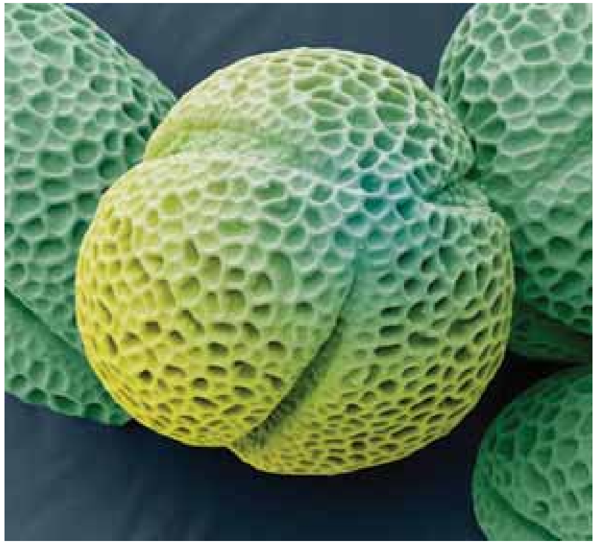
http://www.turbosquid.com/3d-models/3d-model-microscopic-pollen/307565

http://www.phombo.com/art/microscope-images-of-pollen-grains/823606/popular/

The structure and formation of pollen

Pollen itself is not the male gamete.[1] Each pollen grain contains vegetative (non-reproductive) cells (only a single cell in most flowering plants but several in other seed plants) and a generative (reproductive) cell containing two nuclei: a tube nucleus (that produces the pollen tube) and a generative nucleus (that divides to form the two sperm cells). The group of cells is surrounded by a cellulose-rich cell wall called the intine, and a resistant outer wall composed largely of sporopollenin called the exine.
Pollen is produced in the 'microsporangium' (contained in the anther of an angiosperm flower, male cone of a coniferous plant, or male cone of other seed plants). Pollen grains come in a wide variety of shapes (most often spherical), sizes, and surface markings characteristic of the species (see electron micrograph, right). Pollen grains of pines, firs, and spruces are winged. The smallest pollen grain, that of the forget-me-not (Myosotis spp.), is around 6 µm (0.006 mm) in diameter. Wind-borne pollen grains can be as large as about 90-100 µm.[2] The study of pollen is called palynology and is highly useful in paleoecology, paleontology, archeology, and forensics.

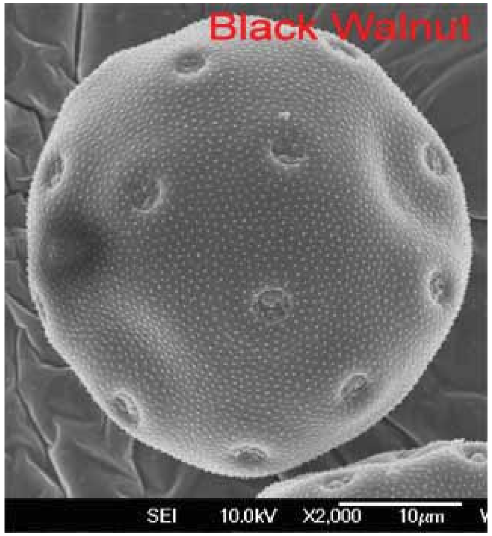
In angiosperms, during flower development the anther is composed of a mass of cells that appear undifferentiated, except for a partially differentiated dermis. As the flower develops, four groups of sporogenous cells form within the anther. The fertile sporogenous cells are surrounded by layers of sterile cells that grow into the wall of the pollen sac. Some of the cells grow into nutritive cells that supply nutrition for the microspores that form by meiotic division from the sporogenous cells. In a process called microsporogenesis, four haploid microspores are produced from each diploid sporogenous cell (microsporocyte), after meiotic division. After the formation of the four microspores, which are contained by callose walls, the development of the pollen grain walls begins. The callose wall is broken down by an enzyme called callase and the freed pollen grains grow in size and develop their characteristic shape and form a resistant outer wall called the exine and an inner wall called the intine. The exine is what is preserved in the fossil record.



http://www.madmoizelle.com/forums/forum-delirium-tremens/48722-le-meilleur-des-images-du-net-195.html

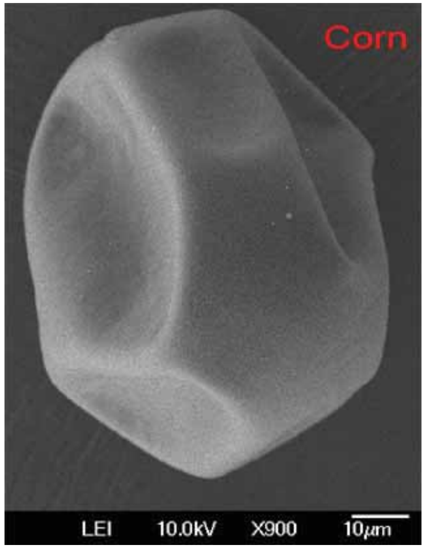
The structure and formation of pollen

The pollen wall protects the sperm nucleus while the pollen grain is moving from the anther to the stigma; it protects the vital genetic material from drying out and solar radiation. The pollen grain surface is covered with waxes and proteins, which are held in place by structures called sculpture elements on the surface of the grain. The outer pollen wall, which prevents the pollen grain from shrinking and crushing the genetic material during desiccation, is composed of two layers. These two layers are the tectum and the foot layer, which is just above the intine. The tectum and foot layer are separated by a region called the columella, which is composed of strengthening rods. The outer wall is constructed with a resistant biopolymer called sporopollenin. The pollen tube passes through the wall by way of structures called apertures.[3]
Pollen apertures are any modification of the wall of the pollen grain. These modifications include thinning, ridges and pores, they serve as an exit for the pollen contents and allow shrinking and swelling of the grain caused by changes in moisture content. The elongated apertues/ furrows in the pollen grain are called colpi (singular: colpus) which along with pores, are a major criterion for the identification of classes of pollen .[4]it leaves the microsporangium, with the generative cell forming the two sperm cells.



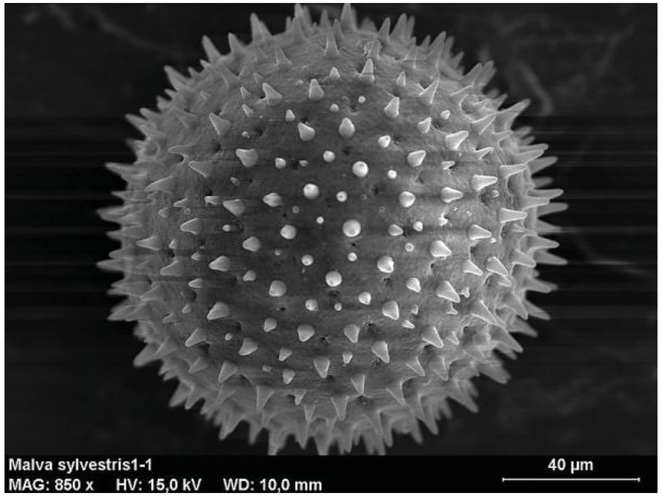
Dint

Pollen grains may have furrows, the orientation of which (relative to the original tetrad of microspores) classify the pollen as colpate or sulcate. The number of furrows or pores helps classify the flowering plants, with eudicots having three colpi (tricolpate), and other groups having one sulcus.[5][6]
Except in the case of some submerged aquatic plants, the mature pollen-grain has a double wall, a thin delicate wall of unaltered cellulose (the endospore or intine) and a tough outer cuticularized exospore or exine. The exine often bears spines or warts, or is variously sculptured, and the character of the markings is often of value for identifying genus, species, or even cultivar or individual. In some flowering plants, germination of the pollen grain often begins before

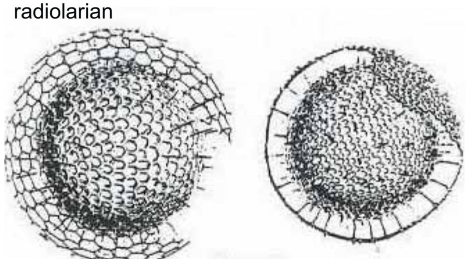


http://www.me.jhu.edu/lefd/BioComp/PollenDensity/PollenImages.htm

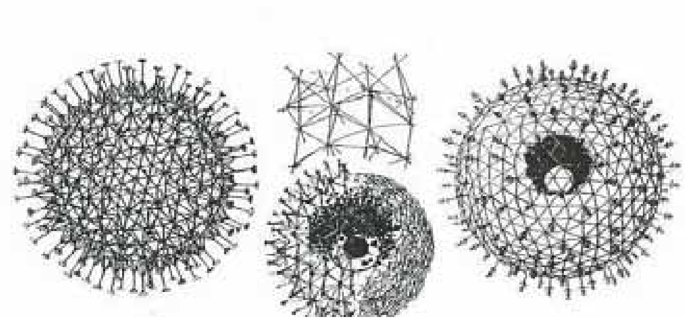
Radiolarian



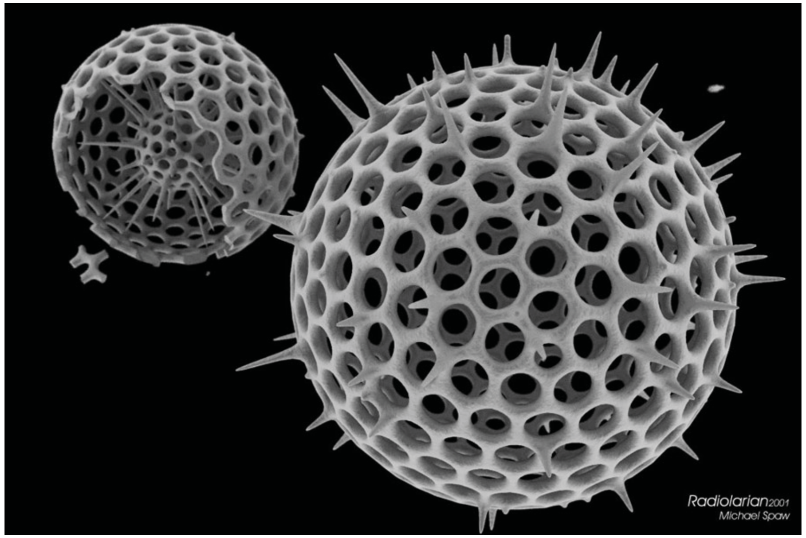
radiolarian



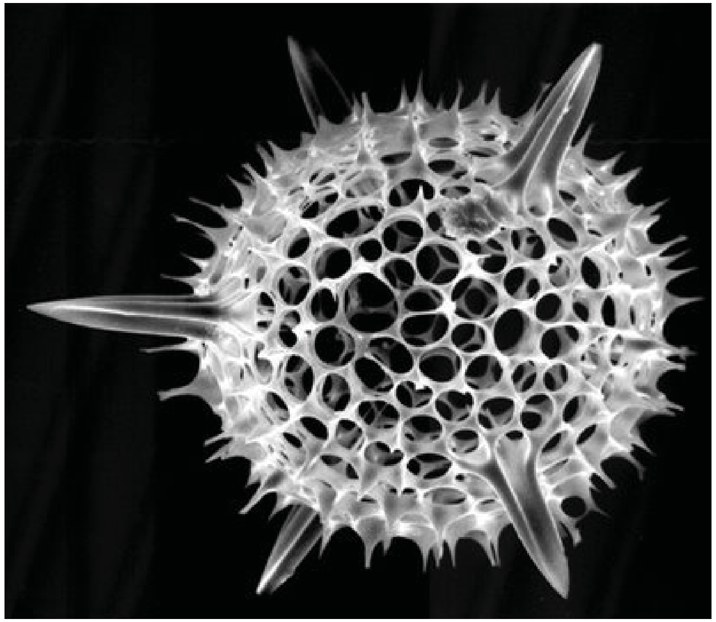
spherical radiolarian skeletons of radiolarian vesicles



triangula radiolarian skeletons
Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

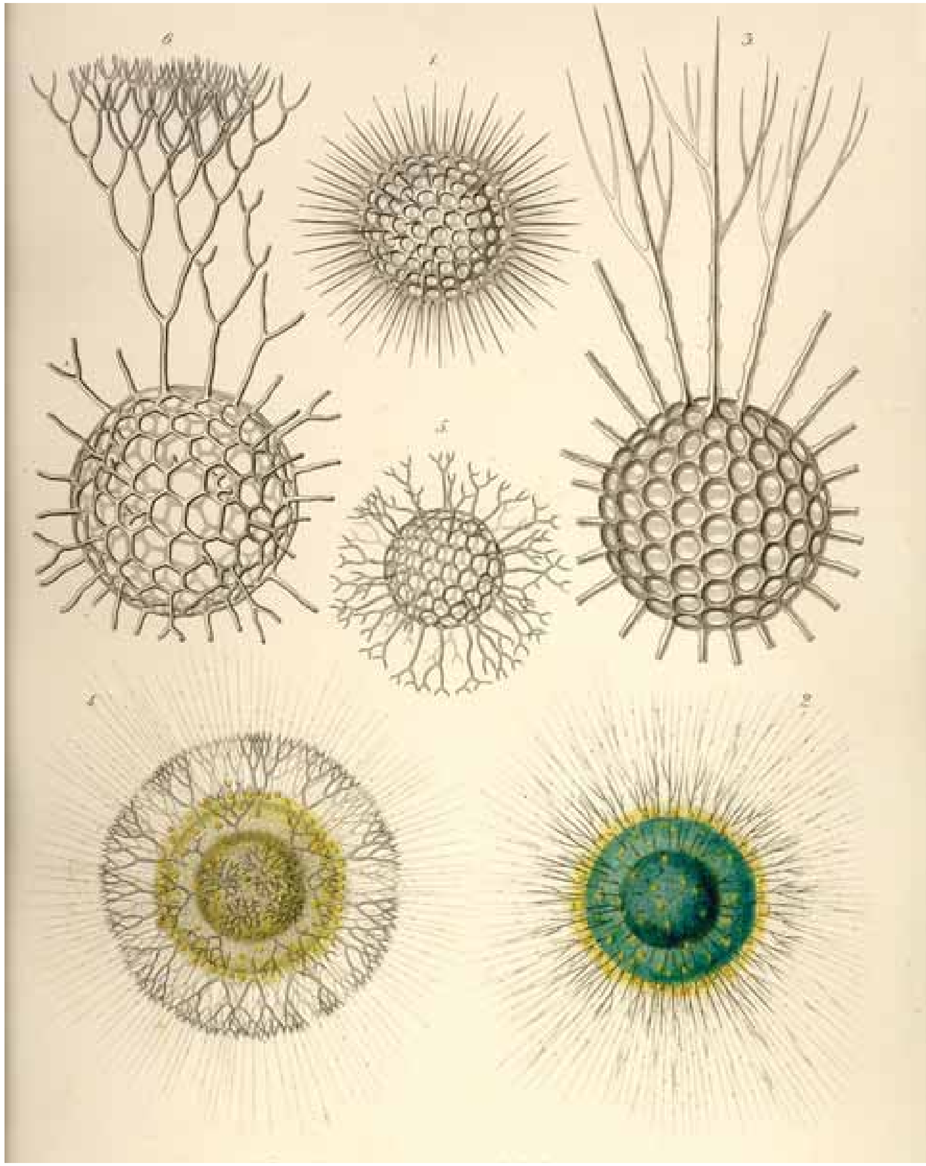


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html



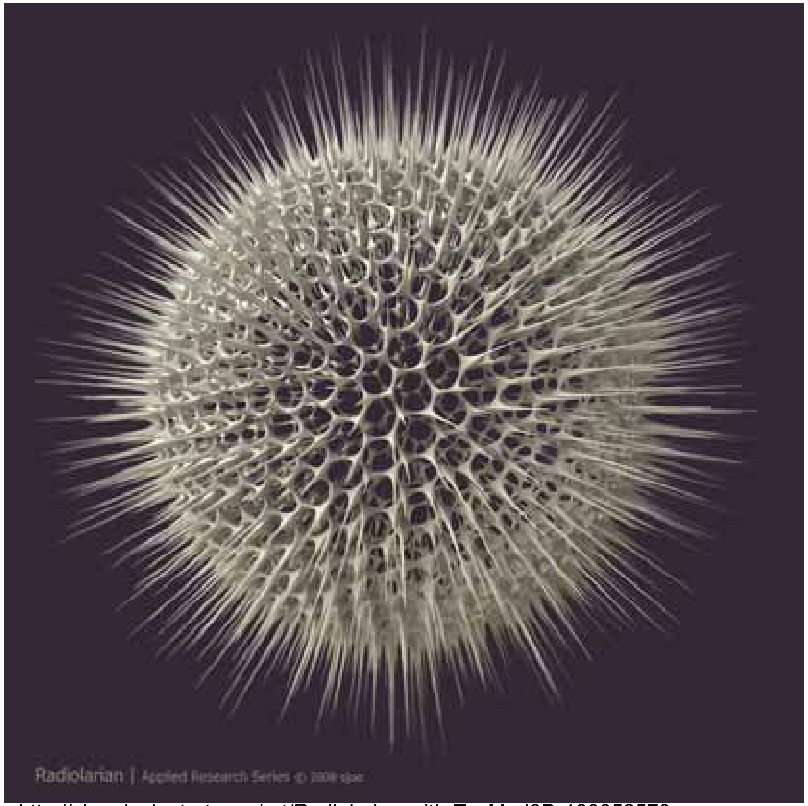
http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

shell



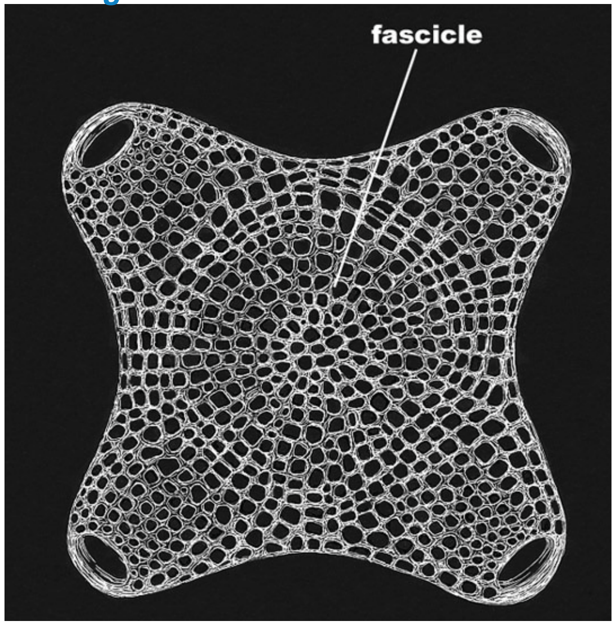
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

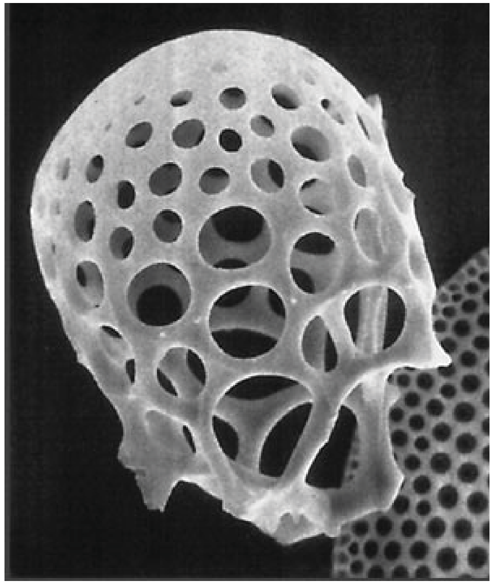
radiolarian



http://sjoo.deviantart.com/art/Radiolarian-with-TopMod3D-108052578

filtering





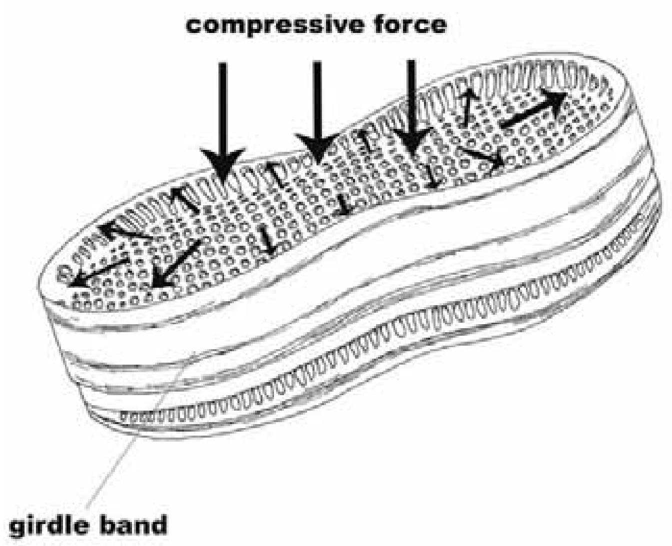
http://www.viewsfromscience.com/documents/webpages/methods_p3.html

Function

The holes in radiolarian and diatom shells respectively exist for differing reasons. Both types of skeleton are formed from silicon compounds.

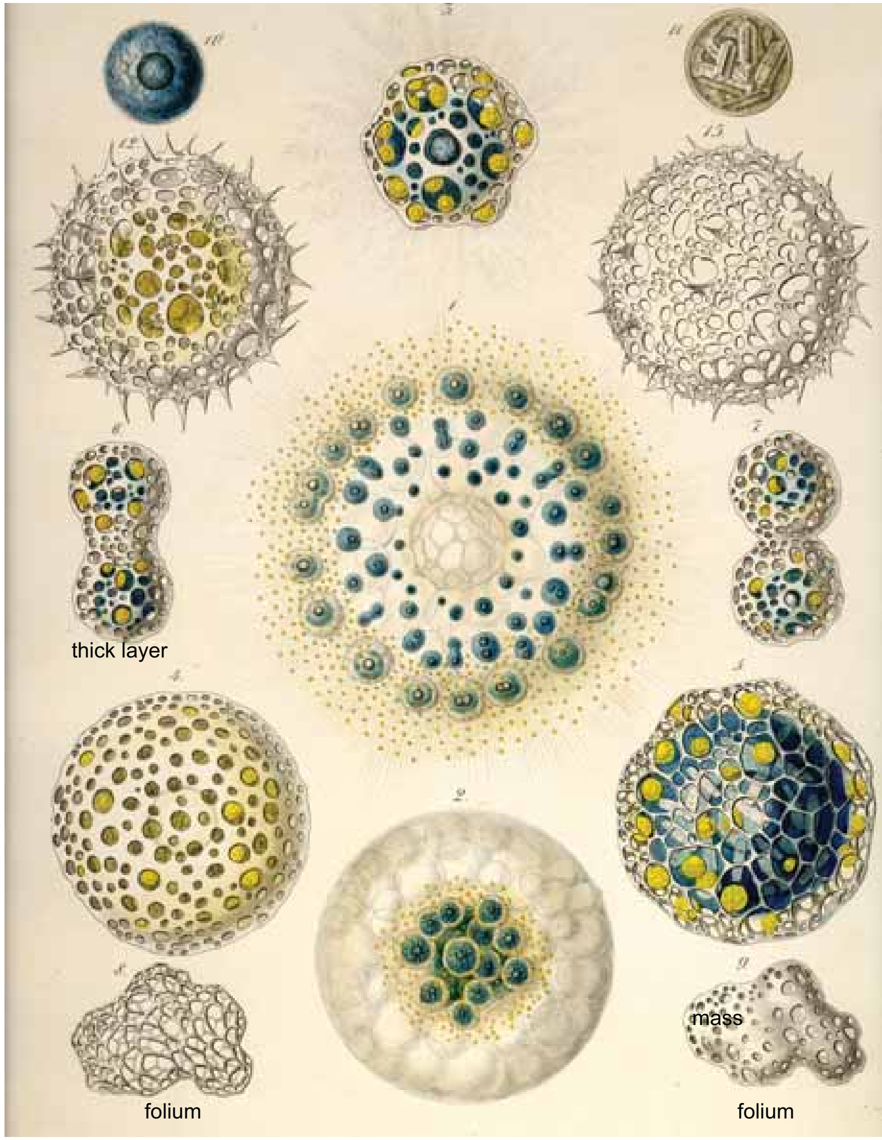
In diatoms, the holes collectively take on the role of a sieve, a two-way filtration mechanism across which water and nutrient molecules permeate the cell. The holes can range from several micrometres down to 100 nanometres in diameter.

A typical diatom frustule is perforated rather than solid, for two reasons. Firstly, the perforated construction allows for a more economic use of silica, especially where low levels of dissolved silica are present. Silicon is also relatively dense, so the structure promotes lightness. Perforations in the frustule also endow the diatom with considerable compressive strength, which explains the frustules' ability to survive undamaged under layers of sediment. When compressive force is applied to a frustule, the lines of force are concentrated along the lines of the silica lattice and continued to the girdle band, which has a greater ability to withstand stress. Costae, or ribs, will also strengthen the upper and lower surfaces of the frustule.



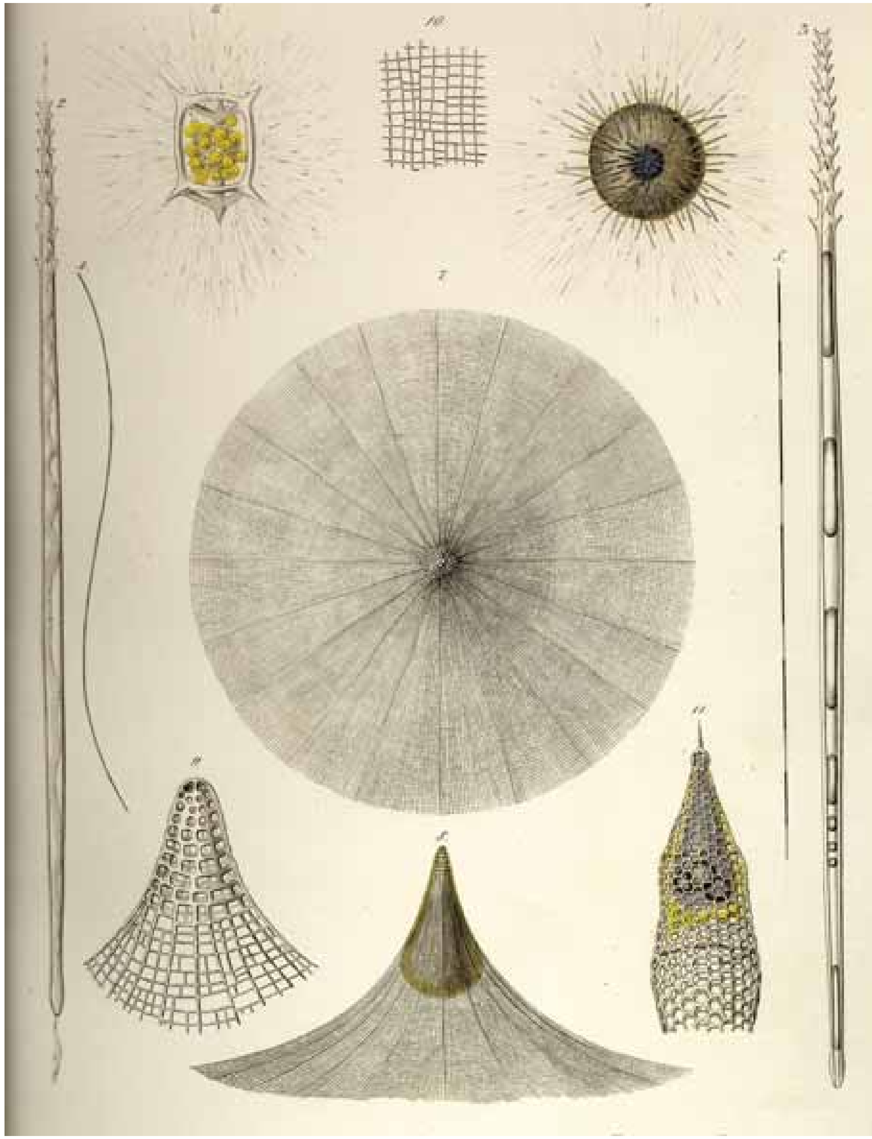
http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artfeb05/cbdiatoms.html

layers



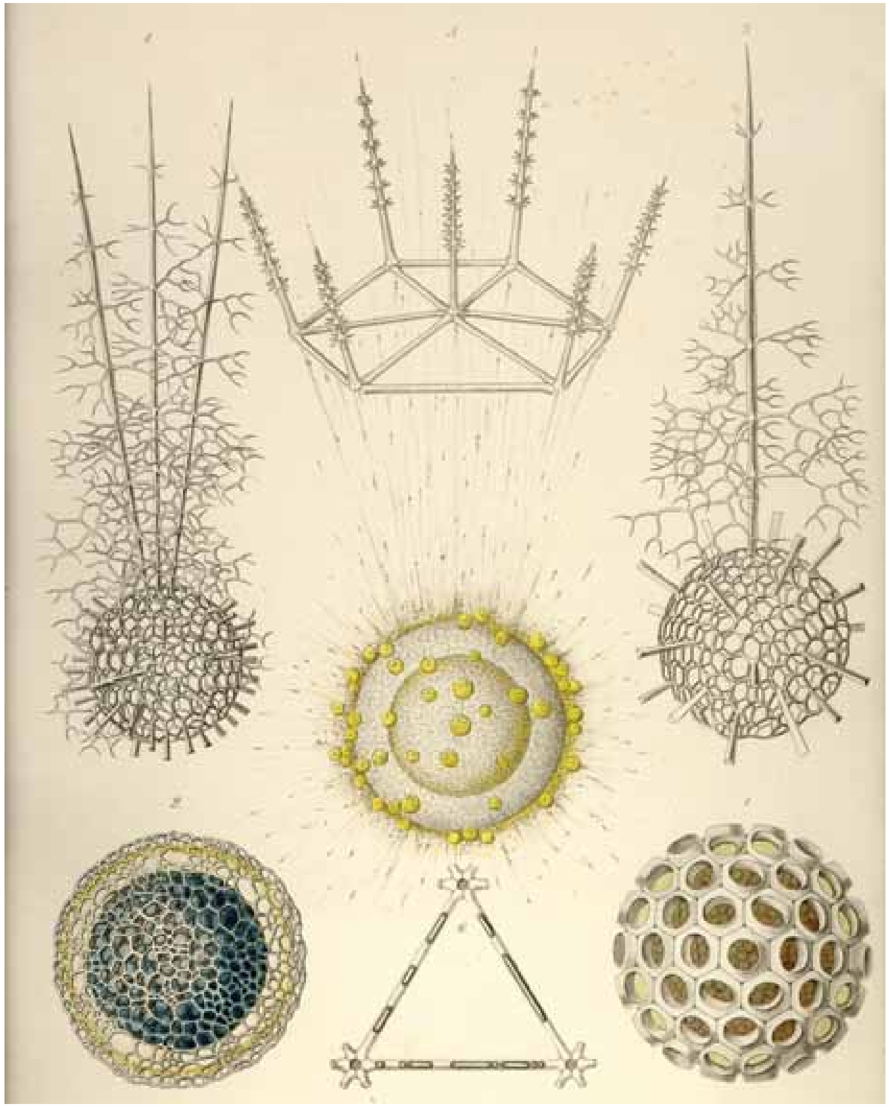
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

cover



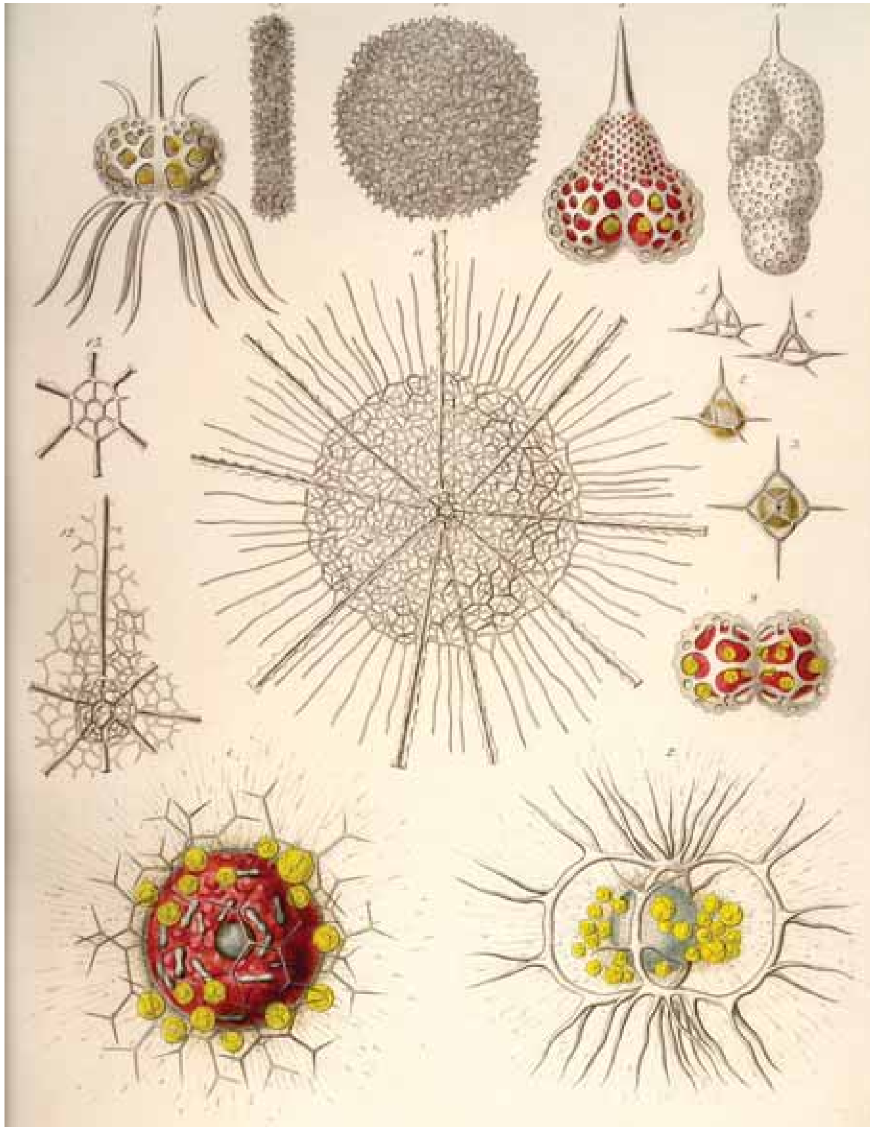
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

Constructive element



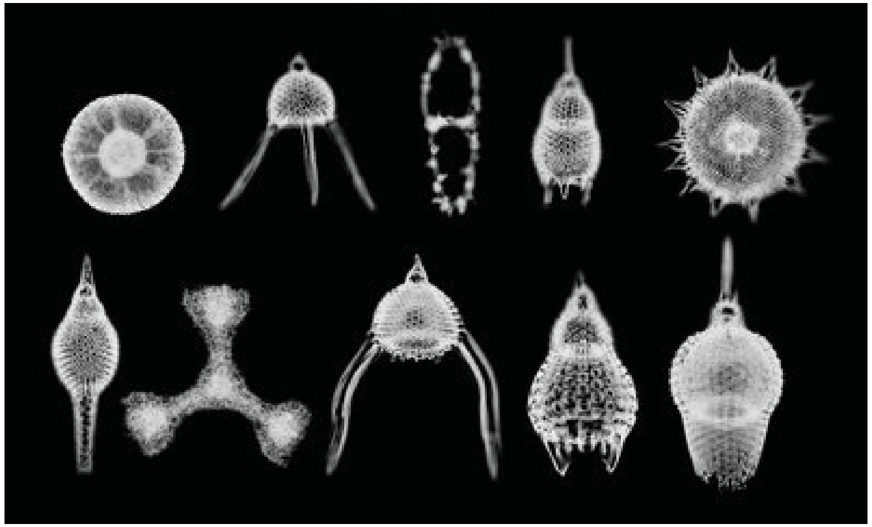
Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

mutation

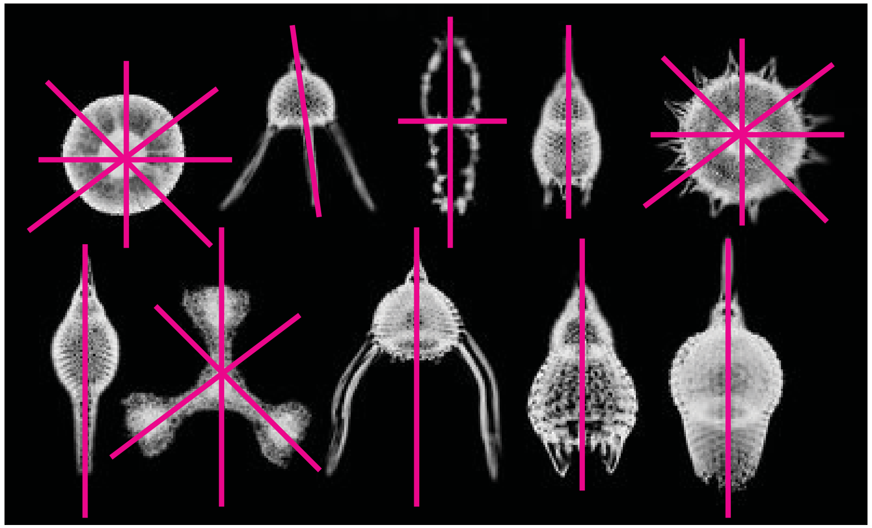


Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

Duplication

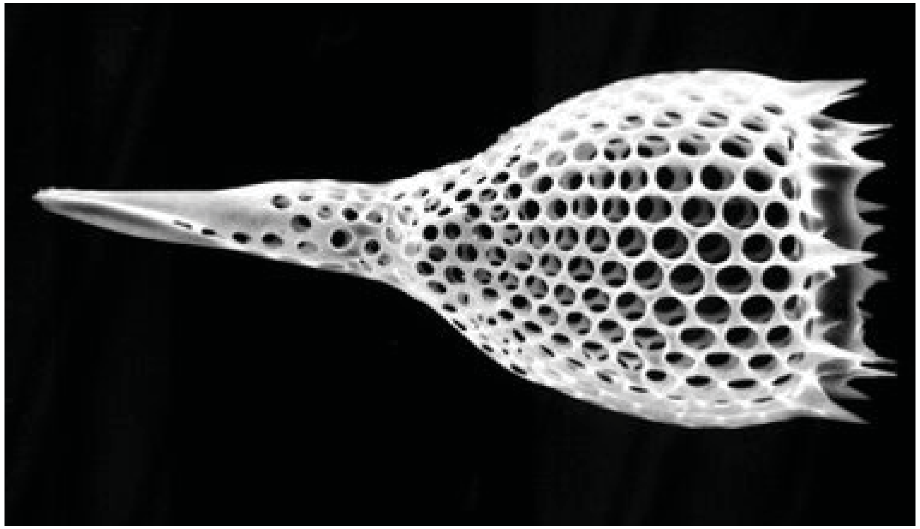


Symmetry

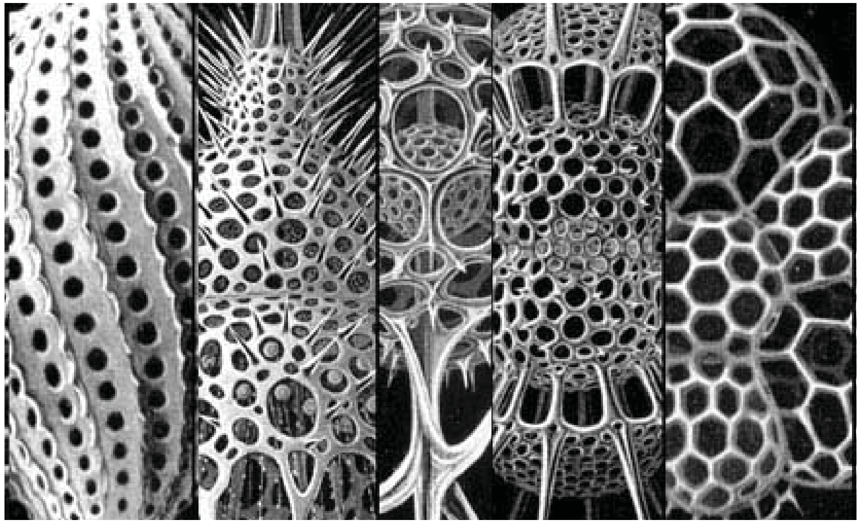


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

radiolarian lattices

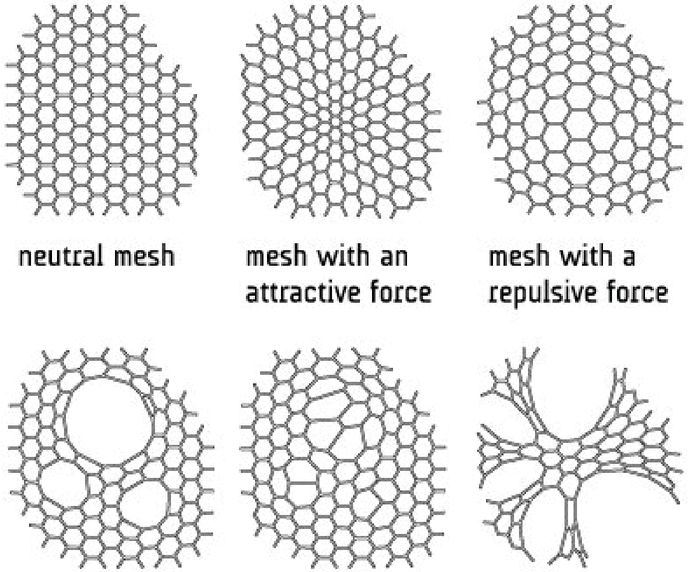


http://doraballa-ommo.blogspot.com/2009/03/radiolarian.html

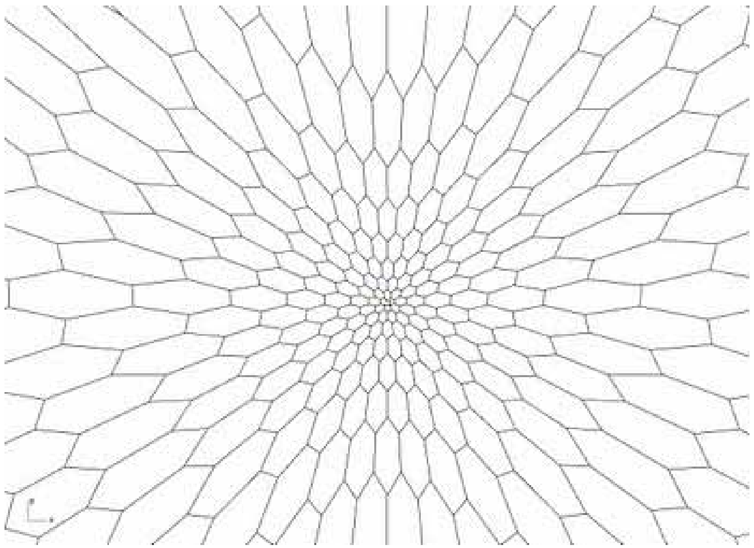


http://www.ucmp.berkeley.edu/people/klf/MicroGallery.htm

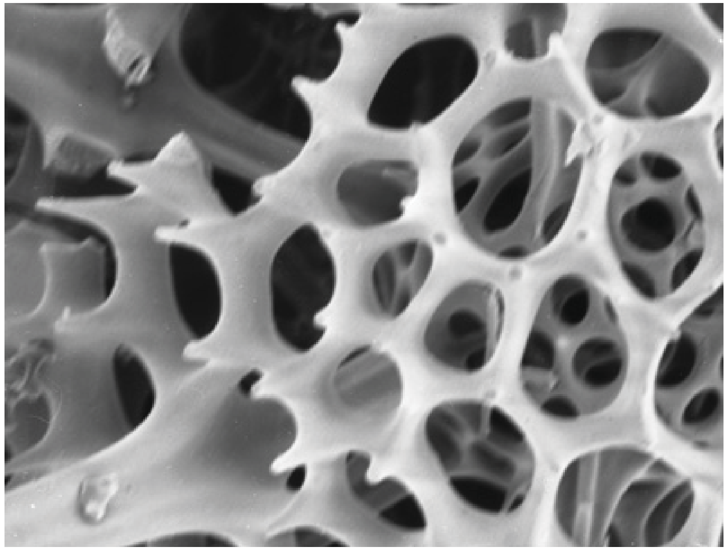
.RADIOLARIAN



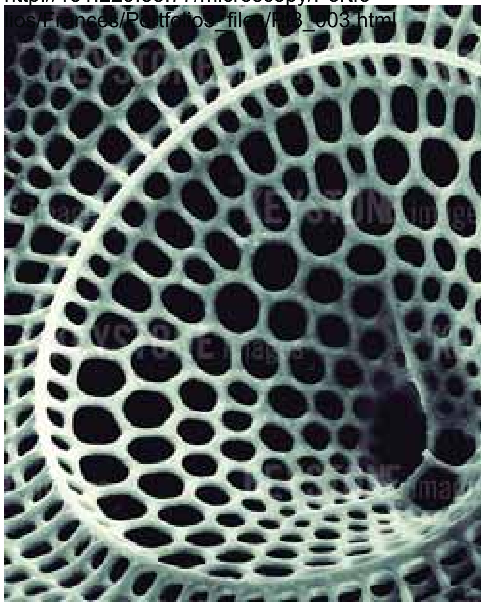
http://sa-mariavera.blogspot.com/2009/03/radiolaria-applet.html



Radiolarian vector deformation
logspot.com/2010/02/radiolarian-vector-deformation-02.html

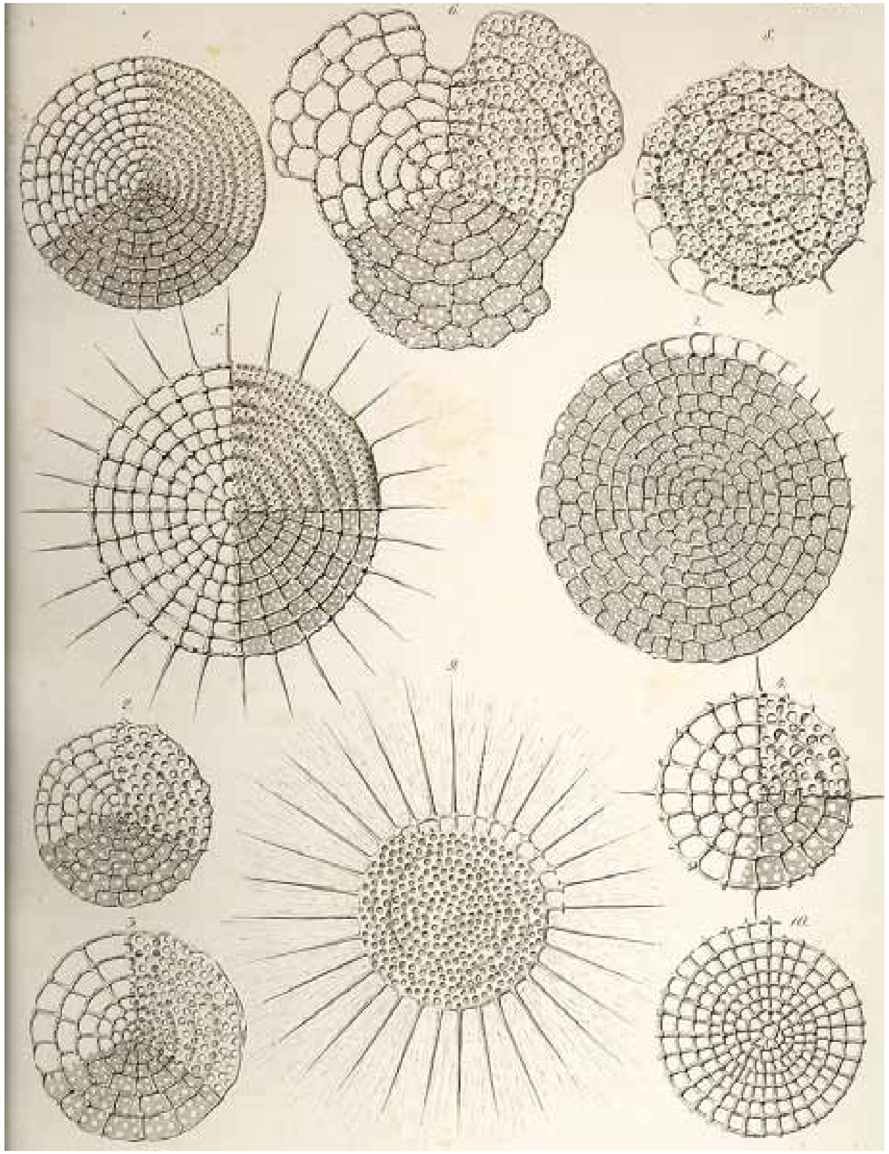


Radiolarian Skeleton
http://131.229.88.77/microscopy/Portfolios/Frances/Portfolio3_files/PI3_003.html

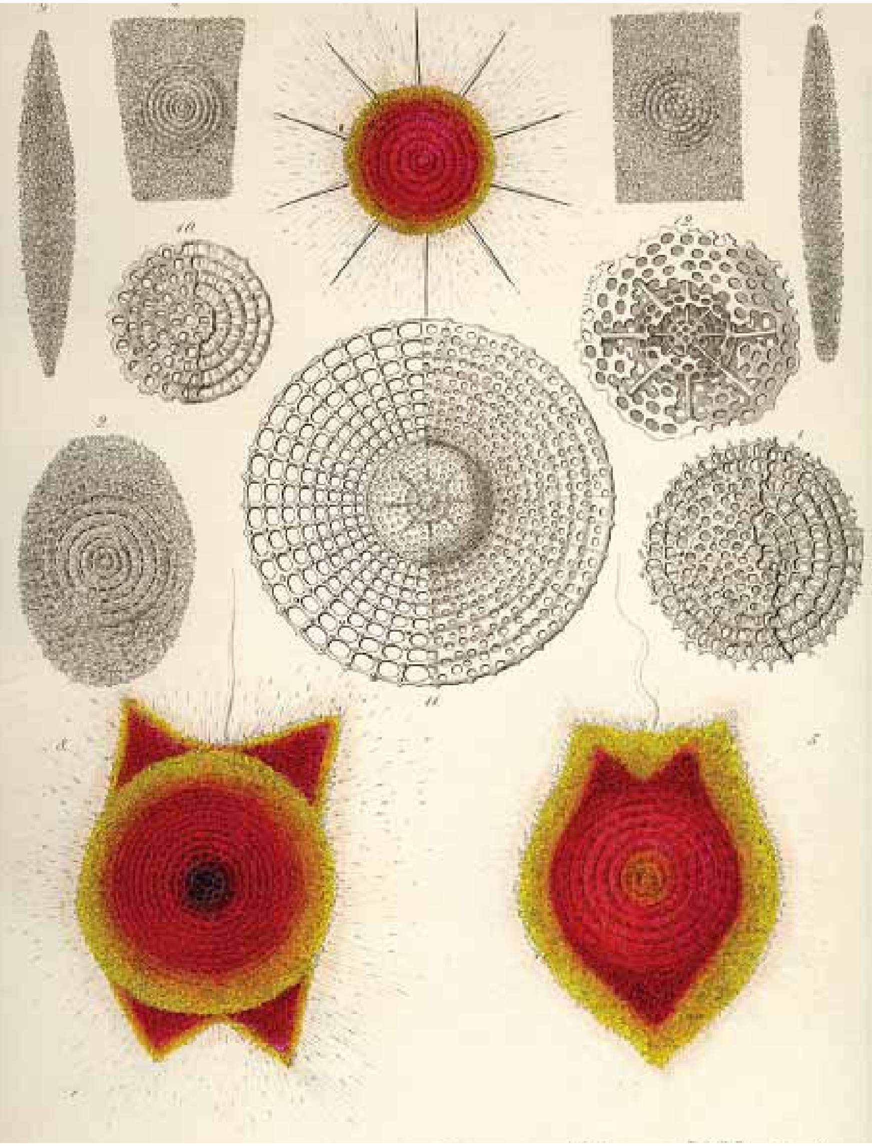


Inside the shell of a single-celled marine animal called a radiolarian. SEM x2700.
http://gallery.bestpicture.ch/bestpicture/category-2/picture-353/?q7=en

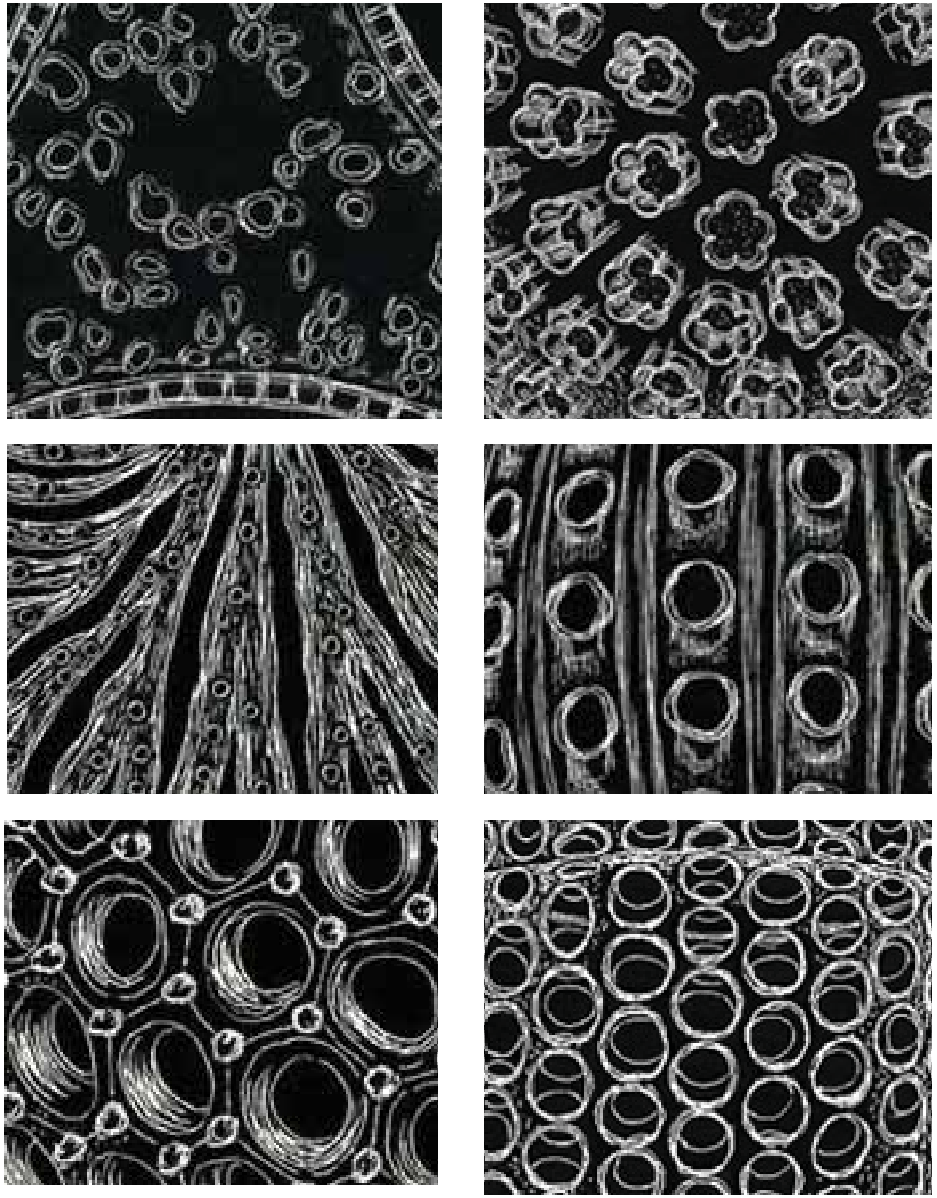
Different level of filtering - different microclimate



Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.

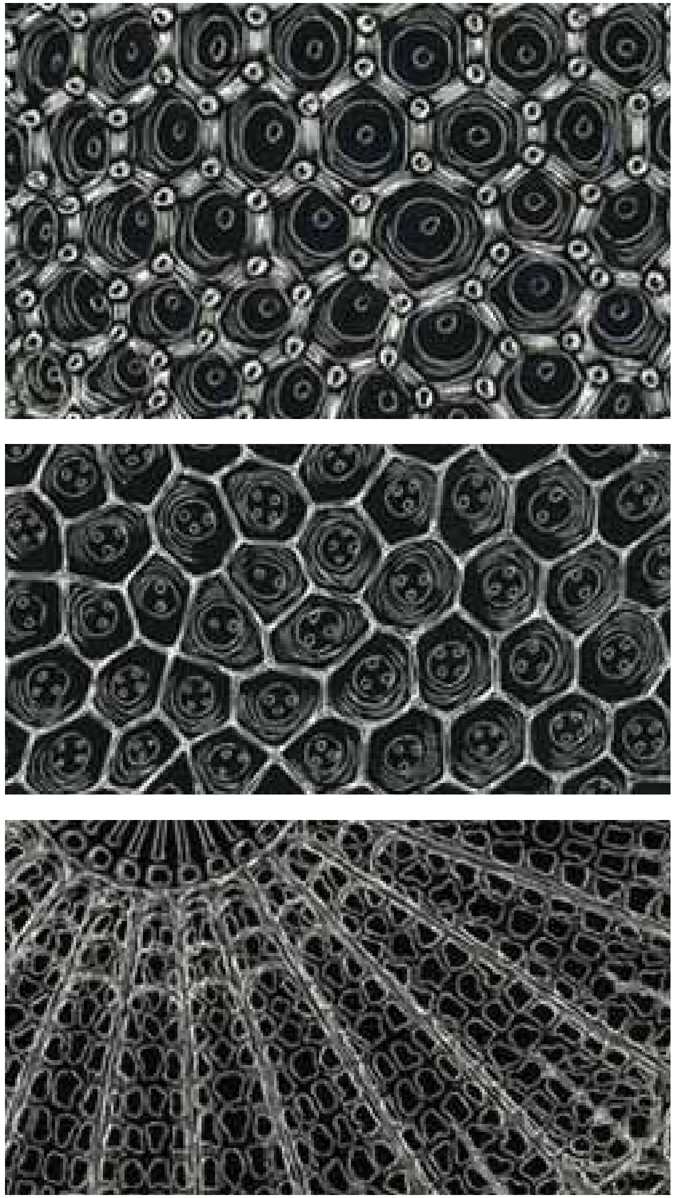


Haeckel, E., 1862. Radiolarien- rhizopoda radiaria, Berlin: georg reimer. Available at: http://caliban.mpiz-koeln.mpg.de/haeckel/radiolarien/.



http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/art-feb05/cbdiatoms.html

Geometry and patterns

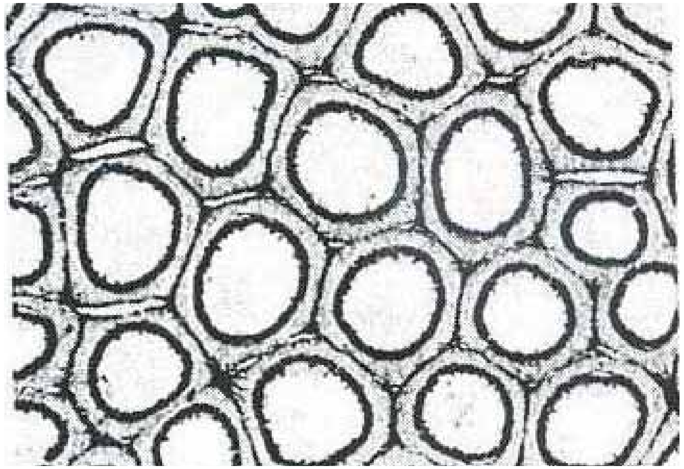


http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/art-feb05/cbdiatoms.html

closest packed tubules

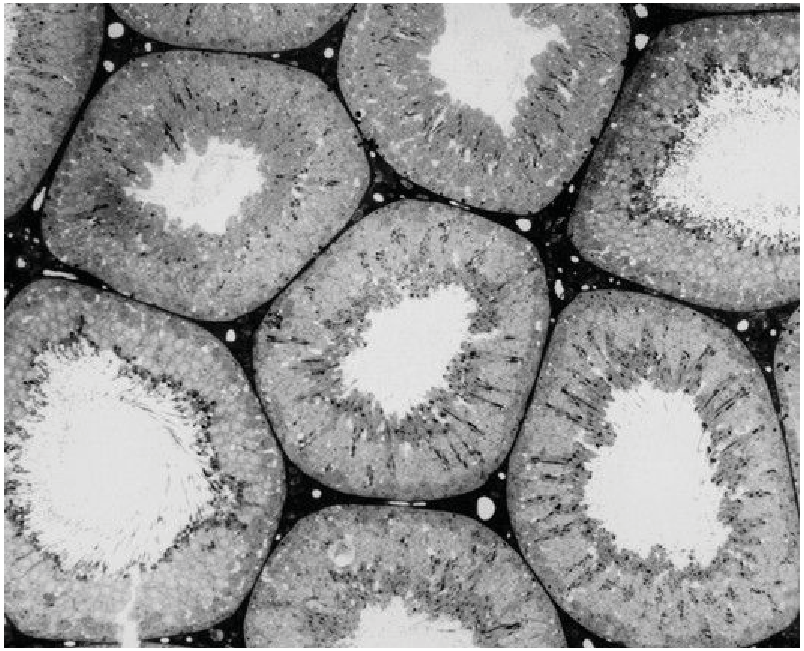
Mushrooms spores

http://morrisonworldnews.com/?p=28397

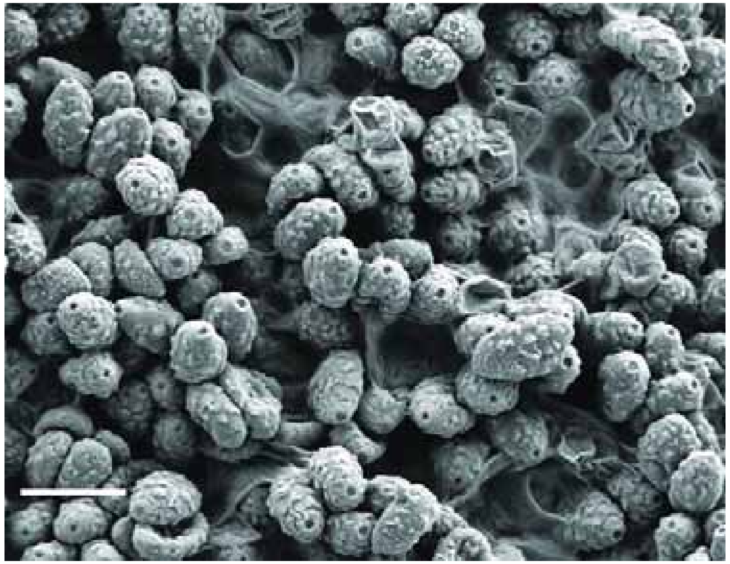


underside of a mushroom (jirovec)

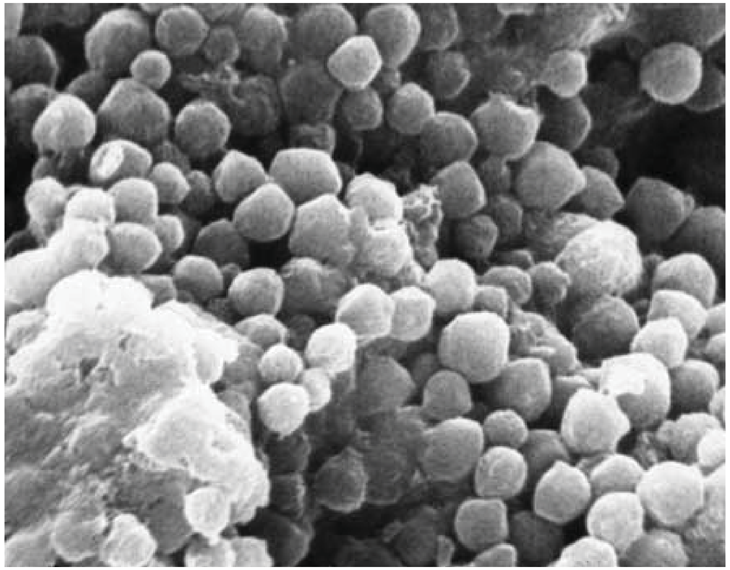
Transmission electron micrograph (TEM) of a transverse section through a number of seminiferous tubules in a mammalian testis, the site of production of sperm. The testis is packed with numerous tubules which are lined by a stratified epithelium consisting of 2 distinct groups of cells; the central white area is the tubule lumen (interior). One group of cells is the spermatogenic series, ie those cells involved in both spermatogenesis (production of male gametes) and subsequent spermiogenesis (evolution of male gamete into motile spermatozoon). The other group are non-spermatogenic cells called Sertoli cells, which nourish the developing spermatozoa.



closest packed tubules

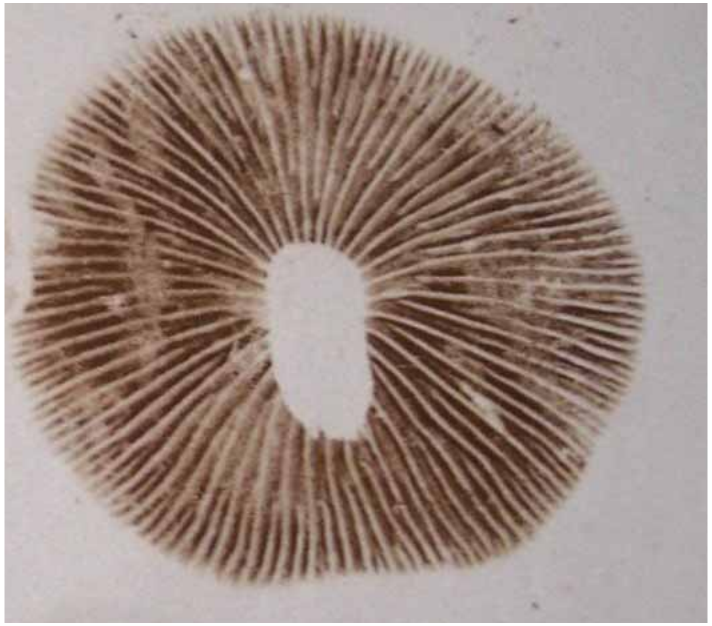


mushroom spores



http://newswatch.nationalgeographic.com/2011/06/16/weird-wild-spongebob-mushroom-named/

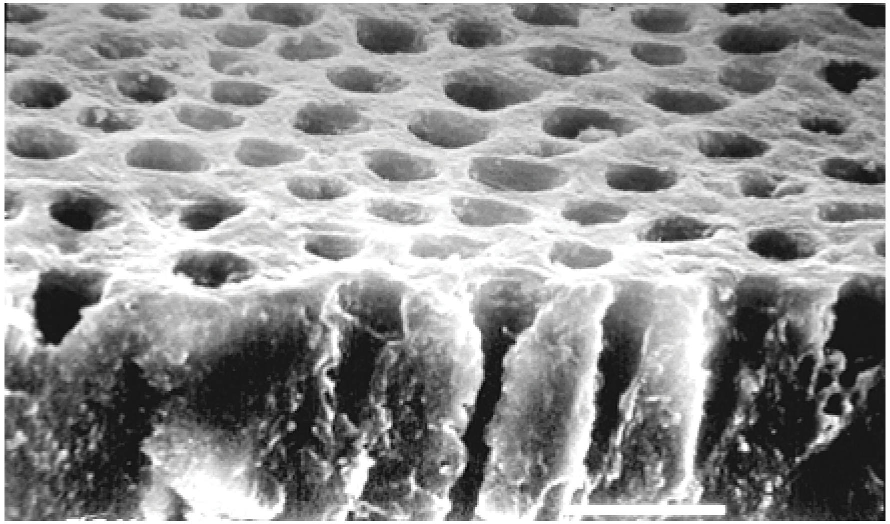
Unit geometry



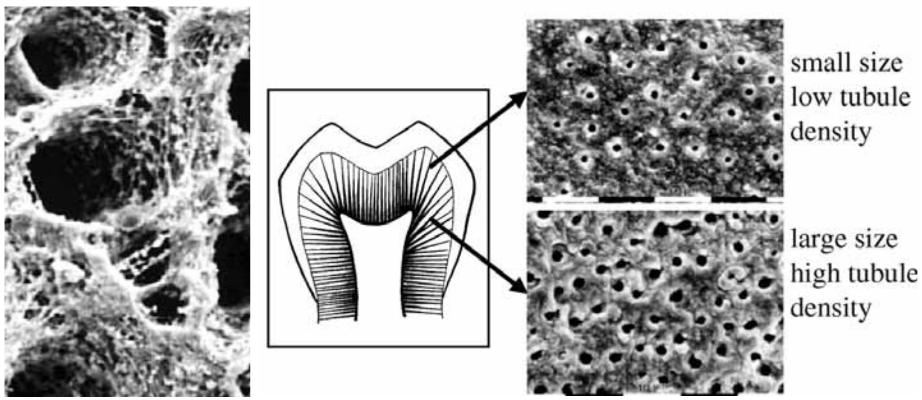
http://www.mushroomsfmrc.com/gpage11.html

Denisty

Dentin tubules



SEM micrograph showing the spatial distribution of dentin tubules.
Misra A et al. J. R. Soc. Interface 2005;2:145-157



As is evident, the structure and properties of dentin substrate vary with location and can affect the bond formation (Marshall et al. 1997).

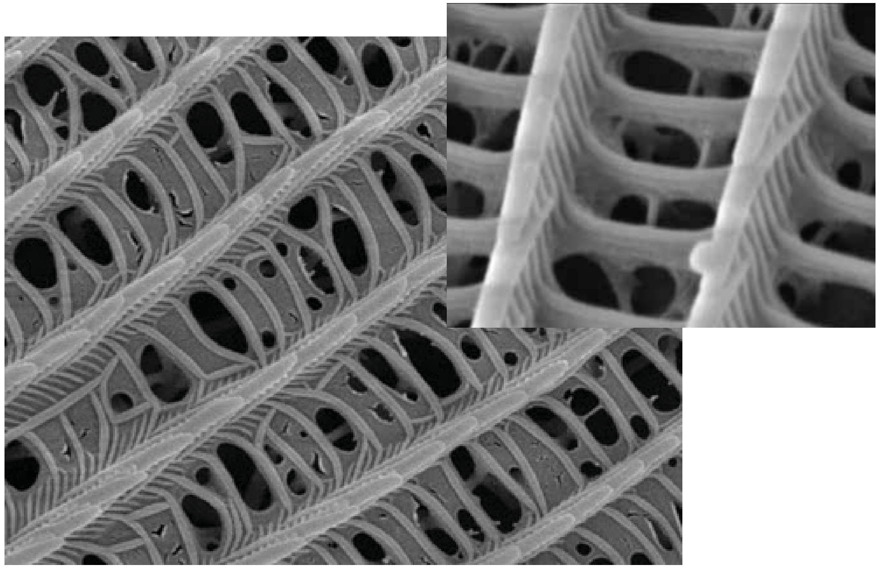
Misra A et al. J. R. Soc. Interface 2005;2:145-157

Mushrooms spores

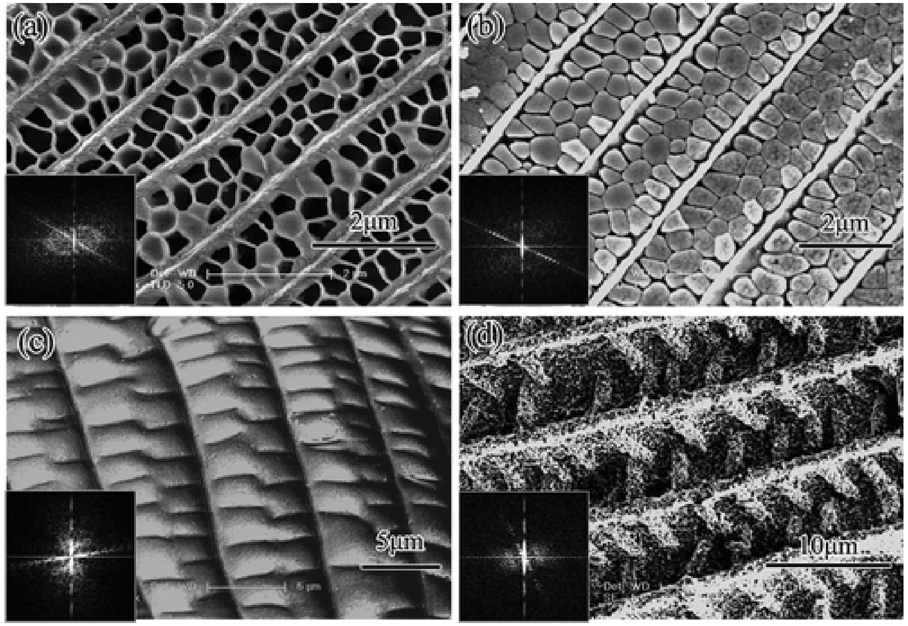
Mushrooms spores. Coloured scanning electron micrograph (SEM) of spores (round, brown, left and right) of the Agaricus bisporus fungus. The spores are the reproductive structures of the fungus, formed by and released by mushrooms, the fruiting bodies of a fungus. Magnification: x480 when printed 10cm wide.

Biomimicry of butterfly wings for more powerful solar cells

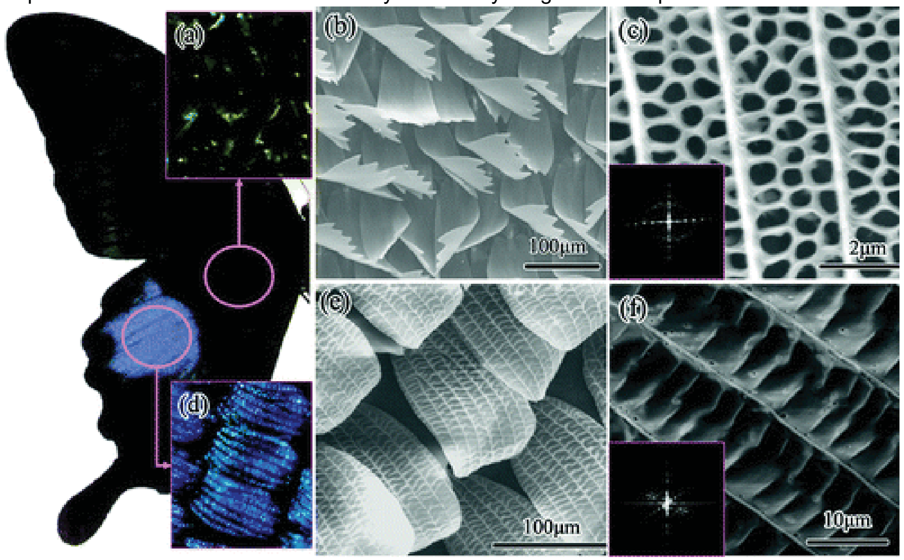
The discovery that butterfly wings have scales that act as tiny solar collectors has led scientists in China and Japan to design a more efficient solar cell that could be used for powering homes, businesses, and other applications in the future. The researchers turned to the microscopic solar scales on butterfly wings in their search for improvements. Using natural butterfly wings as a mold or template, they made copies of the solar collectors and transferred those light-harvesting structures to Grätzel cells.Laboratory tests showed that the butterfly wing solar collector absorbed light more efficiently than conventional dye-sensitized cells. The fabrication process is simpler and faster than other methods, and could be used to manufacture other commercially valuable devices, the researchers say.



This is a SEM (Scanning Electron Microscope) image of butterfly wing scale. The instrument magnification was set at 10,000x. The distance between the parallel main ribs is about 750 nanometers
http://kqedscience.tumblr.com/post/11917017860/this-is-a-sem-scanning-electron-microscope-image
http://www.trincoll.edu/~alehman/



http://www.robaid.com/bionics/biomimicry-of-butterfly-wings-for-more-powerful-solar-cells.htm



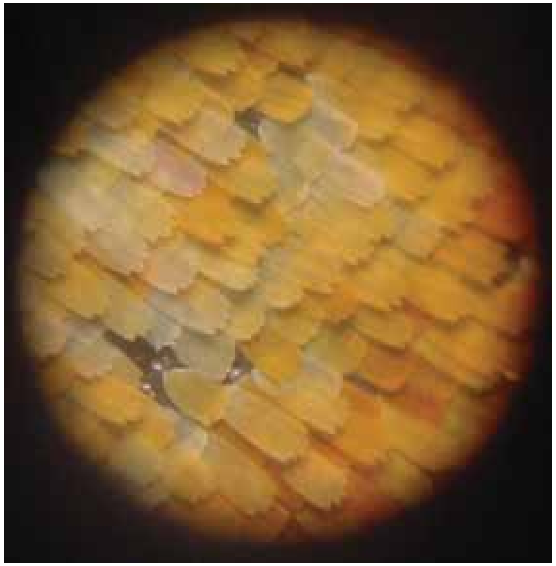
http://www.robaid.com/bionics/biomimicry-of-butterfly-wings-for-more-powerful-solar-cells.htm

co- equal tensions & hexagonal network

butterflywing

Zoomed-out view of an Inachis io.

Closeup of the scales of the same specimen.



High magnification of the coloured scales (probably a different species).

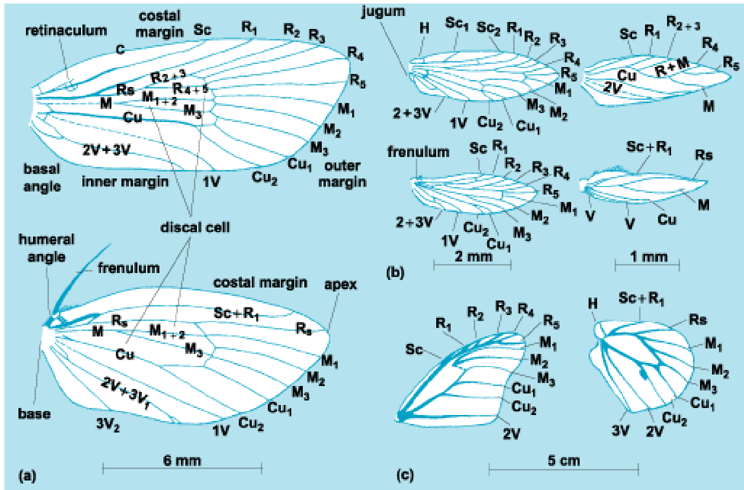
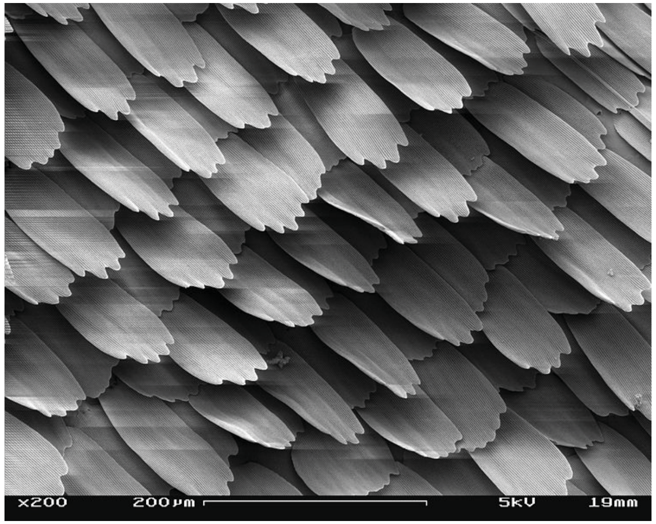
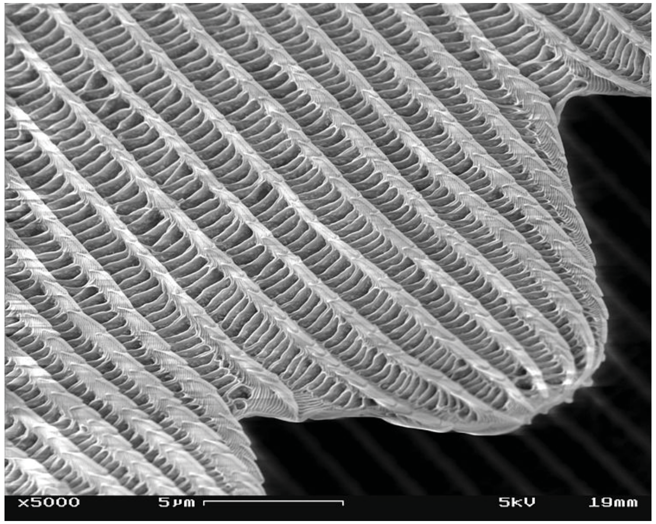


Fig. 4 Wing venation patterns with the veins labeled. (a) Male Acrolophus popeanellus (Tineidae). (b) Epimartyria (Micropterygidae) and Nepticula nyssaefoliella (Nepticulidae). (c) Danaus plexippus (Nymphalidae). C = costa; Sc = subcosta; R = radius; Rs = radial sector; M = media; Cu = cubitus; 1V, 2V, 3V = vannal or anal veins; H = humeral vein; subscripts refer to branches (for example, R2 is second branch of radius).

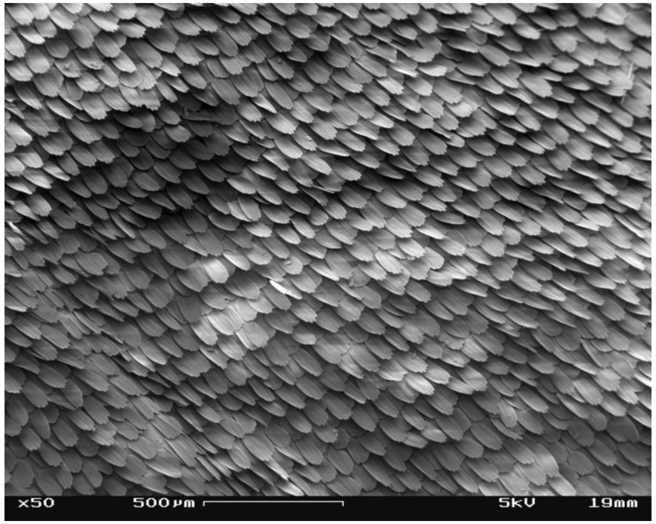
Co- equal tensions & hexagonal network



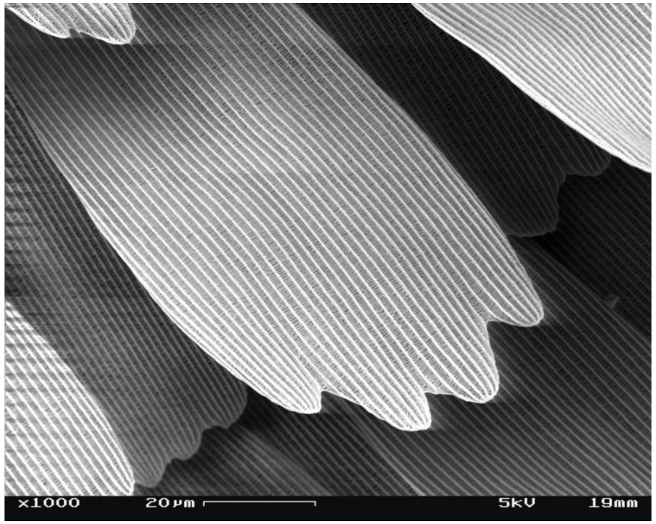
Scales close up



Microstructure of a scale

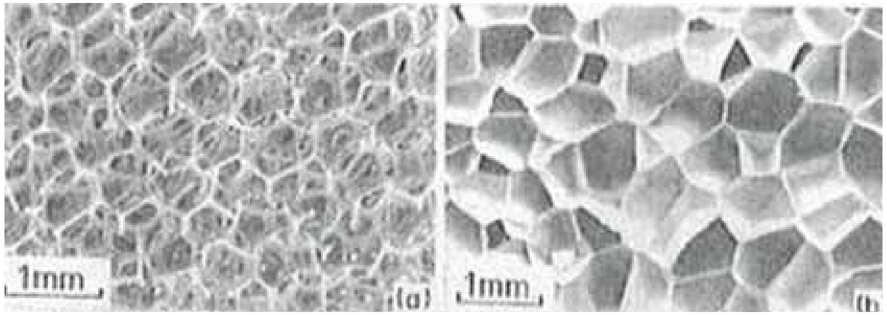


A patch of wing



A single scale

The rule of three edges meeting at a point, but there is a d ١٢٠ strong tendency for each point to be surrounded by .angle



Natural cellular

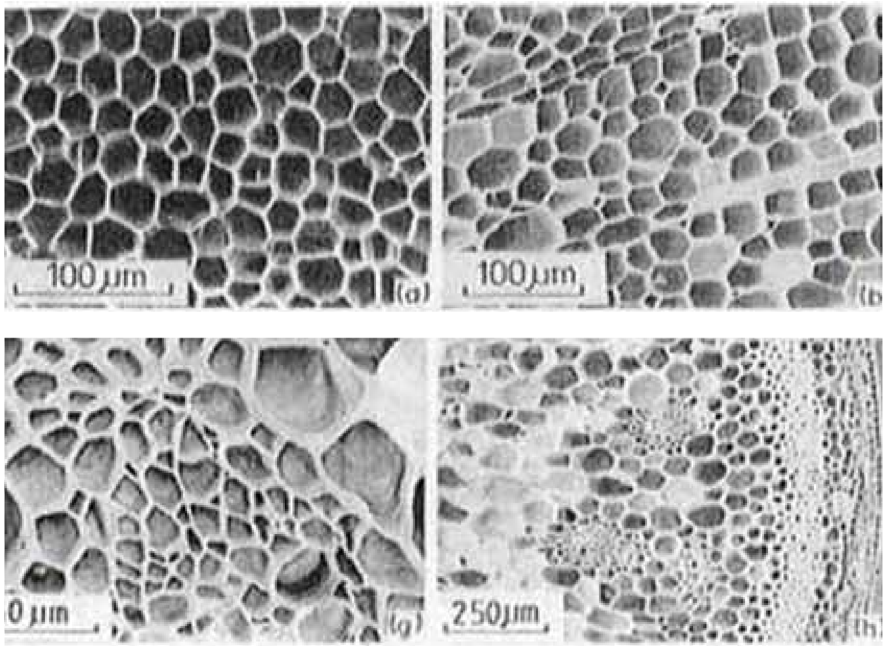
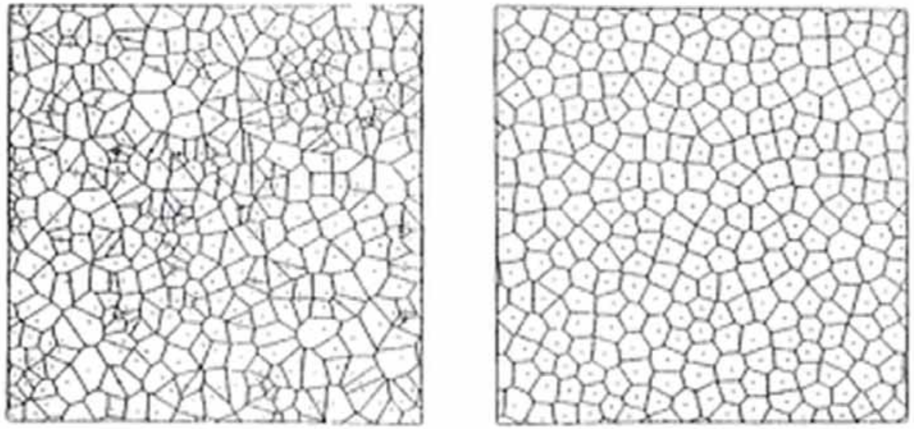


Figure 2.6 Natural cellular materials: (a) cork, (b) balsa, (c) sponge, (d) cancellous bone, (e) coral, (f) cuttlefish bone, (g) iris leaf, (h) stalk of a plant.

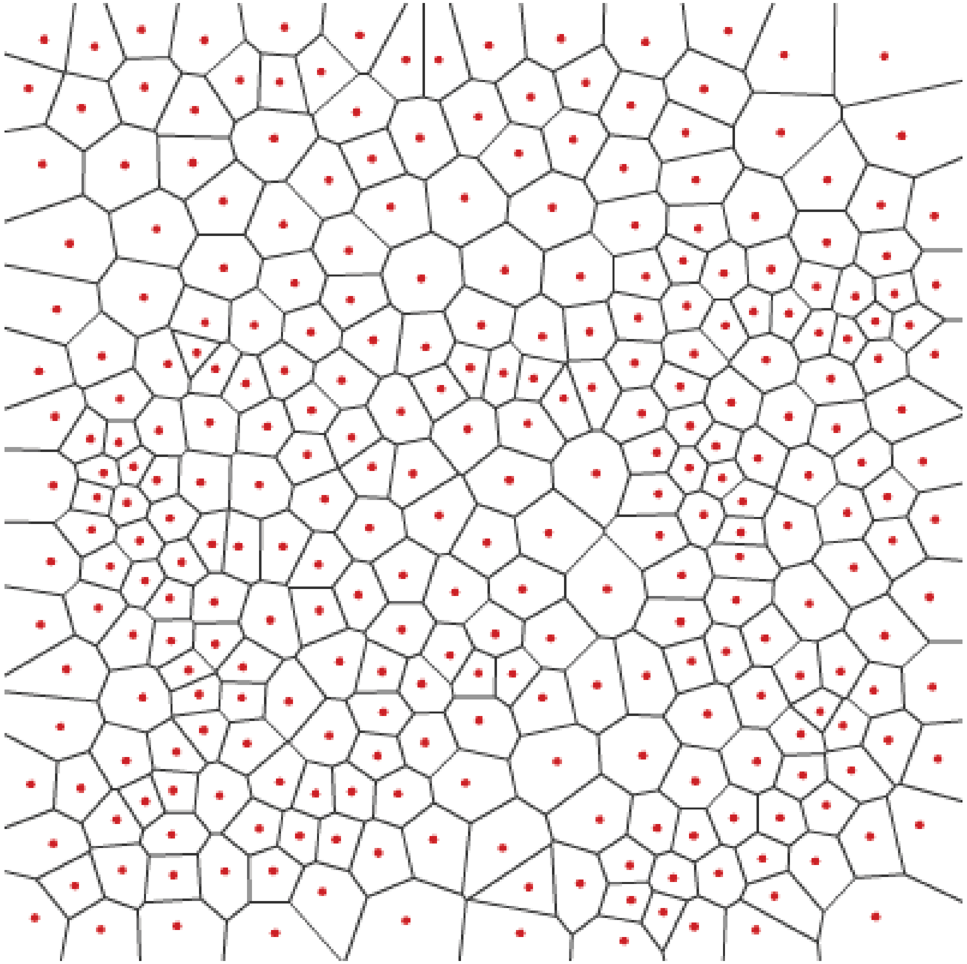


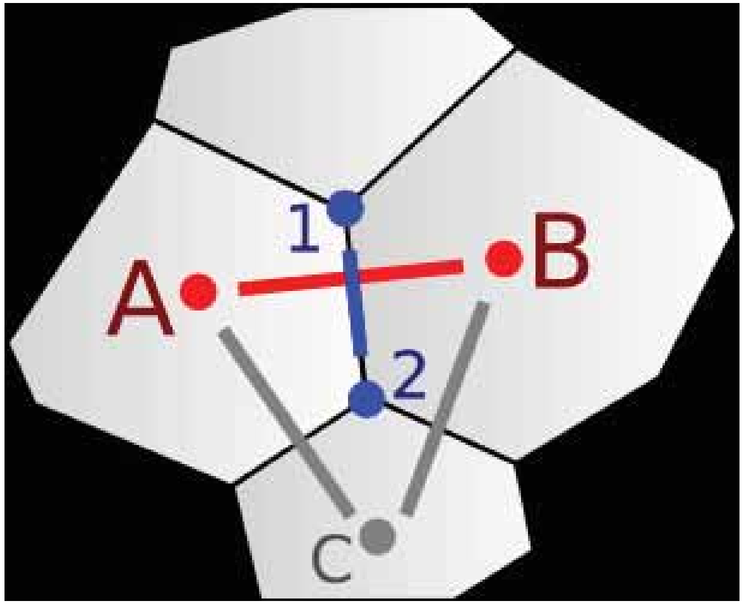
(a) (b)

Figure 2.14 (a) A Voronoi honeycomb for a set of random points (marked). (This is the structure that would form if cells nucleate at random points, all appearing at the same instant, and grow with the same linear growth rate.) (b) A Voronoi honeycomb for a set of points, initially random, from which all points closer than a critical spacing were removed. (This is the structure that would form if cells cannot nucleate closer together than a critical spacing and grow with the same linear growth rate.)

Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

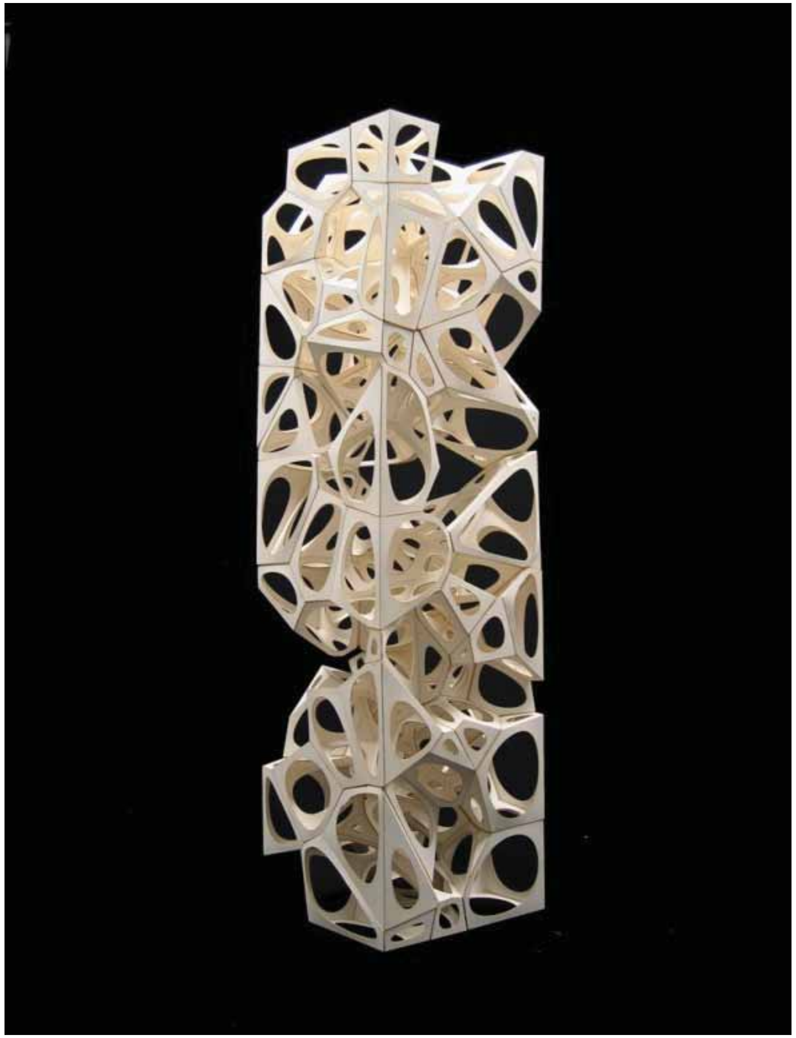
Voronoi corners



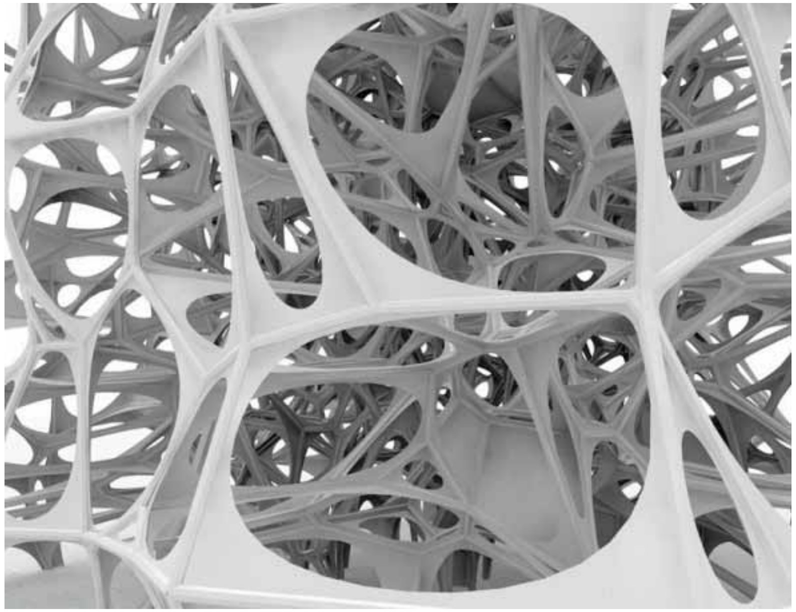


http://www-cs-students.stanford.edu/~amitp/game-programming/polygon-map-generation/

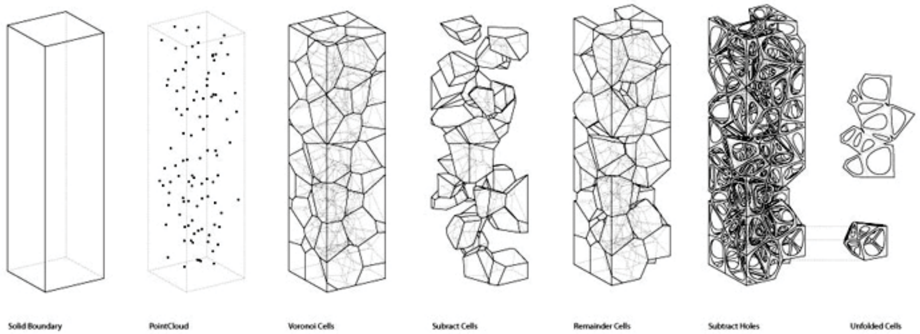
VORONOI MORPHOLOGIES



paper prototype
http://matsysdesign.com/category/projects/voronoi-morphologies/

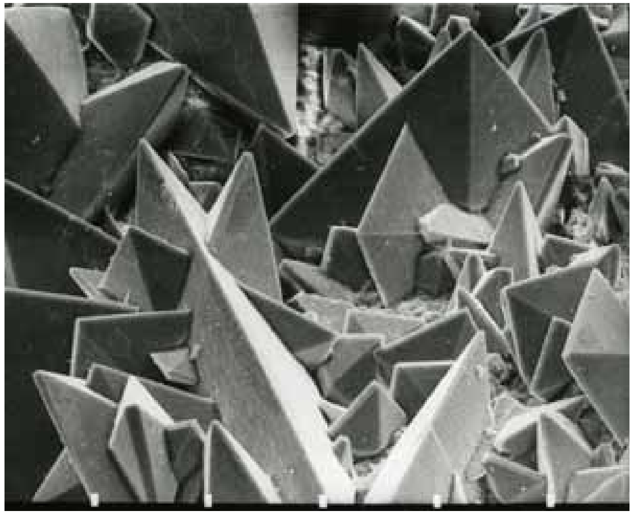


Prototype detail
http://matsysdesign.com/category/projects/voronoi-morphologies/

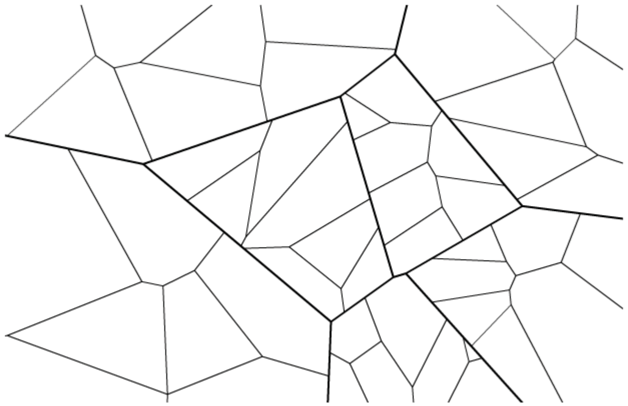


voronoi drawings
http://matsysdesign.com/category/projects/voronoi-morphologies/

Scanning electron microscope

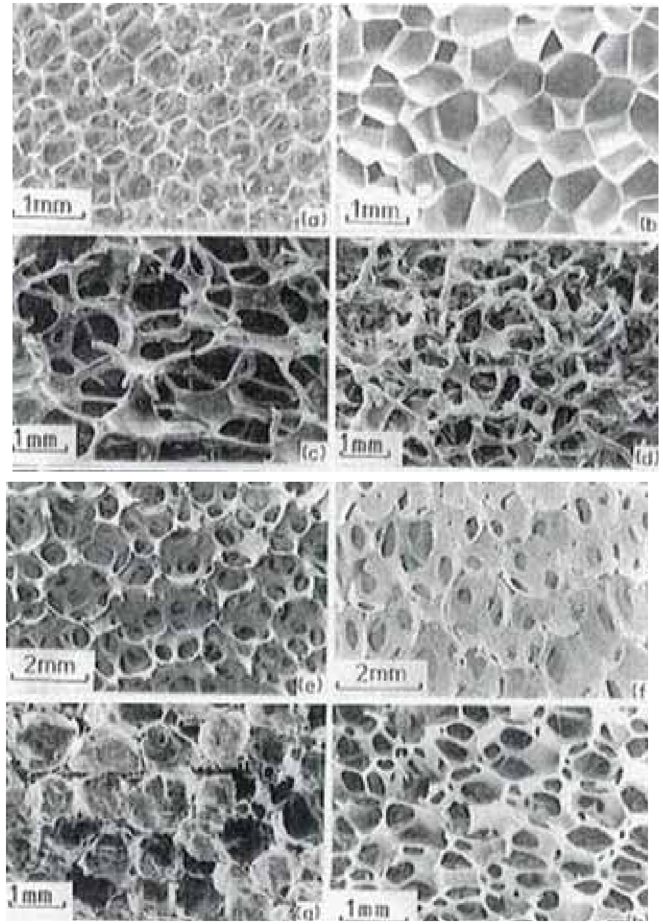


Scanning Electron Micrograph of the surface of a kidney stone showing tetragonal crystals of Weddellite (calcium oxalate dihydrate) emerging from the amorphous central part of the stone



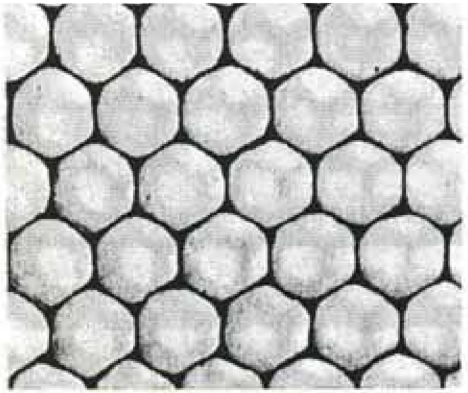
Voronoi Fractal http://blog.inspirit.ru/?p=96

Three diemensional cellular



Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.

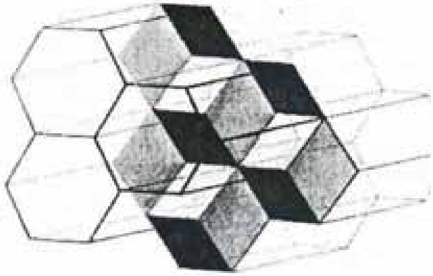
closest packing in nature

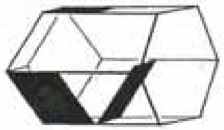


2.1 Bees' honeycomb.

2.2 Honeycomb cell structure.

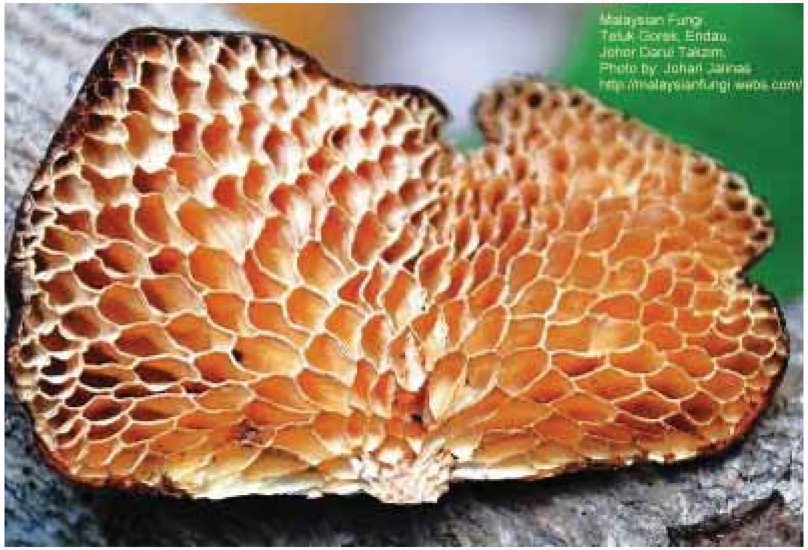
2.3 Single honeycomb cell, showing rhombic dodecahedron within.





least energy
the honeycomb consists of teo set of contiguous cells, positioned back to back. The back to back cells are staggered in such a way that the centers of the set of cells on one side are positioned exactly over helf of the tree rayed intersections of cell walls of the set of cells on the other side. this arrangement corresponds to a packing of two layers of rhombic dodecahedra or
two layers of closet packed spheres .
That closest packing is simply a reflection of nature`s tendency to coordinate extrinsic forces in the most the most economic way.

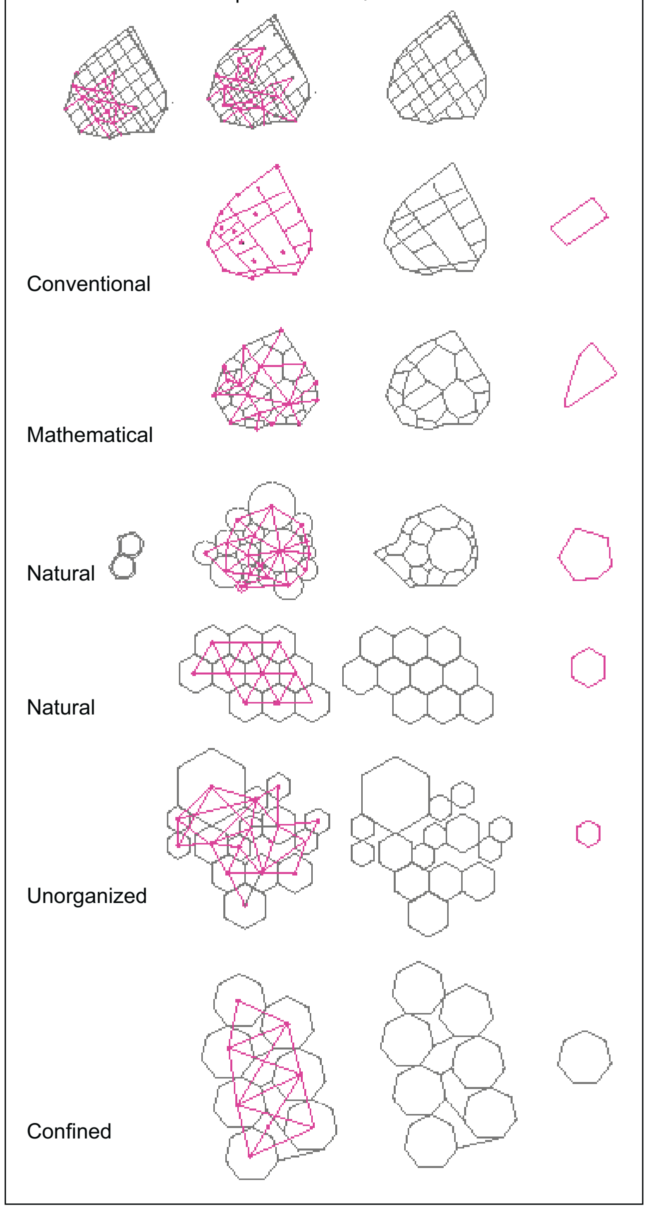
Pearce, P., 1990. Structure in Nature Is a Strategy for Design, Cambridge, Mass: MIT Press.



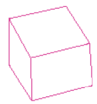
HONEYCOMB- Favolus alveolaris
ttp://malaysianfungi.blogspot.com/2009/10/honeycomb-favolus-alveolaris.html

http://article.wn.com/view/2010/08/18/City_bees_get_richer_diet_than_bees_from_farm-lands_Study/

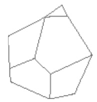
Lattice structure



minimal surface minimal materials



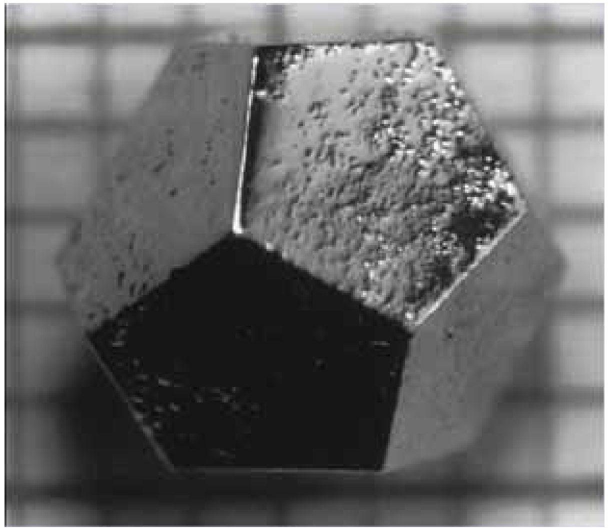
volume (cm) 118.55
surface area (sq m) 2.37



volume (cm) 118.55
surface area (sq m) 2.11

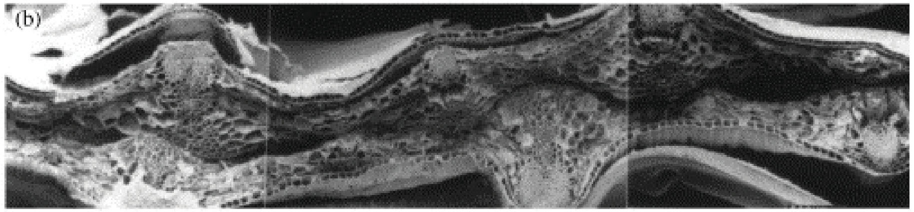
material reduction 32%

http://he.wikipedia.org/wiki/%D7%A7%D7%95%D7%91%D7%A5:Honey_comb.jpg

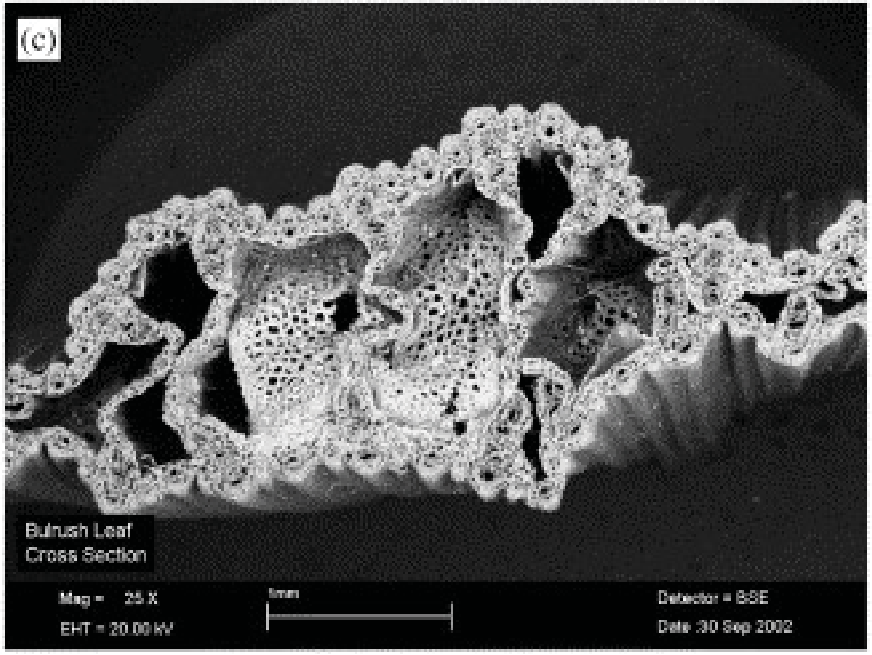


איור מס' 2 : קווזי-גביש יחיד של הולמיום-מגנזיום-אבץ שמתגבש בתצורה דודקהדרית. בעל סימטריה איקוסהדרית כמו גביש האלומיניום-נחושת-ברזל שבאיור מס' 1 [א]. הגביש מצולם מעל קנה-מידה מילימטרי. גביש זה הוצמח על ידי איאן פישר במעבדות איימס שבמדינת איווה בארה"ב. [I.R. Fisher et al., PRB 59 (1999) 308-321]

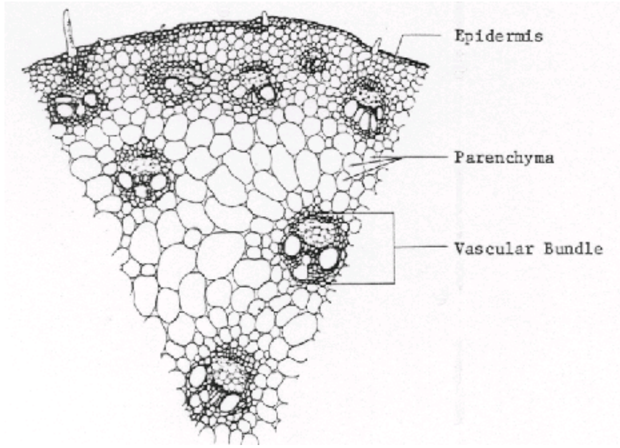
Natural sandwich structures



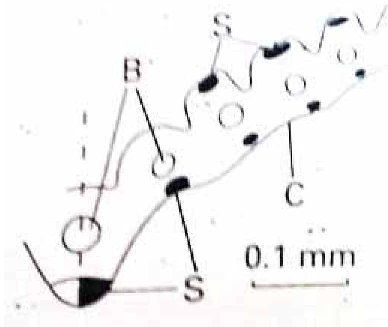
iris leaf MICROSCOPIC
http://www.sciencedirect.com/science/article/pii/S0021929004004919



cattail leaf http://www.sciencedirect.com/science/article/pii/S0021929004004919



Monocot stem,
http://www2.volstate.edu/msd/bio/1020/lab11seedplants.htm



Leaf Structure Illustrations
Ashby, M.F., 2005. Materials selection in mechanical design, Butterworth-Heinemann

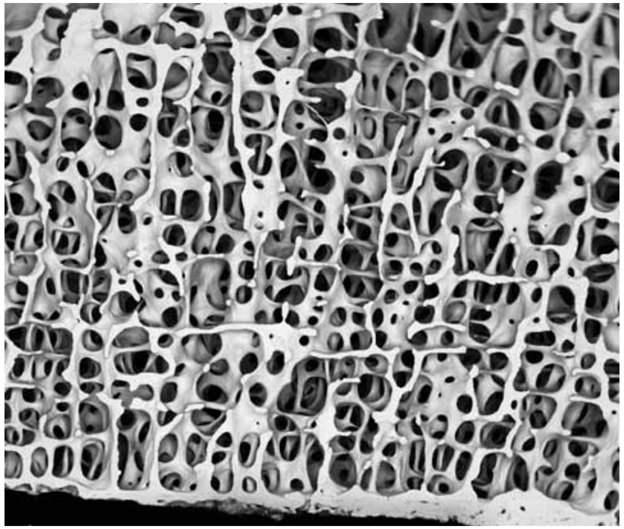
Research

Human bones

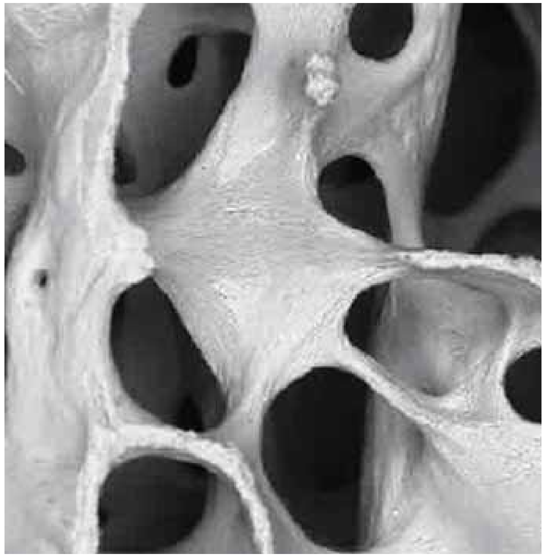
The project started in a research on human bones, bone density, strength and structure. The main reason for this study was to find a constructive principles and laws to create the cellular , the building facade and the building itself.

The study expanded the backbone structure, backbone connection, and more connections in the human body. For example to find a connection the envelope joints, I used the laws of the knuckles.

Human bone - porosity

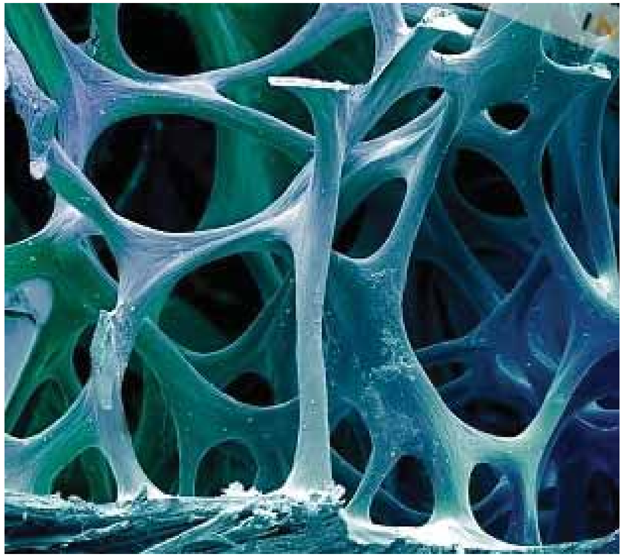


http://joshjung22.blogspot.com/2012_03_01_archive.html



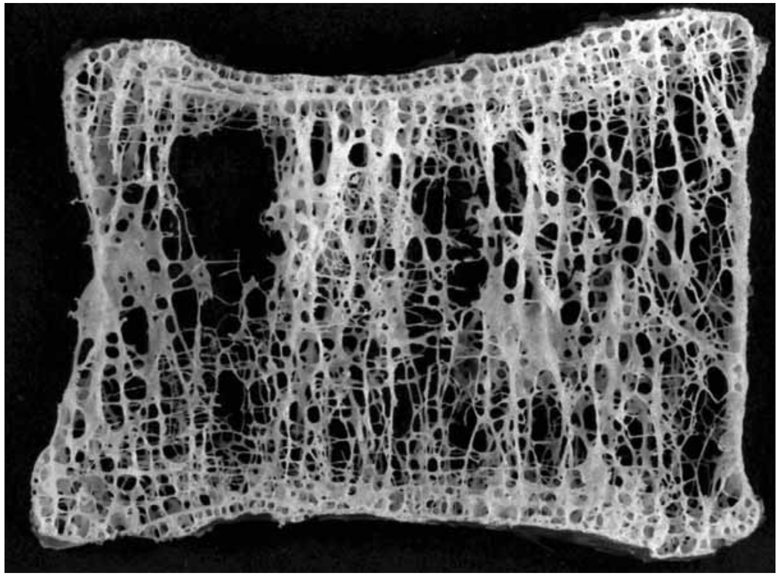
Human Bone Microscopy Image

http://www.microscopicpictures.com/microscope-Human_Bone.php

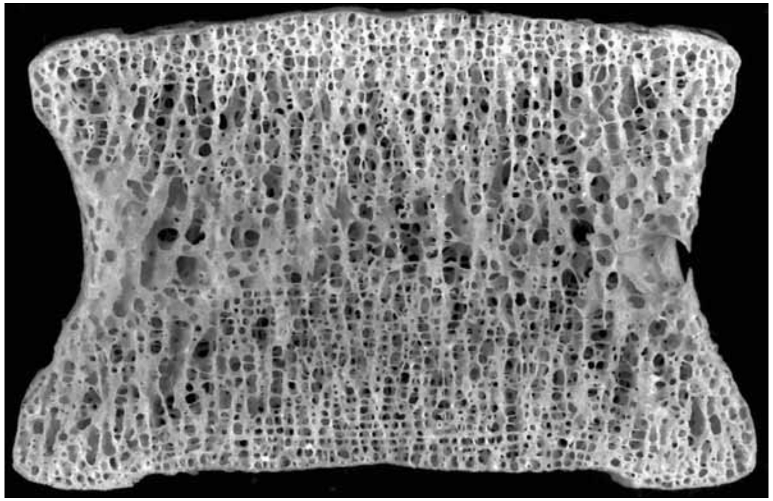


-Microscope bones
http://www.ectsoc.org/gallery/#myGallery-picture(16)

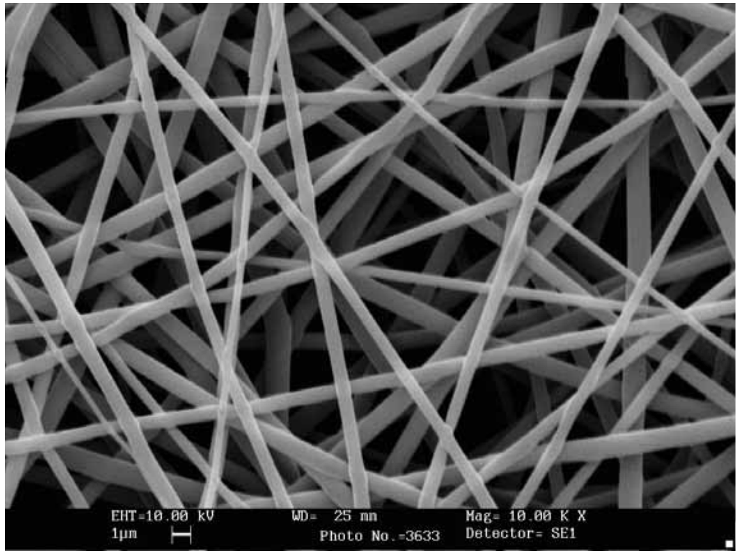
porosity



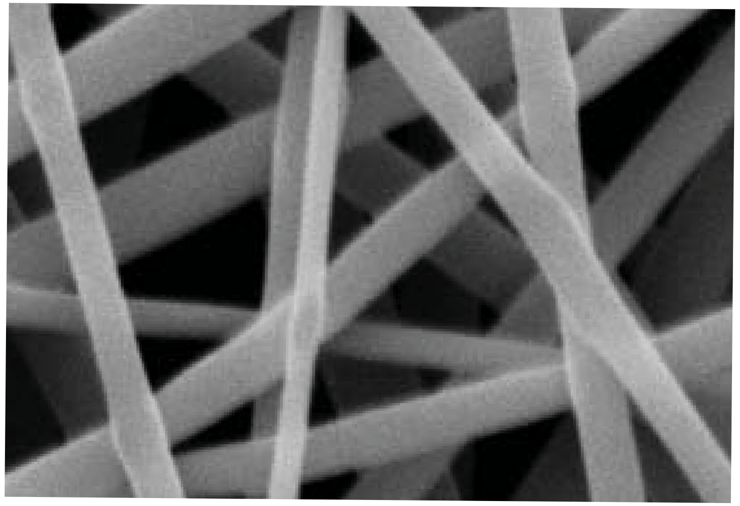
bone,
Human Bone, Osteoporosis ,male,89
copyright Professor Alan Boyde QMUL



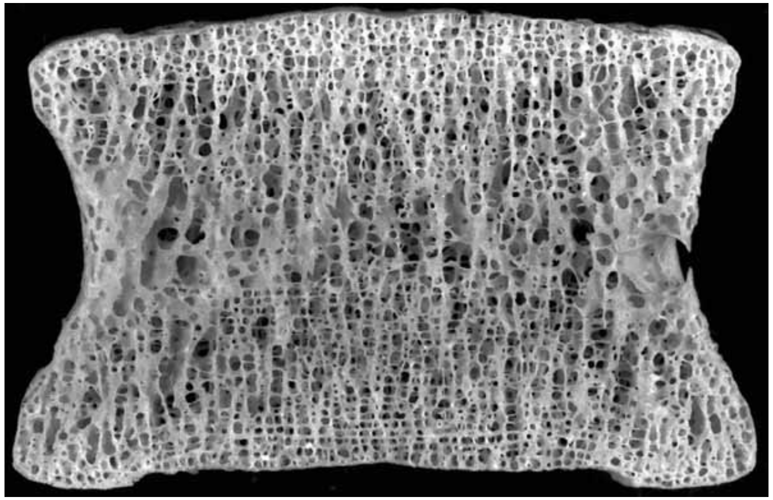
bone, healty women,50
copyright Professor Alan Boyde QMUL

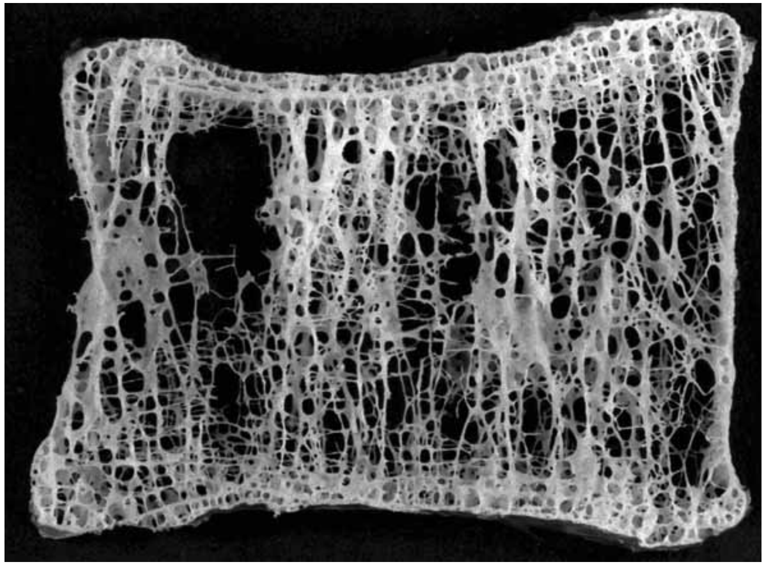


Microscope image of electrospun fibres
http://www.stfc.ac.uk/News+and+Events/5584.aspx



porosity





Radiographs of sections through human lumbar vertebrae (L1) (a) normal bone (b) osteoporotic bone, showing thinning and resorption of trabeculae. (Reproduced with permission from Vajjhala et al., 2000, published by the American Society of Mechanical Engineers.)

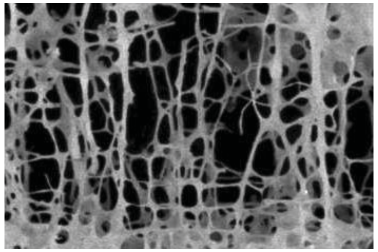
http://mccormickdc.com/osteoporosis

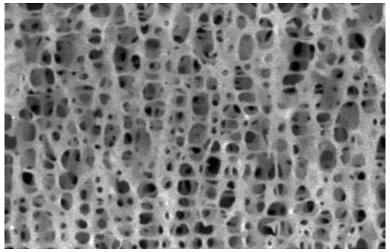
$$\frac{\text{void}}{\text{valid space}} = \text{porosity}$$

Healthy 0.369 = porosity

Osteoporosis 0.121 = porosity

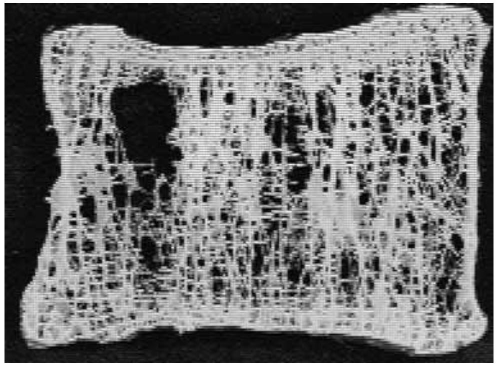
Osteoporosis valid space > Healthy valid space

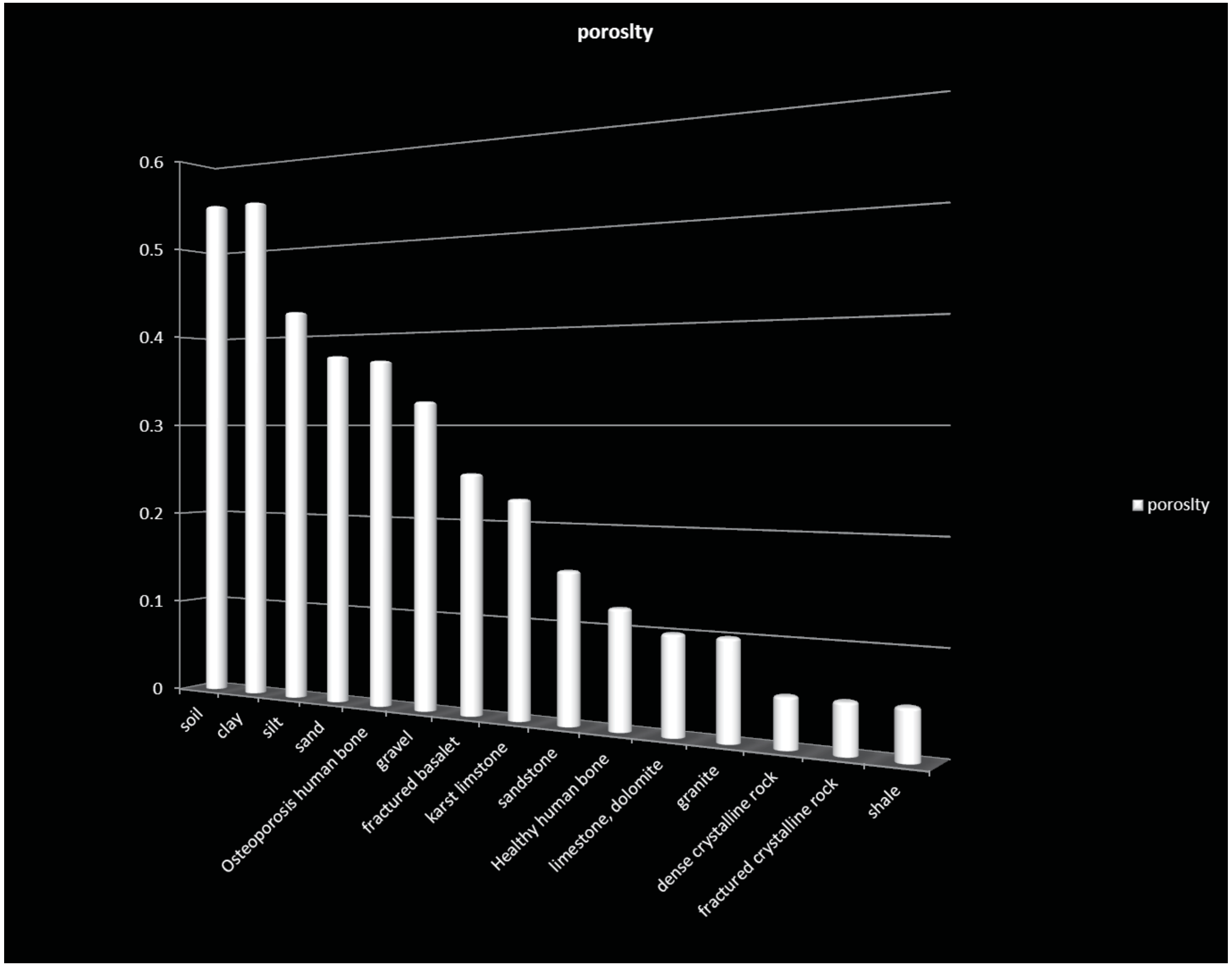




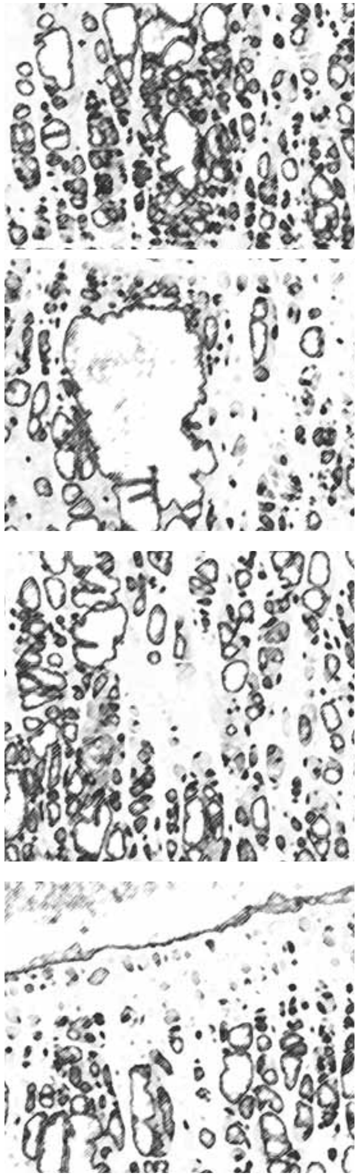
Source: Freeze and Cherry (1979).

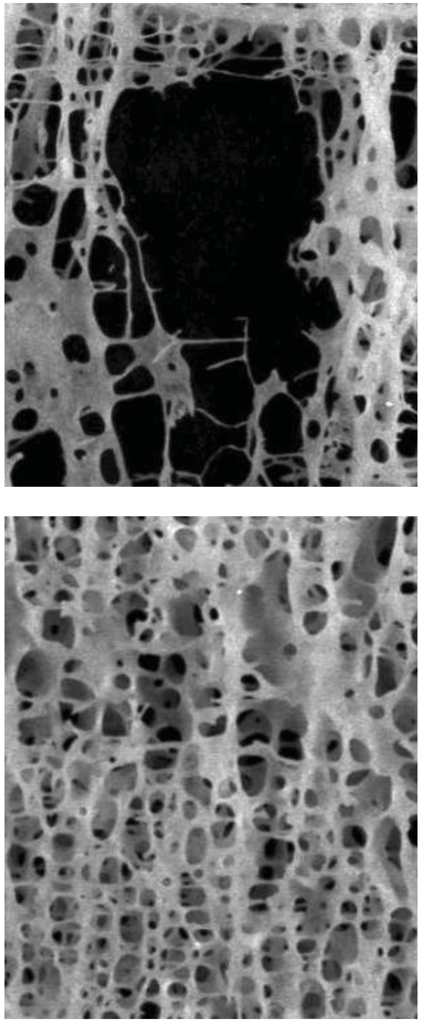
material	poroslty
soil	0.55
clay	0.55
silt	0.425
sand	0.375
Healthy human bone	0.369
gravel	0.325
fractured basalet	0.25
karst limstone	0.225
sandstone	0.155
Osteoporosis human bone	0.121
limestone, dolomite	0.1
granite	0.1
dense crystalline rock	0.05
fractured crystalline rock	0.05
shale	0.05





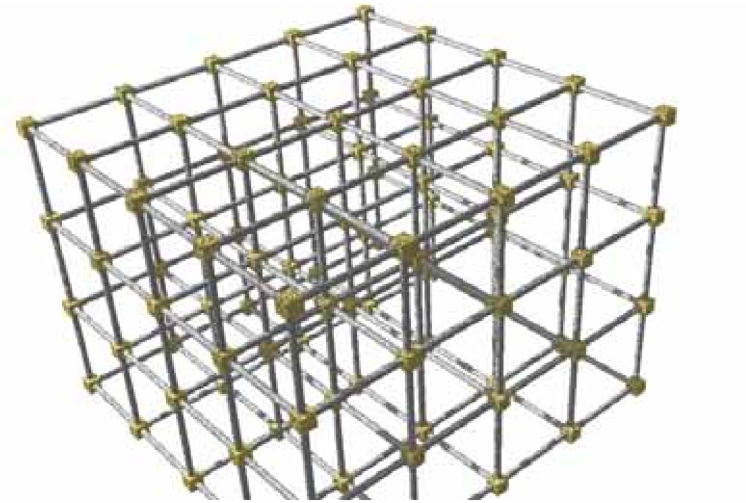
The bone as a surface

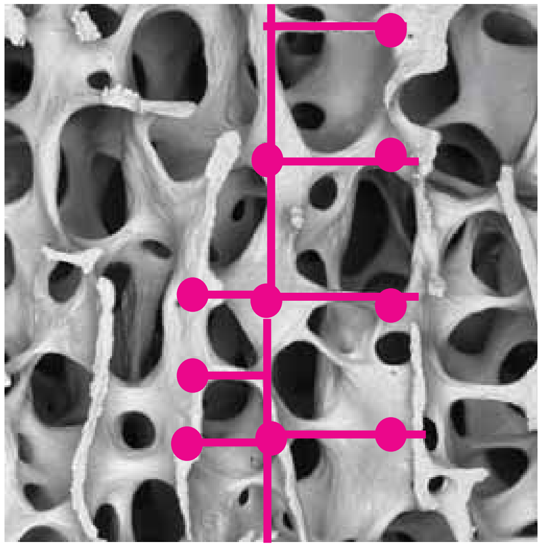


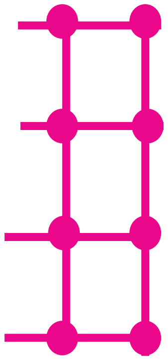


Constructive logic - framework

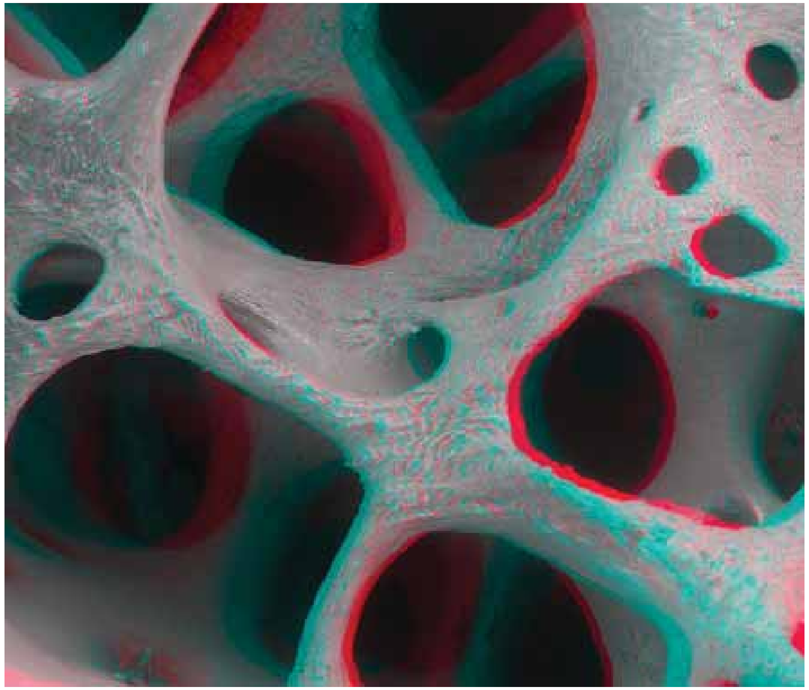
conventional formwork techniques to construct a highly differentiated tower





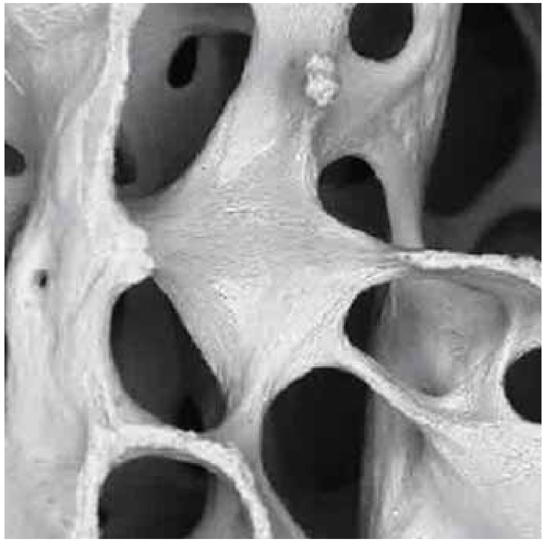


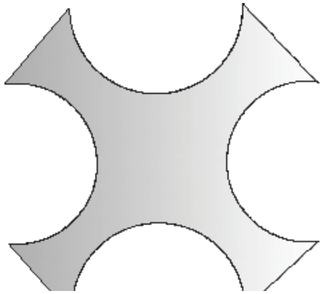
Bone in 3d - geometric design



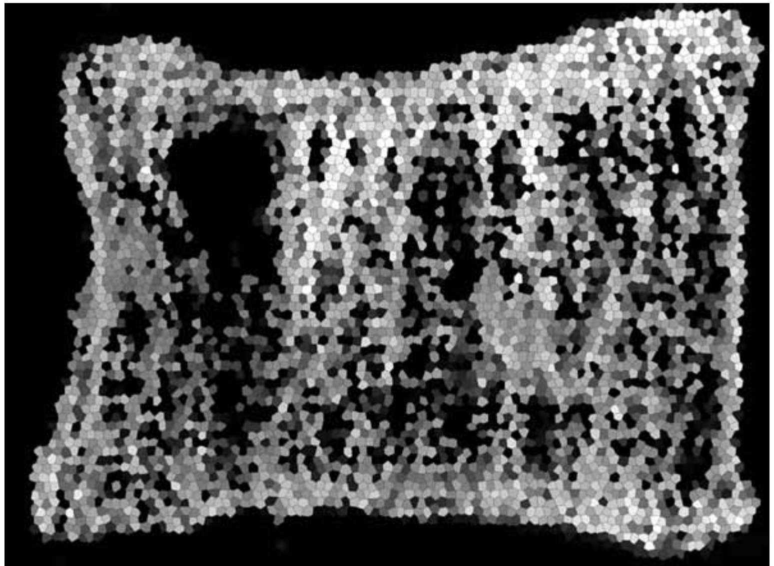
Architectural Association (Great Britain), 1982. Projects review [journal]. United Kingdom: United Kingdom : AA Publications.

Separate unit
Branches of connection



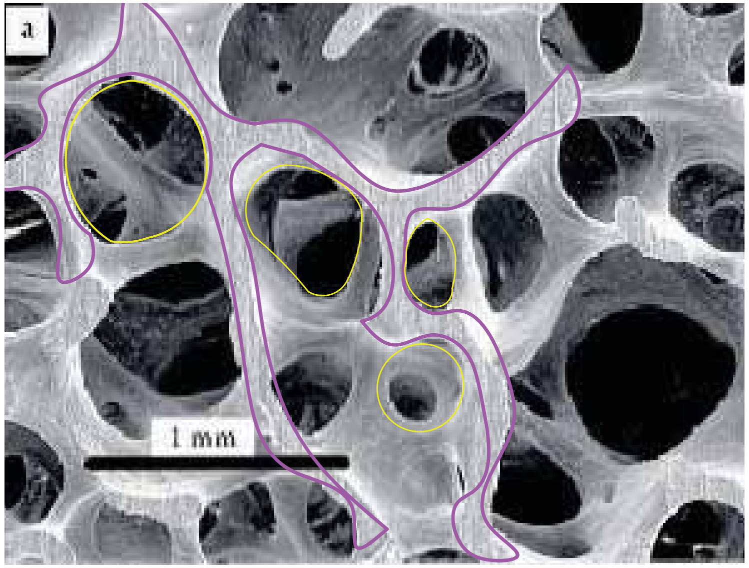


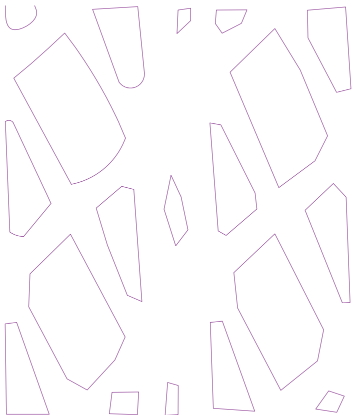
physical unit

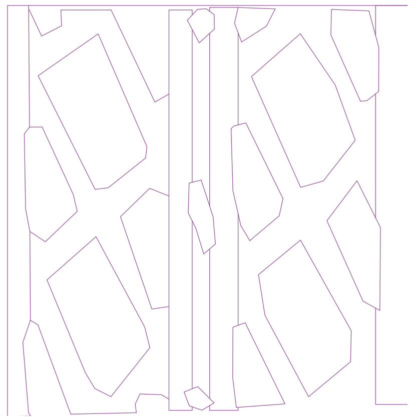


location by color

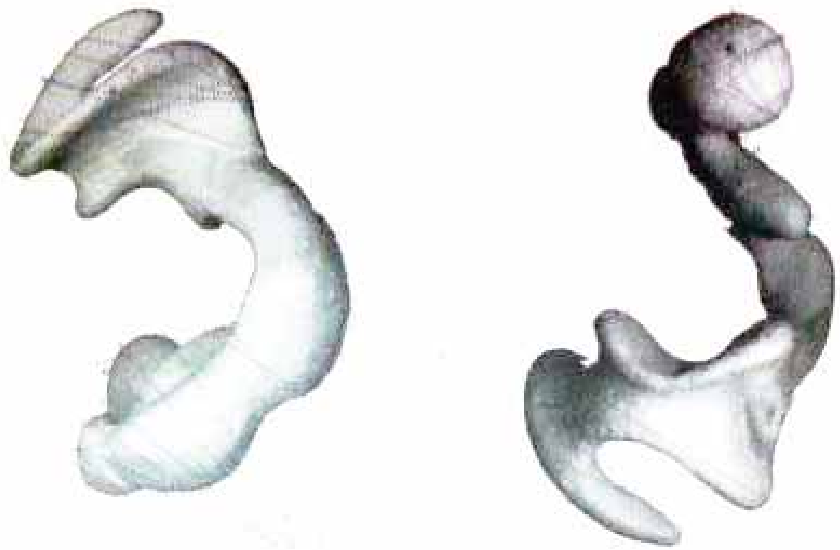
geometric diagnosis

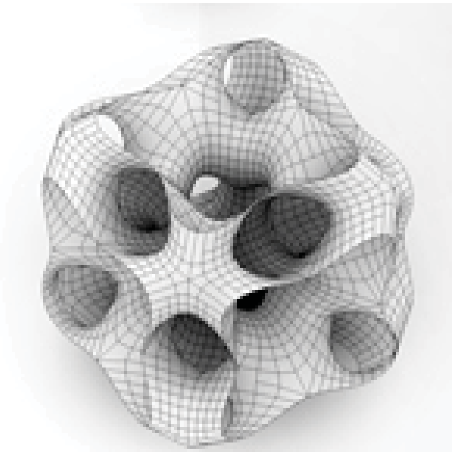




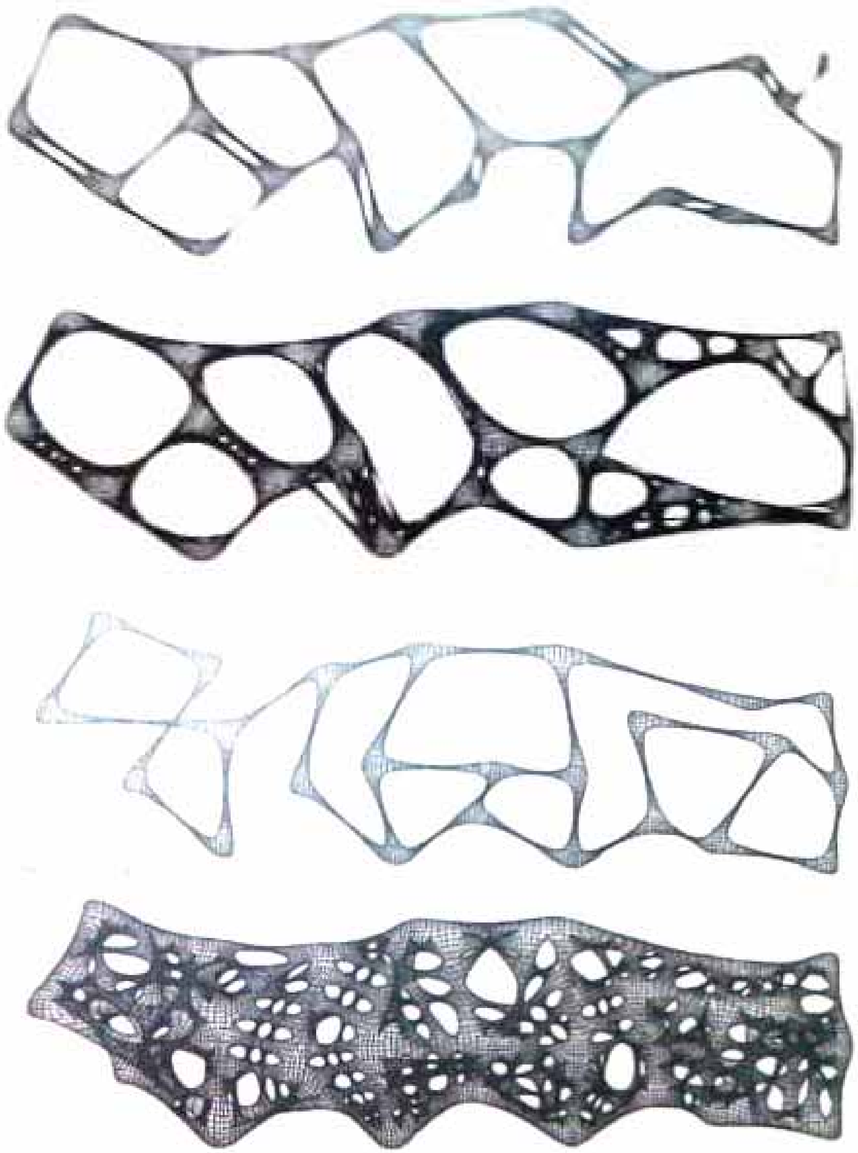


Structure





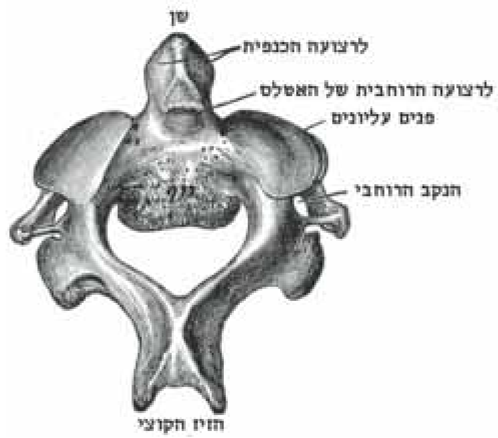
Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.

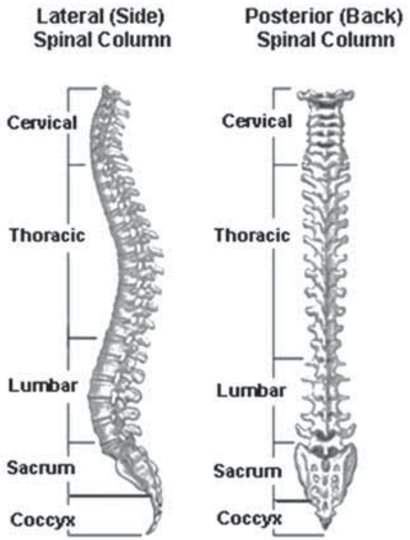


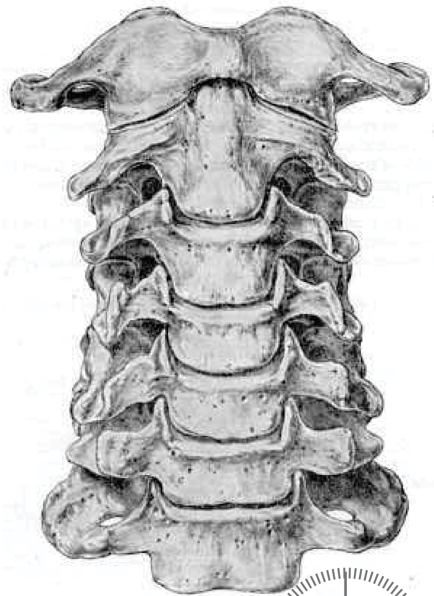
Architectural Association (Great Britain), 1982. Projects review [journal], United Kingdom: United Kingdom : AA Publications.

VERTEBRAL COLUMN

In human anatomy, the vertebral column usually consists of 24 articulating vertebrae,[1] and 9 fused vertebrae in the sacrum and the coccyx. It is situated in the dorsal aspect of the torso, separated by intervertebral discs. It houses and protects the spinal cord in its spinal canal.
There are normally thirty-three (33) vertebrae in humans, including the five that are fused to form the sacrum (the others are separated by intervertebral discs) and the four coccygeal bones that form the tailbone.
The upper three regions comprise the remaining 24, and are grouped under the names cervical (7 vertebrae), thoracic (12 vertebrae) and lumbar (5 vertebrae), according to the regions they occupy. This number is sometimes increased by an additional vertebra in one region, or it may be diminished in one region, the deficiency often being supplied by an additional vertebra in another. The number of cervical vertebrae is, however, very rarely increased or diminished



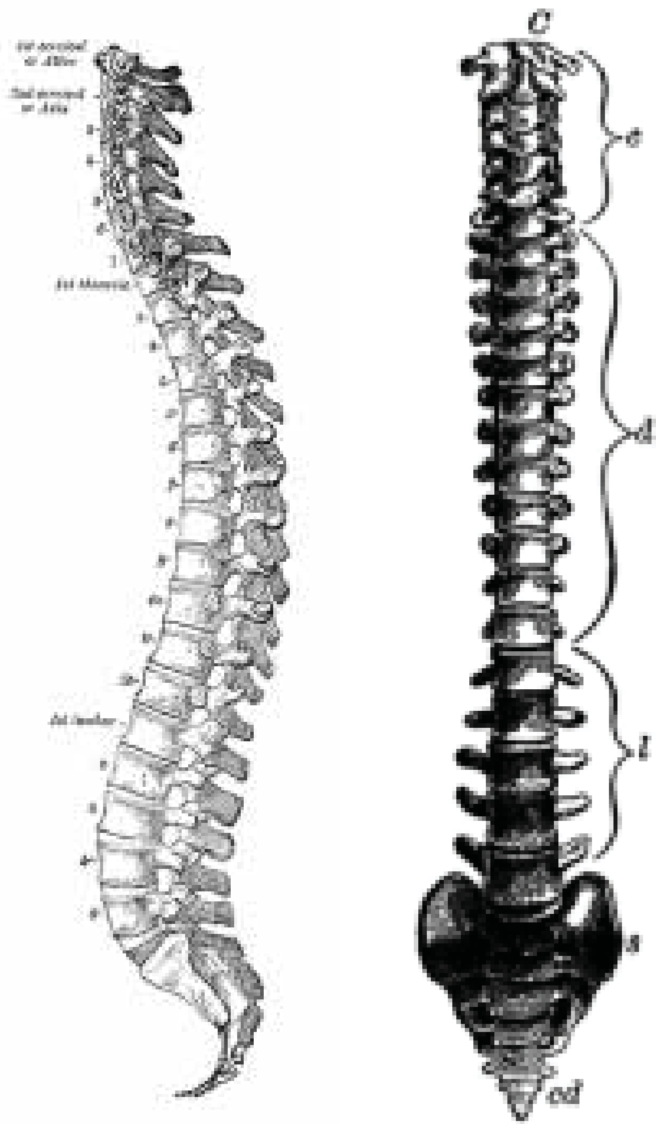




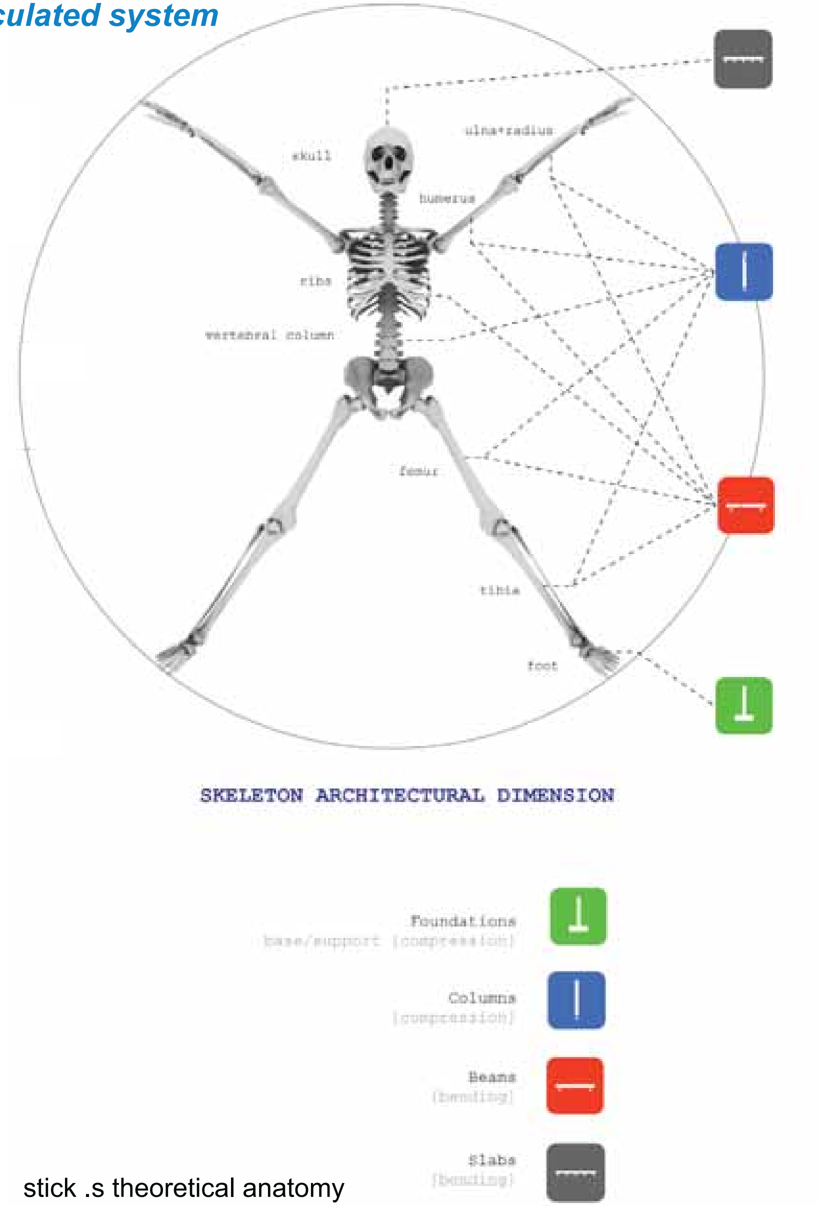
http://www.probertencyclopaedia.com/cgi-bin/res.pl?keyword=Vertebral%20 column&section=&offset=20

http://www.fastpainrelief.org/html/what_is_chiropractic.html

Rotation 90 degrees

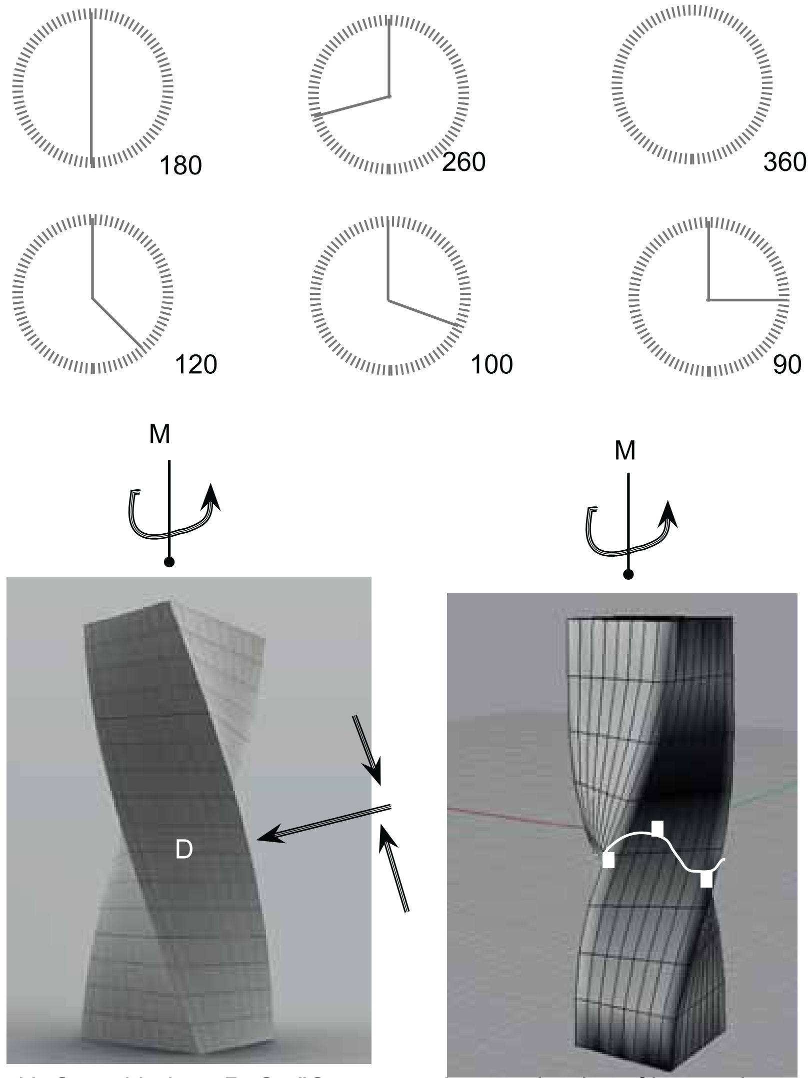


Source for comparison, the human body as an articulated system



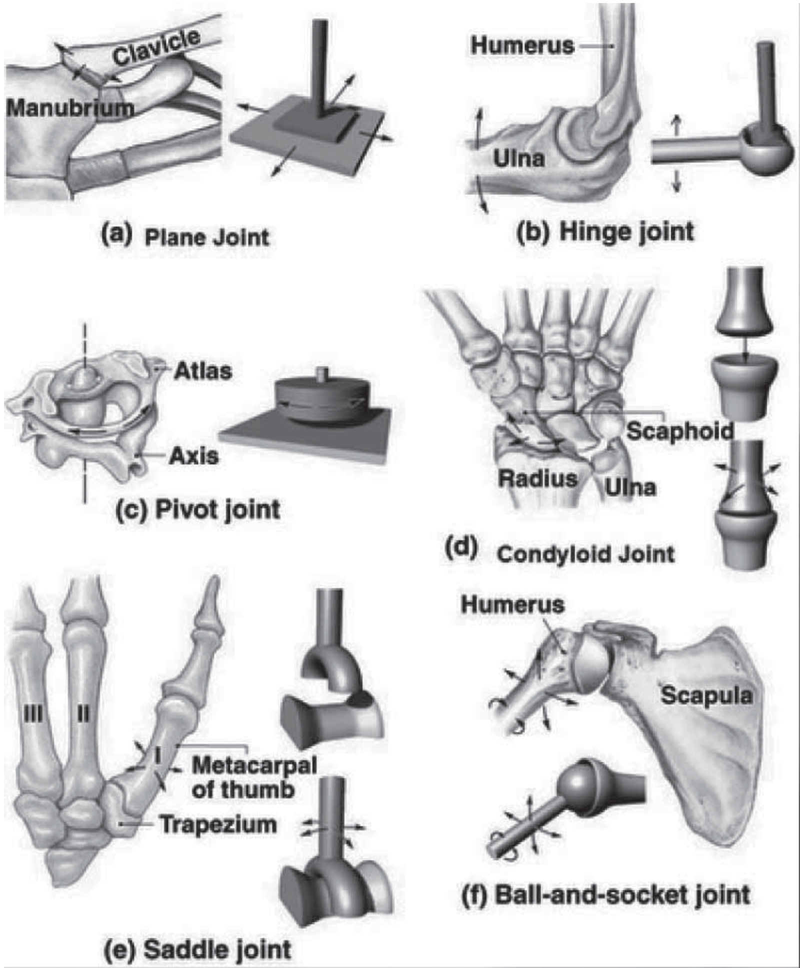
stick .s theoretical anatomy
body architectural & structural dimension

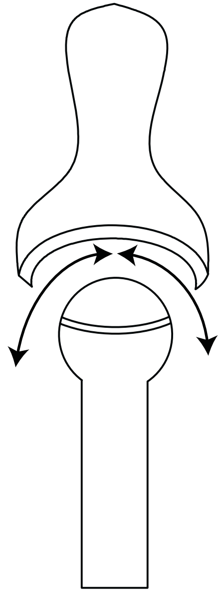
Twist in a human body



ark, H. C. and Lakes, R. S., "Cosserat micromechanics of human bone: strain redistribution by a hydration-sensitive constituent", J. Biomechanics, 19 385-397 (1986)

Fingers connection





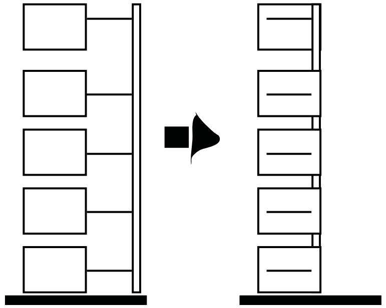
Connection by friction

Precedents from the world

Turning Torso: Calatrava's Sustainable Skyscraper is the Tallest Residential Tower in Sweden

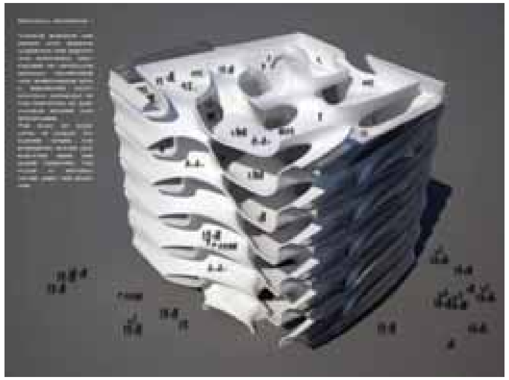
Sweden's tallest residential building is the HSB Turning Torso, a sculptural sustainable skyscraper that gently spirals as it ascends above the skyline of Malmo. Designed by renowned architect, sculptor and structural engineer Santiago Calatrava, the gigantic tower stands 54 floors high and features a form inspired by the Spanish architect's studies on nature and human bodies. The fantastic tower is completely powered by renewable energy, and **it twists a full 90 degrees from top to bottom.**

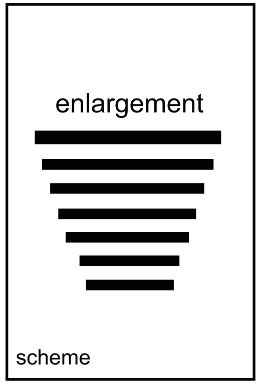
Anon, Turning Torso: Calatrava's Sustainable Skyscraper is the Tallest Residential Tower in Sweden. Available at: http://inhabitat.com/sustainable-and-twisted-turning-torso-sculptural-building-in-malmo-by-santiago-calatrava/ [Accessed May 7, 2012].



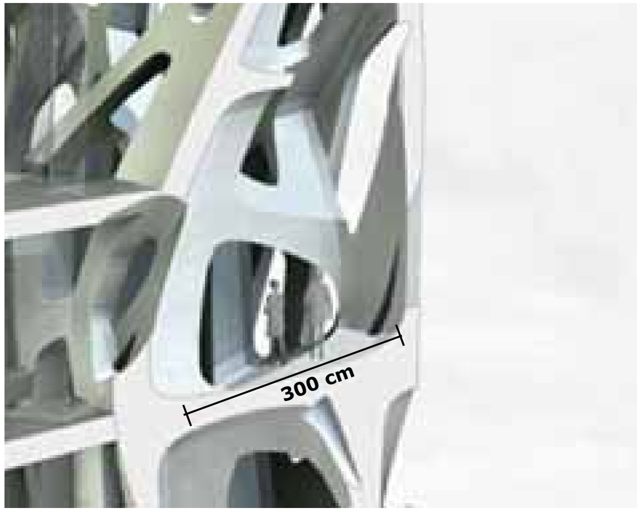
Anon, Turning Torso: Calatrava's Sustainable Skyscraper is the Tallest Residential Tower in Sweden. Available at: http://inhabitat.com/sustainable-and-twisted-turning-torso-sculptural-building-in-malmo-by-santiago-calatrava/ [Accessed May 7, 2012].

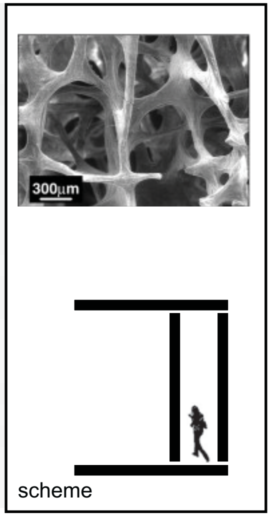
Algorithmic Tower





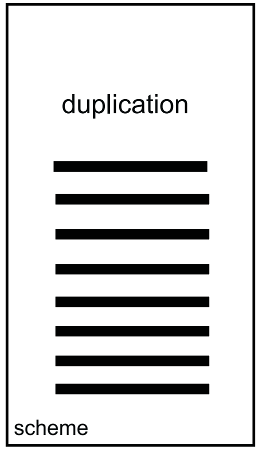
algorithmic Tower- Shanghai 2008
http://www.worldarchitecture.org/world-buildings/world-buildings-detail.asp?no=2815





Fibrous Tower, by Kokkugia

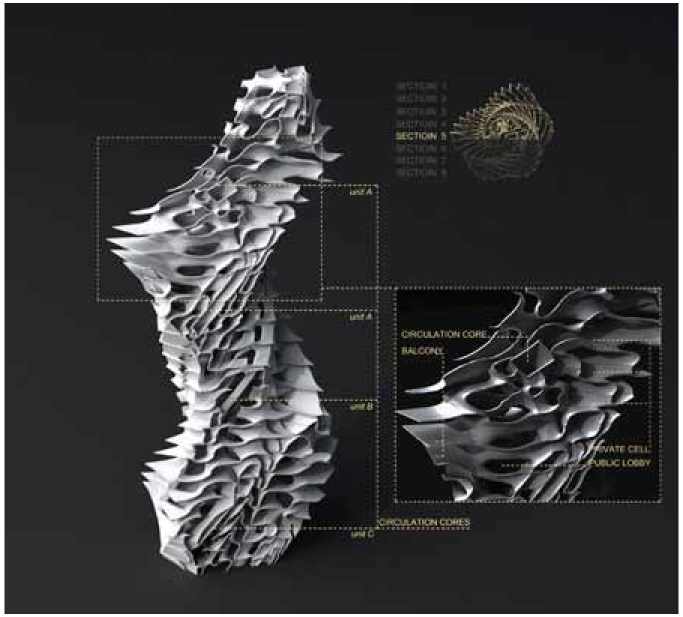
http://www.google.co.il/imgres?um=1&hl=iw&sa=N&pwst=1&rlz=1C1GGGE_
iwIL466IL466&biw=1333&bi

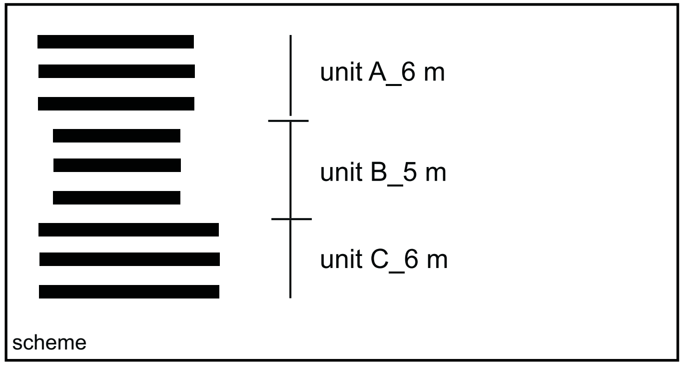


http://www.flickr.com/photos/153/4183086509/sizes/m/in/photostream/

Algorithmic structure

This is the section of Algorithmic Tower (eVolo Special Mention)





Sections of Algorithimic Tower (parametric design)- by deCode
http://www.flickr.com/photos/36528907@N05/sets/72157616499523757/

Tower_Prototype - by am:Pm

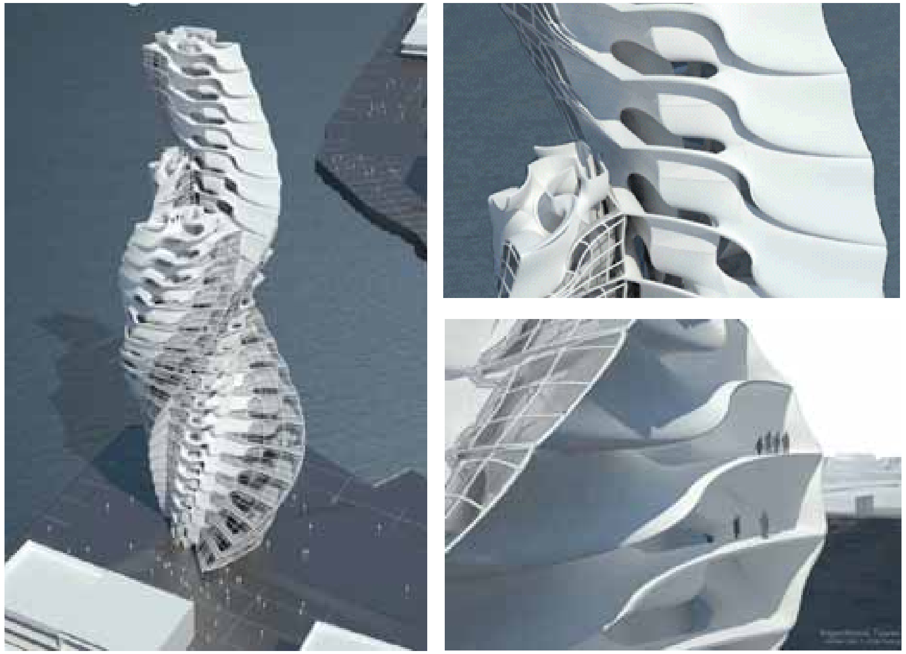
Sectional STL model.
around 25cm X 5cm X 8cm

This model is to investigate the space organization. There are small and big spaces within the tower in order to satisfy different programmes.
The tower splits into two pieces so that we can see the spacial organization more clearly.

http://www.flickr.com/photos/36528907@N05/3953921374/sizes/m/in/photostream/

Algorithmic Tower
2009 Skyscraper Competition,Junkai Jian, Jinqi Huang

The cities of the twenty-first century embody extreme qualities of communication and complexity of interaction. In response to the new urban demands the Algorithmic tower employs a code-based scripting methodology that configures higher orders of complexity required by a new kind of aggregation logic. **It is coded with specific rules for growth** and subdivision that articulate spatial organizations with a mathematical approach.

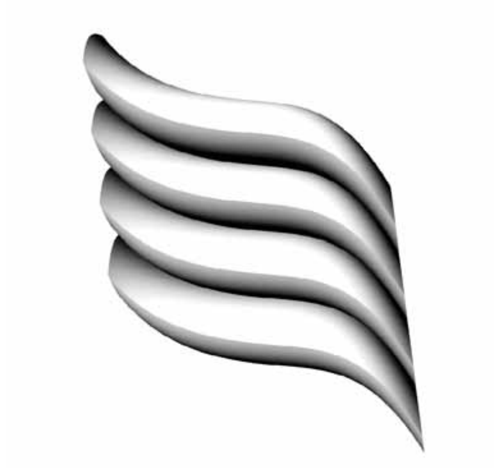


http://www.elitismstyle.com/blogazine/algorithmic-tower.html

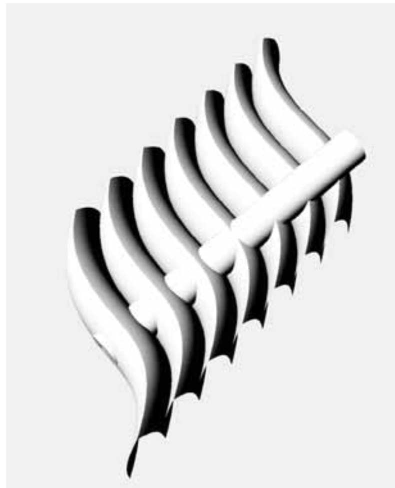
The Algorithmic tower is formed by cells that are divided into three distinct continuous non-intersecting volumes that allow interplay between indoor and outdoor spaces. These interacting spaces maintain their character, while adapting to growth, and gradually transform into a series of vertical aggregates. The skin wraps and changes its shape, porosity and character in response to the indoor spaces which vary in dimensions, according to the proposed parametric growth. The cells grow vertically and spirally, creating curved modules that are locally controlled with a set of rules for program, density, orientation, and expected growth.

Conclusions

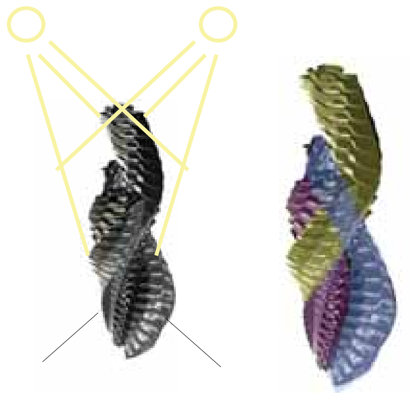
A.Each unit operates separately but But reinforced by a cloumn
B.Shell
C.Full connections
D. wraps and changes
E.Three volumes



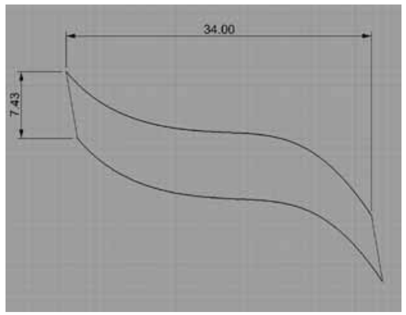
Form



Connections



Volumes



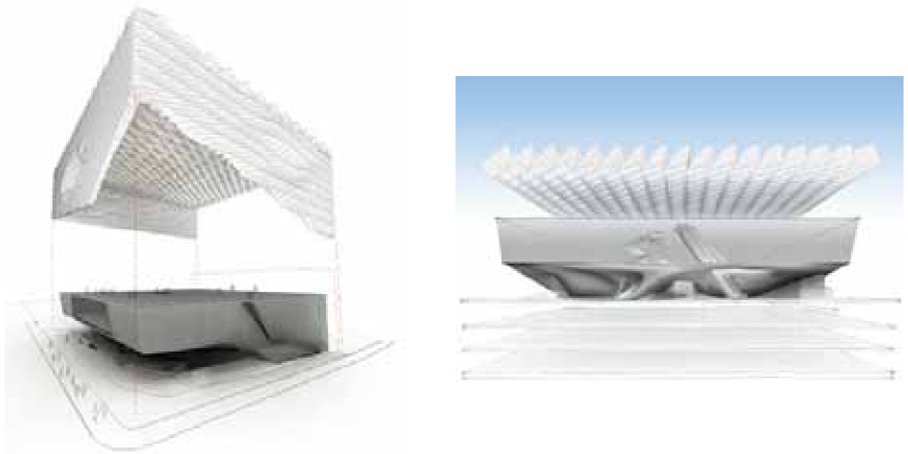
Dimensions

Diller Scofidio + Renfro - The Broad Museum, Los Angeles, California

The core of the design lies with in two large rectangular boxes. The foundation box serves as the parking garage and the upper box, or 'vault', contains the interior spaces for art storage, archives and office space for the Broad Art Foundation.

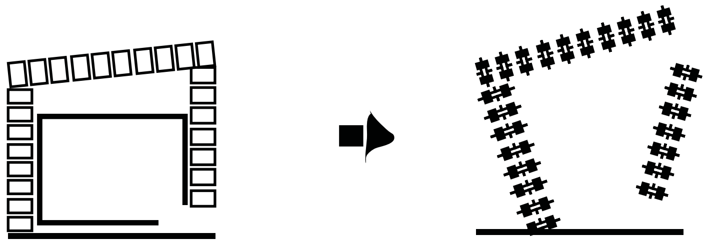
The vault, veil, and dimple are just some of the terms that have been used by the architects to refer to the different areas of their design. A dramatic facade of varying cast-concrete hexagonal shapes lifts at the corner of 2nd Street and Grand, near Disney Hall, creating the main entrance to Broad Museum. The veil, wrapping the gallery space on the third floor, the vault on the second floor and the lobby at ground level, is structural bearing the roof load and also serves as a sunshade for the building. The exterior skin will have varying thickness and transparency on its four facades, and it dimples on Grand Avenue taking the form of a sunken window.

Diller Scofidio + Renfro - The Broad Museum, Los Angeles, California. http://www.habitables.co.uk/architecture/2409



Concept Diagram
http://www.archdaily.com/101909/design-unveiled-for-the-broad-museum-by-diller-scofidio-renfro/

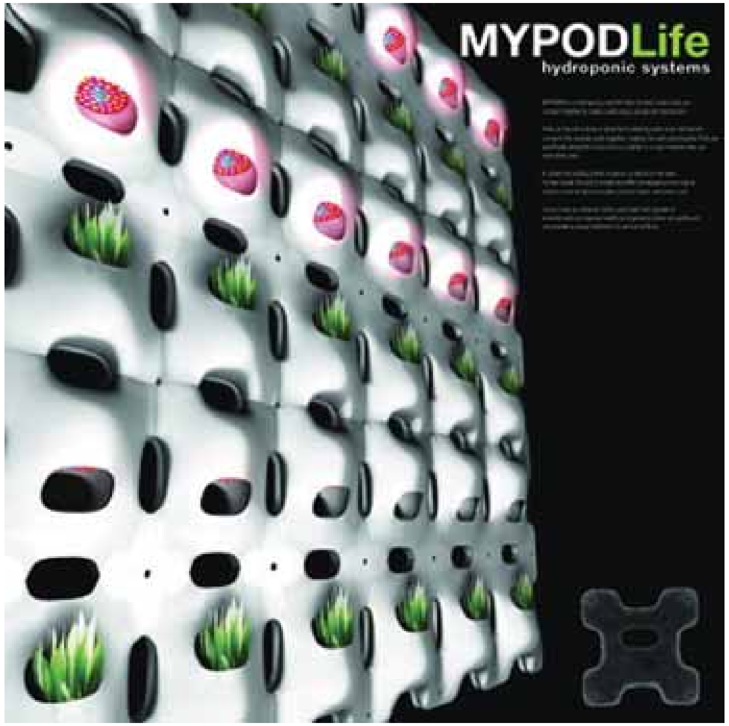
http://www.designboom.com/weblog/cat/9/view/12759/diller-scofidio-renfro-broad.html



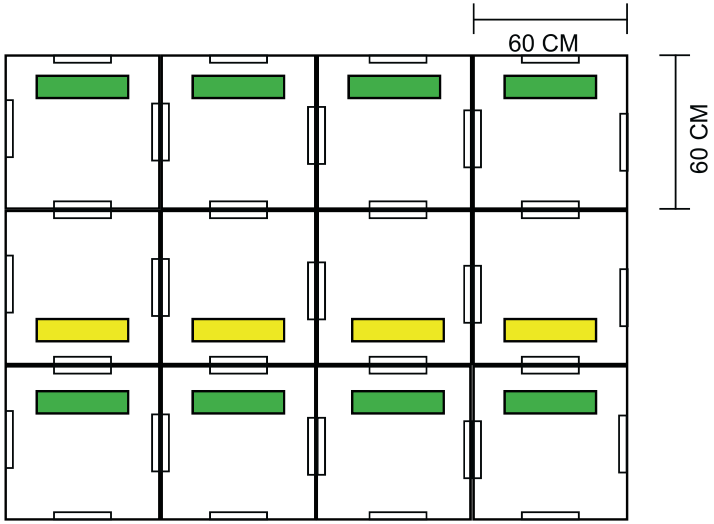
scheme

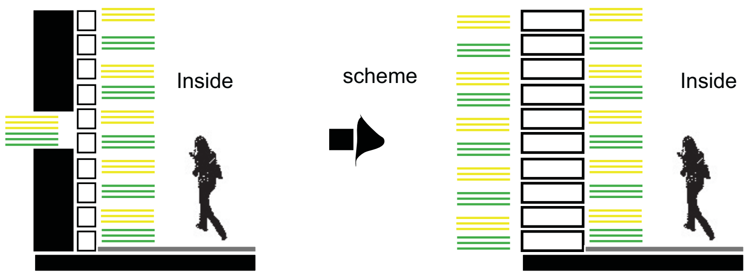
MY POD Life

The second iteration in the MYPODLife series is a living wall and light box, made in Corian. The wall was commissioned by Tracy Stone Architects for the Sip tea house, in downtown Los Angeles. The custom design was inspired by the science of tea, etching into corian the bubble formations of various heating temperatures of tea water. The plant pods are planted with aromatic tea plants, such as mint, rosemary and chamomile and are watered using the excess tea. At night, the etched bubbles illuminate the space with an integrated LED lighting system. Interior living walls can function as filters, cleaning and improving indoor air quality and removing harmful VOC's.



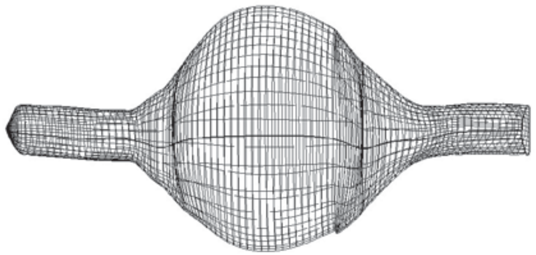
http://greenmeme.com/projects/mypodlife/

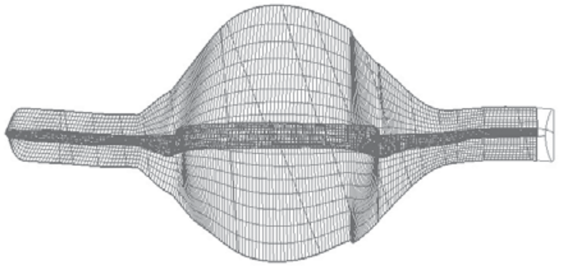


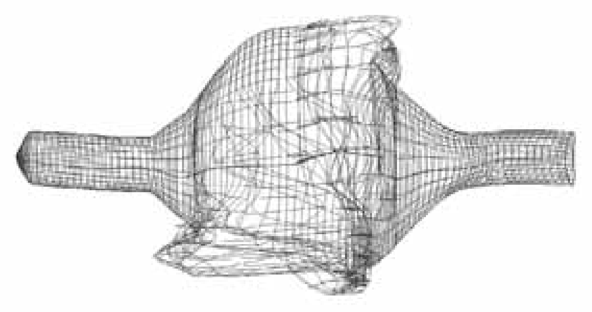


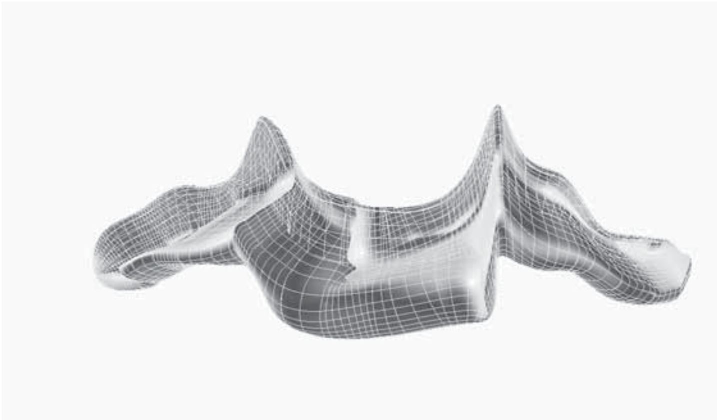
The facade cellular

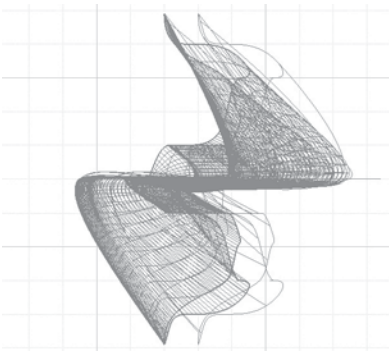
Spinal cell- Work process

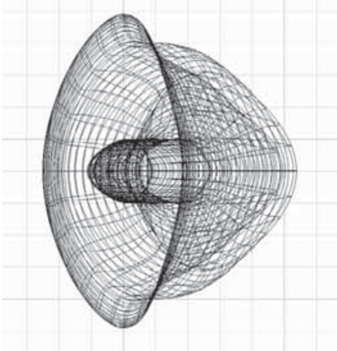




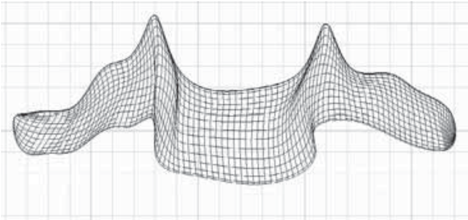




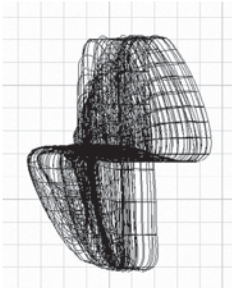




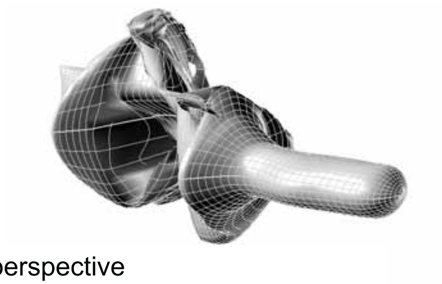
Work process - the cellular



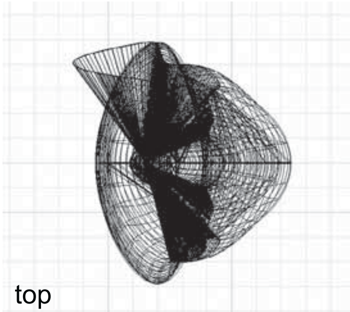
plan



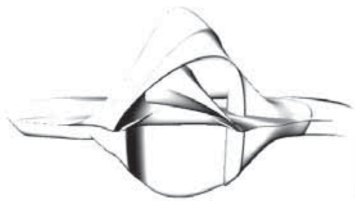
section



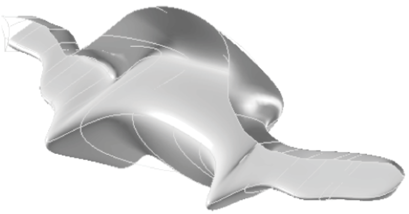
perspective



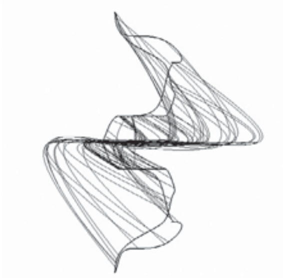
top



front



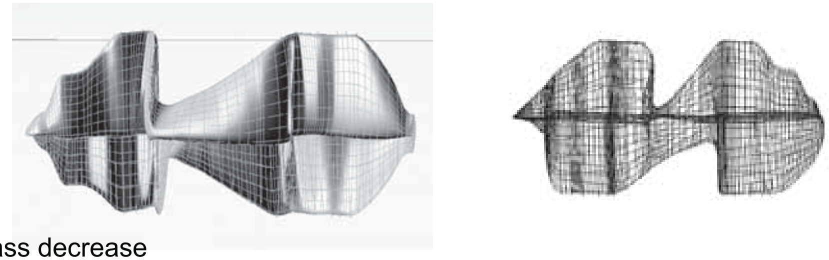
perspective



section

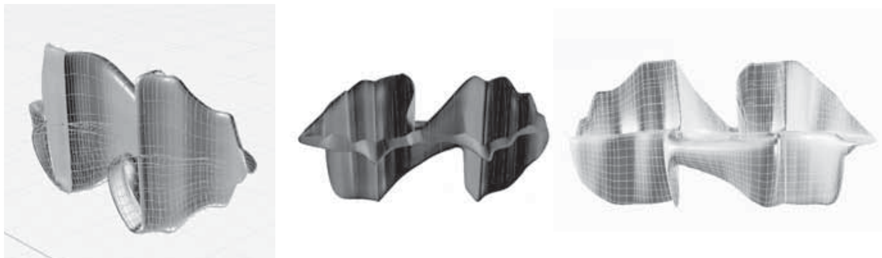
The key

mass



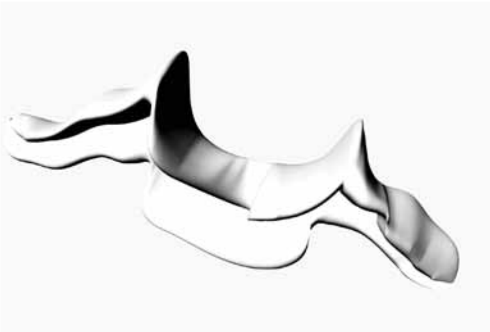
mass decrease

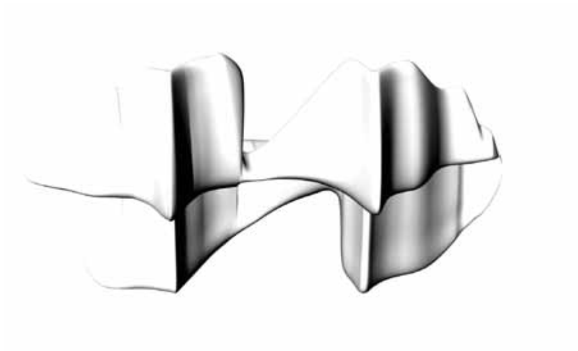
porosity



skin

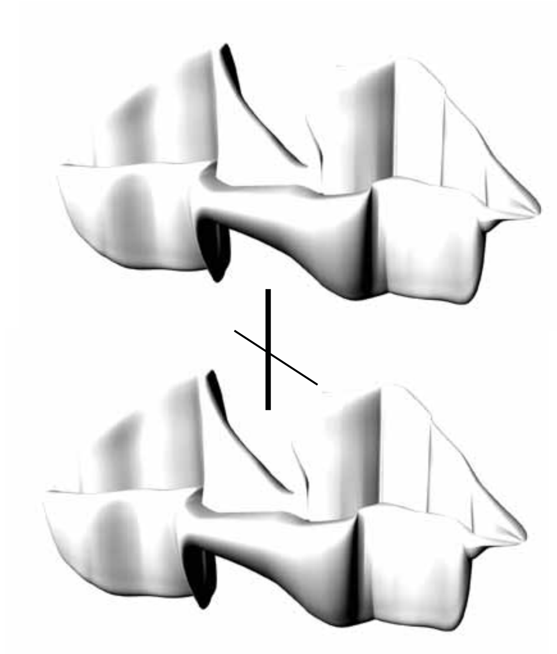
The cellular



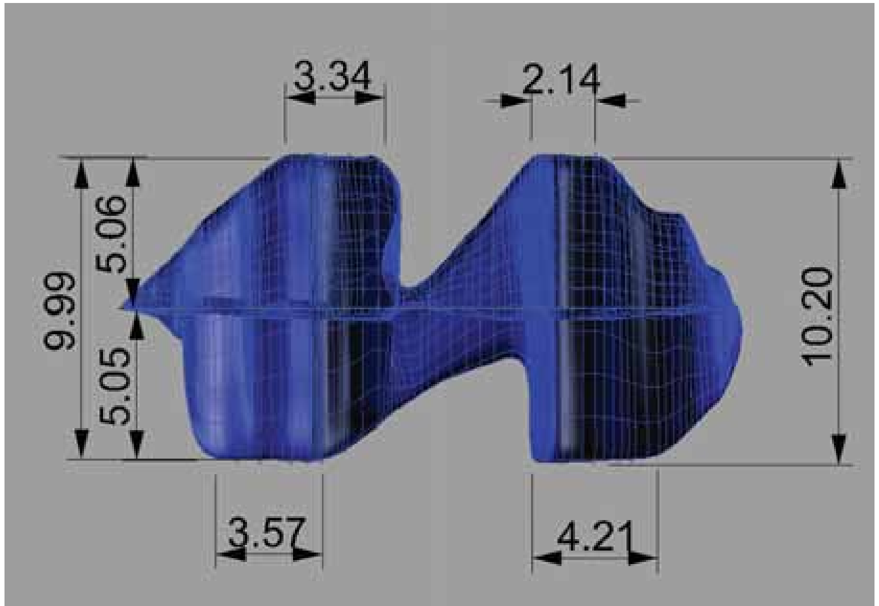


Conclusion- cellular 1

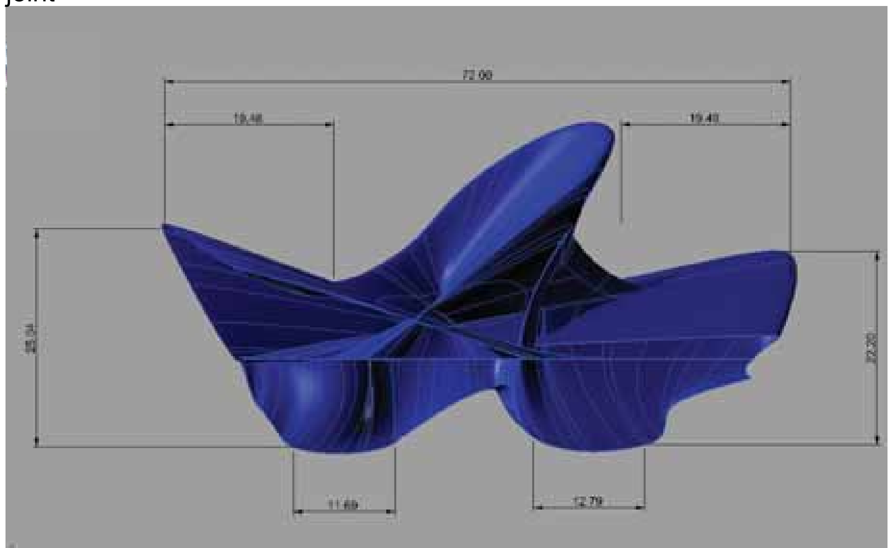
Cell Size is not suitable,
Connection problem between cells,
There are two negative and therefore cannot be attached



Work process - the cellular dimensions

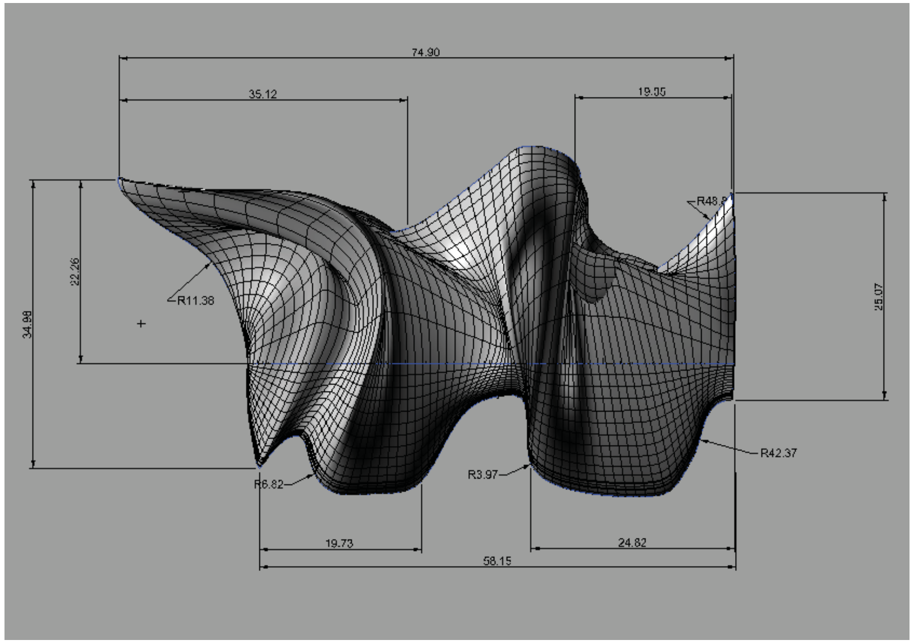


joint



Positive to negative

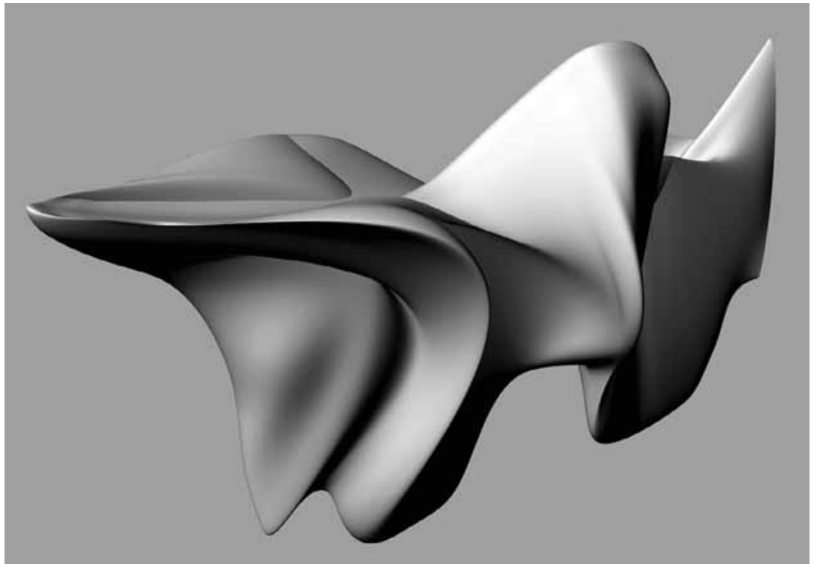
Cell expansion and increasing length of one side

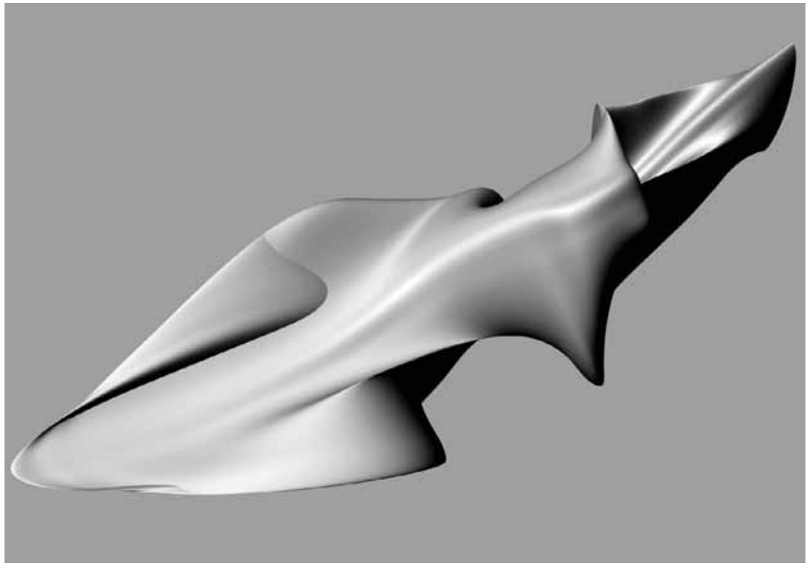


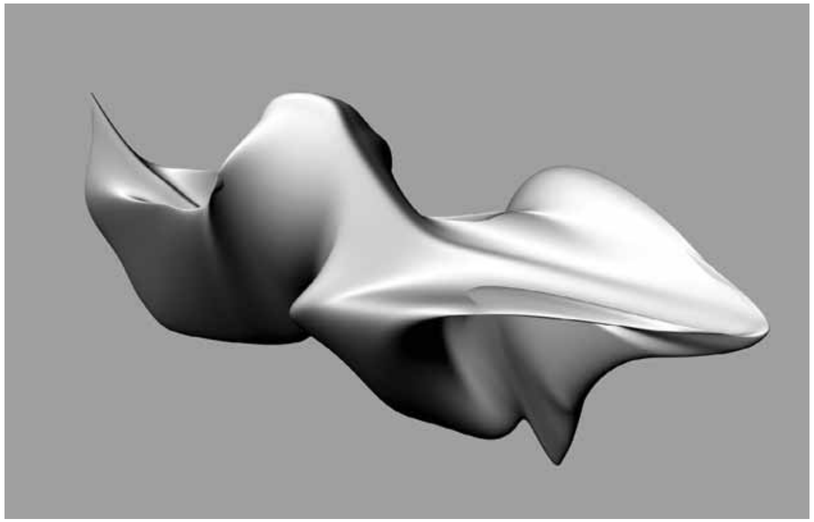
Symmetrical to asymmetrical

1.The facade cellular

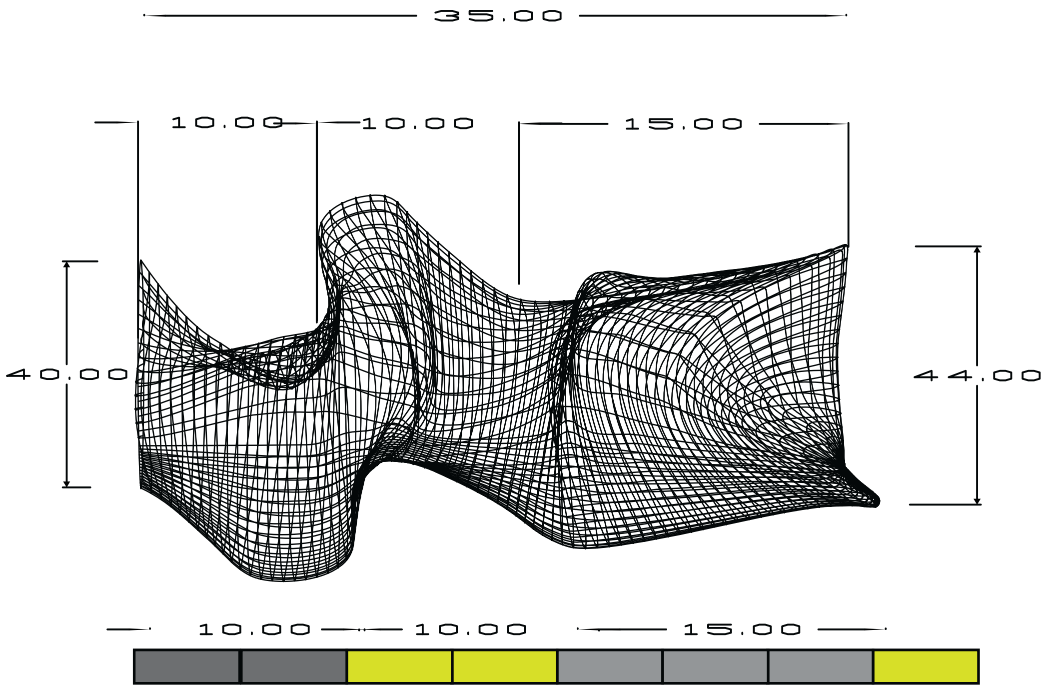
Cell expansion and increasing length of one side



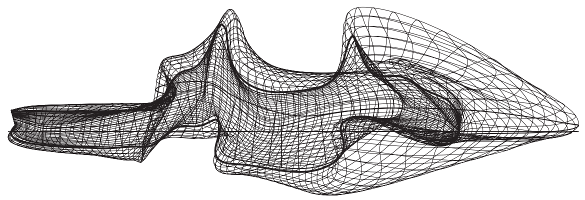




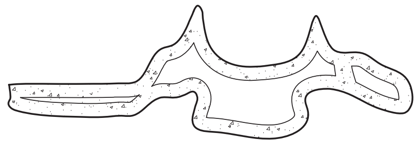
Limits and proportions

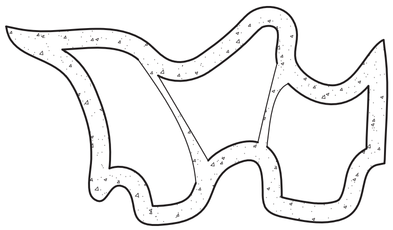


Inside the cellular



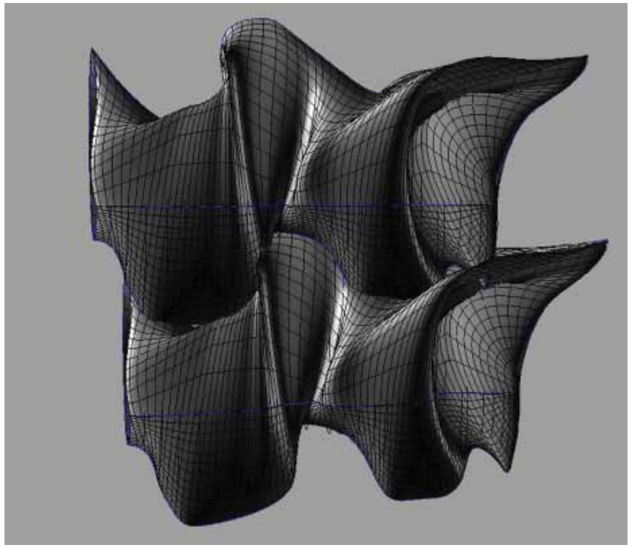
Creating isolation through air space

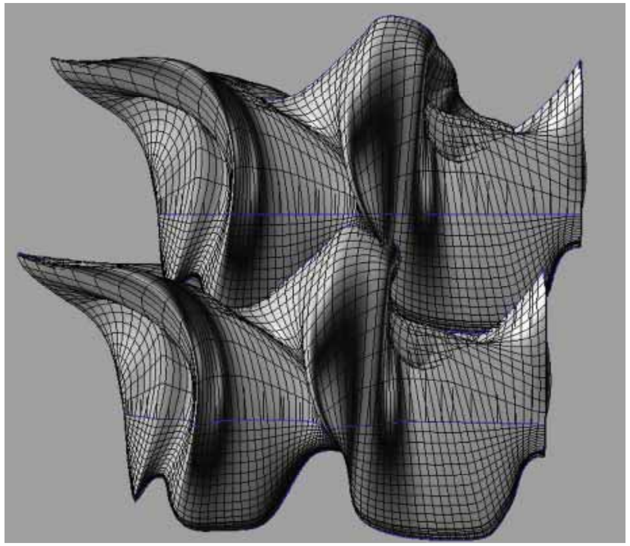


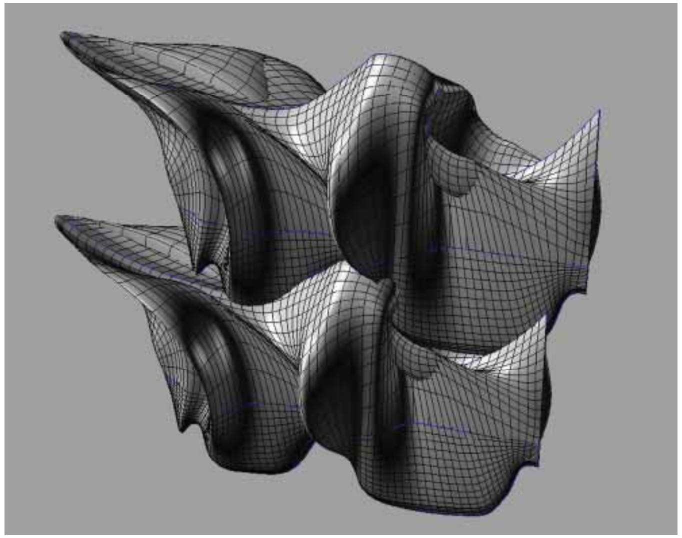


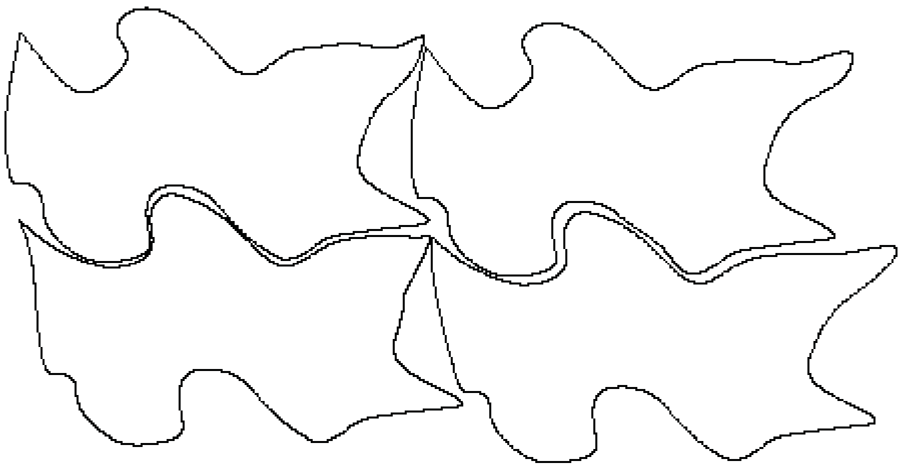
Air pockets

construction method

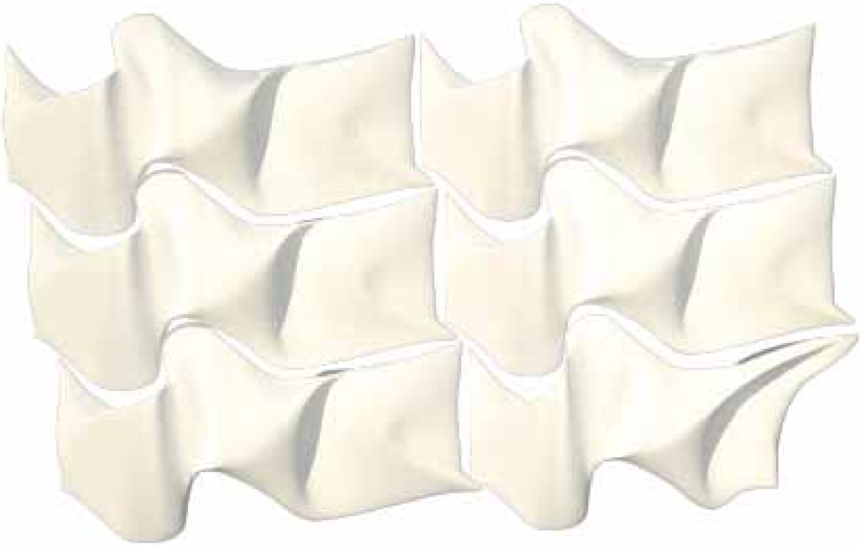




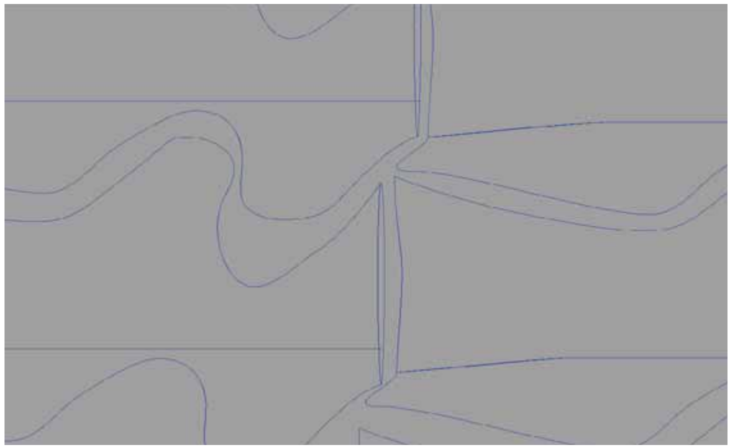


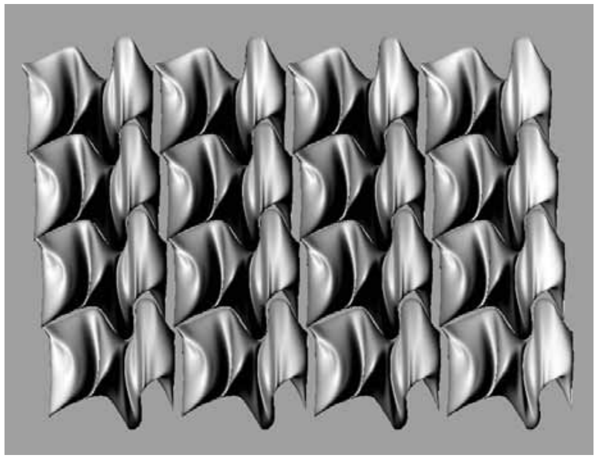


Cell connection by friction



Surface made of cells connected by friction

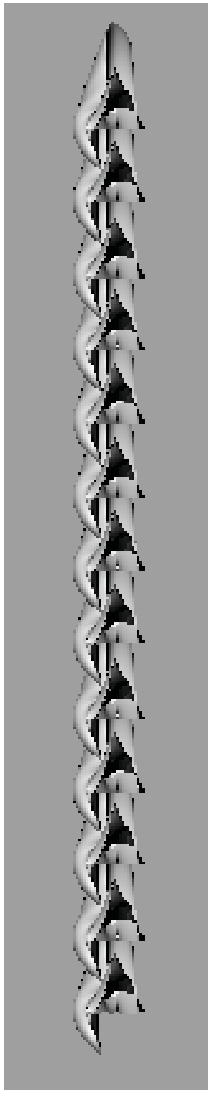


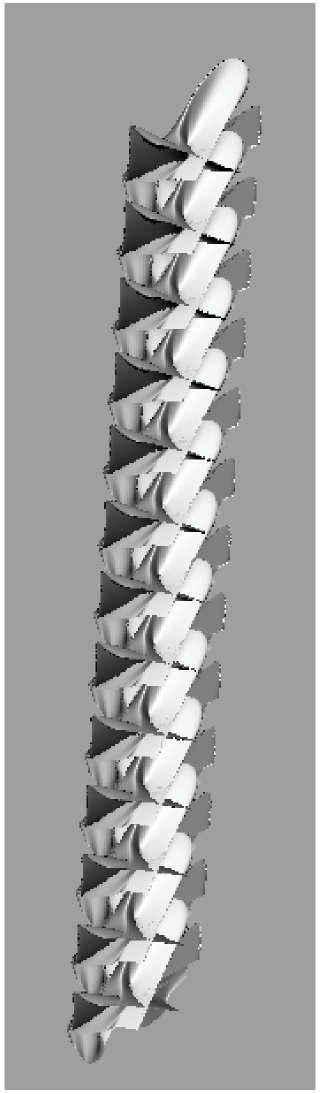


The facade

Work process
Constructing backbone model

Using cellular structures as part of a constructive system

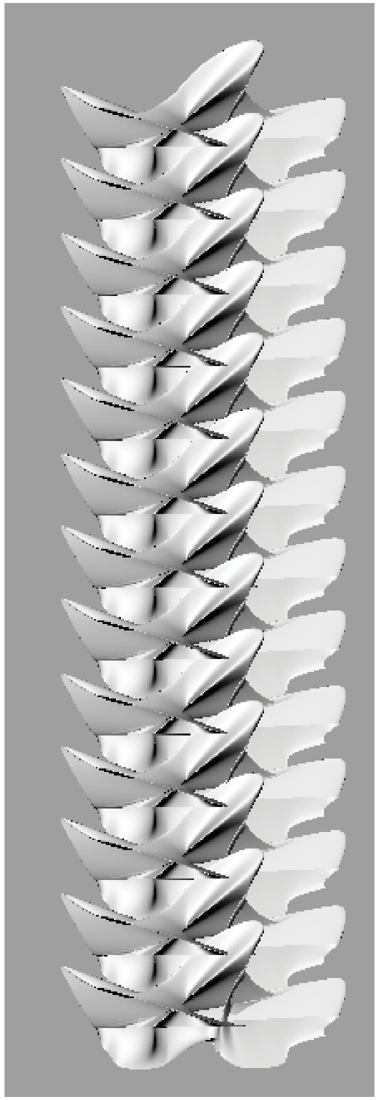


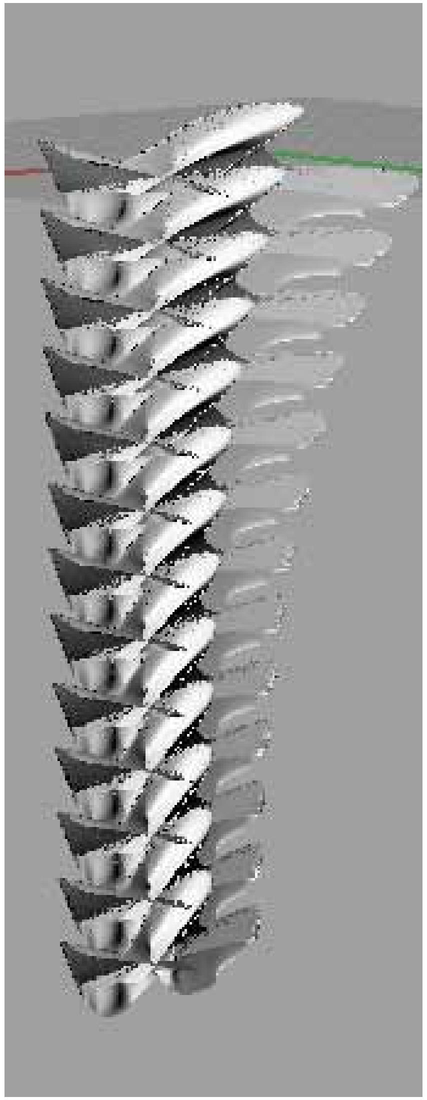


Before Expansion

Work process

cell replication





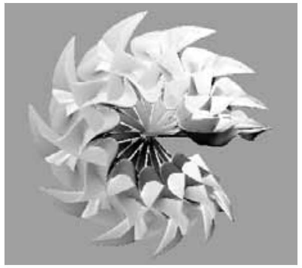
After expansion

Work process

Rotate the model at 180 degrees such as maximum rotation of backbone

Using cellular structures as part of a constructive system

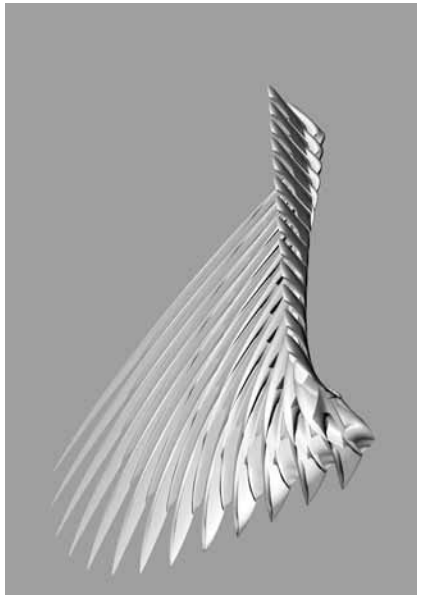
Front



Top

Work process

As part of continuous spinal- examination



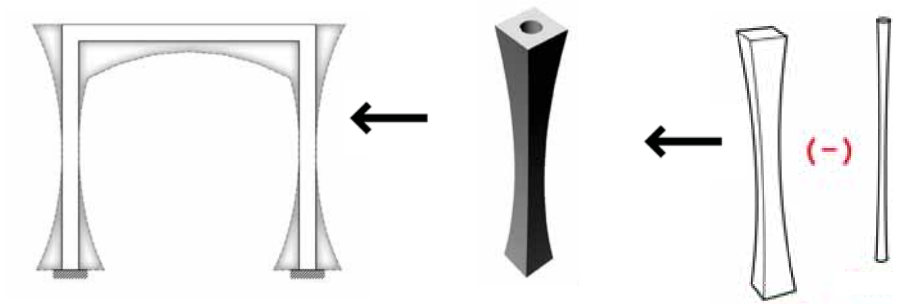
Front sealed without ventilation

proposed
specs
f'c =4000 psi
pu =125,781 pounds
y= 11.18 cu.ft
weight = 1677 pounds

conventional column
specs
f'c =4000 psi
pu =125,781 pounds
y= 166.33 cu.ft
weight = 2450 pounds

stability

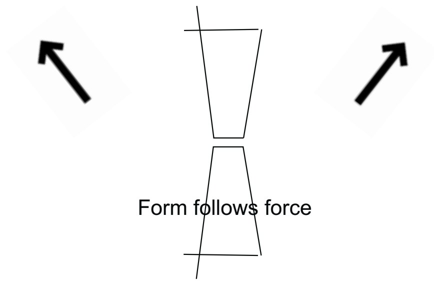
Translarion



Frame stress lines spectum

substraction

reduced bending moments

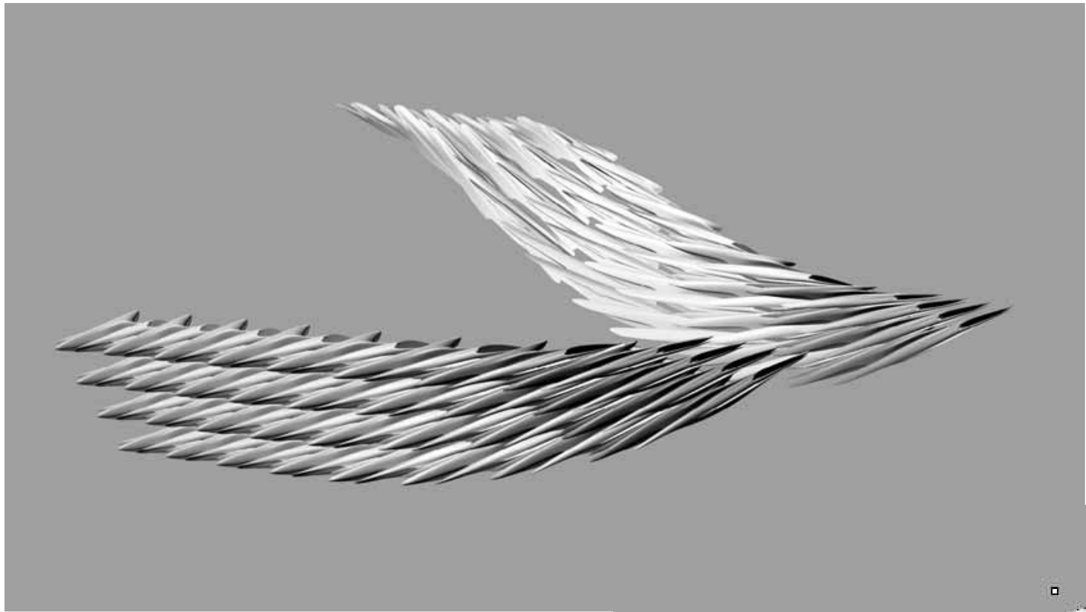


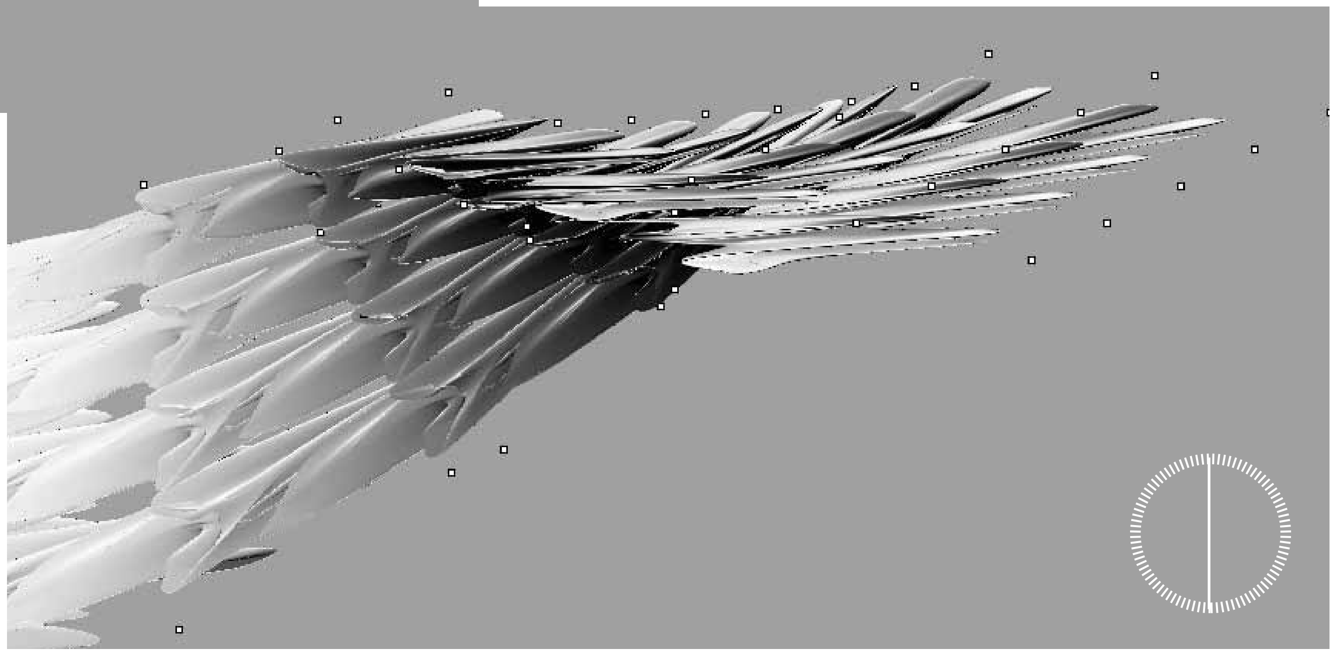
Form follows force

Work process

Demountable system, Movement of a bird wing

Dynamic front- Rotate the front, 180 degrees





Conclusions- the facade

A. Variety of forms

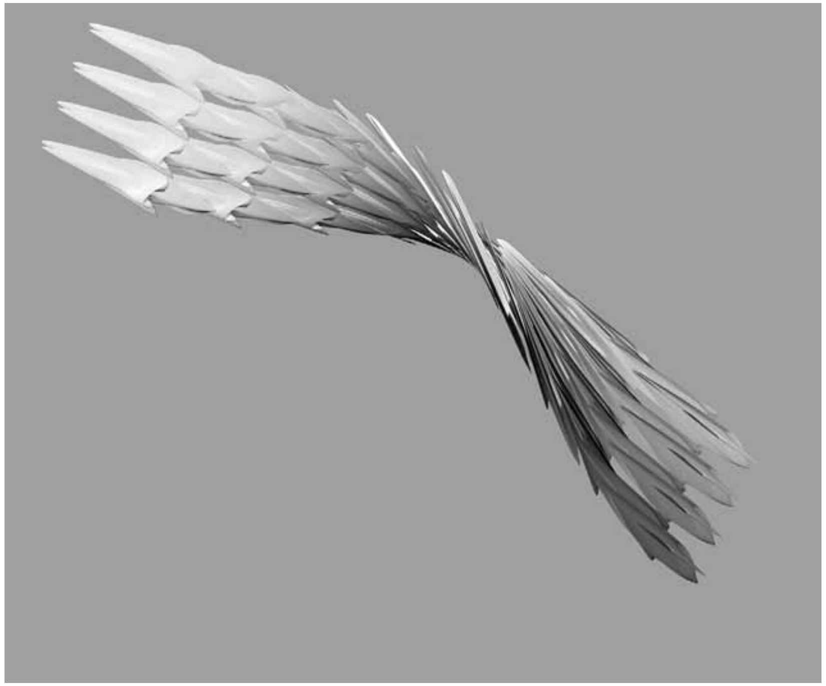
B. Skeleton as part of the building

C. Stability

D. Innovation

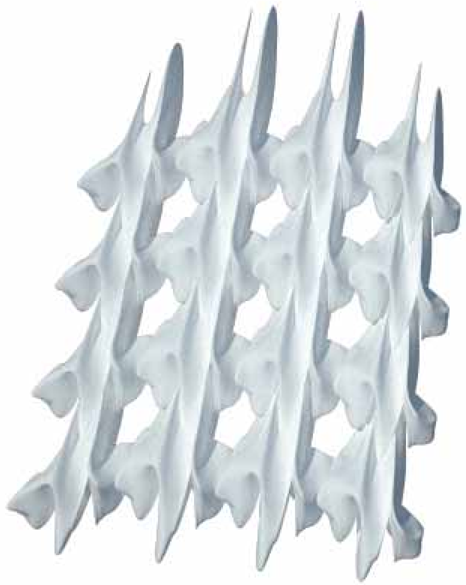
E. Dynamic front

F. No need for several layers in the building



Fronts

1



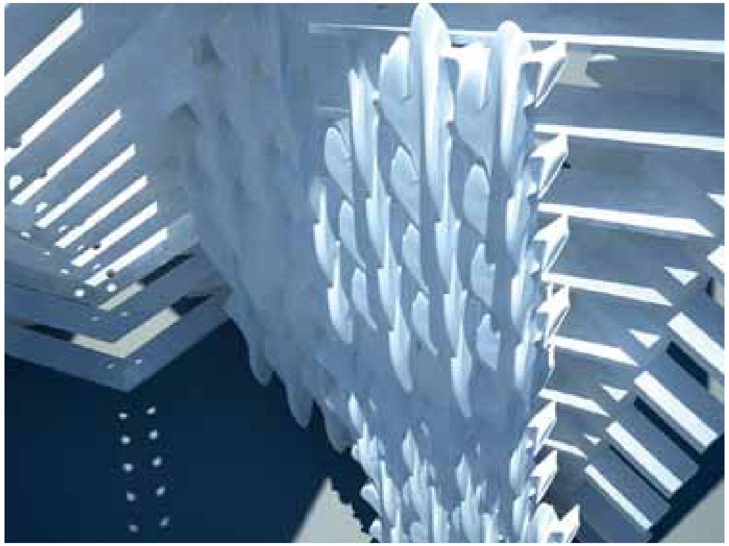
2

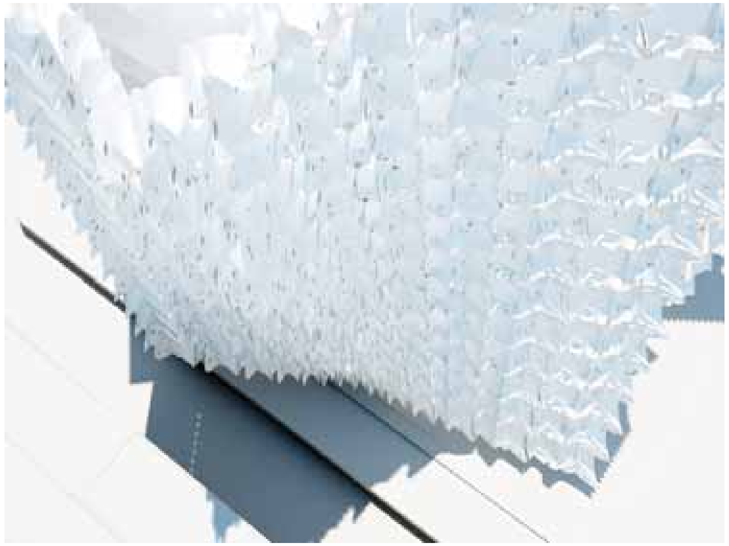
3

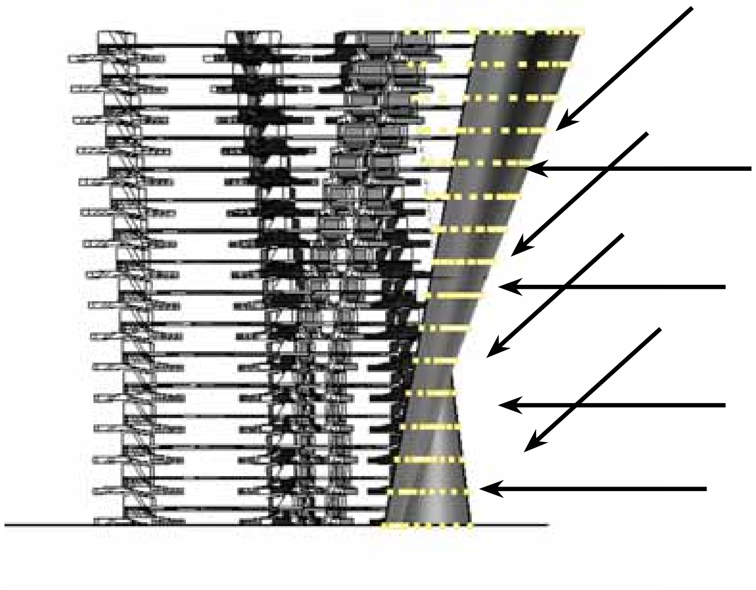
4

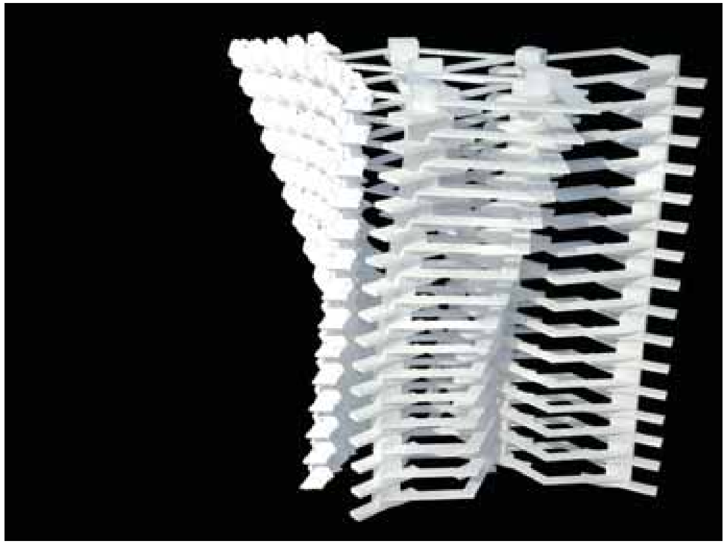
5

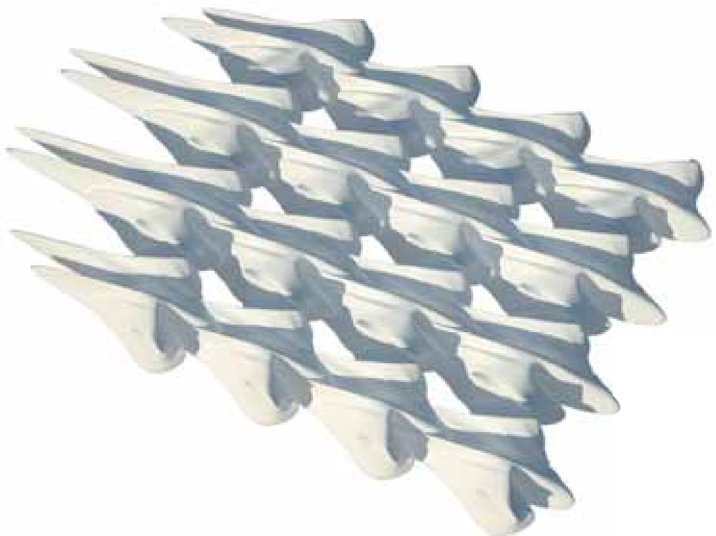
The facade









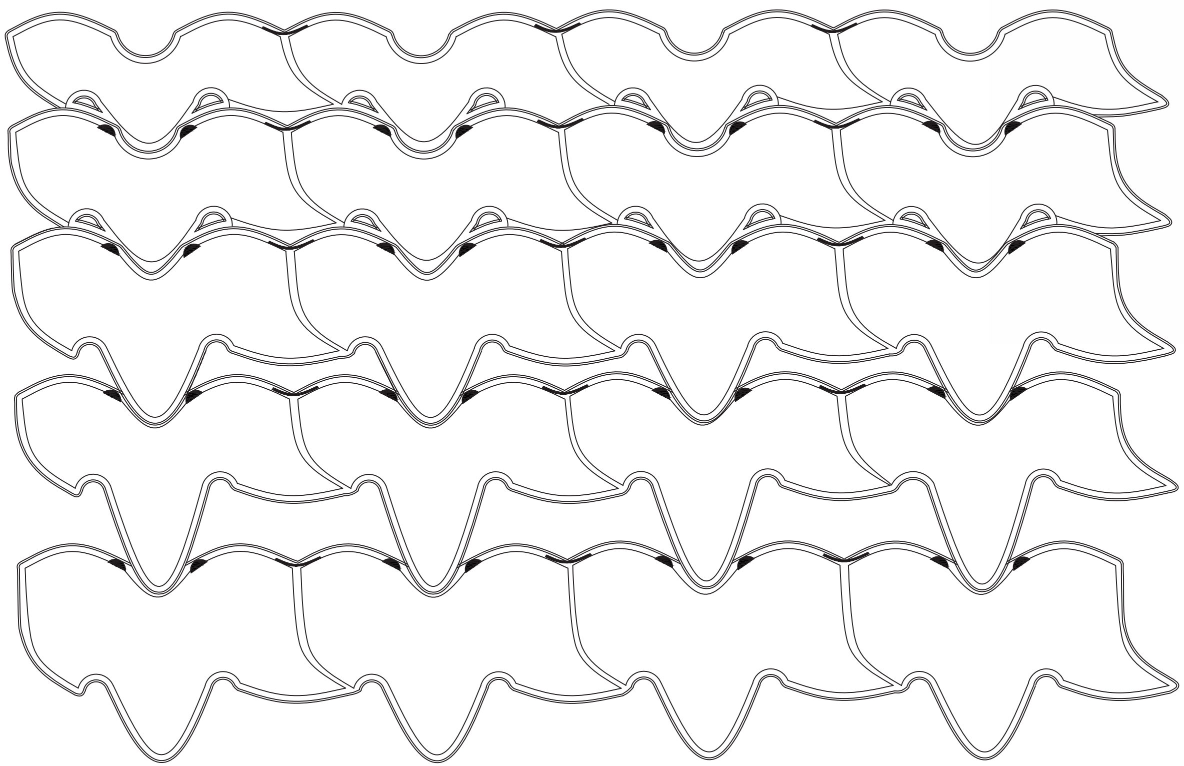


The facade

The facade consists cells, inspired by the spine features
First using cellular structures as part of a constructive system.

The skin (facade) function as a membrane, and the ribs installations it.
The skin hung, and sustain itself.
The facade bearing forces like wind, it is independent with connections between them.

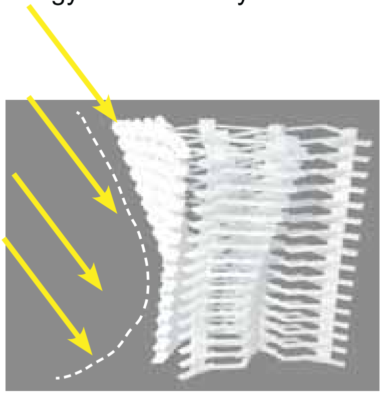
The cells produce air holes, thanks to their size and shape space inside them



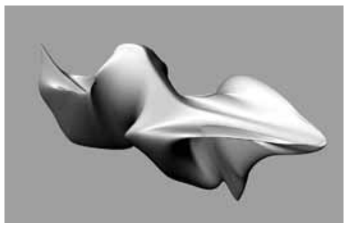
The facade

Facade connection detail With plants
Section through the facade of the building
through the polymer cells.

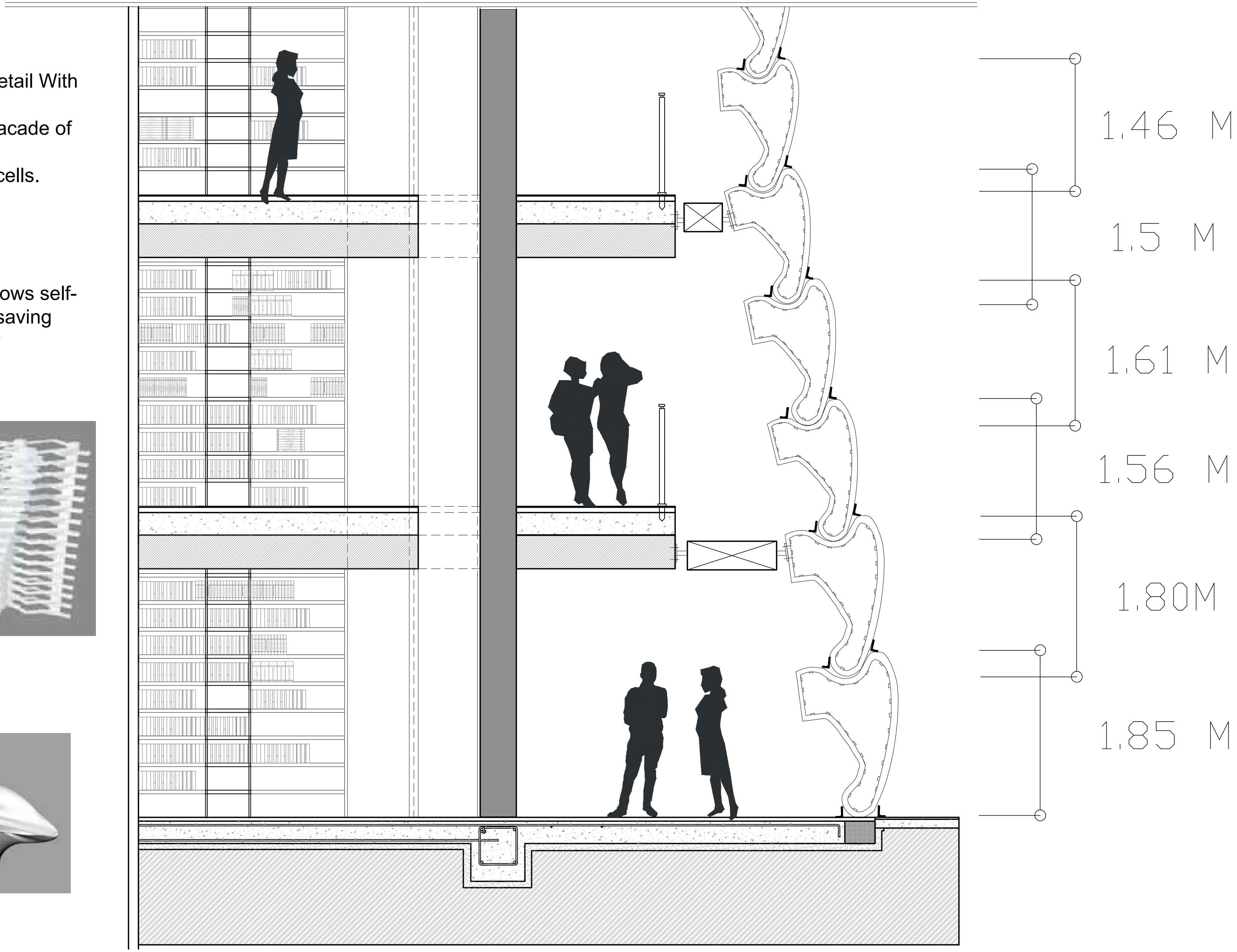
The shape of front allows self-shadowing and thus saving energy and electricity



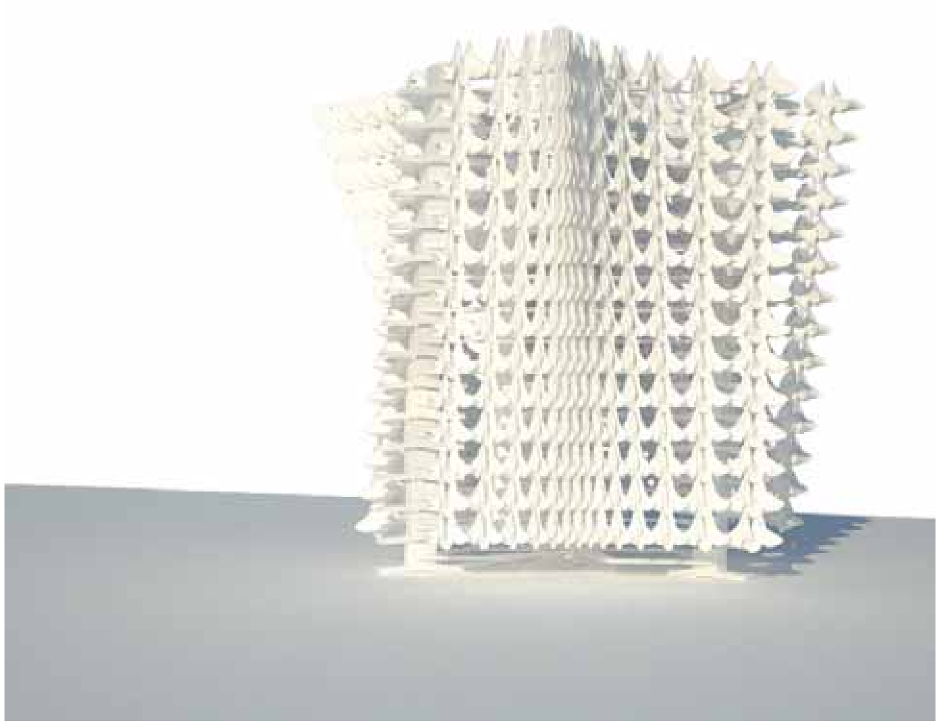
Self-shadowing



The cellular



The building with the facade



The programe

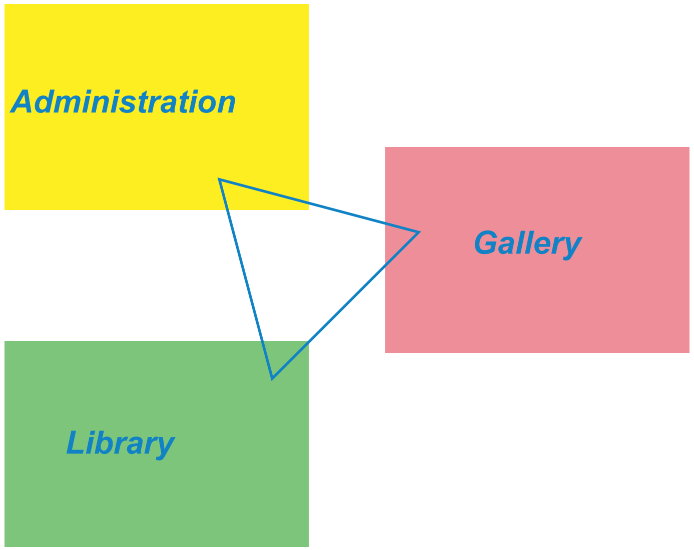
Library building and Galleries program

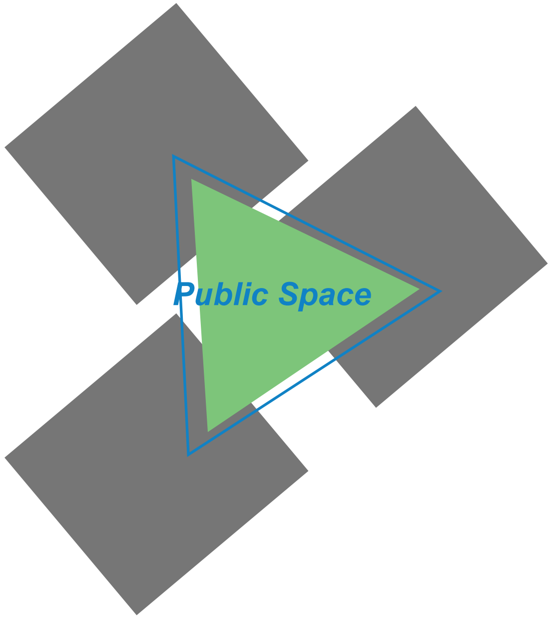
Site size: 4062 Square feet

Notes	Total square meters	Square meters per unit	Number of units	Type of space
For all types of activities	300	50	6	Activities Room
Check connection to the foyer hospitality department	200	200	1	Lobby / exhibition
	5	5	1	Box office
Can be considered in connection cafe and restaurant. It should be easy unloading .commodity	200	100	2	Coffee (including (kitchen and storage
Should be considered for garbage .collection	30	30	1	Garbage room
Nature of the store according to the context; must take into account unloading commodity easily - can be combined with a .restaurant	200	50	4	stores
	60	30	2	Public toilets
	450	30	15	
Chairs storage rooms flat - as needed	30	15	2	Storerooms (including (chairs
Average	375	25	15	Galleries
	2600	0	0	Library
	30	30	1	+ Rest room kitchenette
	120	30	4	Services
.Areas does not include transitions, etc	4600			Total net
	5980			Extra 30% gross ,space (circulation (.technical spaces, etc
As needed (including parking for two buses (trucks /	4000	1000	floors 4	Parking and other areas

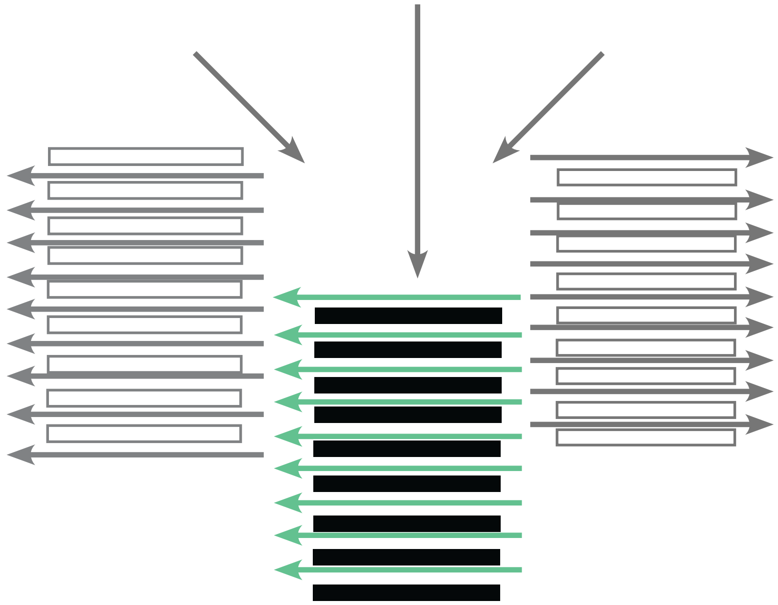
Total
2600
875
1125

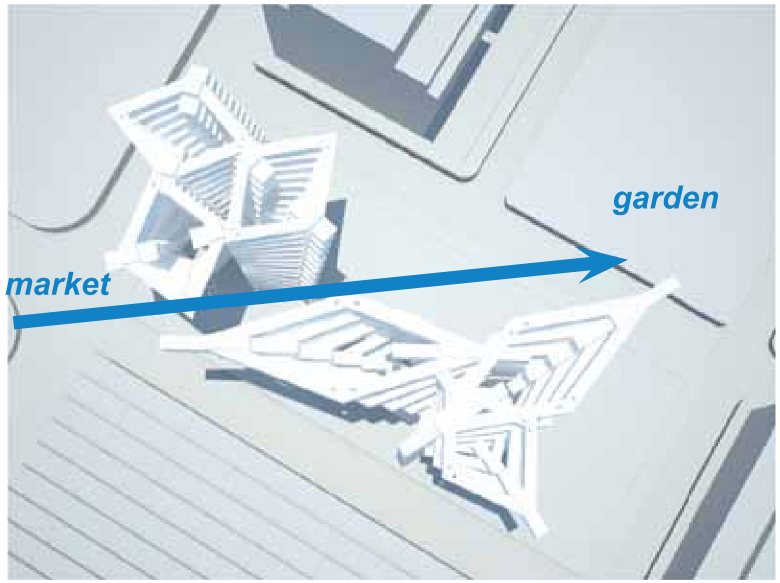
Schemes





Circulation





Examination of libraries in Israel and worldwide

progrem

	Jewish localities Urban	Non-Jewish localities |Jewish localities urban| rural
Volumes per library	27,751	15,590
Borrowers per library	2,339	945
Days of service per week:		
1-2	1.5	33
3-4	23.0	19.9
5+	75.5	47.1
Hours of service per week:		
Up to 10	6.5	45.5
11-20	30.6	15.1
21-30	30.9	15.3
31+	32.0	24.1
Computerized libraries	70.0	44.8
Libraries with internet services	11.7	7.1
Libraries with multimedia stations or data bases	32.4	15.7
Libraries with reading rooms	92.0	73.3

Ex.

1,400,000 books- 34,000 m2 230 shelf high

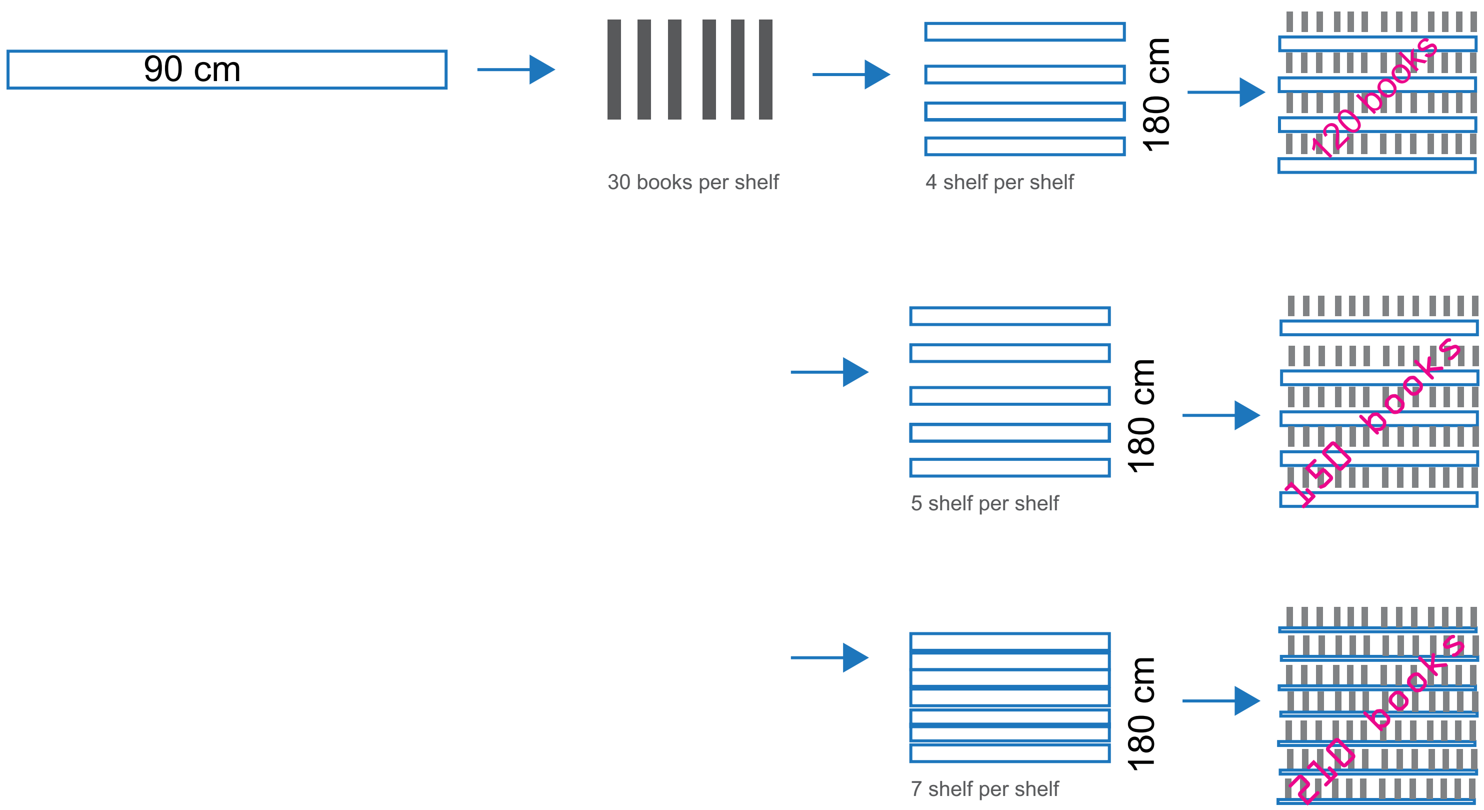
5000 books- 13,650 m2 220 shelf high

3500 books- 10,000 m2 180 shelf high

Israel national library program

400,000 Books

How many books should be in the library?



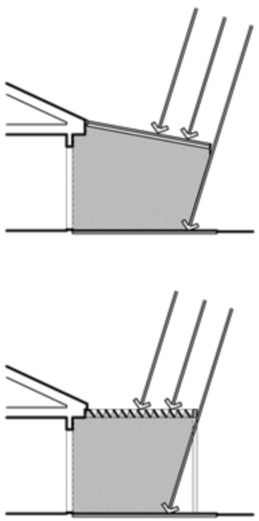
VS.

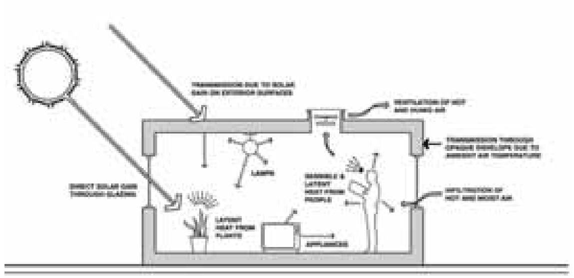
Cellular library	Cellular library & gallery	
9,700 books- 2,600 m2	5,700 books- 1,540 m2	Reading Area- 850 m2
220 shelf high - 324 shelfs	220 shelf high - 324 shelfs	Computer Zone- 690 m2
Double high - 19,600 books	Double high - 11,400 books	

Examination Terms

WEATHER DATA SUMMARY													
LOCATION: Tel Aviv-Bet Dagan, -, ISR													
Latitude/Longitude: 32.0° North, 34.8167° East, Time Zone from Greenwich 2													
Data Source: MSI 401790 WMO Station Number, Elevation 114 ft													

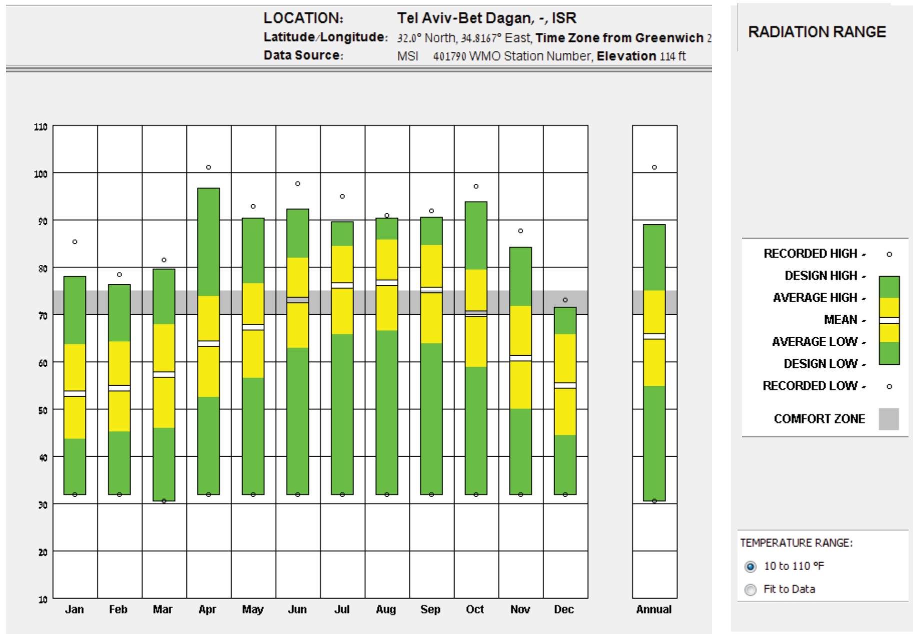
MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	93	117	142	157	179	176	186	183	156	130	97	89	Btu/sq.ft
Direct Normal Radiation (Avg Hourly)	124	110	126	136	159	161	180	177	182	179	157	120	Btu/sq.ft
Diffuse Radiation (Avg Hourly)	29	43	41	44	46	36	36	34	34	28	24	35	Btu/sq.ft
Global Horiz Radiation (Max Hourly)	201	248	284	308	310	311	302	293	274	246	198	165	Btu/sq.ft
Direct Normal Radiation (Max Hourly)	300	306	305	285	302	278	267	278	285	300	288	256	Btu/sq.ft
Diffuse Radiation (Max Hourly)	89	116	109	108	130	93	101	97	101	76	79	79	Btu/sq.ft
Global Horiz Radiation (Avg Daily Total)	856	1105	1451	1809	2125	2306	2226	2111	1747	1338	988	779	Btu/sq.ft
Direct Normal Radiation (Avg Daily Total)	1115	1065	1301	1547	1831	2086	2154	2032	1971	1744	1475	993	Btu/sq.ft
Diffuse Radiation (Avg Daily Total)	273	412	433	516	561	472	457	413	393	291	242	298	Btu/sq.ft
Global Horiz Illumination (Avg Hourly)	89768	89582	90122	89803	89903	89721	90005	89903	89624	89903	89803	90009	footcandles
Direct Normal Illumination (Avg Hourly)	89768	89582	90122	89803	89903	89721	90005	89903	89624	89903	89803	90009	footcandles
Dry Bulb Temperature (Avg Monthly)	53	54	57	63	67	73	76	76	75	70	60	54	degrees F
Dew Point Temperature (Avg Monthly)	44	45	47	49	56	61	65	66	64	57	46	46	degrees F
Relative Humidity (Avg Monthly)	71	70	69	63	68	65	69	69	67	64	60	73	percent
Wind Direction (Monthly Mode)	190	230	180	240	340	300	180	180	300	90	150	120	degrees
Wind Speed (Avg Monthly)	5	8	8	7	5	8	7	6	5	5	6	5	mph
Ground Temperature (Avg Monthly of 1 Depths)	58	59	61	70	79	86	89	91	88	81	71	64	degrees F

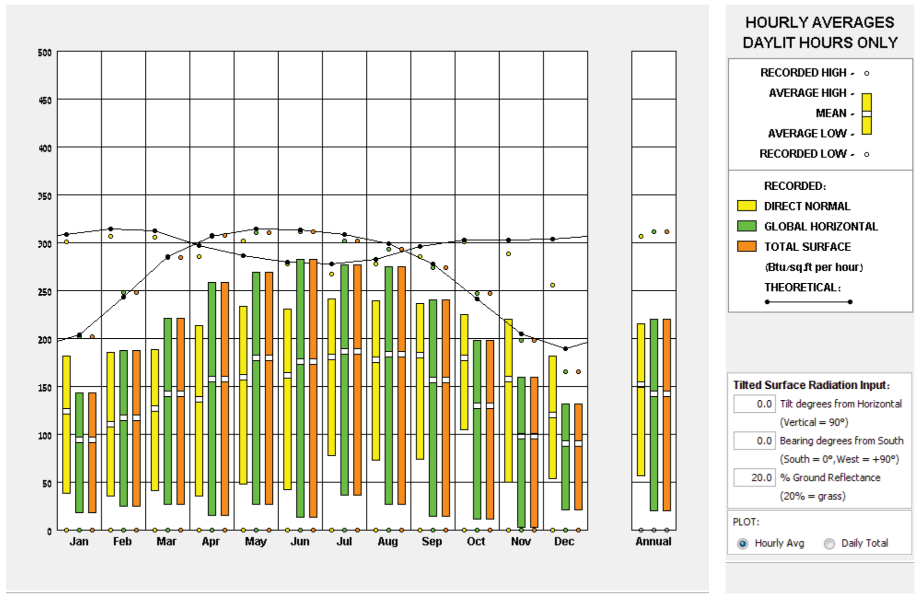




11

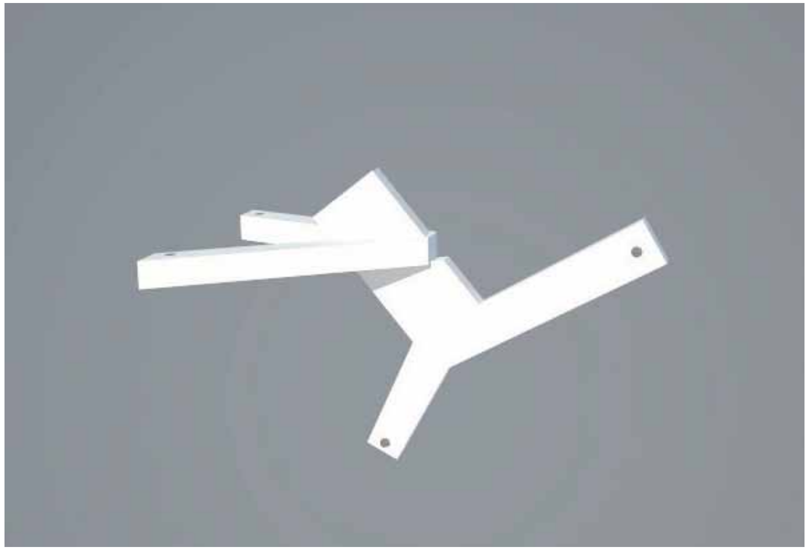
Heat gain from equipment, lights, and occupants will greatly reduce heating needs so keep home tight, well insulated (use ventilation in summer).

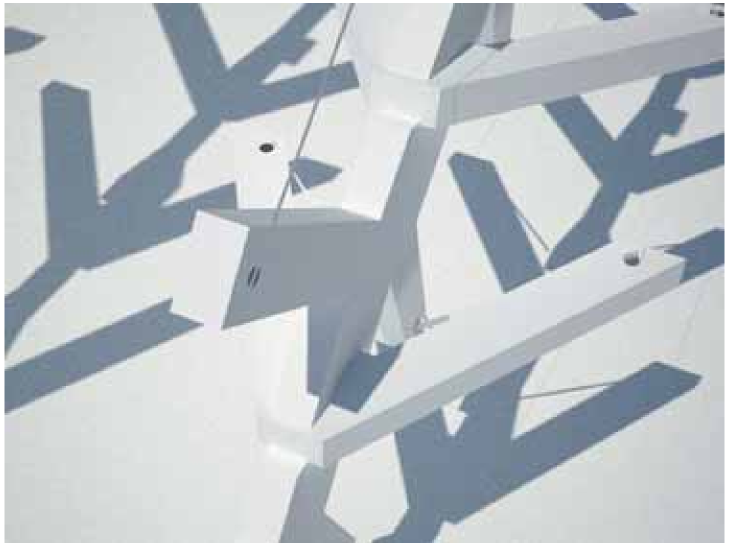


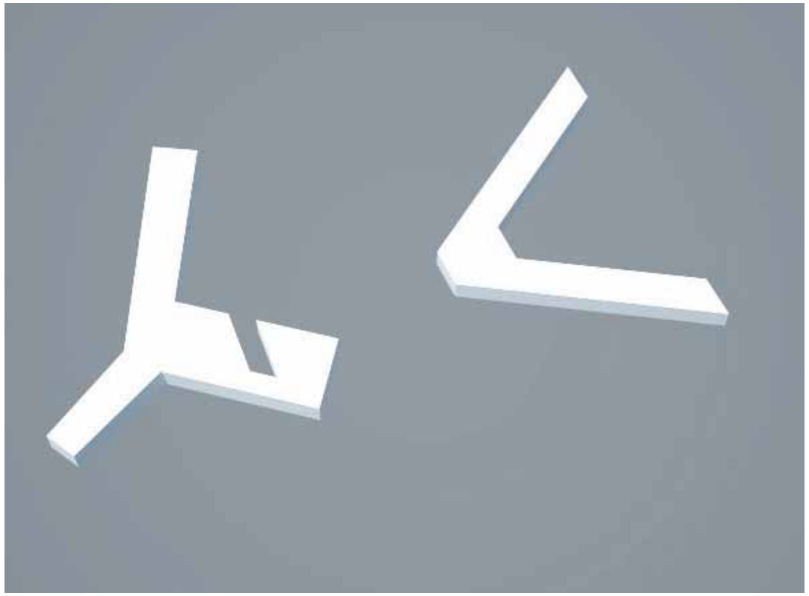


The structure cellular

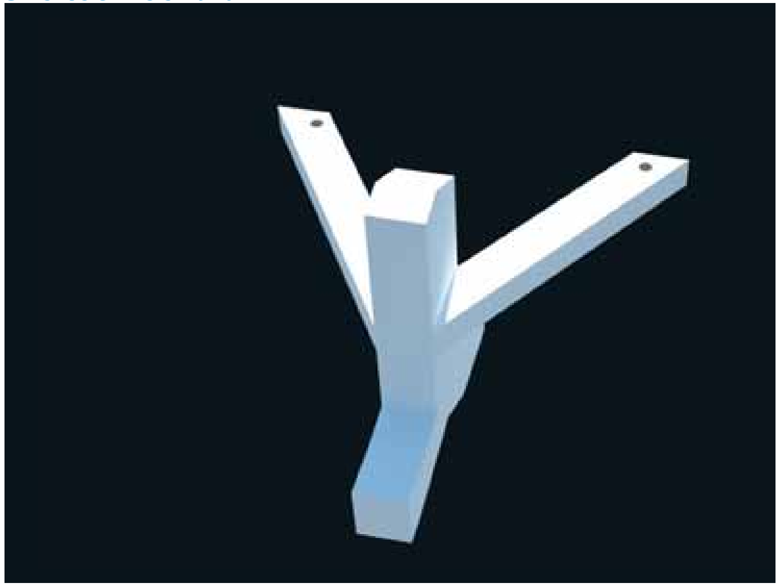
2. skelteon cellular

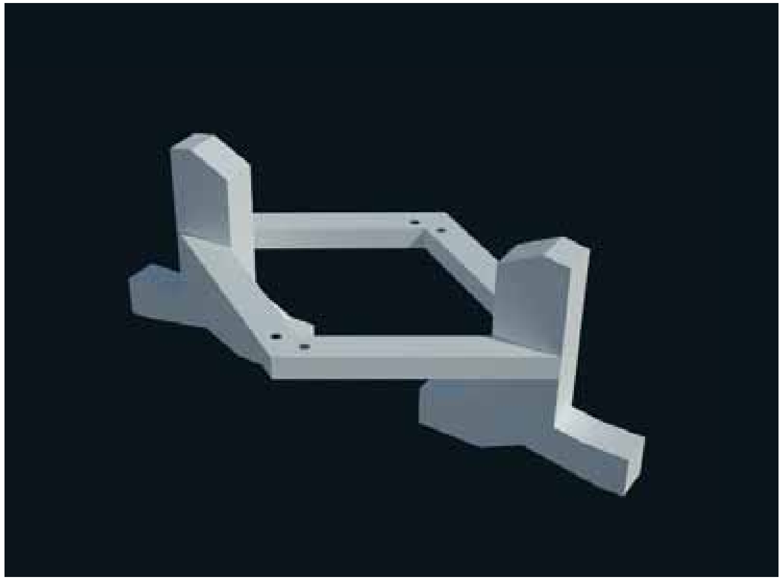


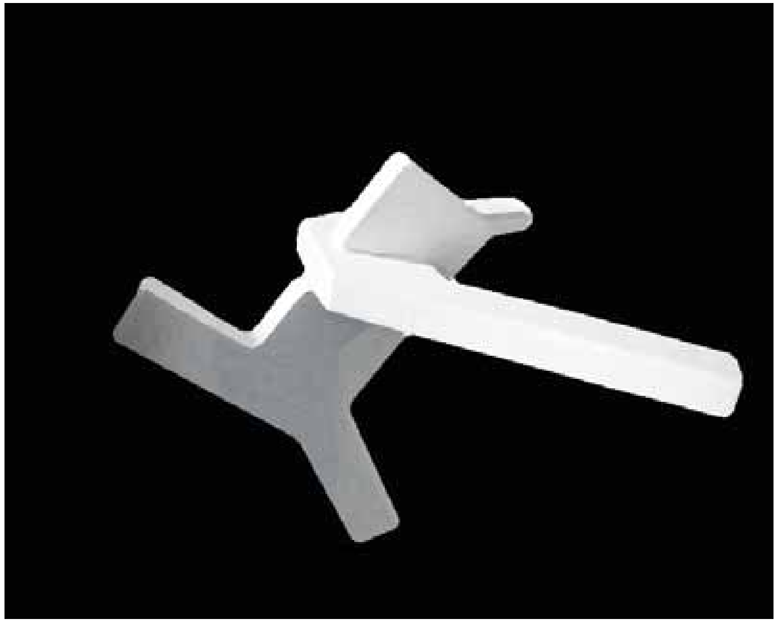


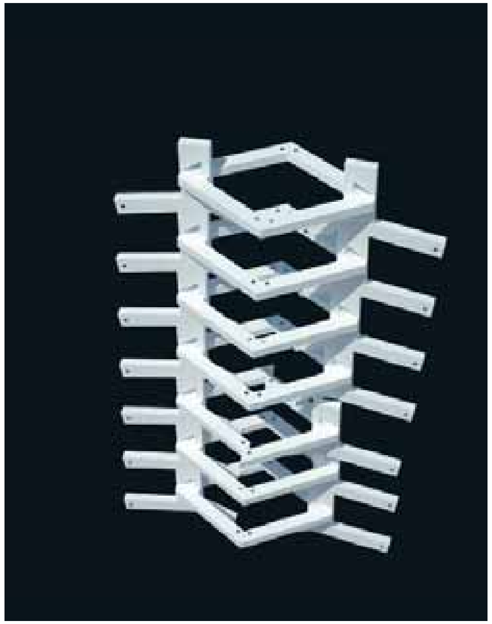


skelteon cellular

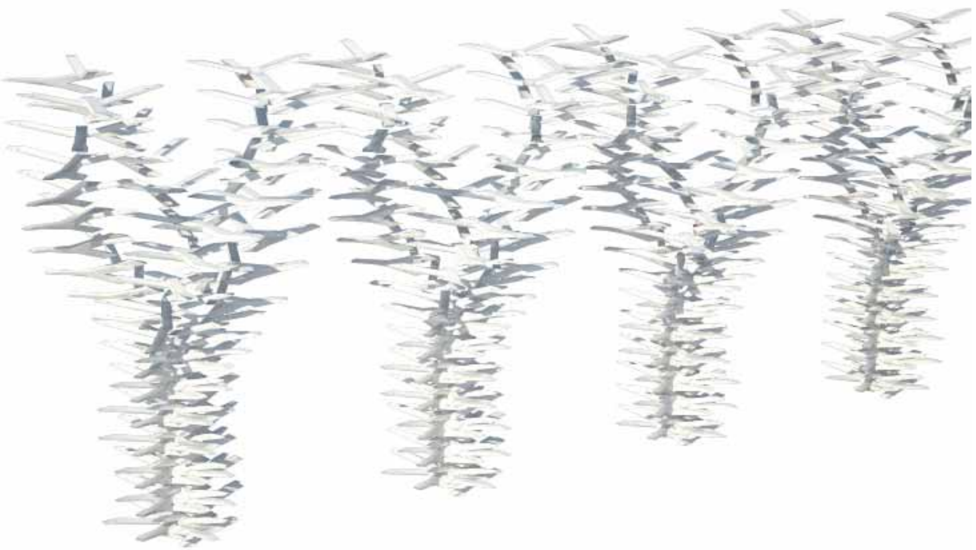


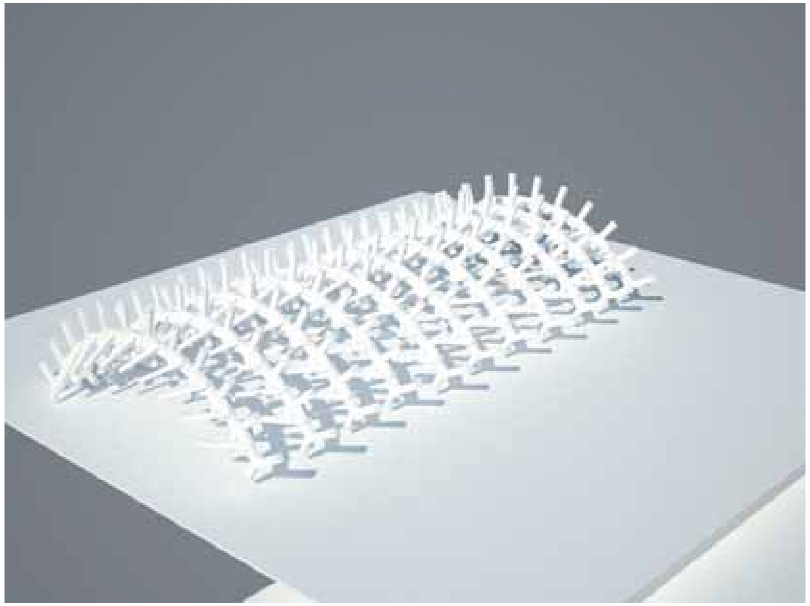




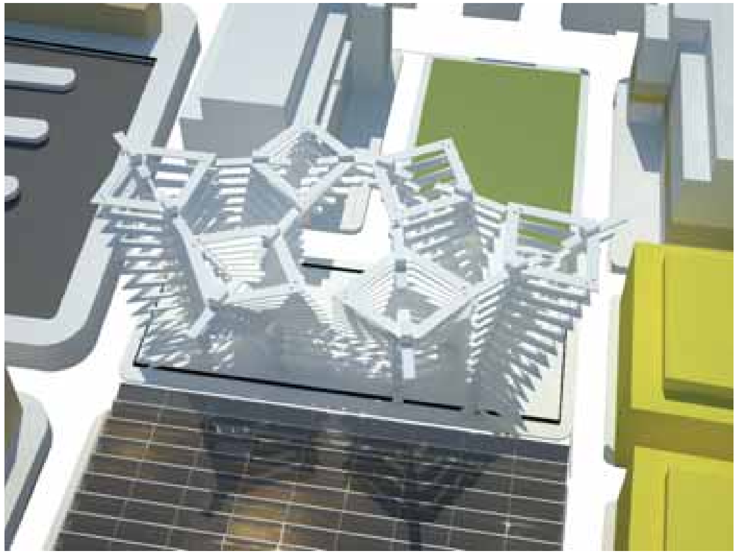


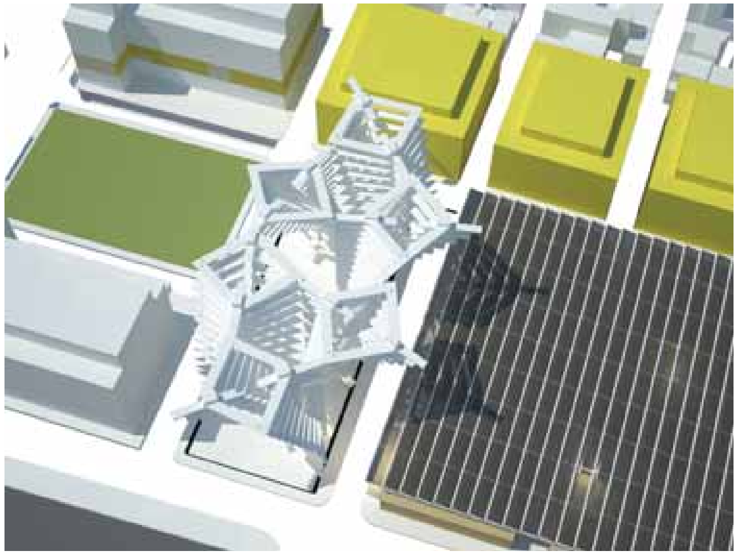
Dependent cells



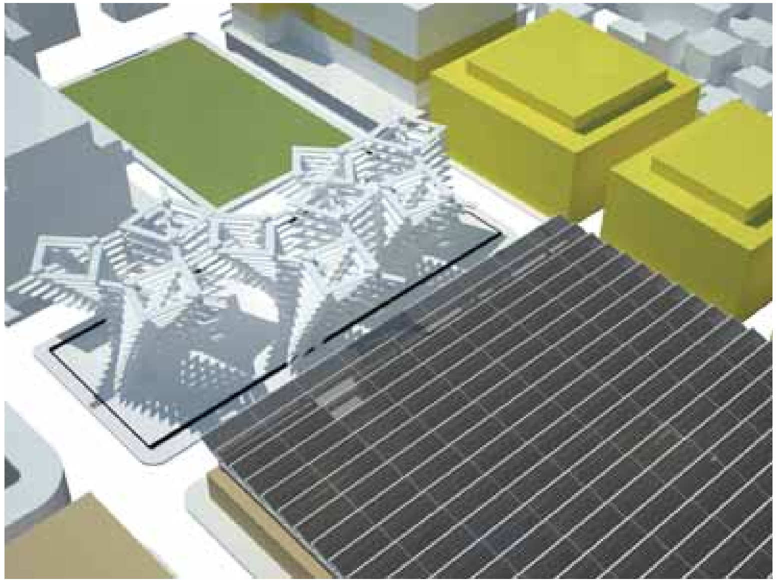


The two buildings are connected, each structure consists of three

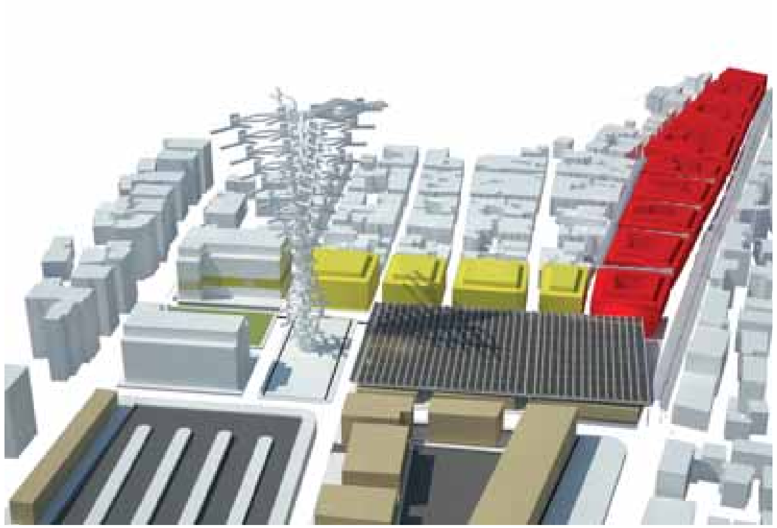




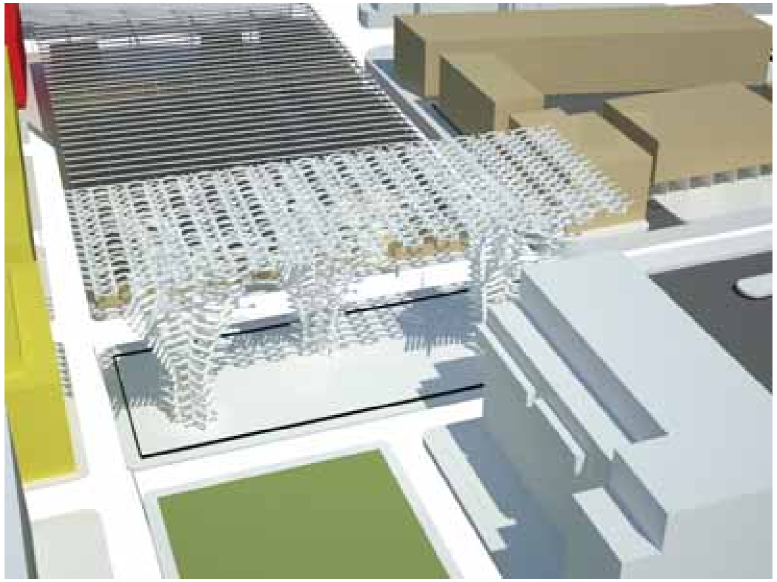
Three connected buildings, each building has three



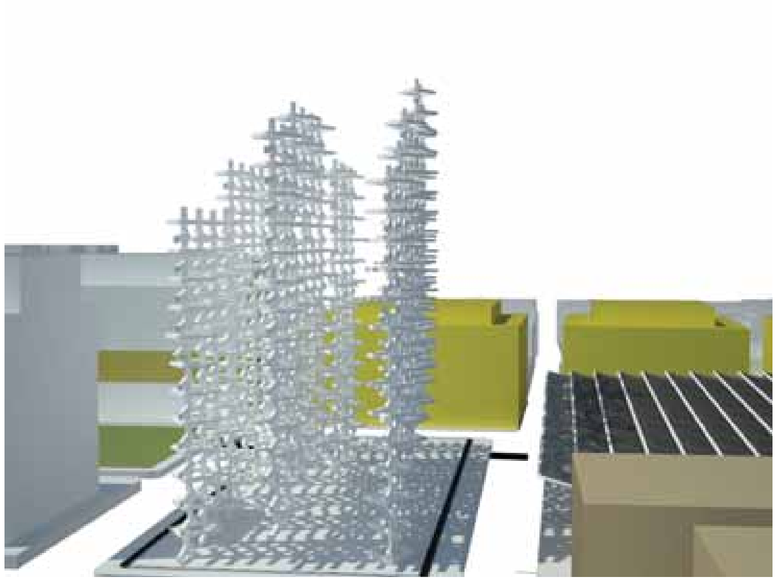
Towers



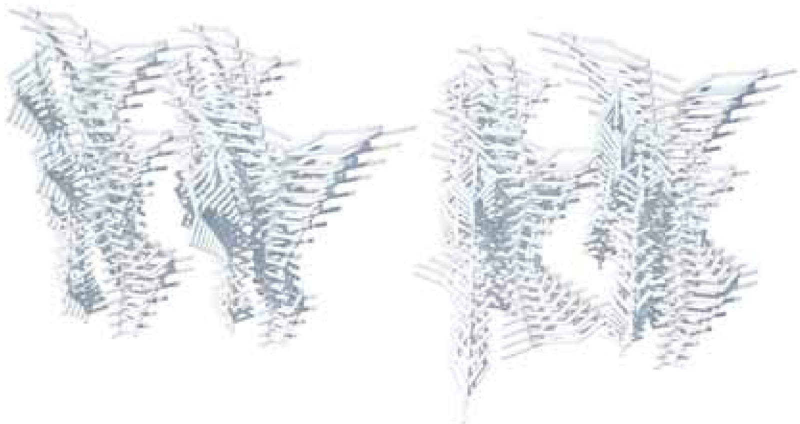
Three buildings with coverage

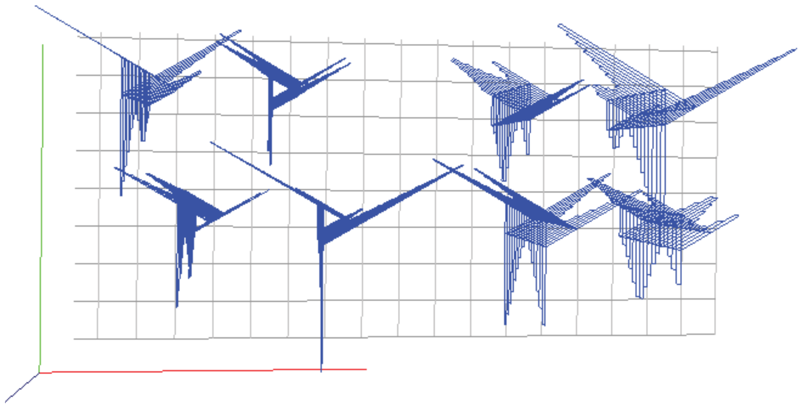


Dependent cells



Structured forest





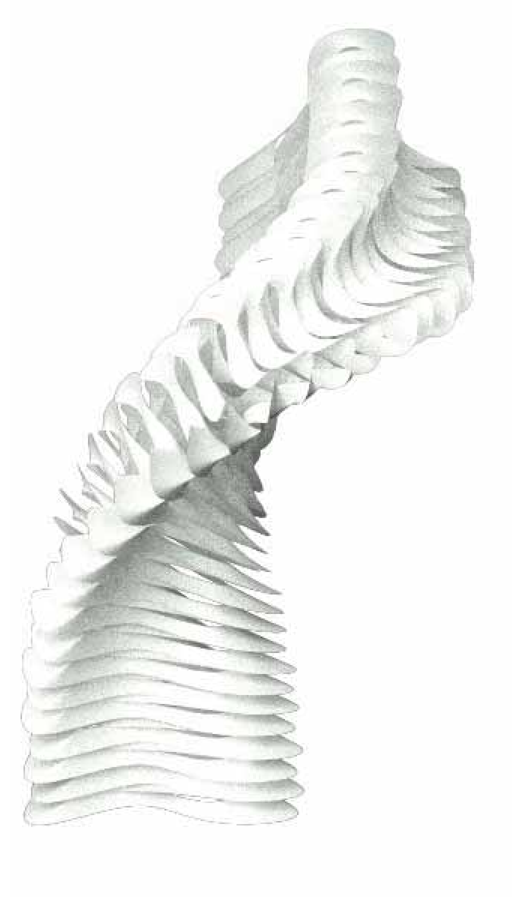
The structure skeleton

Work process - growing structure

A. String

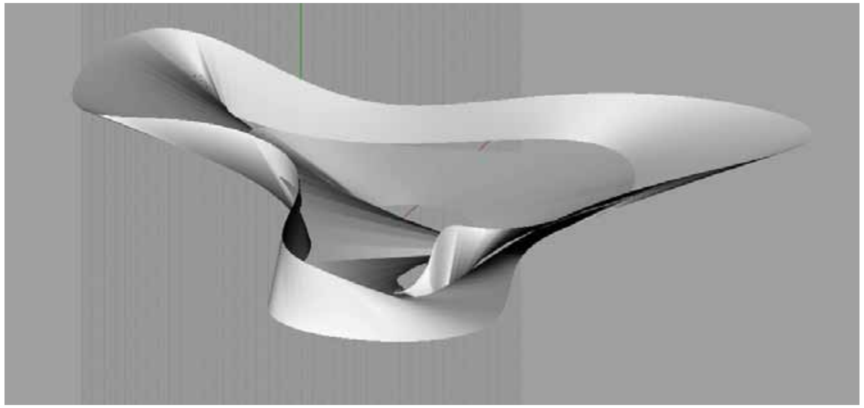
B. Algorithmic connection

Twisted surface- rotation in gem- 360 degrees Celsius

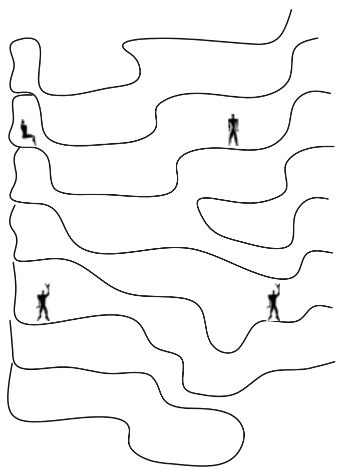


front

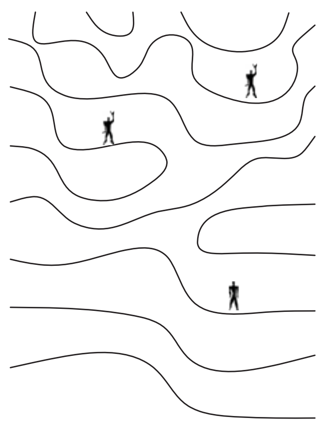
B. Connection by lug



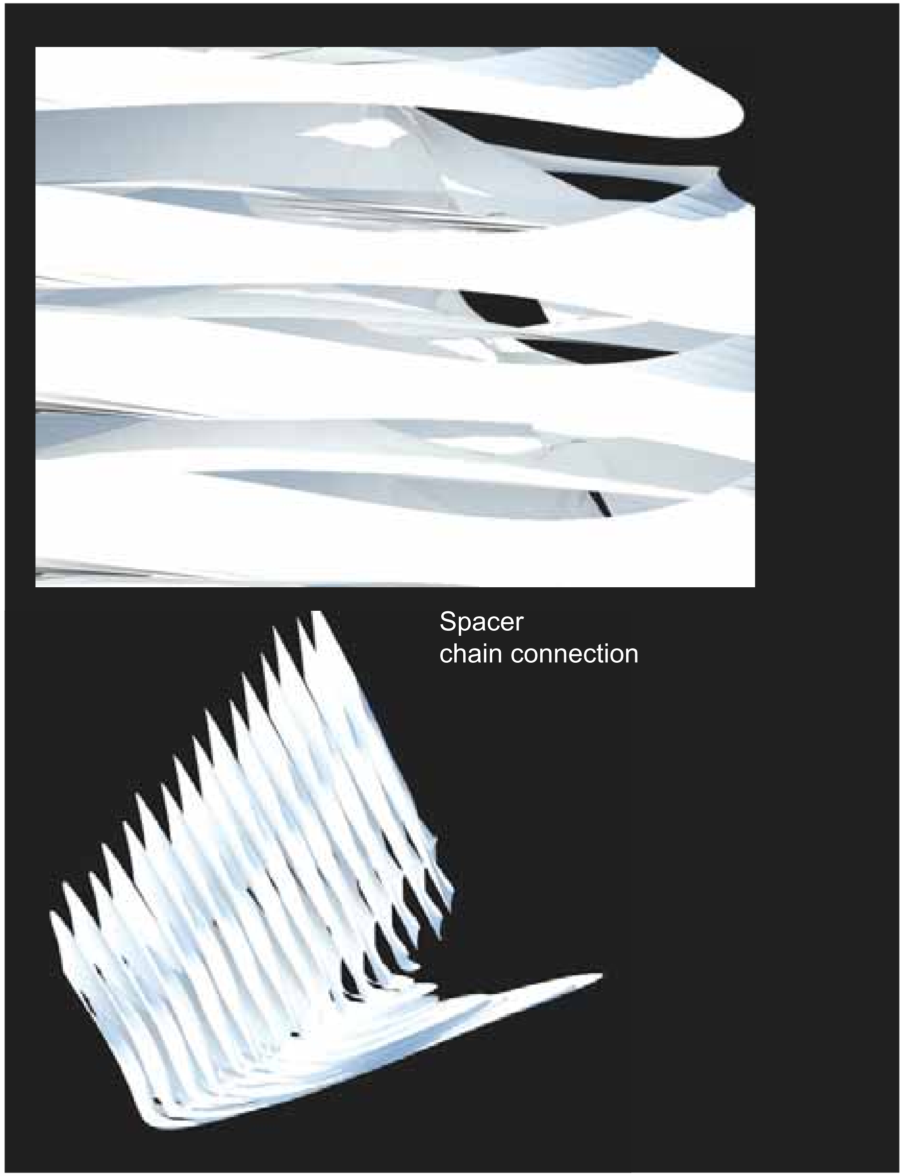
flat cell

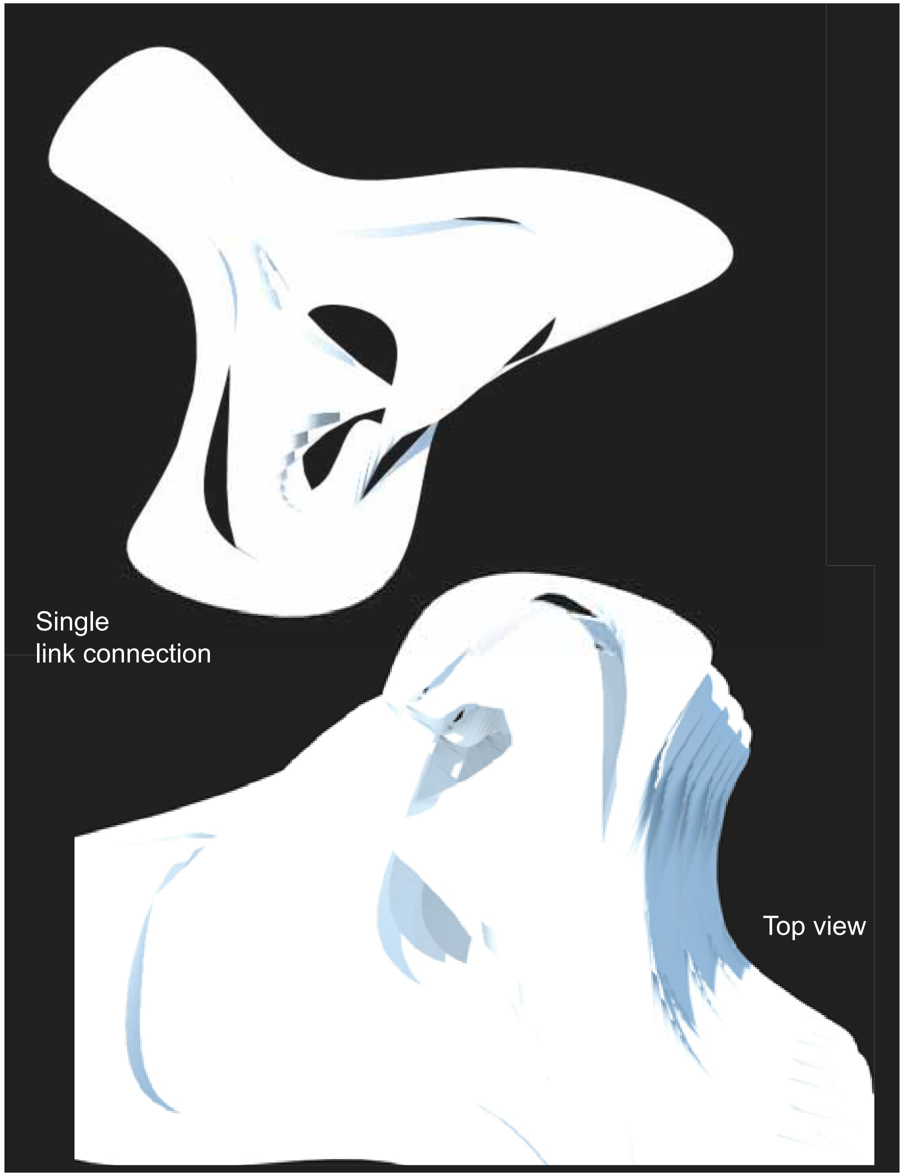


dynamical



Changes in the center of the building


Spacer
chain connection

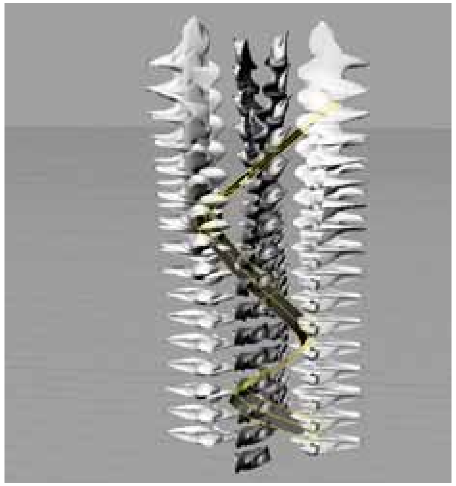

Single
link connection
Top view

Work process - rotation principle for building constructive

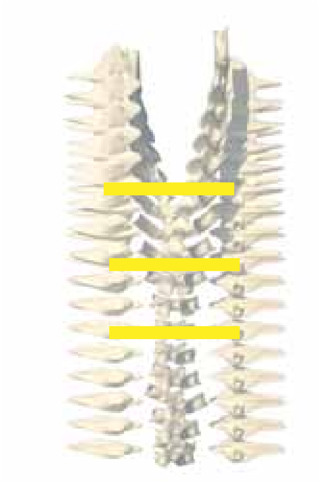
D. Twisted structures divided into cells

Twisted surface- two rotation in gem- 180 degrees Celsius

Twisted structures - Analysis

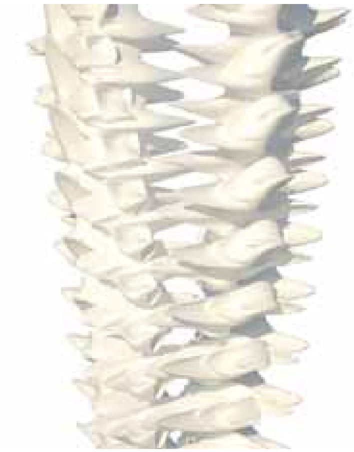


external fast circulation system



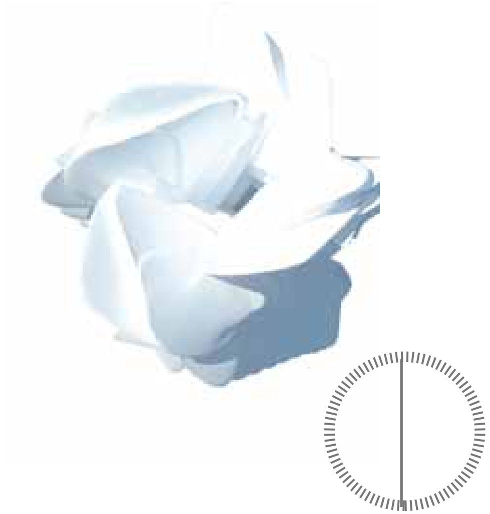
Horizontal movement

Relationship between the vertebrae



E. Connection between two buildings

180 degree Rotation- growing form



The skeleton

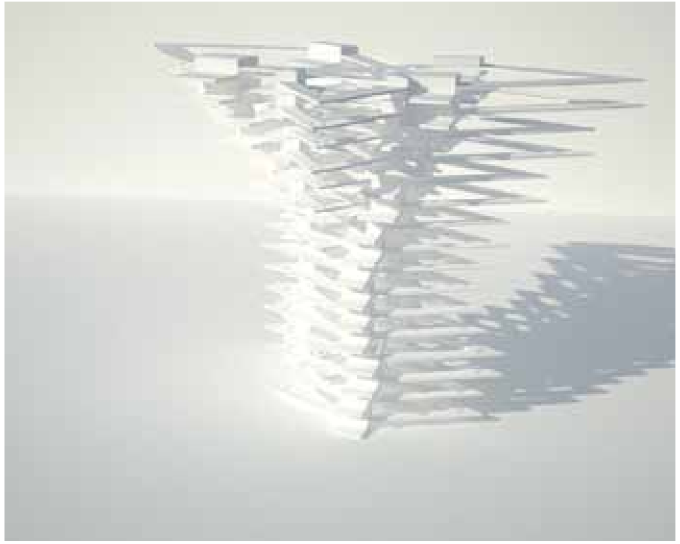
Construction:
Construction of rods made of a frame that relies on each other.
This spatial structure with horizontal frames, which moves weight by touching.

To maintain strength

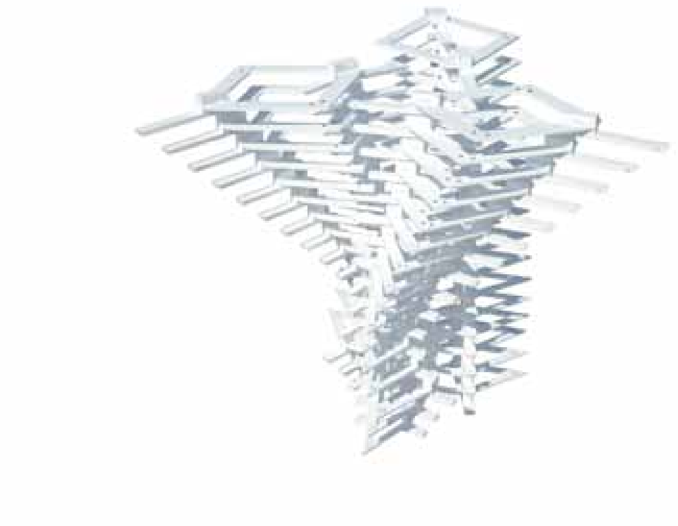
A. Divided into 3 types of cells - different thickness of the lower division thickest and heaviest materials with (Cement, concrete and steel, wood and steel, wood)

B. High surface area of the frames

C. Large overlap between the lower cells

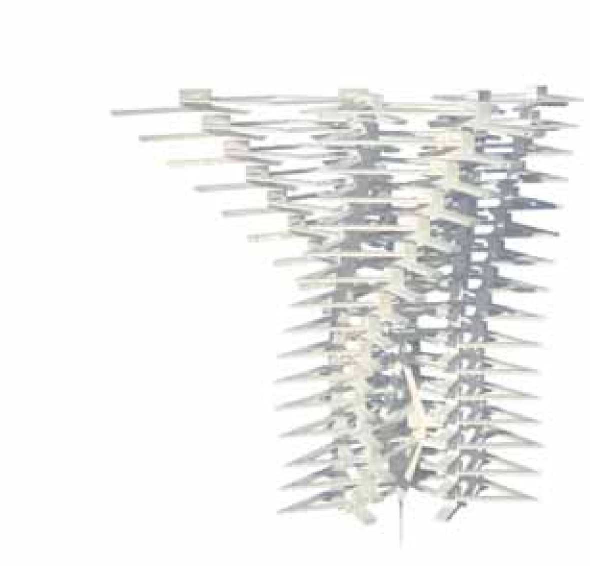


Composition of three buildings



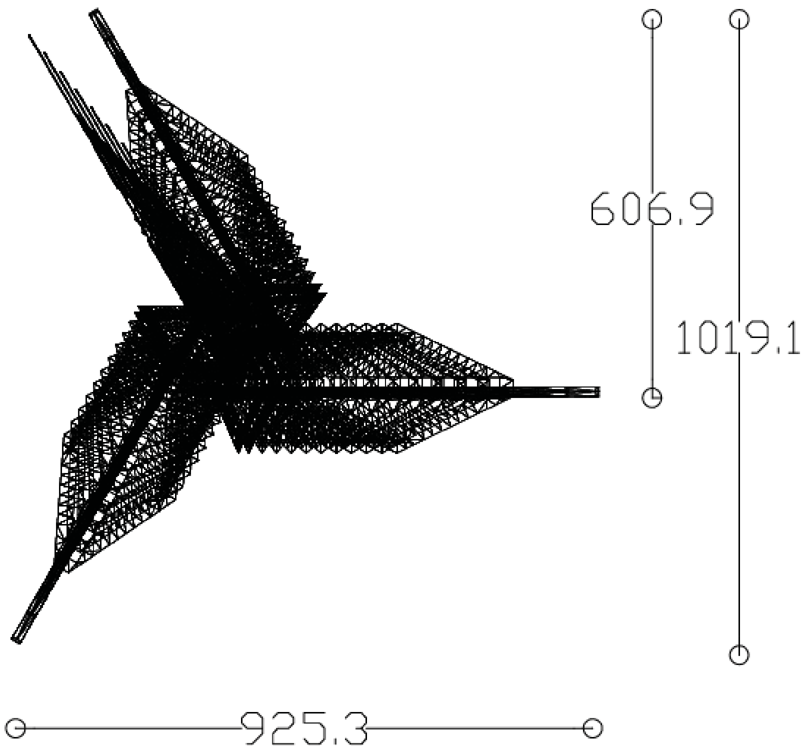
Composition of three thin structures

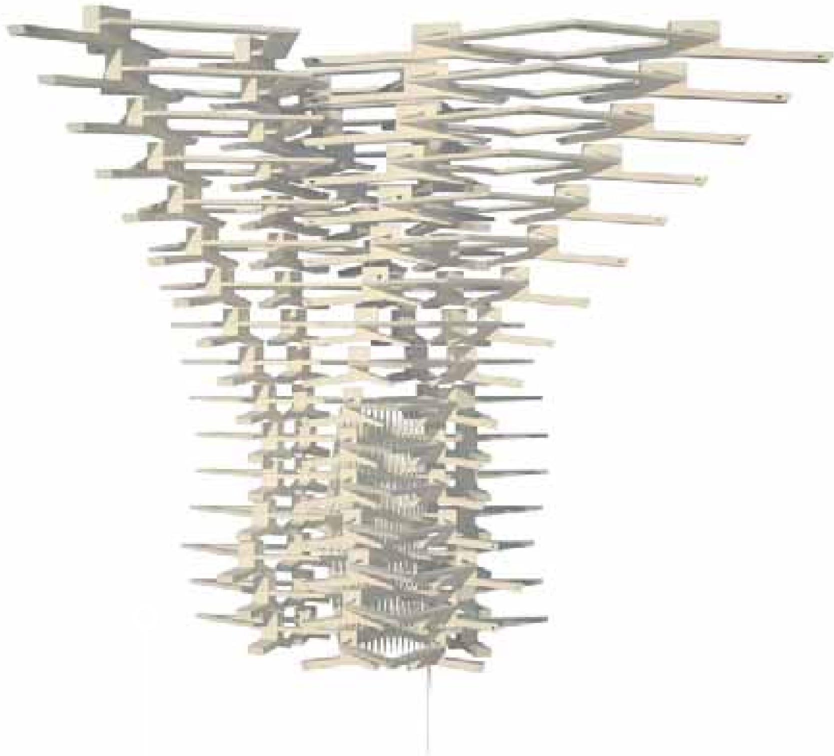
Composition of four thin structures



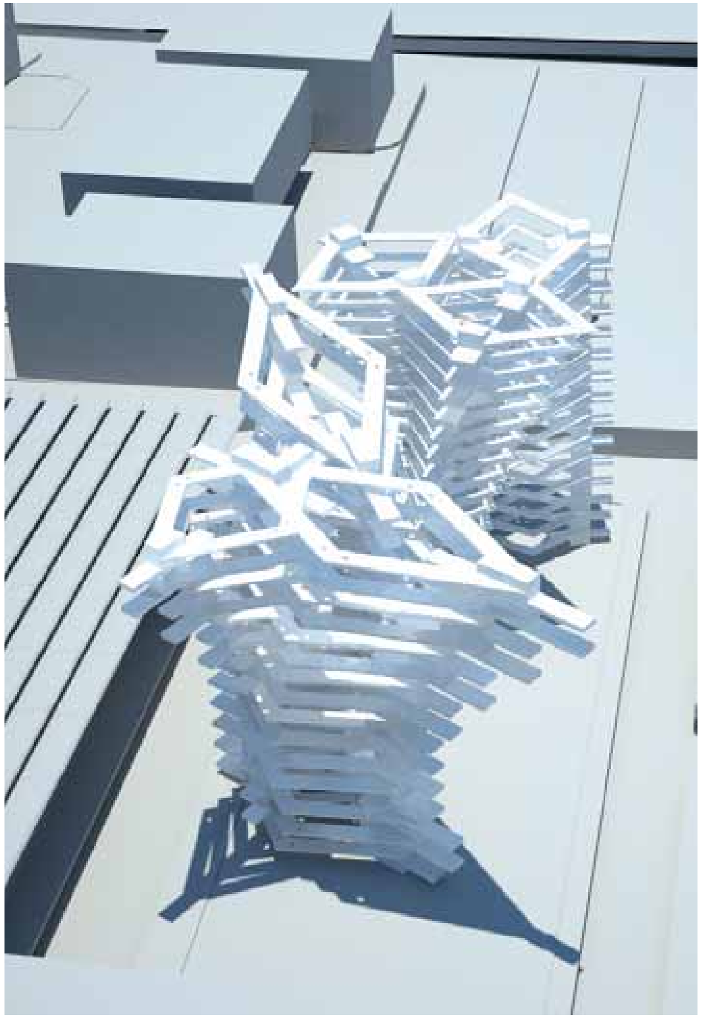
Composition of three buildings to a long narrow structure

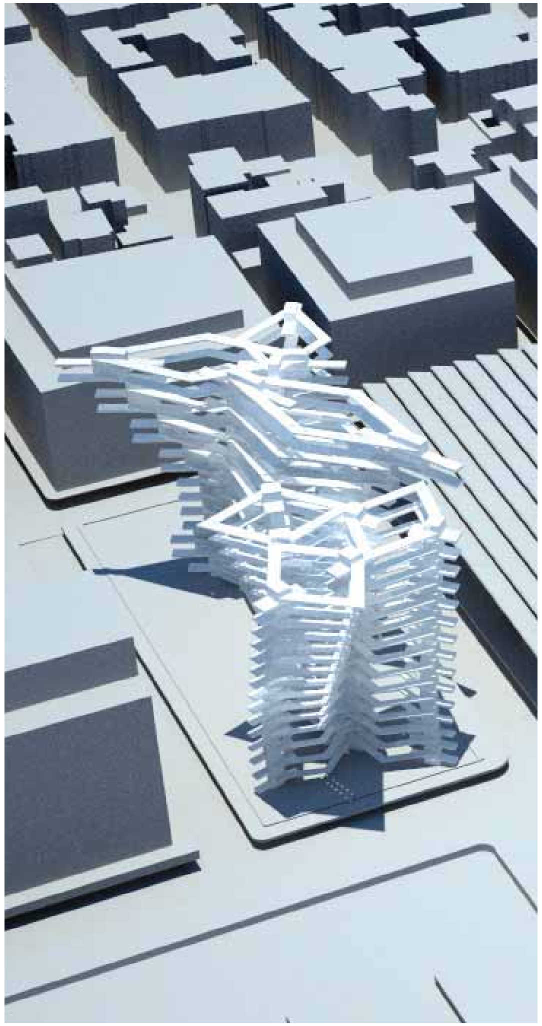
Dimensions

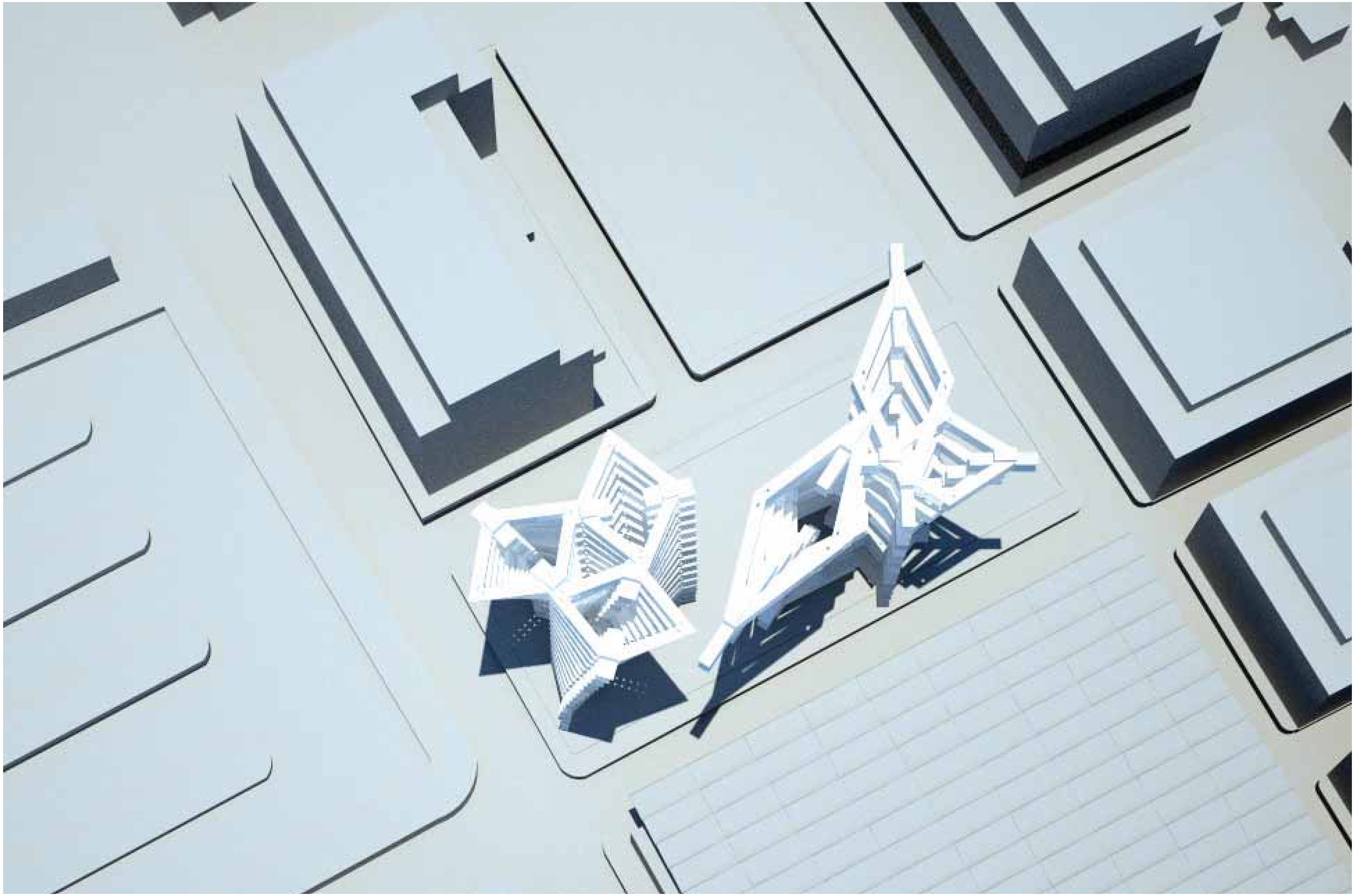




skeleton

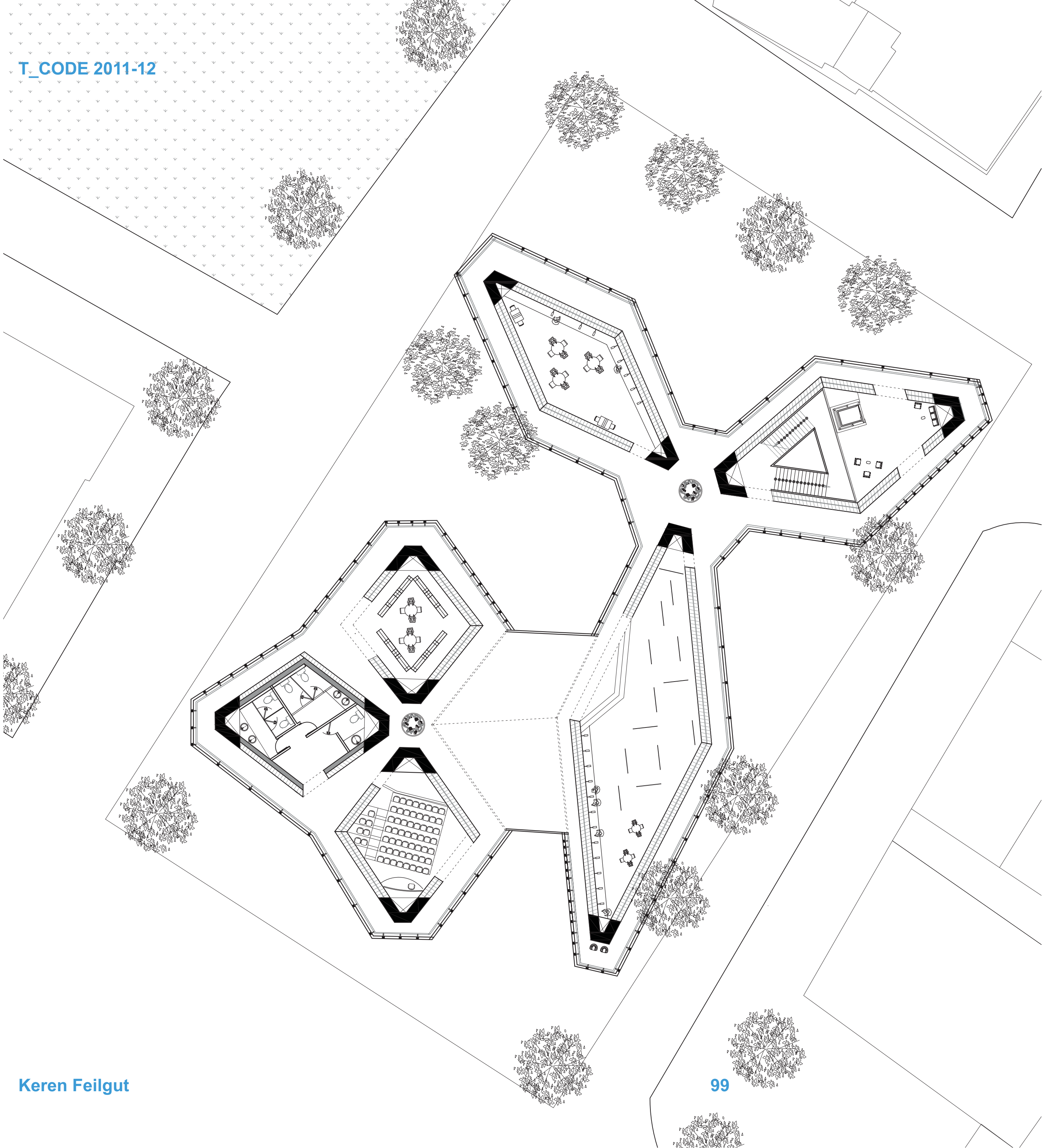






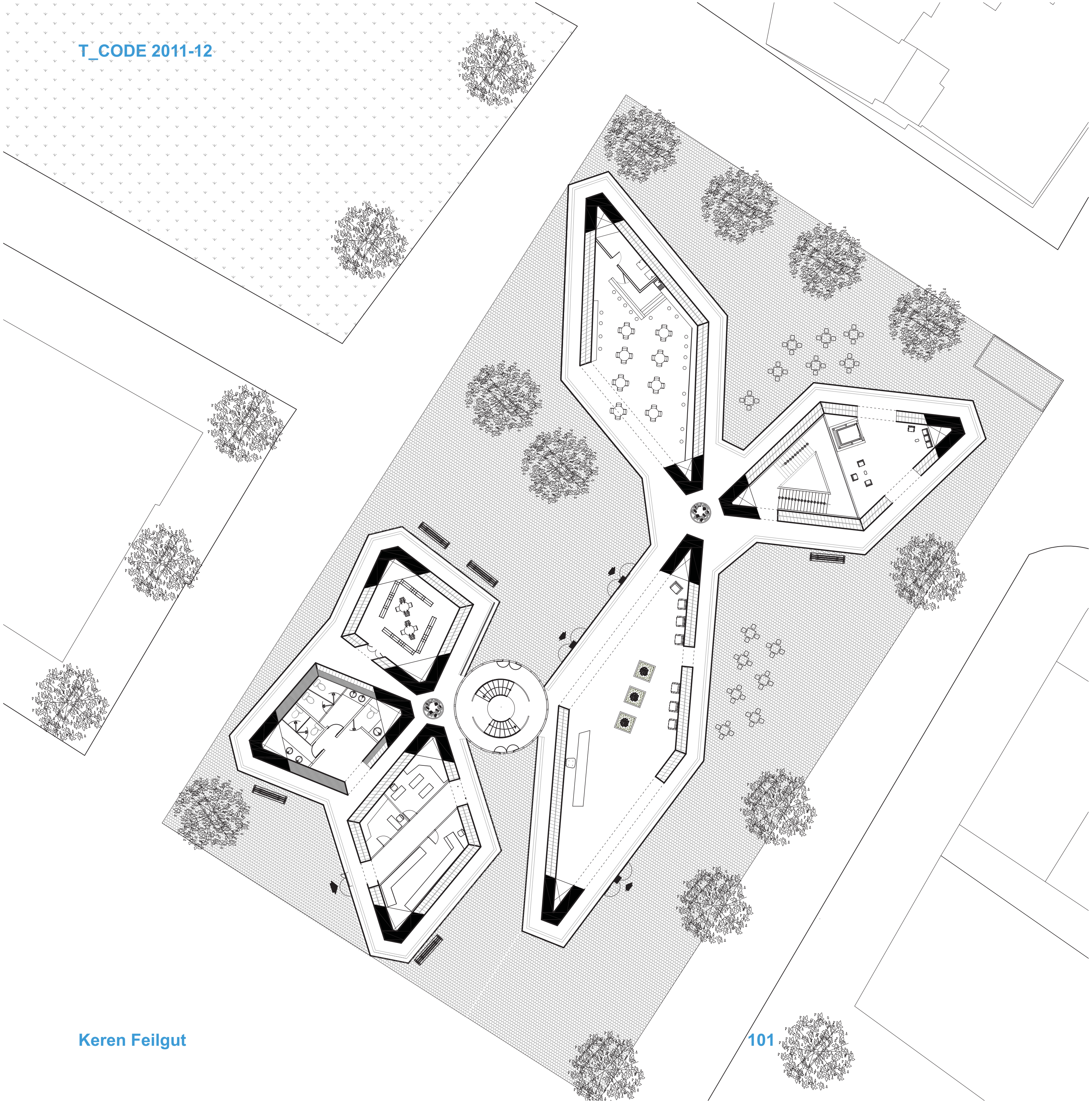
The building
Plans option A

Floor a 1:400

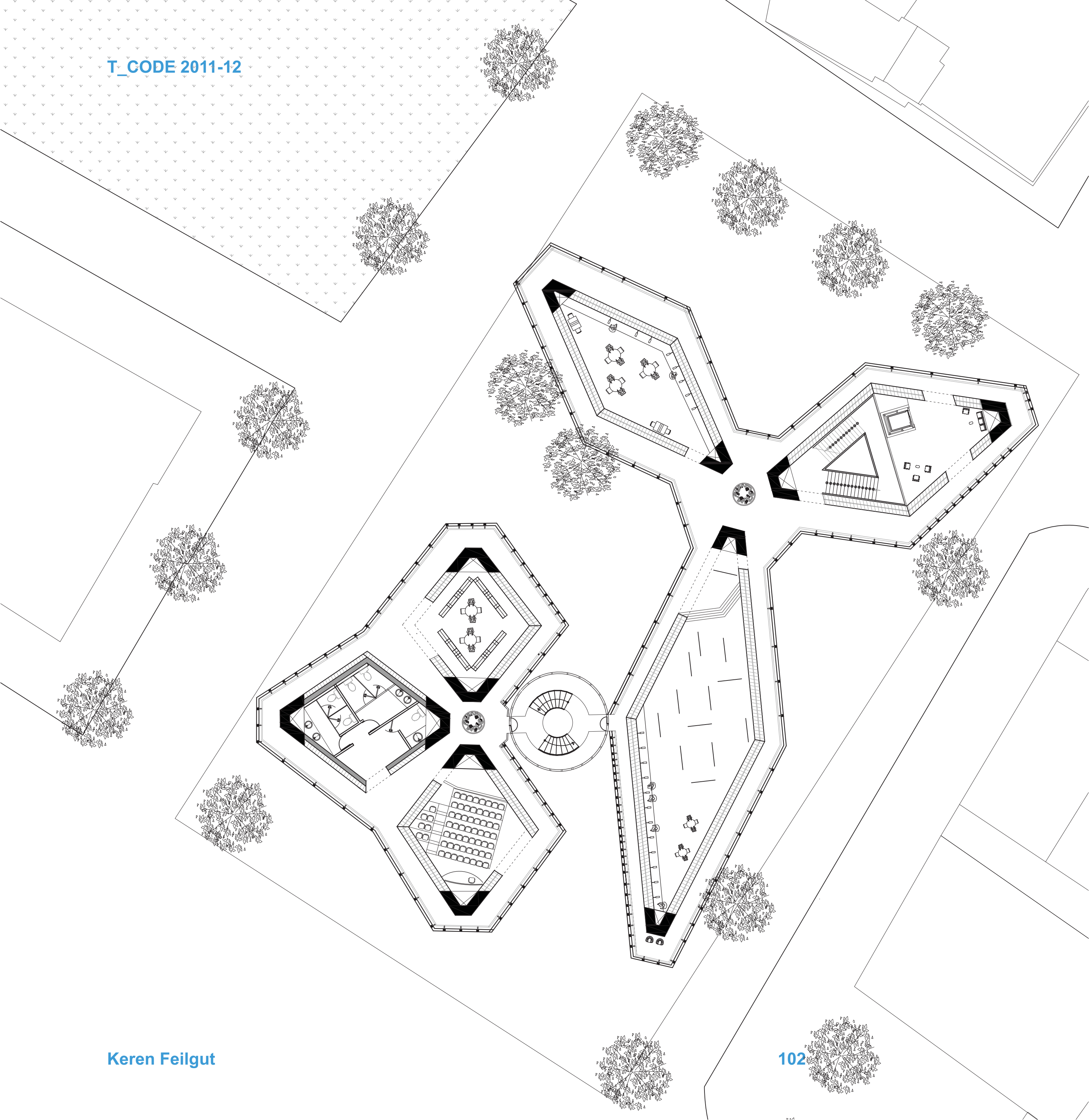


Floor c 1:400

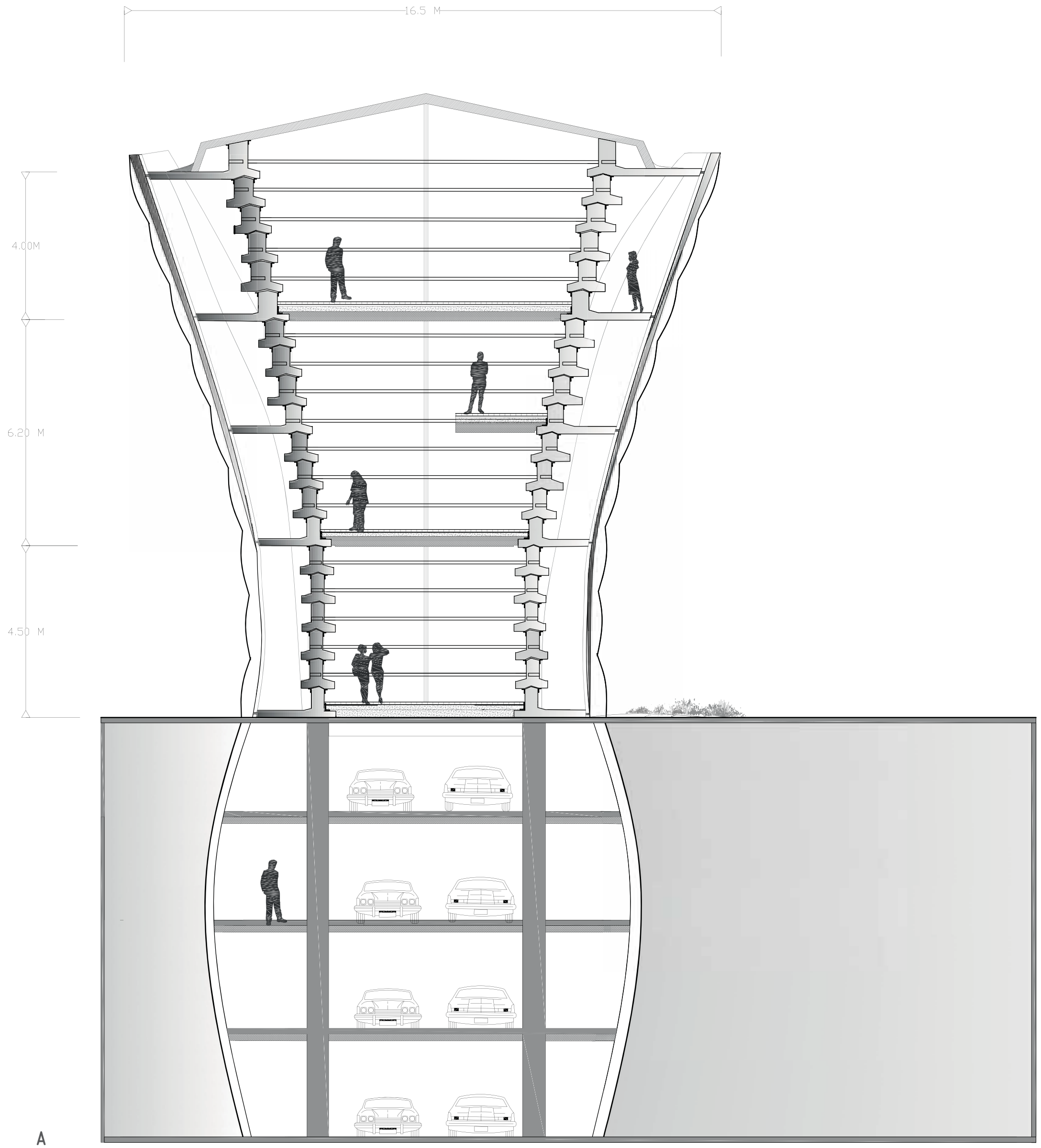
Plans option B



Floor a 1:400



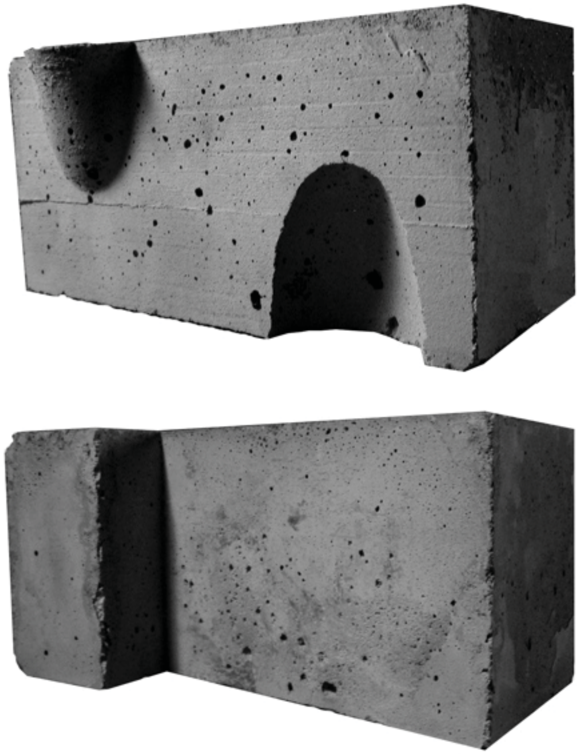
Floor c 1:400



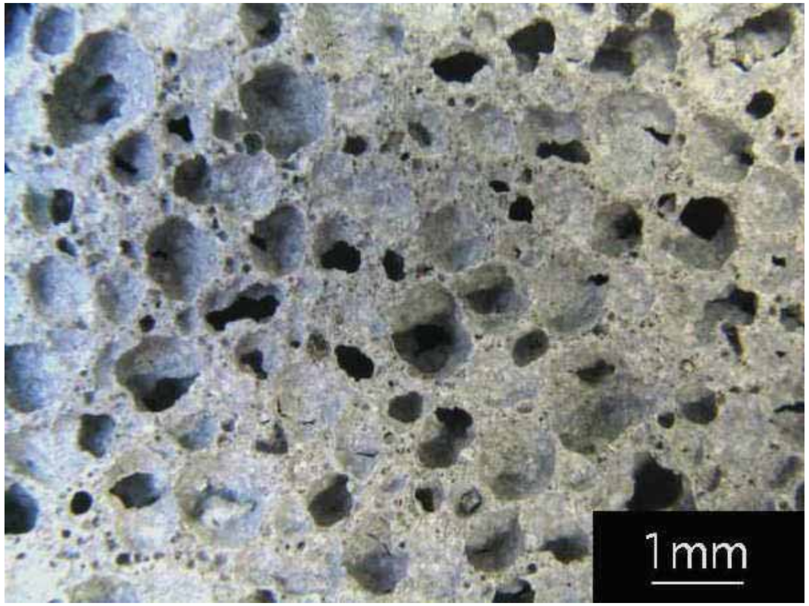
Section A

Materials

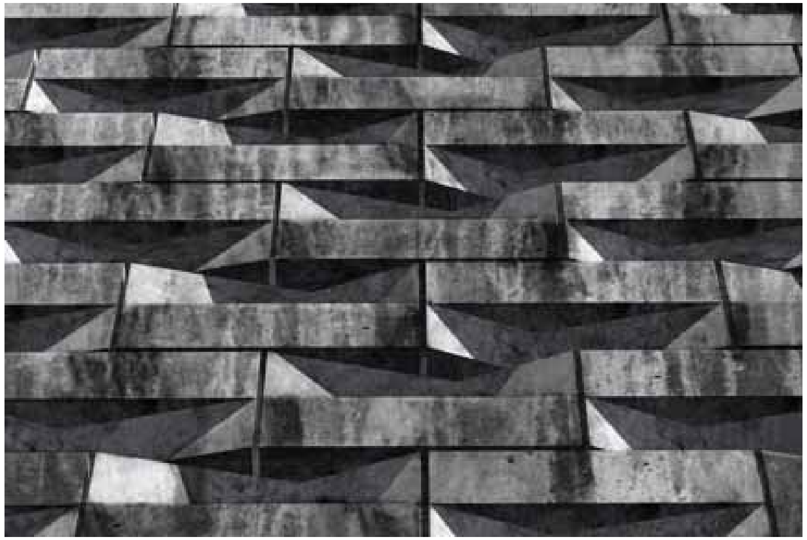
Materials



12 Blocks project by Loom Studio
http://www.dezeen.com/2007/10/09/12-blocks-project-by-loom-studio/



Autoclaved aerated concrete block
http://concrete-block-form.concreteblockss.com/autoclaved-aerated-concrete-block/



12 Blocks project by Loom Studio
http://www.dezeen.com/2007/10/09/12-blocks-project-by-loom-studio/

ULTRAPORCRETE – A NEW HIGH-STRENGTH FOAM CONCRETE

Concrete is a modern building material, which is used on nearly every construction site worldwide and which has obtained high acceptance among planners and users, thanks to its varied field of application. Due to its high density, standard concrete only has insufficient heat insulation, which implicates that residential buildings made of concrete need additional heat insulation. The light cellular or foam concretes with a good heat insulation produced to date, are hardened by means of costly and energy-intensive processes under high pressure and high temperature in autoclaves. Or their technical applicability is strongly limited due to their low strength. The team Prof. Dr. Bernhard Middendorf, Prof. Dr. Jürgen Neisecke and Dr. Armin Just from the Chair of Building Materials at Technische Universität Dortmund had the plan to develop a building material made of concrete, which combines the strength and flexible applicability of standard concrete and the low density and the good heat insulation of cellular and foam concrete.

http://www.tu-dortmund.de/uni/International/News/10-01-14_Ultrapocrete/index.html

The result of their research: ‘Ultraporcrete’, a high strength, chemically expanded, air hardened construction concrete with excellent heat insulating properties.

‘Ultraporcrete’ is worldwide the first foam concrete with the physical properties allowing to be used as construction material for load bearing building components. Due to the high rate of air voids, the building material also has excellent heat insulating properties. Another advantage of ‘Ultraporcrete’ is the low dead load of just about one third of a comparable structure made of conventional concrete. Above that, the tailor-made adjustment of the air void distribution allows the properties like, for example, compressive strength and density to be flexibly adapted to the requirements of the building object.

“Therefore, ‘Ultraporcrete’ opens up totally new possibilities in concrete engineering. It is also possible to use this building material to produce, for example, economic load bearing roof constructions for which wood is still preferred today due to a variety of reasons”, Middendorf and Just explain.

TU Dortmund applied for a patent for ‘Ultraporcrete’ and the industry is already very interested. Together with the patent marketing agency PROvendis GmbH, the Dortmund scientists expect the building material to be used in numerous innovative building projects.

Flexible polymer

The main advantages of polycarbonate and acrylic, on the other hand, is that they are 20 times less brittle than glass and their ultimate streght can be two times higher than glass (see data on the table below). So, we will focus on polycarbonate and PMMA / acrylic from now on.

A composite construction consisting of a polymer double skin with an inner composite core, configured to provide a stiffer, safer, energy efficient and lightweight alterative to a glass façade system.
This new 'glazing' system has spurred studies that evaluate the material performance of polymer and composites as a cladding material. The polymer skin has a sustainable characteristic due to its recyclability, which can help to reduce the environmental impact associated with raw material depletion and disposal.

Reiss London. Acrylic milling process and finished facade panel.

		Thermoplastic				Glass
		Polycarbonate PC	Polyesters PET	Polypropylene PP	Polymethylmethacrylate PMMA	
Mechanical Properties						
Density (ρ)	Mg/m^3	1.14-1.21	1-1.40	0.89-0.92	1.16-1.22	2.44-2.5
E-modulus (E)	GPa	2.21-2.44	0.3-0.41	0.9-1.55	2.24-3.8	68-72
Poison's Ratio (ν)	dimensionless	0.38-0.42	0.34	0.43	0.37-0.43	0.2
Yield Strength (σ_y)	MPa	58.6 - 70.0	1.30 - 72.2	20.7-37.2	45.0 - 86.0	31-35
Ultimate Strength (σ_{ult})	MPa	65.0 - 72.4	9.70 - 53.0	17.2 - 31.0	30.3 - 100	31-35
Elongation at yield	%	6.00 - 50.0	20.0 - 50.0	5.00 - 37.0	-	0
Elongation at break	%	10.0 - 125	50.0 - 900	10.0 - 600	3.50 - 40.0	0

http://facadesconfidential.blogspot.co.il/2010/11/will-transparent-polymers-kill-glass.html

Characteristics of Polymers and Glass

	Pros	Cons
PC	Easy to bond and connect Easy to manufacture curved forms High creep resistant High impact resistant High service temperature Recyclable Lightweight	High processing temperature Expensive Low heat/flame resistant Low UV resistant Low weatherability Susceptible to moisture absorption Low abrasion resistant
PET	Tough and rigid Ease of manufacturing Recyclable Lightweight	Low resistant to acids and bases Low heat/flame resistant Low solvent resistant
PMMA	Easy to bond and connect Easy to manufacture curved forms High UV resistant Recyclable Lightweight	Brittle Low weatherability Low heat/flame resistance Susceptible to moisture absorption
PP	Ease of manufacturing Low coefficient of friction High moisture resistant High fatigue resistant High abrasion resistant High service temperature High chemical resistant High flexural strength High impact r Recyclable Lightweight	Low UV resistant Low weatherability Low heat/flame resistance Low bond ability Low solvent resistant
Glass	UV resistant Recyclable Low embodied energy High service temperature High heat resistant	Heavy weight High heat conductivity Brittle Expensive to manufacture curved sheet

From “Industrial plastics,” by E. Lokensgard, 2004.

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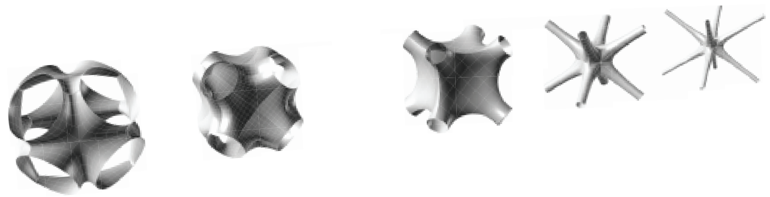
Zheng, W. et al., 2012. Endothelialization and patency of RGD-functionalized vascular grafts in a rabbit carotid artery model. Biomaterials, 33(10), pp.2880–2891.

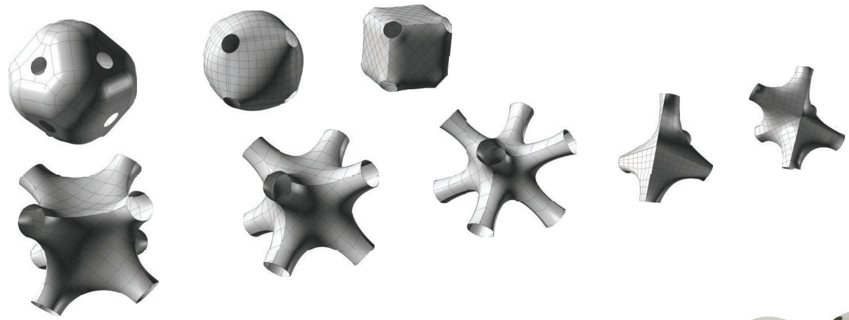
Do-see-aaH Center

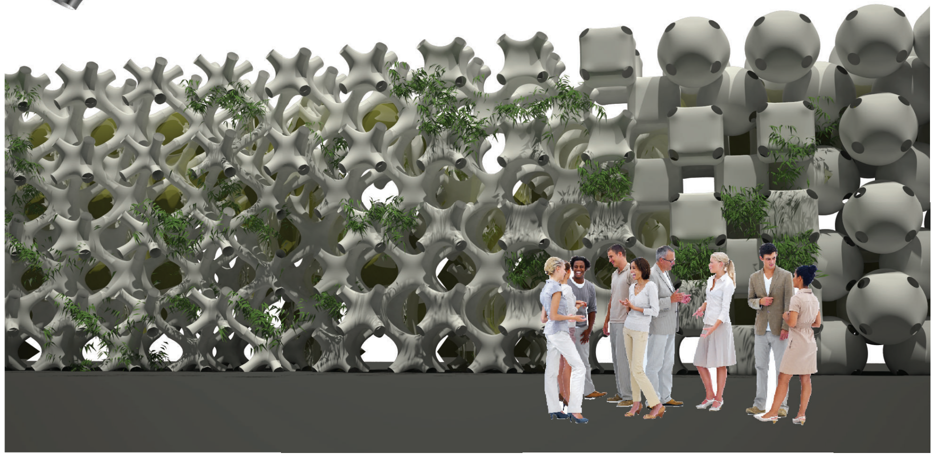
מרכז דו-שיח

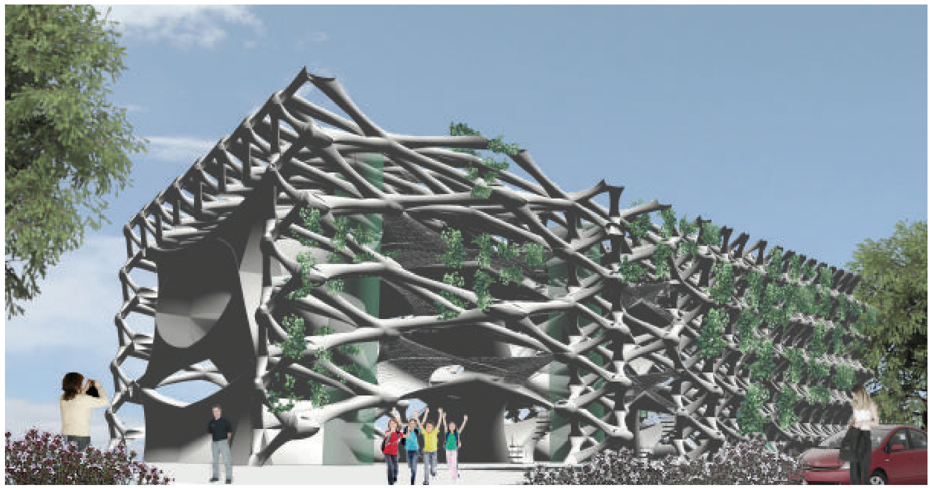
***dual-net cellular structure
for a community center
and an urban mediatek***

***מבנה רשתות דואליות תאיות
כמרכז קהילתי ומדיה-טק עירוני***

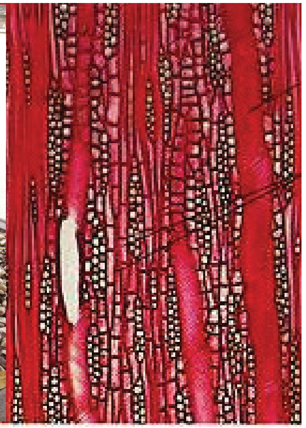
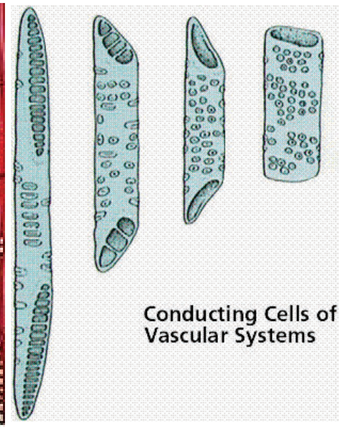








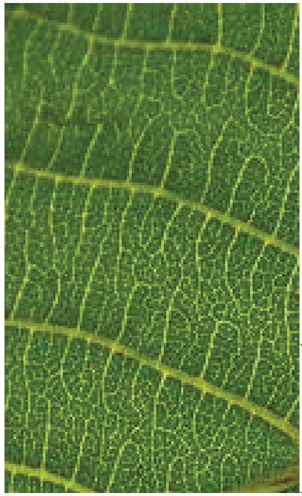
tubular cells

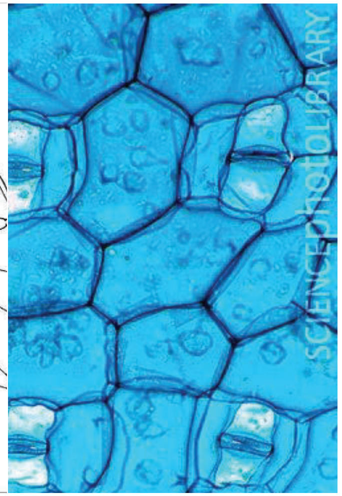




organ tubular cells　tissue tubular cells in stem　basic tubular cells in stem

http://preuniversity.grkraj.org/html/3_PLANT_ANATOMY.htm

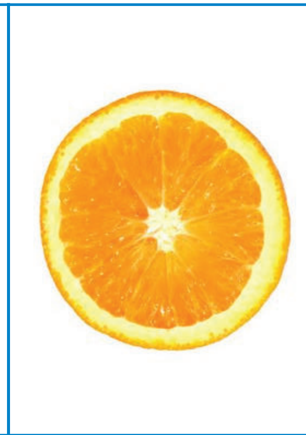
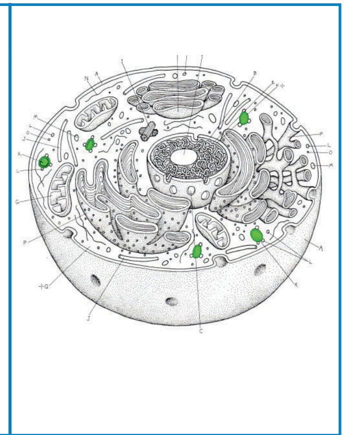
surfuse cells



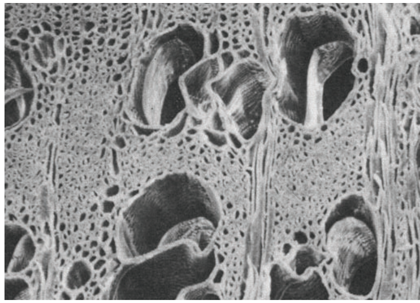
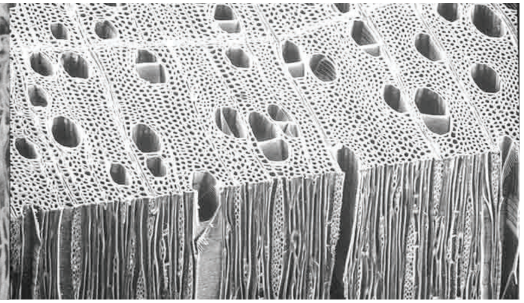
www.swst.org/teach/set2/struct1.html

radial symetry in cells

organ radial symetry cells　tissue radial symetry cells　radial symmetry in a single cell

anisotropic cells structures in wood

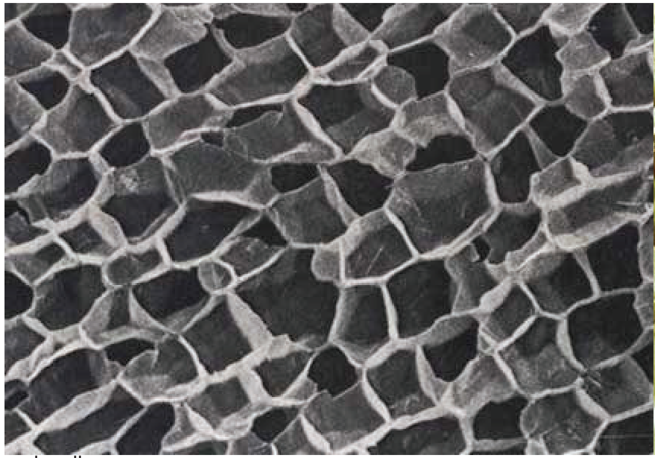



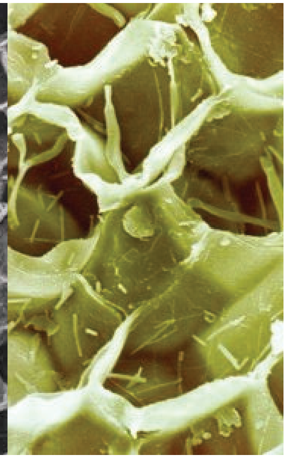
http://www.engr.wisc.edu/alumni/perspective/06.4/branches.html
http://ruscork.ru/en/index.php?option=com_content&task=view&id=4&Itemid=6

This is a scanning electron micrograph of a eastern spruce wood block, a softwood. Most cells run longitudinally, but some cells, run horizontally. The big hole is called a resin canal. The majority of the cells shown here are called "longitudinal tracheids". On different surfaces, the wood structure appears differently. This is called anisotropic or orthotropic structure. This unique structure differs from other raw material, e.g., metal, plastic, concrete and rocks.

low Specific gravity cells

http://commons.wikimedia.org/wiki/File:Luffa_operculata_08.JPG
lufa fruit





cork cells
http://www.engr.wisc.edu/alumni/perspective/06.4/branches.html
http://ruscork.ru/en/index.php?option=com_content&task=view&id=4&Itemid=6

dynamic fruit cells - spreading seeds

by air and wind

by floating on water. above-by animals stomach

http://www.flowersinisrael.com/Seneciovernalis_page.htm
http://bioteach.snunit.k12.il/upload/.webpage/pictofaot.html

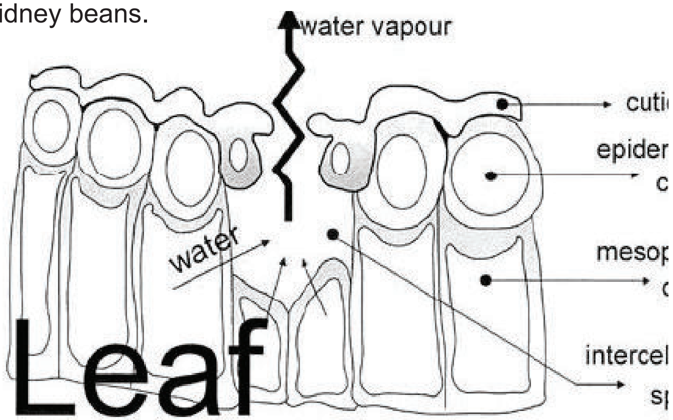
by jetstream preasure

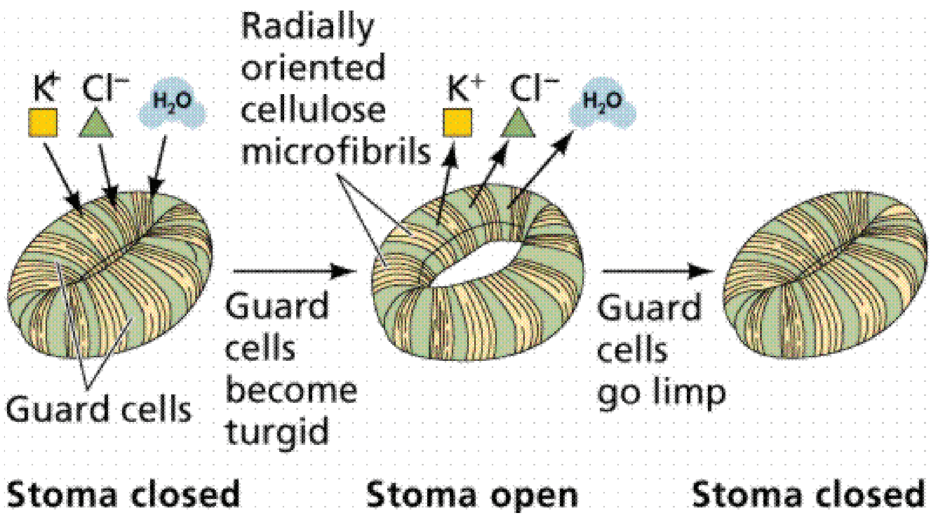
by clinging on animal's fair

http://www.keiriosity.com/gallery/main.php/v/plants/Fabaceae/Medicago_polymorpha/Medicago_polymorpha01.jpg.html

stomata distribution

Stomatal density refers to the number of stomata per squared millimeter. Typical densities can vary from 100 to 1000 depending on the plant species and the environmental conditions during development. More stomata are made on plant surfaces under higher light, lower atmospheric carbon dioxide concentrations and moist environments. Grasses typically have lower stomatal densities than deciduous trees. The size and shape of stomata also vary with different plant species and environmental conditions. For example, grasses have guard cells that resemble slender dumbbells whereas trees and shrubs have guard cells that resemble kidney beans.





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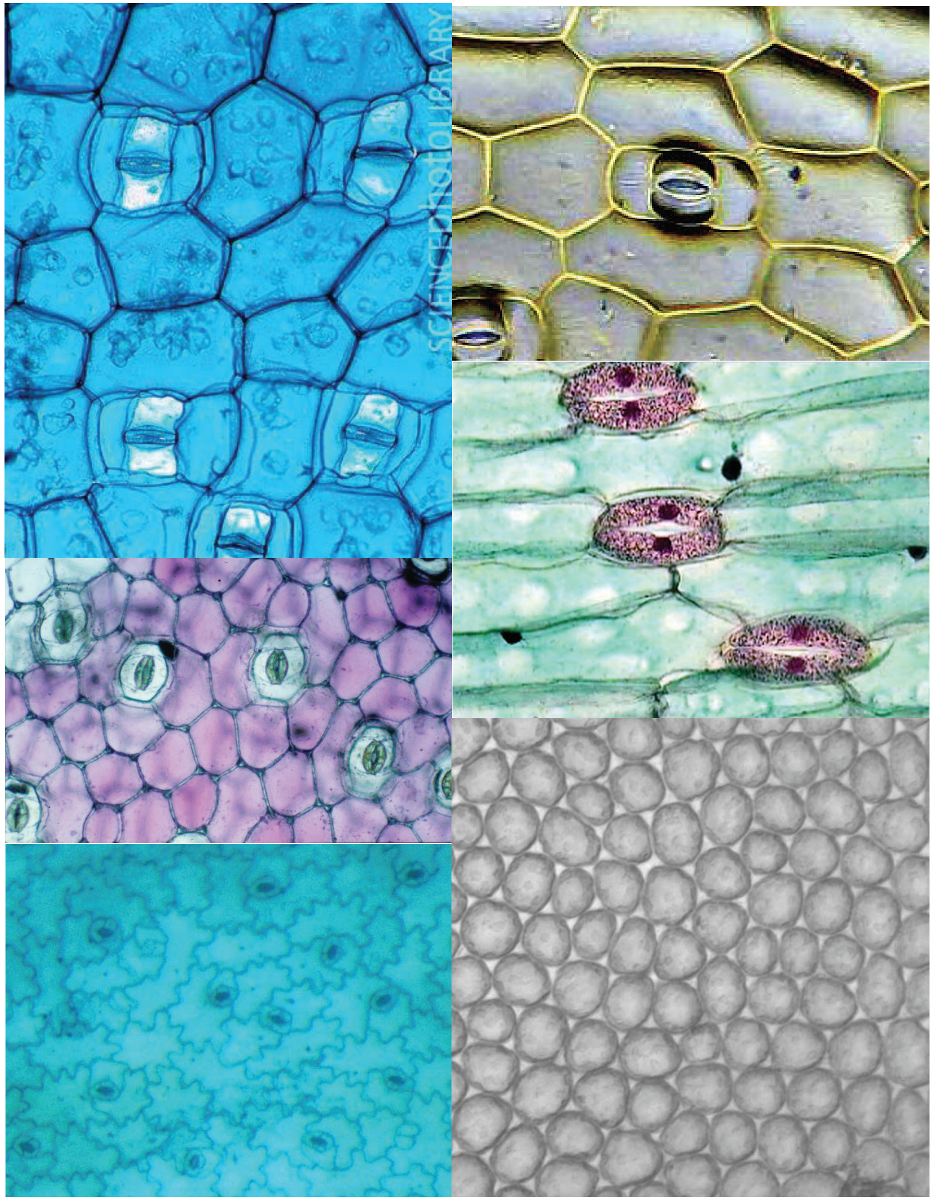
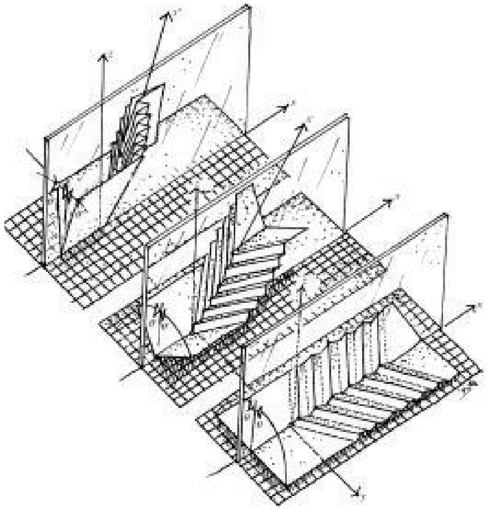
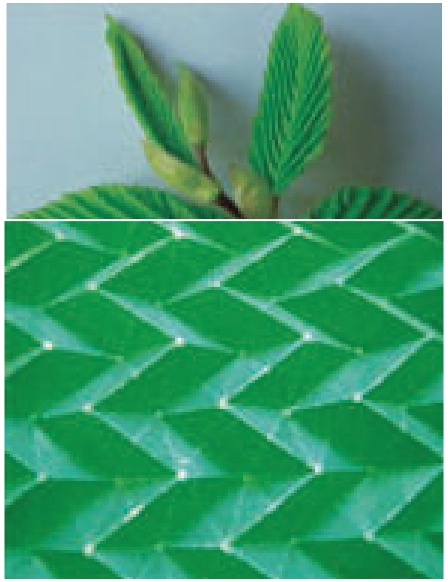


http://www.sciencephoto.com/media/91320/enlarge
http://micro-scopic.tumblr.com/post/17839517731/stomata
http://stomata.watishet.info/

other water accumilation,
anti vapor and micro climate strategies in plants

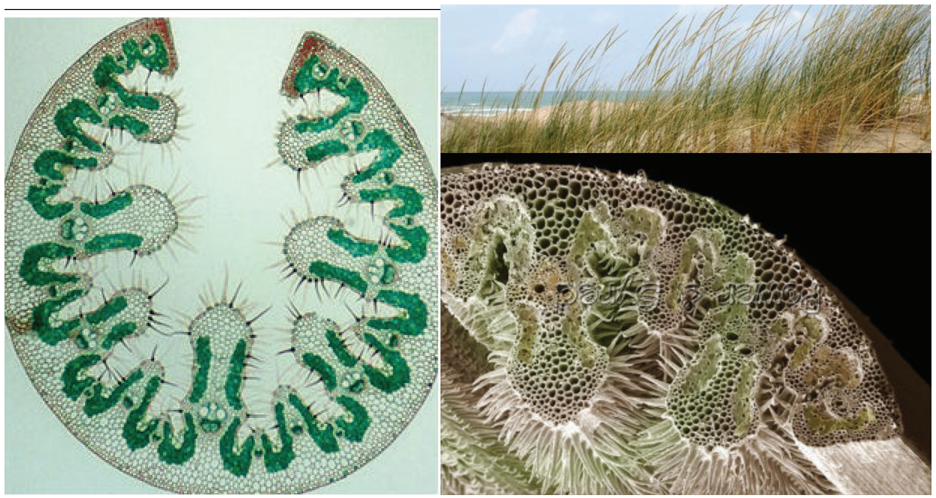
1. folding leaves





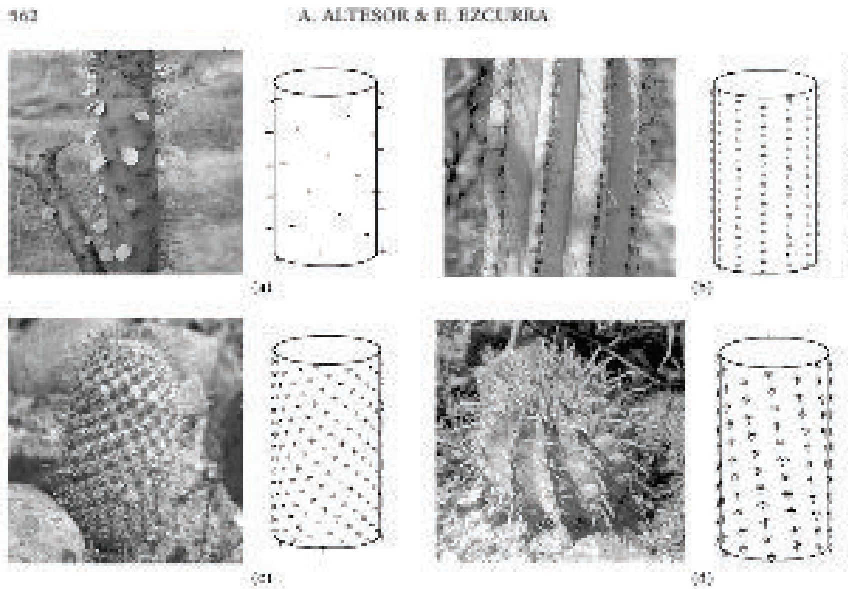
2. funnel shaped leaves towards center & stem

2. funnel shaped leaves , sunken stomata



3. maze texture

efficient compact morphology of stem & areoles
convection upwards



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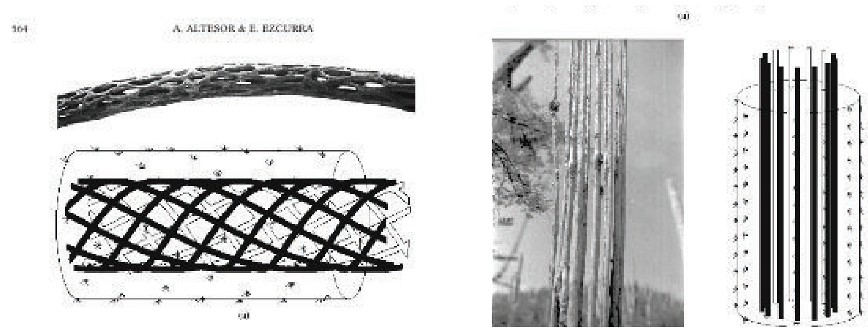
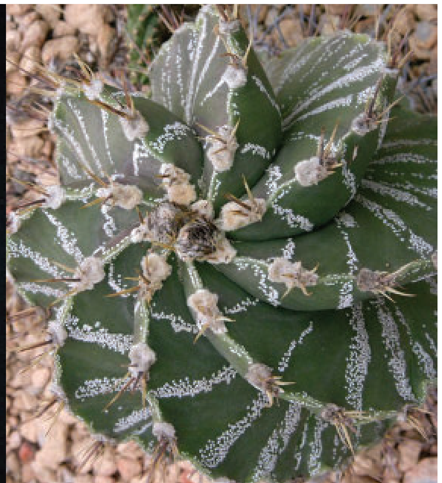
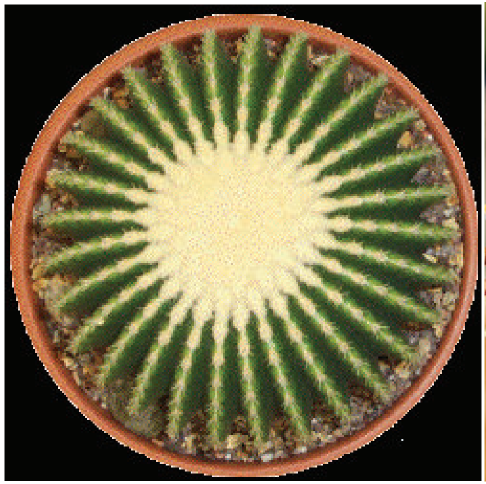


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC542674/

ribs increase surfuse by %80
ribs shade % 60 of the surfuse
ribs reduce wind speed - creating insulating air layer

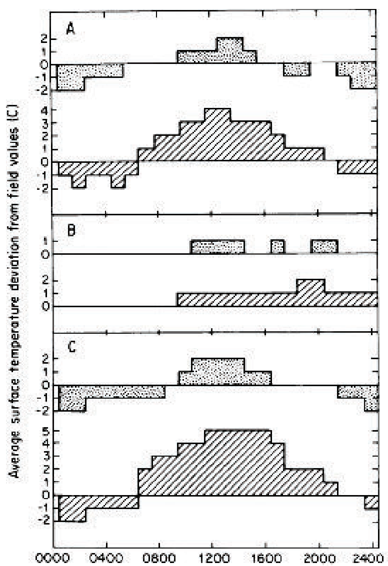



https://marketplace.secondlife.com/p/3D-Concepts-320-Desert-Plant-Textures/9097




http://www.exo-terra.com/fr/products/ground_desert_plants.php

unifomaly dense spines & areoles for shading and protection

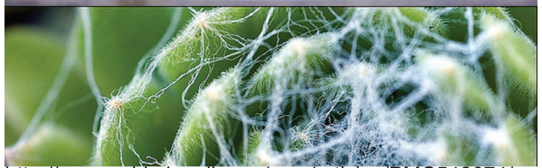


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC542674/

high density, bright spines at the apex for shading and reflection of thermal energy
low density, dark spines at the base for ventilation and thermal energy absorption

http://www.photochart.com/photo_5983_Desert%20Plant.html
http://www.photochart.com/photo_5985_Desert%20Plant%203.html

leaf hair microclimatic effect



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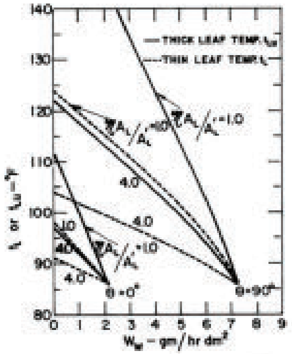
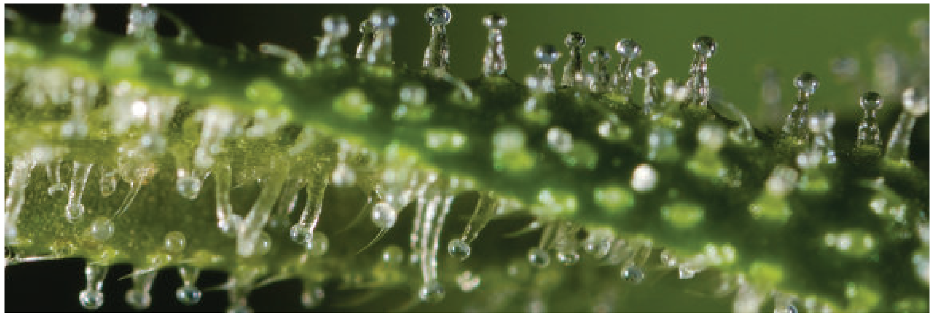
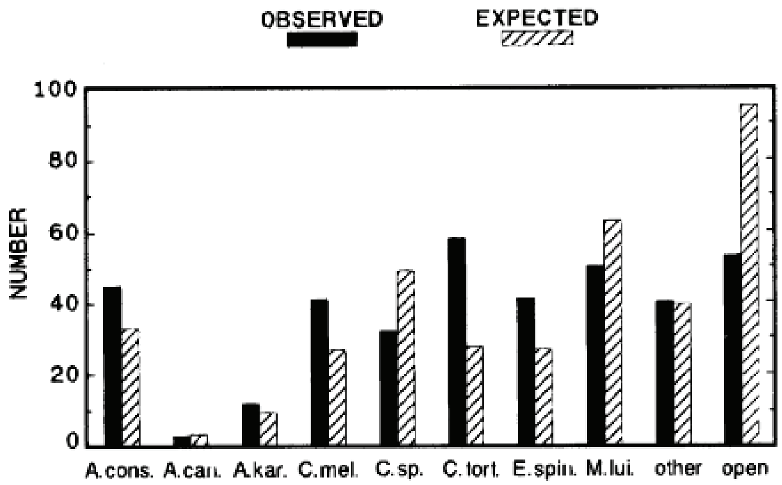


FIG.4. LEAF TEMPERATURE vs. WATER EVAPORATION RATE IN STILL AIR WITH LEAF ORIENTATION, θ; THICKNESS; AND AMOUNT OF SURFACE HAIR, AS PARAMETERS



nurse shrubs cooling effect
even greater considering water compatition



http://www.ncbi.nlm.nih.gov/pmc/articles/PMC542674/

Pattern analysis indicated that the establishment of two columnar cacti, Neobuxbaumia tetetzo and Cephalocereus hoppenstedtii, and of three small globose cacti, Coryphantapallida, Mammillaria colina andM casoi, is aggregated and associated with perennial nurse shrubs. Some nurse species, Castela tortuosa, Caesalpinia melanadenia and Eupatorium spinosarum have a higher number of cacti beneath their canopies than would be expected by chance. A replacement pattern was found between the columnar cacti and their nurses, an aspect which was not found with the globose cacti. Following the assumption that protection against excessive radiation is the main factor determining the nurse effect, the azimuth orientation of the cacti with respect to their nurses was evaluated. Only Coryphanta pallida presented a non-random distribution with a tendency towards the North and West. The difference in maximum temperature between the soil surface under the different nurse species and of open spaces, which is reached at midday, was 16 °C. No significant differences were found in beneath-canopy temperatures for the three nurse species considered. Soil nitrogen levels were significantly lower beneath the different nurse plants than in open spaces. This result suggests that soil fertility is not an important factor in the nurse-plant phenomenon in Zapotitlán.

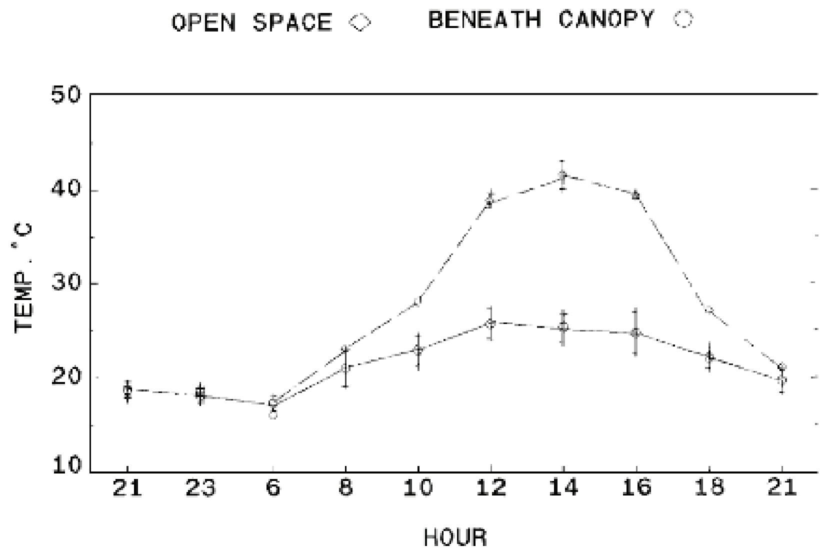


Fig. 5. Temperatures on the soil surface beneath the canopy of *Mimosa luisana* ($n = 5$) and in open space ($n = 2$) for a 24-hour period (July 23, 1988).

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC542674/

spines contribution to protection and micro climate

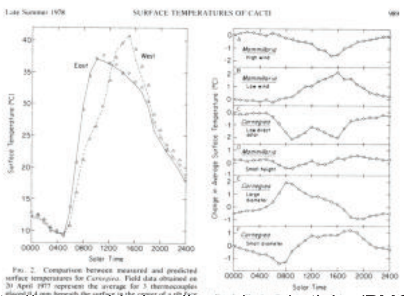


TABLE 6. Comparison of simulated stem surface temperatures for 3 species of cacti under identical microclimatic conditions. The temperatures were determined for the coldest (31 March 1977) and hottest (21 July 1976) days examined

Taxon	Min temp on coldest day (°C)		Max temp on hottest day (°C)	
	Midheight	Apex	Midheight	Apex
Mammillaria	3.0	1.8	46.7	39.1
Ferocactus	2.1	1.8	48.6	36.5
Carnegiea	1.8	1.2	53.0	36.1

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC542674/

Interspecific morphological differences and intraspecific morphological changes with latitude were evaluated to help examine the distributional ranges of Carnegiea gigantea, Lemaireocereus thurberi, Lophocereus schottii, Pachycereus pecten-aboriginum, and P. pringlei in the Sonoran Desert (USA and Mexico). A computer model, which predicted the average surface temperature of the stem within 1@?C of that measured hourly throughout a 24-h period, was particularly useful in studying the thermal relations of the stem apex, where the lowest surface temperature occurred. Simulated increases in stem diameter raised the minimum apical temperature for C. gigantea and may help account for the extension of its range to higher latitudes than the other species studied. However, diameter increases led to a slight decrease in minimum apical temperatures for Lophocereus schottii. The immature stems of L. schottii are morphologically distinct from the mature stems which caused minimum apical temperatures to be 1.6@?C lower for the immature stems under given environmental conditions; thus, freezing damage to the immature stems could limit the northward extension of the range of this species. As the apical pubescence in the simulations was increased up to the normal amount (10 mm), the minimum apical temperature for the stem of C. gigantea increased 2.4@?C. Simulated increases in spine shading of the apex also raised the minimum apical temperatures, again indicating the influence of morphological features on the temperature of the meristematic region. Under the same environmental conditions the minimum apical temperatures were 7.7@?C, 5.9@?C, and 3.9@?C for C. gigantea, Lemaireocereus thurberi, and immature stems of Lophocereus schottii, respectively, which is the same relative order as their northernmost limit (34@?56'N, 32@?38'N, and 31@?55'N respectively). The northern limit for these three species, but not for Pachycereus pectenaboriginum and P. pringlei, may well be determined by the low temperatures occurring at the stem apex.

TABLE 4. Effect of spines on the simulated surface temperature at various locations on *Mammillaria*. Microclimatic conditions are from Lewis and Nobel (1977)

Condition	Surface temperature (°C) Midheight Minimum	Midheight Maximum	Apex Minimum	Apex Maximum
Winter day				
no spines	9.1	29.1	7.2	22.3
½ spines	9.6	26.8	8.5	20.5
usual	10.0	24.5	9.6	19.2
1½ spines	10.4	21.0	10.1	18.1
Summer day				
no spines	23.8	52.2	19.8	46.4
½ spines	24.6	49.4	21.9	42.4
usual	25.2	46.7	23.8	39.1
1½ spines	25.9	44.8	25.1	37.7

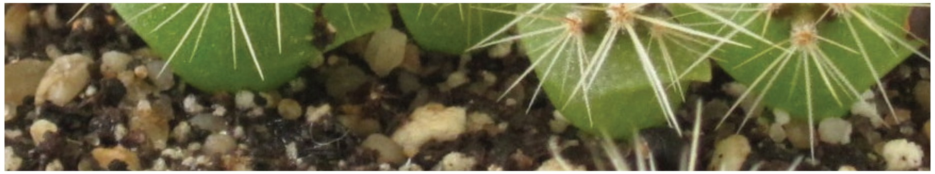
Root contraction aids in lowering the internal stem temperature, when combined with the cooling effects of the rocky surface

this is the style for captions

"Ariocarpus fissuratus earned its nickname "living rock" because it blends into the rocky surroundings with its small stature that is level with the soil's surface. The researchers hypothesized that the cactus could "escape" high temperatures by moving more of itself below the soil surface where it is cooler.
To find out, the researchers mimicked summer desert conditions by growing plants on a rooftop in Los Angeles, where air temperature was above 99°F for several days. All the cacti were grown in sandy soil, but half had rocks covering the surface of the soil, similar to their native habitats. For plants grown in rocky soils, the internal temperature of the stem was about 7°F lower than those grown in sandy soils alone. While this may seem like a small decrease, it had a significant effect on the health of the plants.
Unlike the cacti grown in sandy soil which all died, those grown in rocky soil survived the intense heat. Root contraction aided in lowering the internal stem temperature, but only when combined with the cooling effects of the rocky surface. The opposite was true in sandy soil where cacti planted higher above the surface had slightly lower stem temperatures than those planted close to the surface. "Even in rocky soil, experimental plants attained nearly lethal temperatures during a summer heat wave in Los Angeles" said North. "Thus, root contraction and rocky microhabitats may not provide enough protection should desert temperatures get much higher due to global warming.

nurse shrubs
0.8C (-16c soil temperature)

Root contraction to rocky surface
0.5C



spines
6C-1.4C

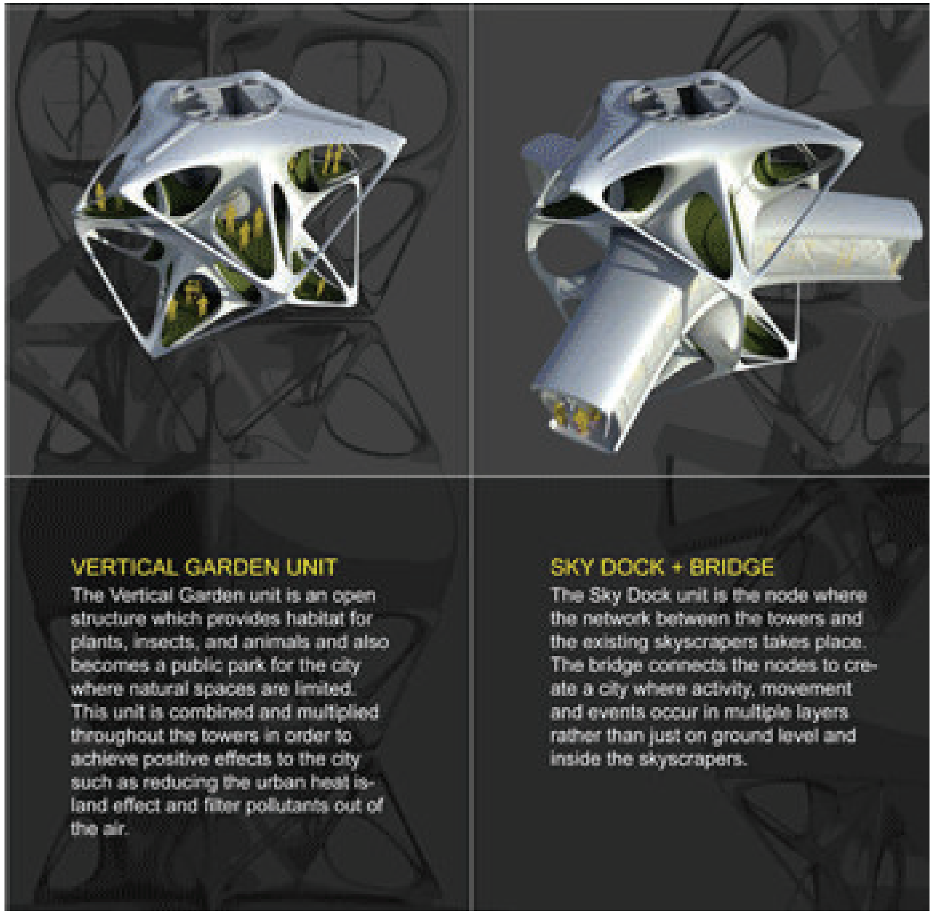
leaf hair
11C

ribs
2C

Architectural Precedents

Symbiotic Interlock

Given that most urban cores are already densely built, one designer has proposed an auxiliary series of structures to be attached to existing structures in downtown areas. These modular constructions would provide garden and recreation spaces for residents as well as light and air filters for the adjacent buildings. In some cases, these retrofits could even provide structural stability to aged buildings and prevent the need to tear them down. Architecturally, these modular units stand out and add another layer to the visual hierarchy of the cities around them.



http://greenarki.blogspot.com/2008/11/symbiotic-interlock.html

Clearly we can't very well tear down all of the world's old skyscrapers for not being environmentally friendly – that kind of approach would itself be (ironic and) wasteful. At the same time, many of these buildings are projected to last for decades (or centuries) more. So what is the solution for making them green now? One rather clever proposal involves adding an auxiliary environmental layer to the existing structures that could house gardening and natural wind power production spaces.

skyscraper architecture Brilliant Green Architectural Design Concept? Skyscraper Retrofits for Power and Food

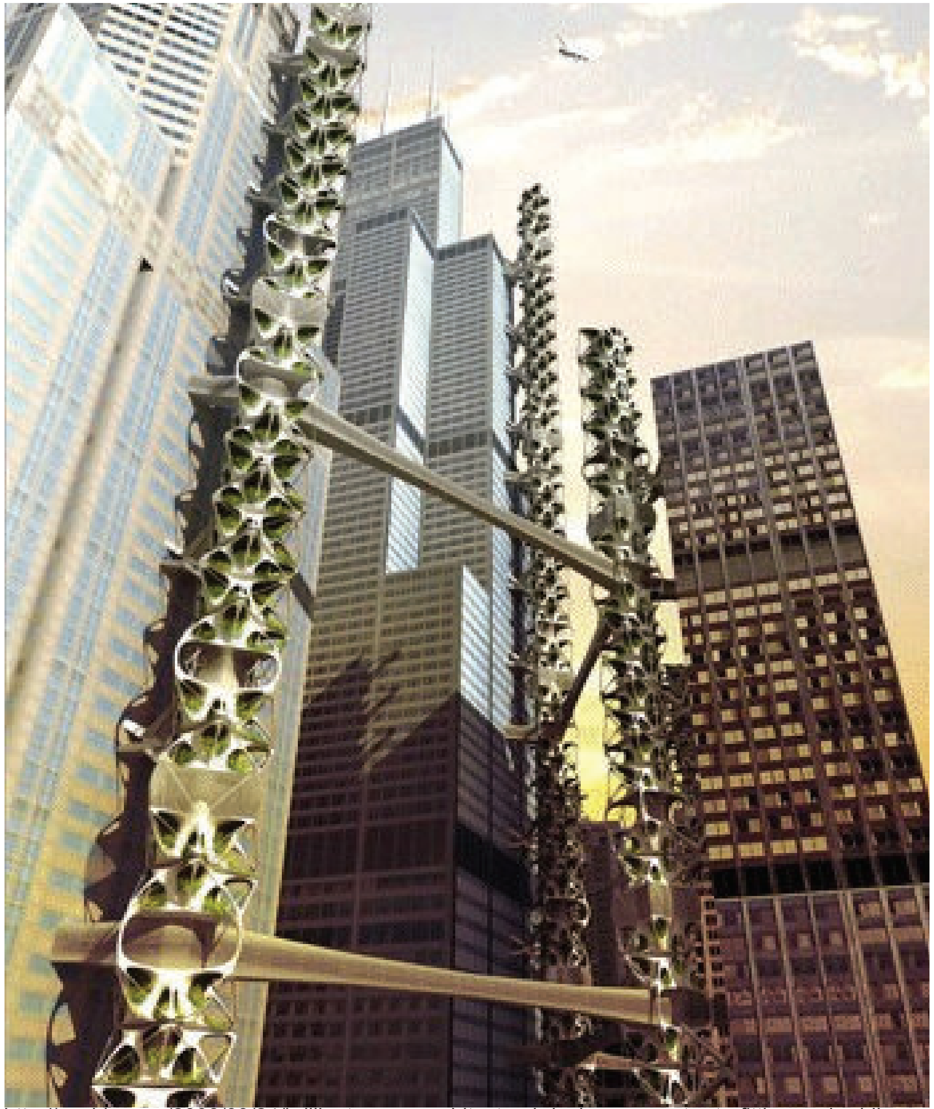
This particular proposal calls for a few basic modules with particular functions that could be combined in various ways to create networks of green functionality outside of and between various skyscrapers. Structural rigidity would rely to some extent on the structures they would be attached to as well as their complex geometries and interconnections.

environmental skyscrapers Brilliant Green Architectural Design Concept? Skyscraper Retrofits for Power and Food

The beauty of modularity is that plug-and-play systems like these are highly adaptable for future use and modules could, theoretically, be added and removed as-need during the lifetime of the structures. Taken as a whole a series of such modules would be able to provide both the indirect benefits mentioned above as well as direct benefits to adjacent skyscrapers including potential wind and sun regulation to reduce energy needs.

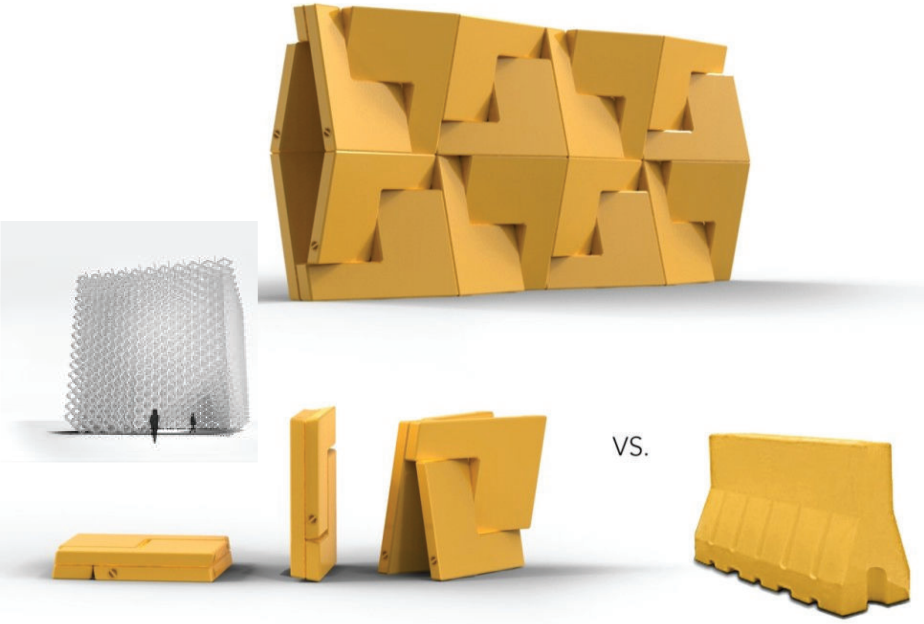
green skyscrapers Brilliant Green Architectural Design Concept? Skyscraper Retrofits for Power and Food

Of course the entry shown above is still purely theoretical. Nonetheless (and regardless of whether or not such a thing is ever truly built) it points toward new possibilities beyond the old paradigm of build and destroy and rebuild – a possible (and more ecological) approach that involves a middle path.



http://ecoble.com/2008/03/24/brilliant-green-architectural-design-concept-retrofitting-and-adding-to-skyscrapers-to-provide-food-and-power/

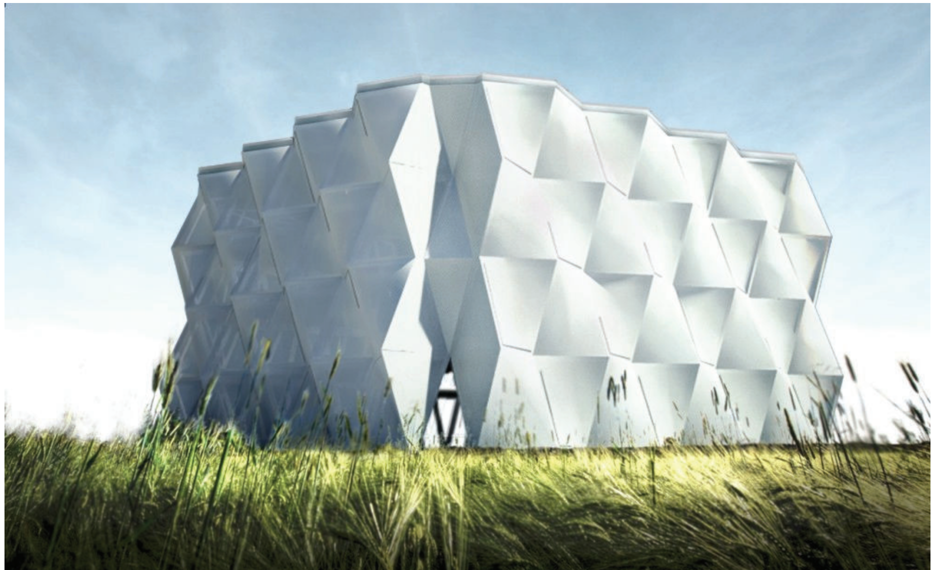
QuaDror: A New Structural System



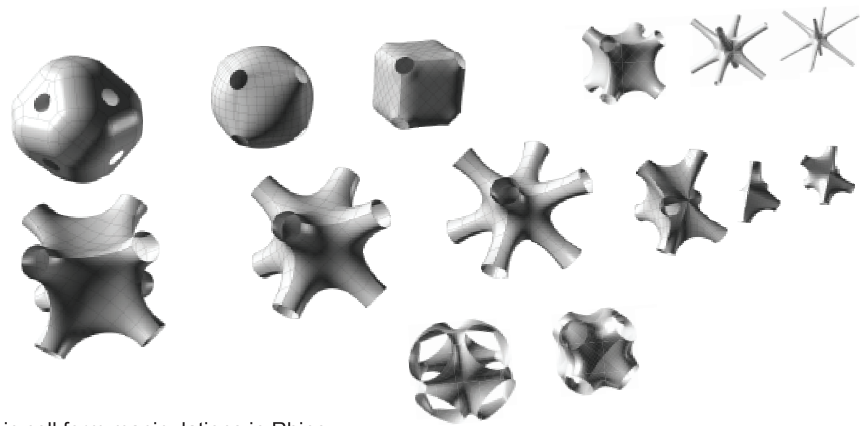
http://www.archdaily.com/114141/quadror-a-new-structural-system/

An exciting new structural system will be unveiled tomorrow at the Design Indaba conference in Cape Town, South Africa. QuaDror, invented and patented by Dror Benshetrit, is a space truss geometry system inspired by versatility and structural integrity of interlocking members.

Like a magician revealing the secrets behind his magic, Dror Benshetrit shows that the mechanism behind these structures is surprisingly simple but it is the complex interaction of the interlocking members that makes it so unique. From a simple block model to a bridge support system, the QuaDror system shows its abilities at all scales.

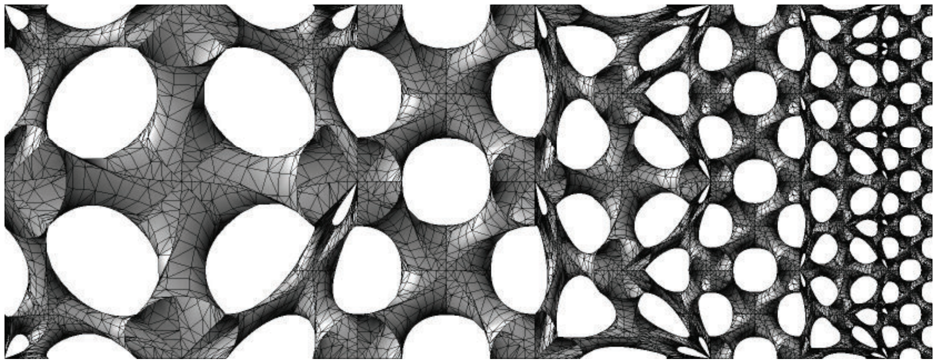


Basic Cell Form Research



basic cell form manipulations in Rhino

cellular structures offer an adaptive modular system. the variations of the ingle cell and the variaty of relations between them offer particular solution according to the .parameters of each space and location of the building
i chose an infinite double mesh based on diagonal hollow joints for the posibilities of relations between the dual spaces and between the interior and exterior of the building.

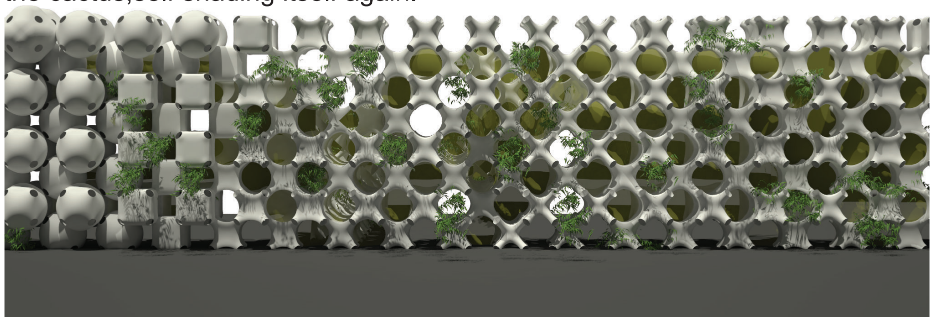


cells scale transformation in GEM

climate-depended Parametric facade

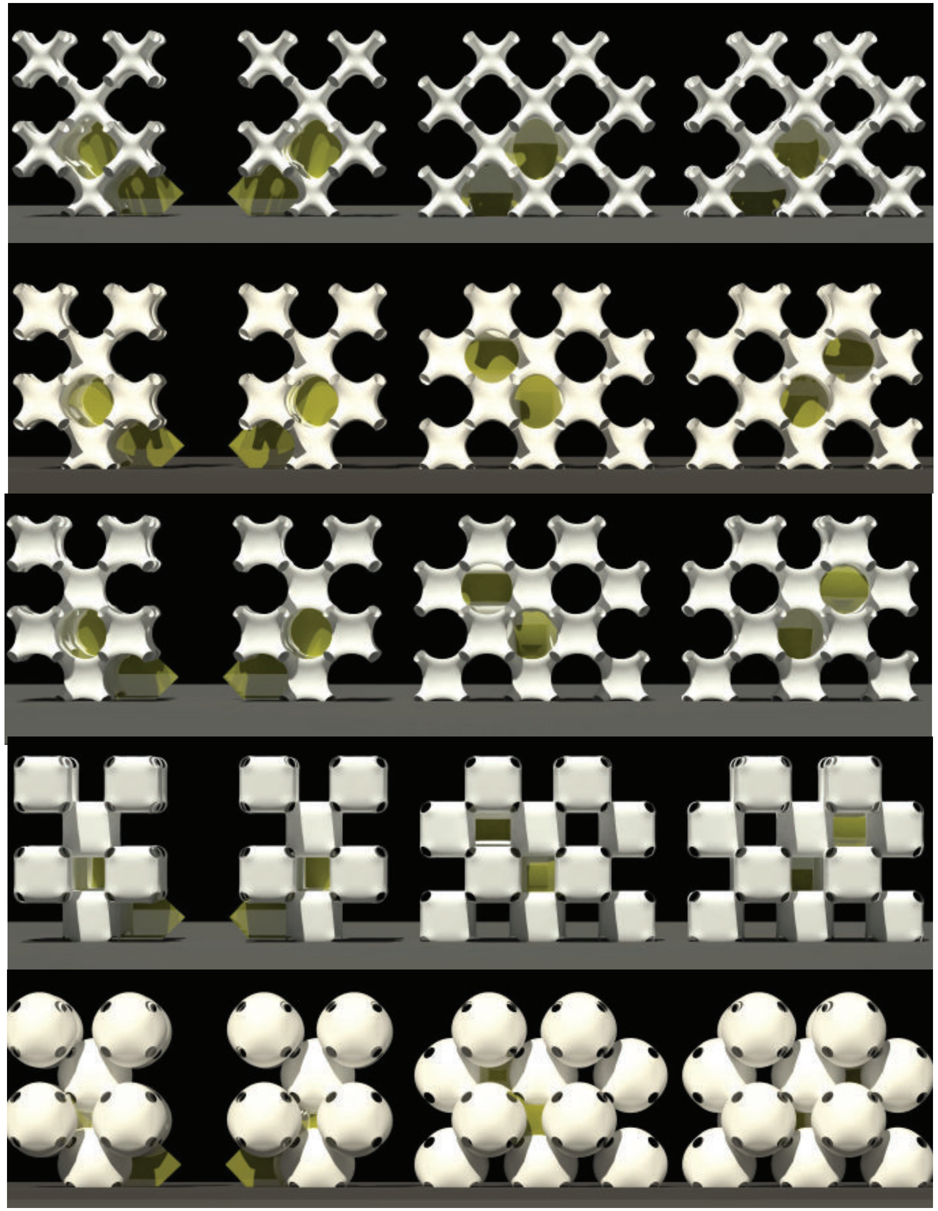
the sponge-like facade allows to control localy the exposere to air, light and heat. the hollow tubes contain soil for vegitation, which helps to create a microclimate
the monocoque structure operates as a skin between the dual spaces. the flexibility of spaces is achieved by three methods of transforming the basic cell and by rotations that allow control on the angle of the surfaces and the size of the spaces .

a lot can be learned from the cacti about acumilating water and self-shading. when dry, the cell-ribs are thin and the angle between one another resaults in self shading. the tunnels between the ribs helps to acumilate water. as it absorbed by the plant, the ribs swalow, and shrink back as water are used by the cactus,self shading itself again.

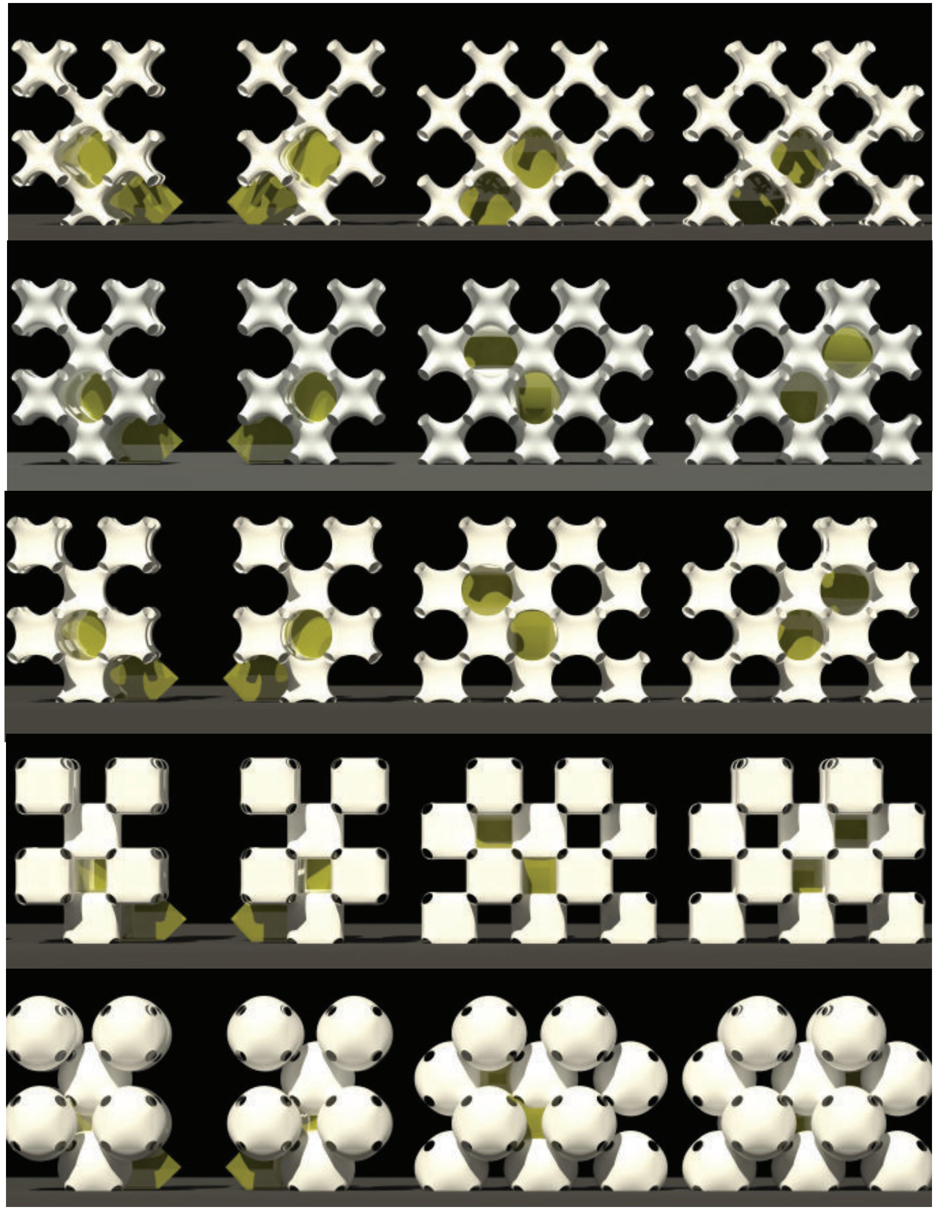


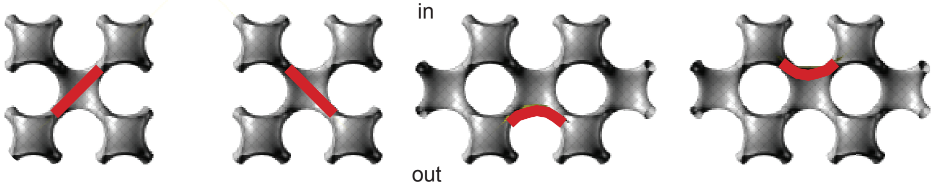
cells change form in the parametric facade

21 september 12:00 south facade



21 september 09:00 east facade

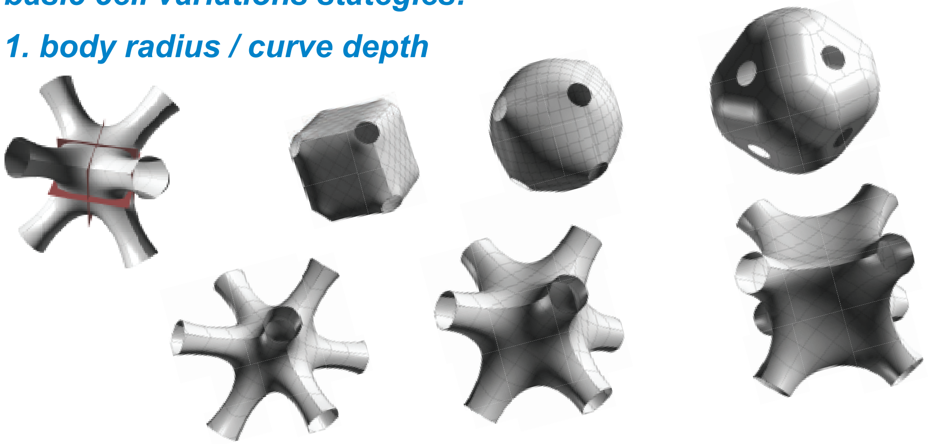




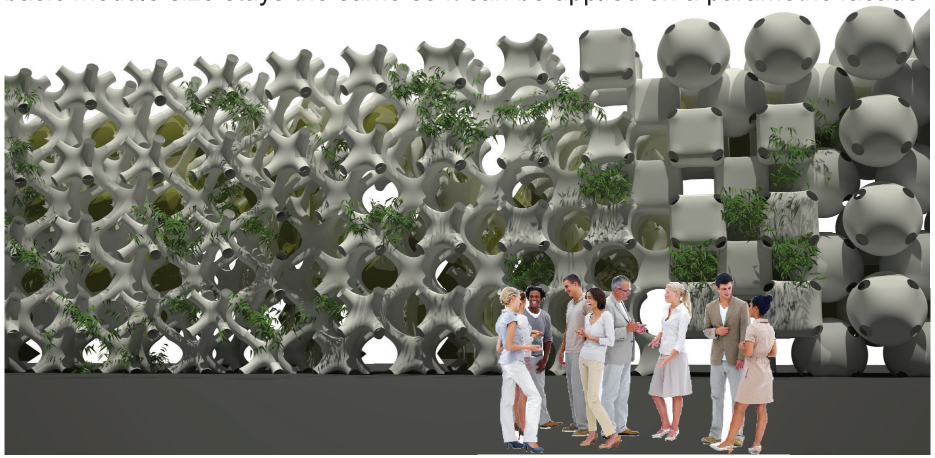
previous page - shade on east and south facades. the plan above indicates the positioning of the window in the cellular grid. the rows shows the shade made by different propotions of the cells.

basic cell variations stategies:

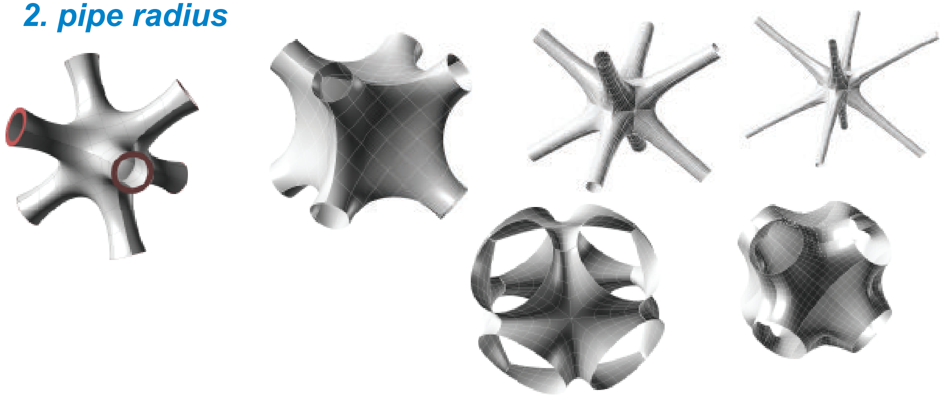
1. body radius / curve depth



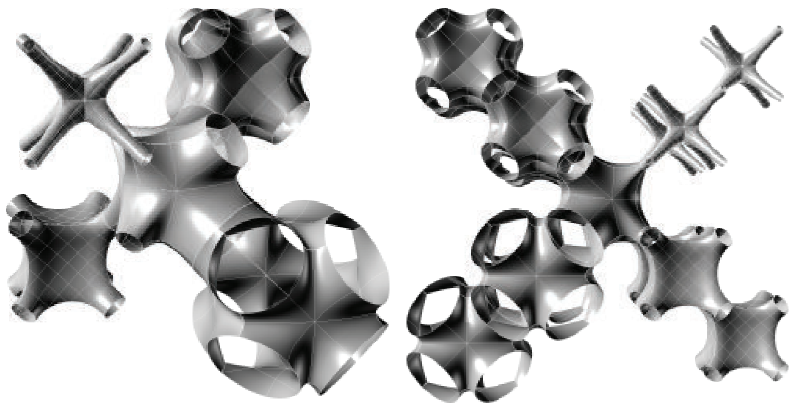
this method changes the ratio between spaces of the dual meshes while the basic module size stays the same so it can be applied on a parametric facade

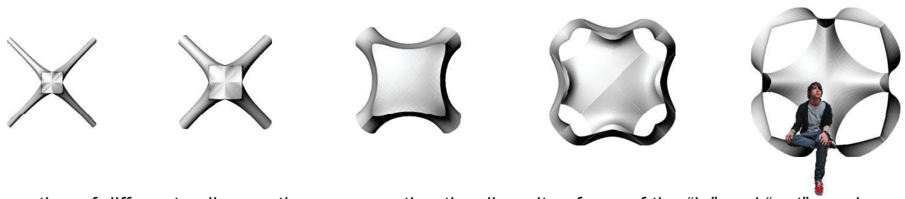


2. pipe radius

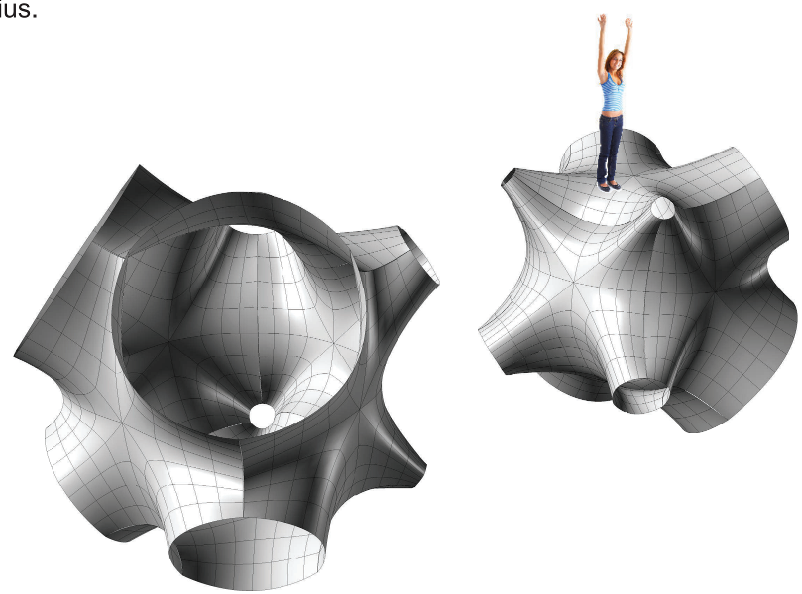


in this method both the ratio between the “bodies” of the dual meshes and the radius of the diagonal “pipe joints” varries, while the basic module size stays the same. it can be applied to different structural needs, according to preasures, in addition to the varried posibilities of use for each mesh-spaces.

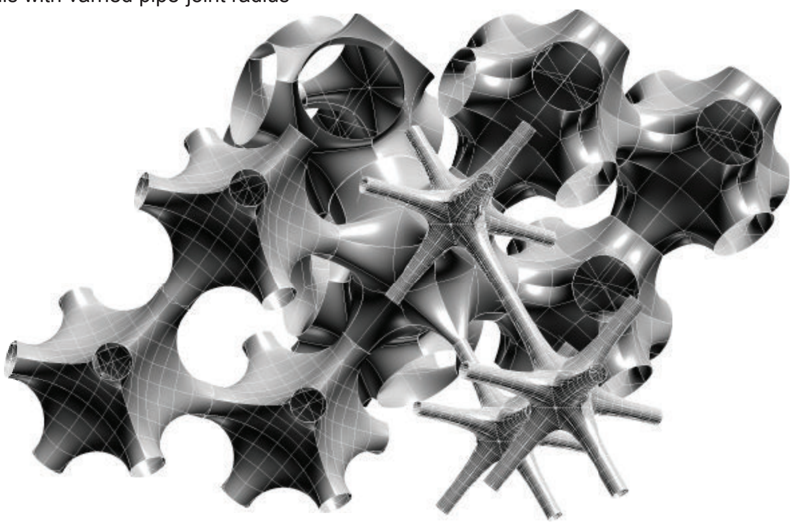




section of different cell propotions, suggesting the diversity of use of the “in” and “out” meshes this method brings the need of connector-cells between cells with different pipe radius.

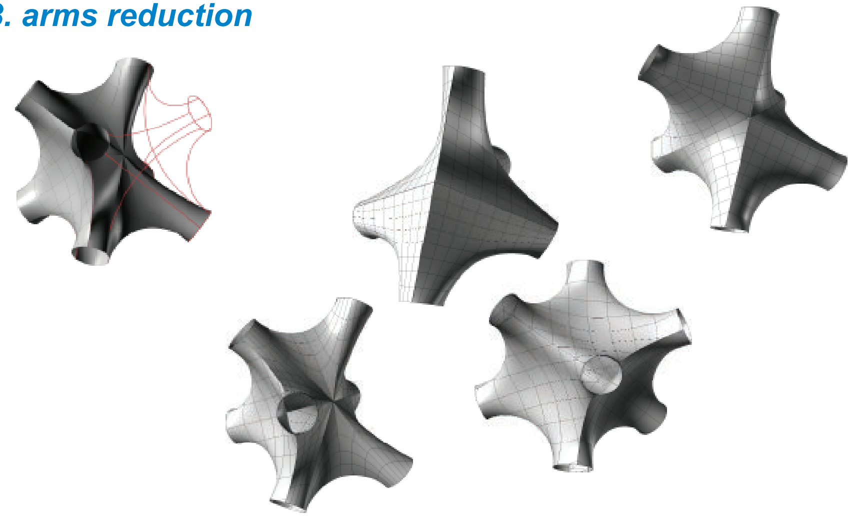


connector cells with varried pipe-joint radius

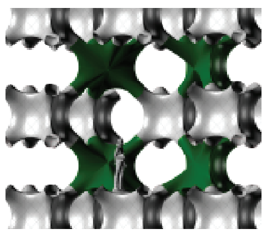


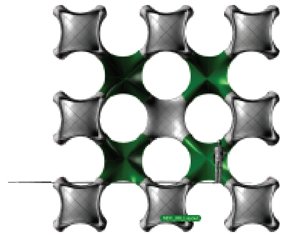
varried cells composition

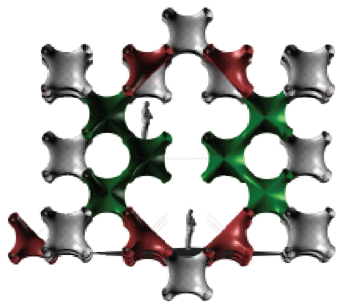
3. arms reduction

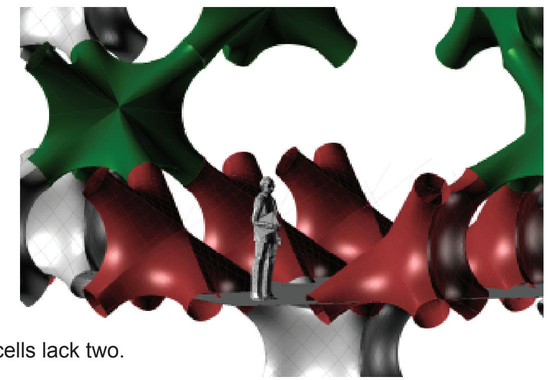


by “cutting off” or one or more of each cell’s 8 pipe-joints, it’s possible to skipping a module of the “in” mesh, thus, creating a variety of bigger, more complicated spaces of the dual “out” mesh.



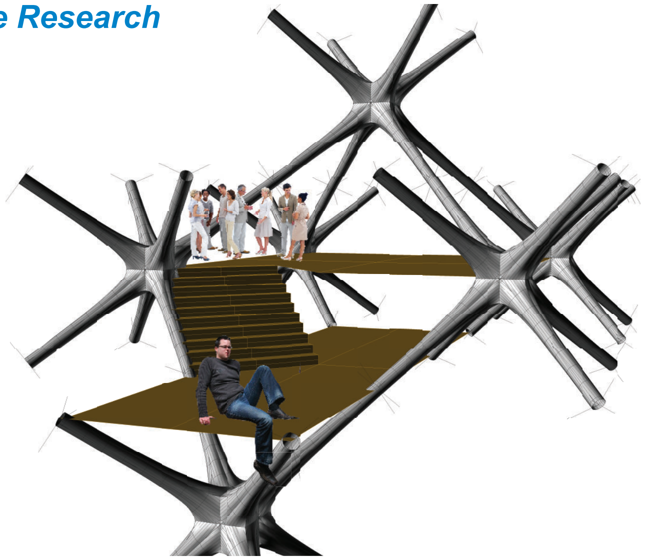




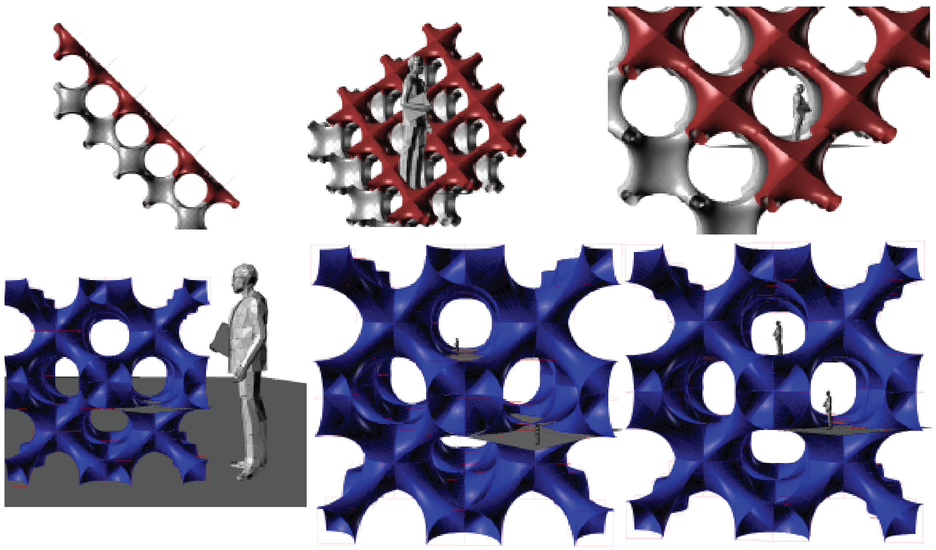


green cells lack one diagonal pipe, red cells lack two.

Cellular Structure Research

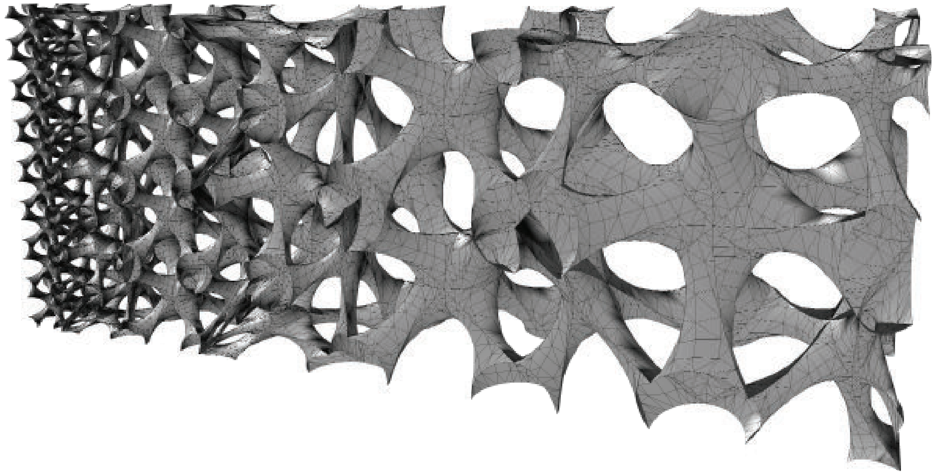


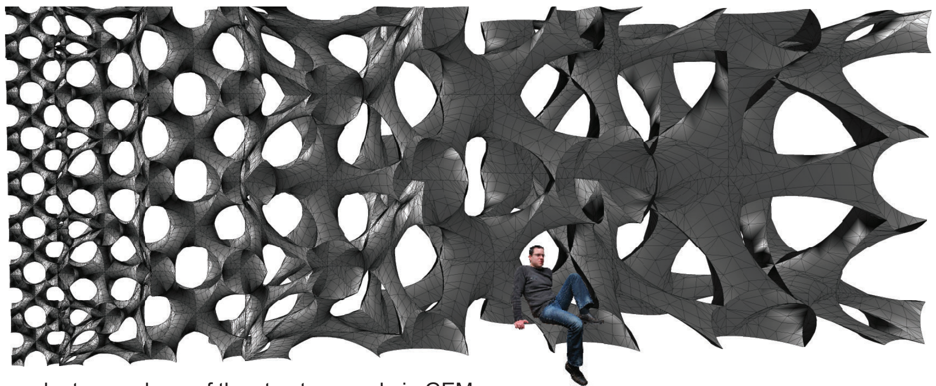
basic efforts to accommodate the cellular structure, by changing scale and confronting with the challenges the diagonal structure presents.



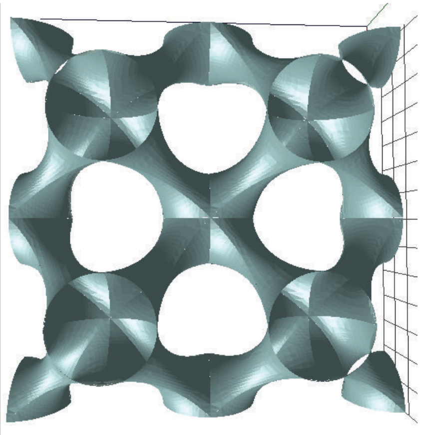
manipulating the dual mesh structure

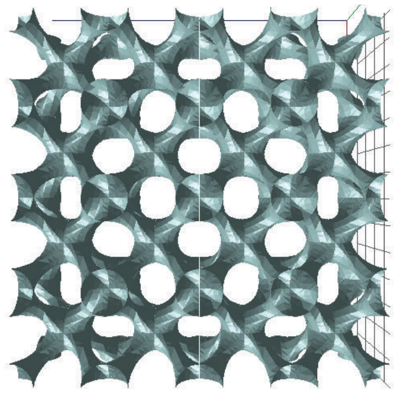
the next step was to find ways to control and manipulate a structure of cells. a major challenge is to allow the system to gradually change scale so the cells will adapt to different structural and functional uses.

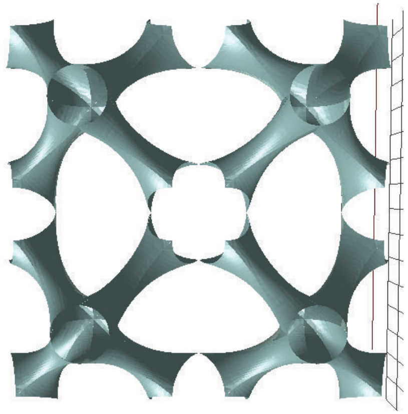


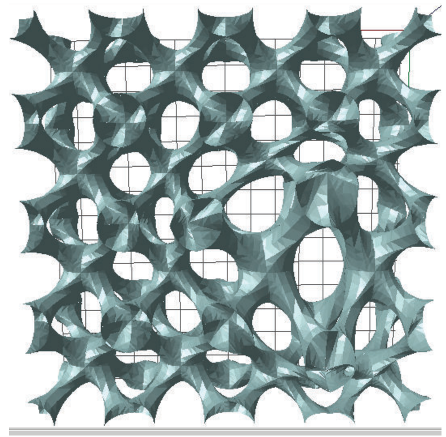


graduate morphsys of the structure made in GEM

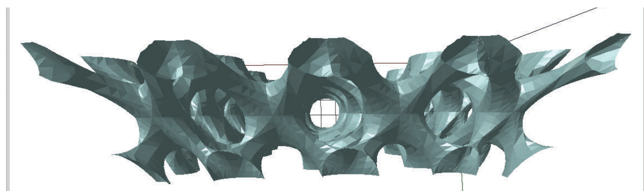


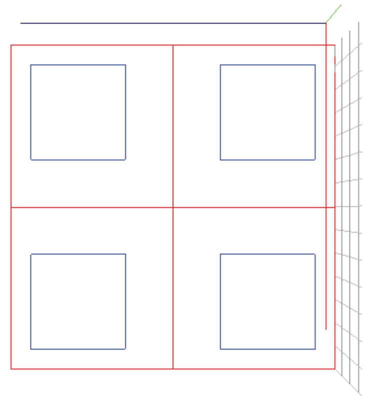


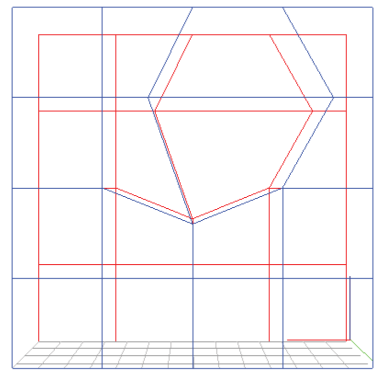




here is an evolution of the form finding research, made in GEM. Op-art manipulations of rectangles in shape, size and angles inspired the geometric grid warping.



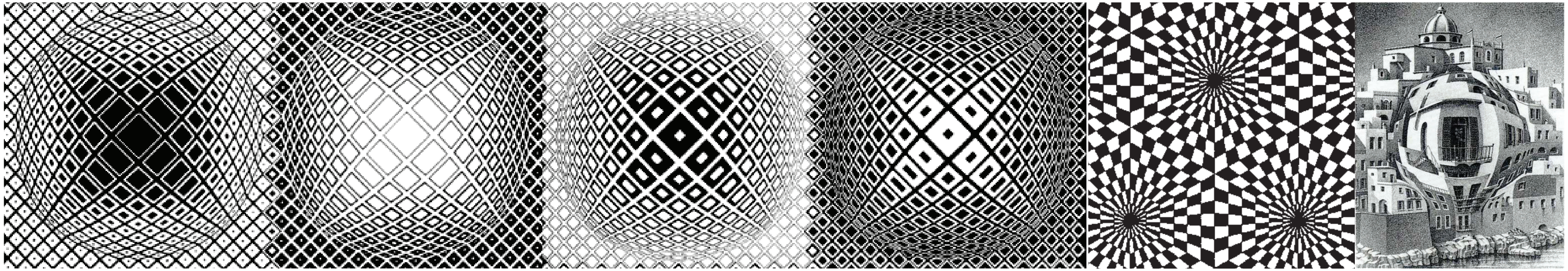


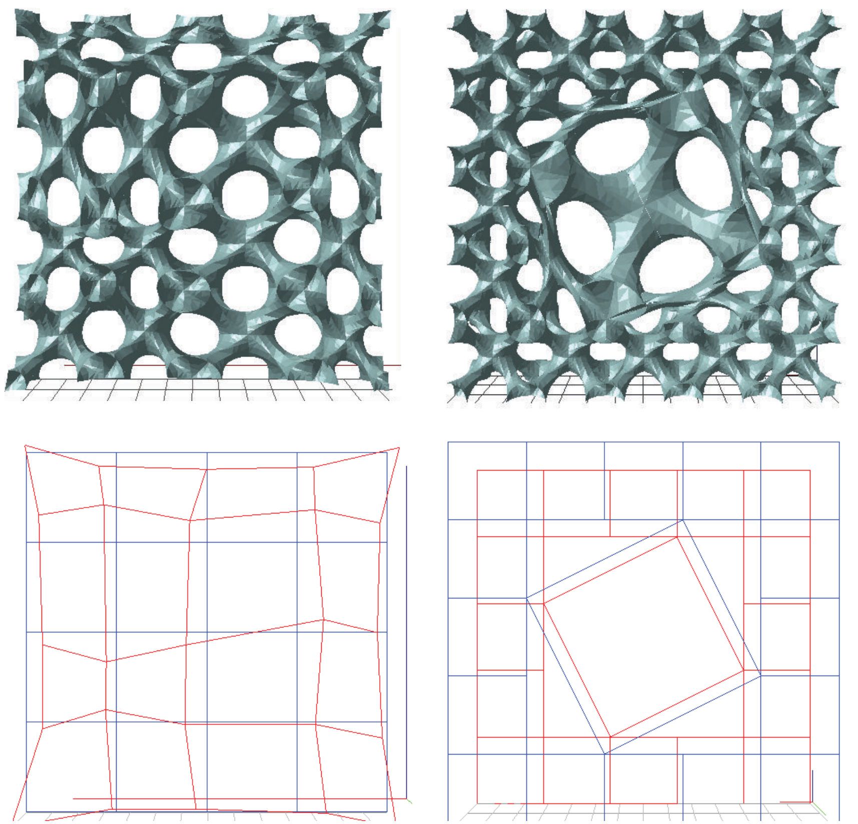


http://www.artlex.com/ArtLex/o/opart.html
http://www.math.twsu.edu/history/Topics/geometry.html

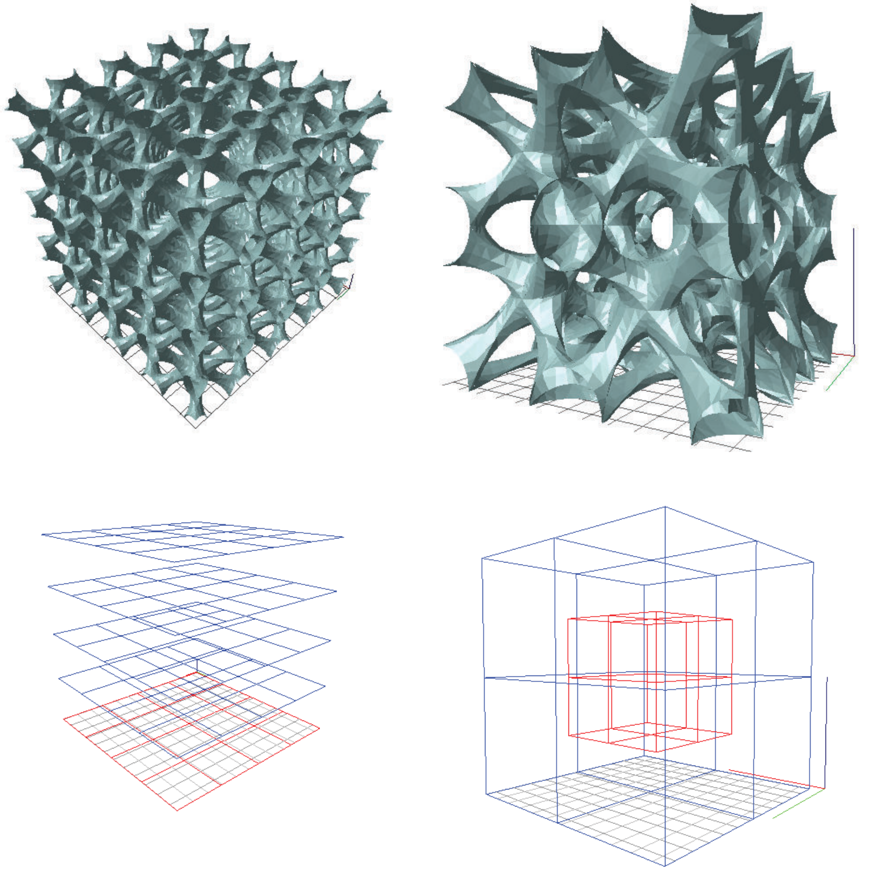
after the first atempt with regular grid, on the right a random change of some of the squares

http://www.artlex.com/ArtLex/o/opart.html



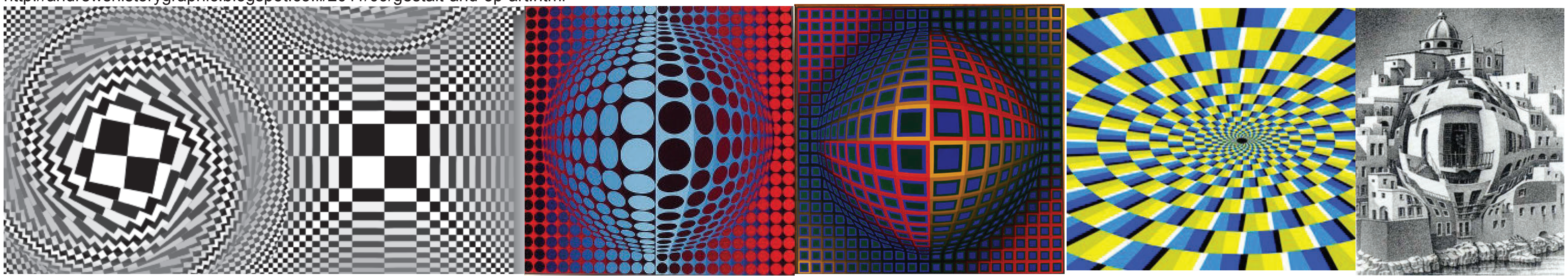


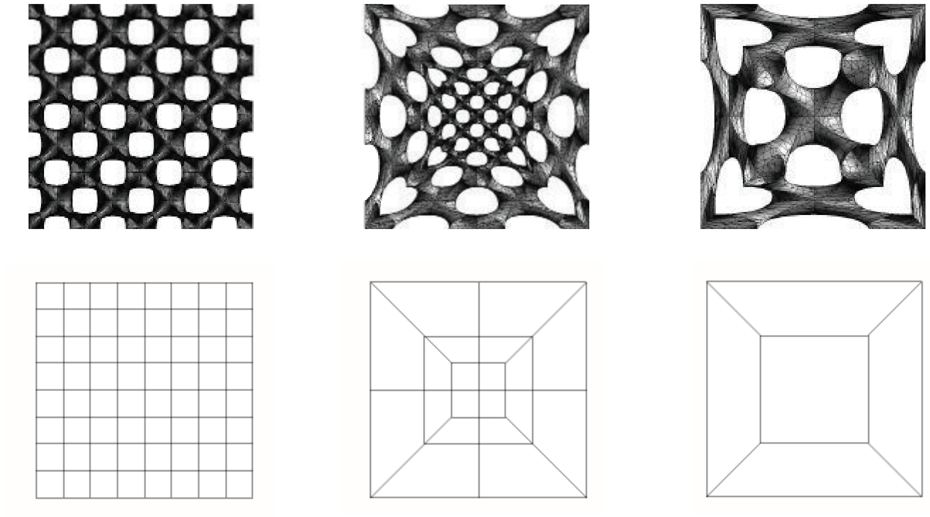
an atampt to make a centric major space by rotation



an atampt to make a 3D dual mesh by using layers of the grid.

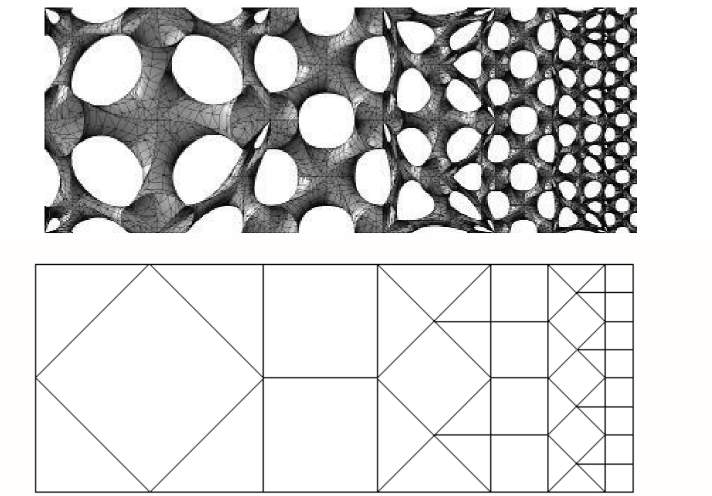
http://www.artlex.com/ArtLex/o/opart.html
http://andrewshistorygraphic.blogspot.co.il/2011/09/gestalt-and-op-art.html



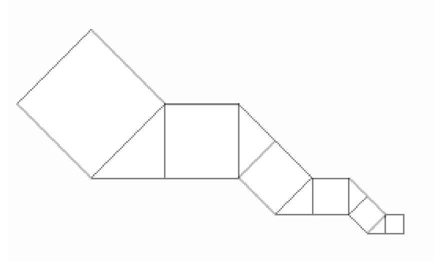


above, transforming rectangles on the grid into trapezoids scale up and down the cells towords the center

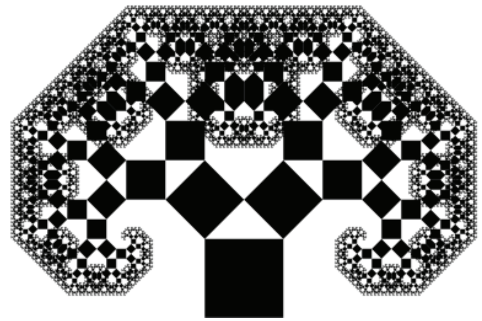
below, using fractal principles to regulate scale. the squares turned into triangles rotate the squares by 45* and rescale them from right to left.



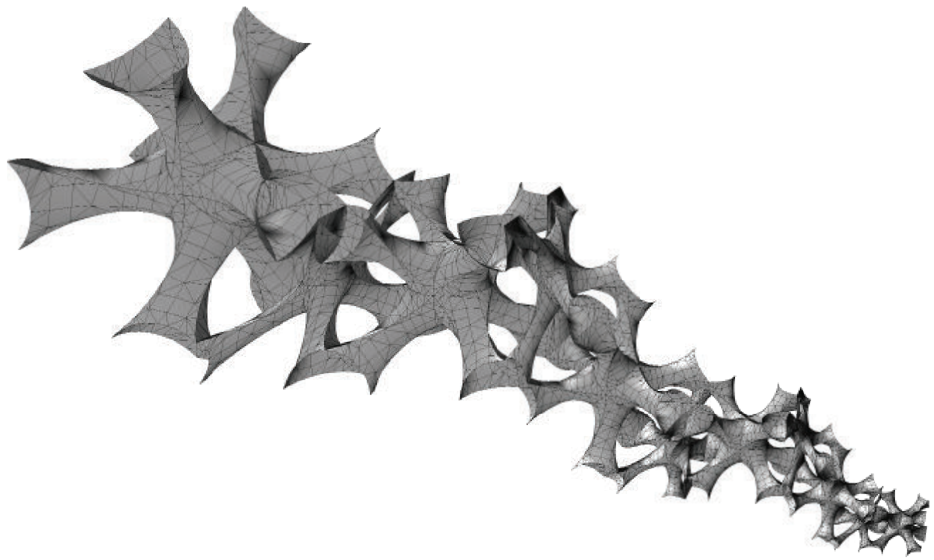
multiple cell fractal grid



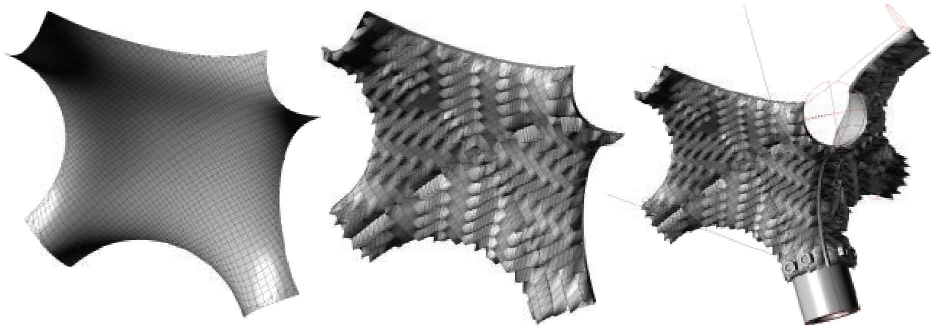
single cell fractal grid



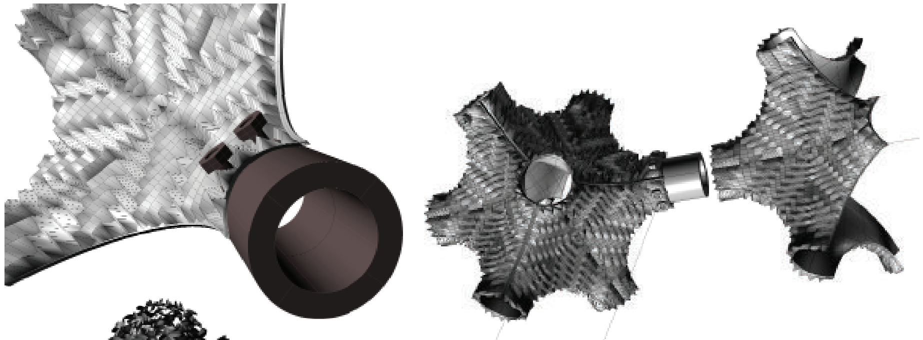
http://root2art.co.uk/news/?cat=18

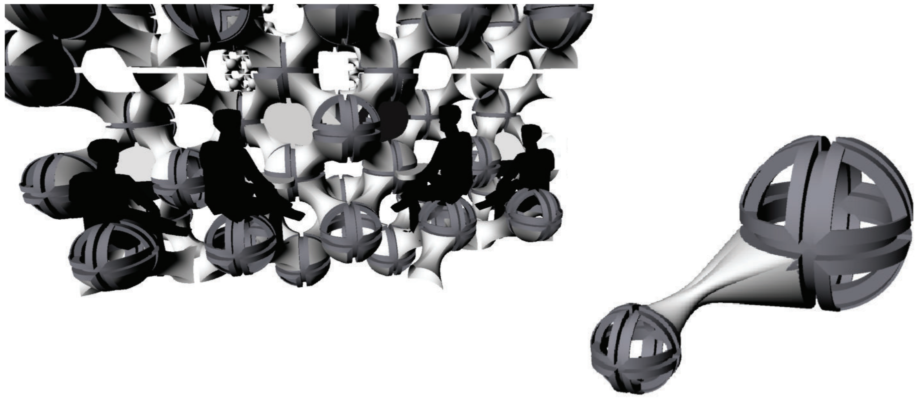


basic facade cell evolution

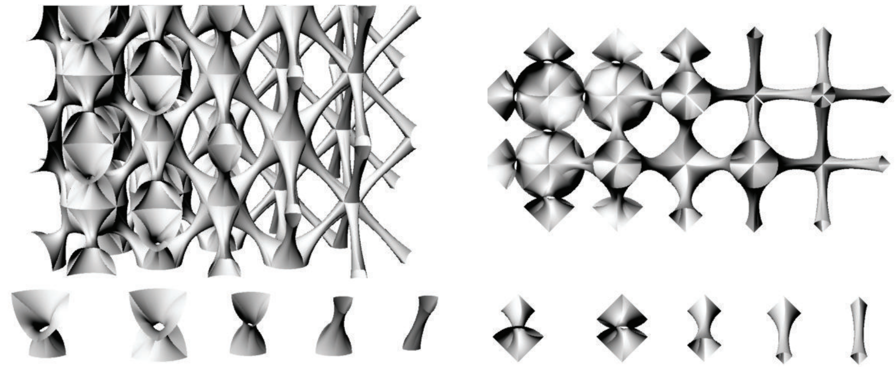


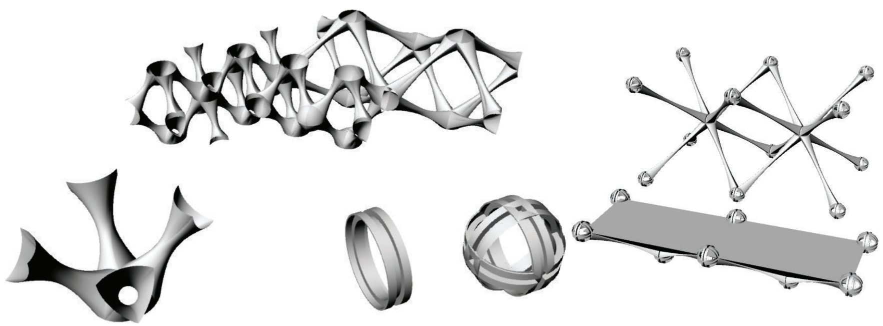
a first version of the single cell. each cell esembled of 6 or 5 spiky metal panels that create a planter, filled with soil. the panels are connected by steel pipes which connect the cell to the next one diagonaly. the pipes ensure the flow of water and soil between the planter cells. the spikes collect water and enable vine plants to atach to the panels.



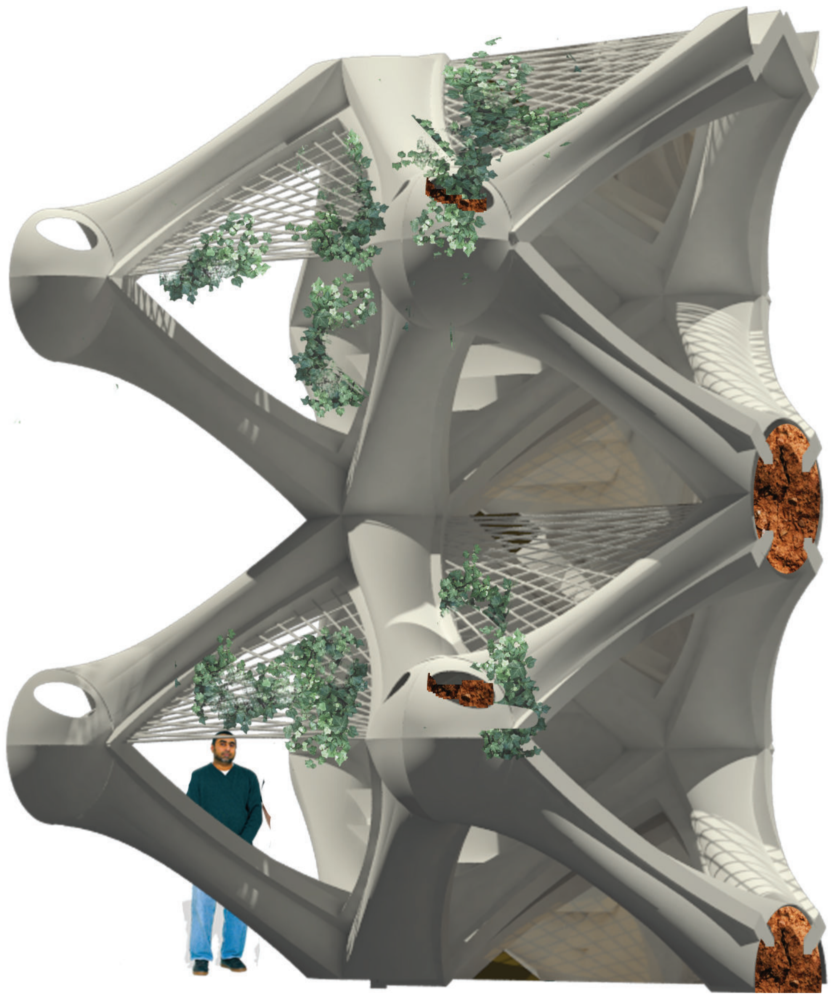


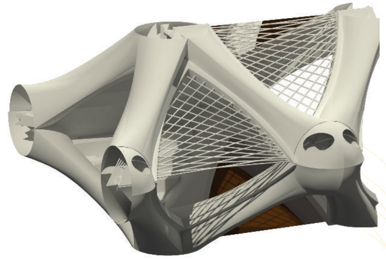
the next version is constructed of rounded steel frame made of 3 conjoining profiles. the frames are connected by the bent metal panels, creating the pipe-like joints of the cells. the inside of the. those cells can function as planters and mediatek instalations, depending on their location.

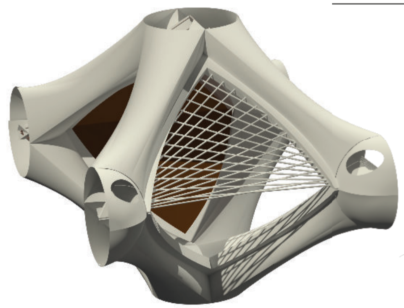


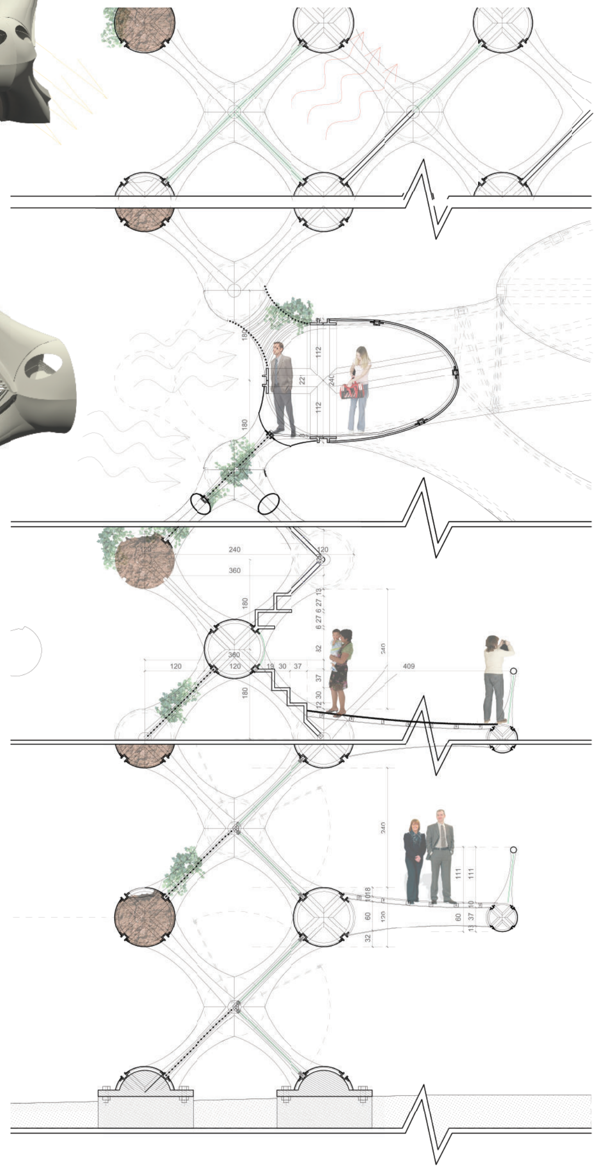


in the final version there are two frames. the ball-like planter frames become joints for steel profiles that create the pipes. those profiles are bearing 3 shell modules: upper outer frame carries Grating metal rods anchored into the corners planter for climbing plants. Inner frame carries off Kip windows and zig-zag metal-covered Polystyrene panels on which books and tapes are displayed on the media tech galleries.









Do-see-aaH Center

dual-net cellular structure for a community center and an urban mediatek

מרכז דו-שיח

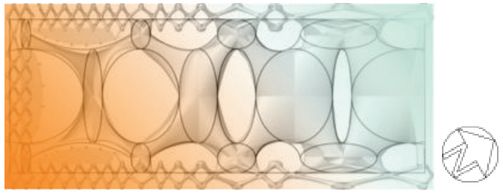
מבנה רשתות דואליות תאיות כמרכז קהילתי ומדיה-טק עירוני

Programatic concepts of the building

The site is situated on the southern edge of Kerem Hatemanim neighbourhood, facing the southern enterance to the market. this location is a focal point both for local residents and passer-byers. this suggests the posibilty of creating a dual perpuse building, one for each group of users, that offer them both the privacy for their activities and the casual simbiotic sencounter with the others.

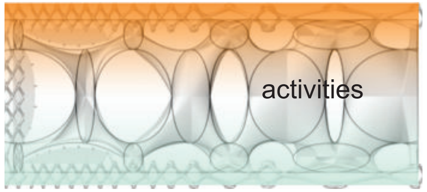
urban context

locals dwellers



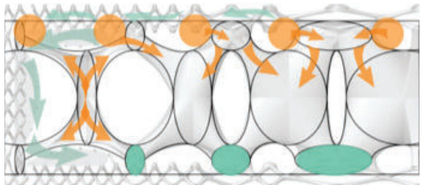
urban visitors

functions

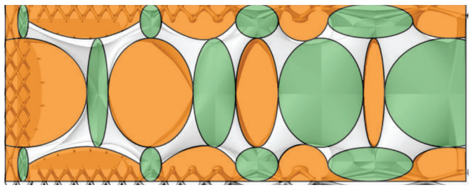


the urban center contains a bar, a versatile open performence space and the mediatek located on the galleries overlooking the action on the ground floor. The local community center contains 2 kindergartens, an auditorium and studios. Each center populates one of the dual meshes so it can activate autonomously but with a variety of meeting situations, observation, and transitions between them.
Size ratio between the dual mesh cells gradually changes from north to south, from the Civic Center to the Media Tech, and from east-west towords the center, so that the central spaces for the activities are the biggest, the transition spaces on the west and service spaces on the east are medium size and shell cells are on smaller scale, creating the inner micro-climate.

transition



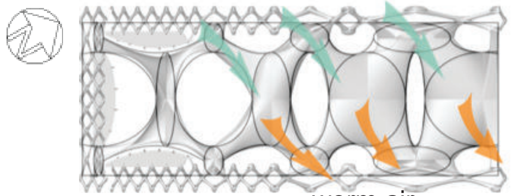
dual mesh space division



The two transition systems meet at certain points, allowing visitors to move from one mesh to the other.

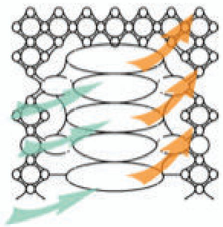
microclimate

Western spaces are middle movement system, while the eastern are service spaces. This organization allows the insertion of the west breeze from the bottom of the The central workshops, and the emission of hot air from the eastern upper openings.



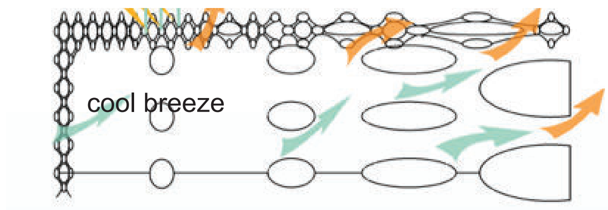
While the facade cells offer shade and ventilation, solar panels and the tilted windows on the roof cells create tunnels that drain the rain water into the front planters network.

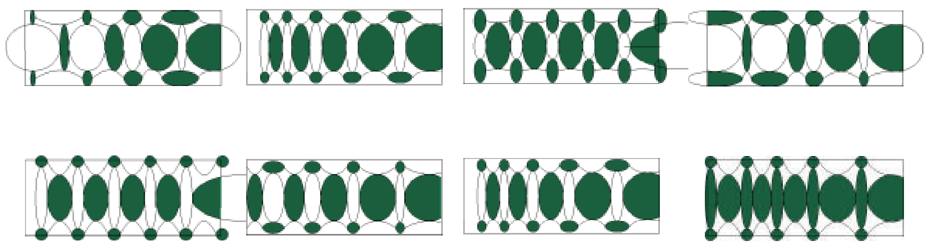
worm air



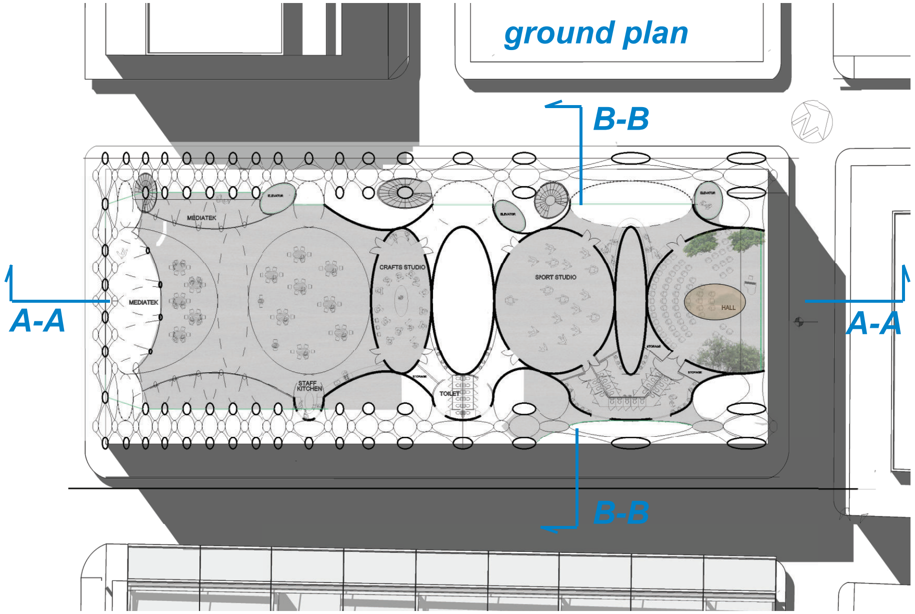
cool breeze

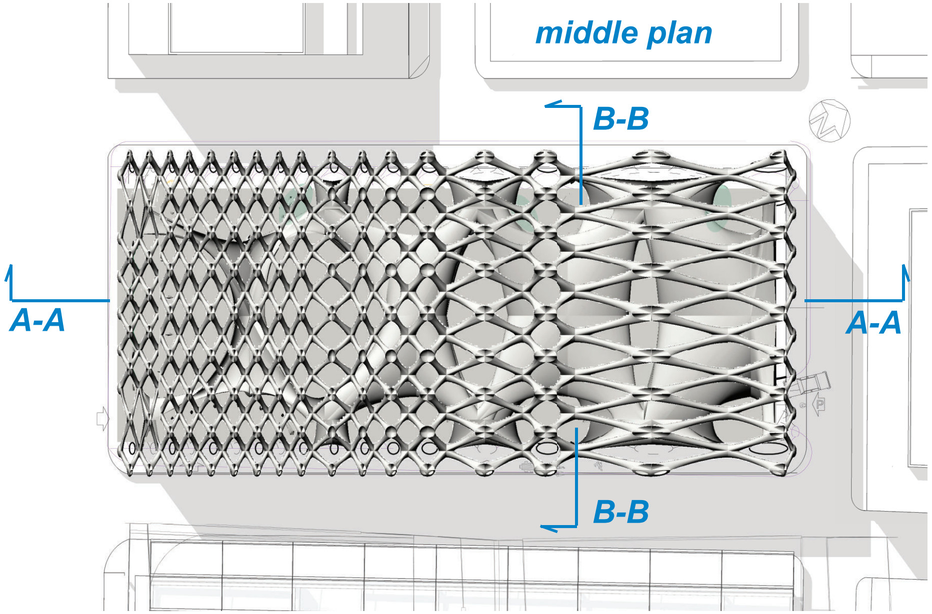
solar energy and water gain

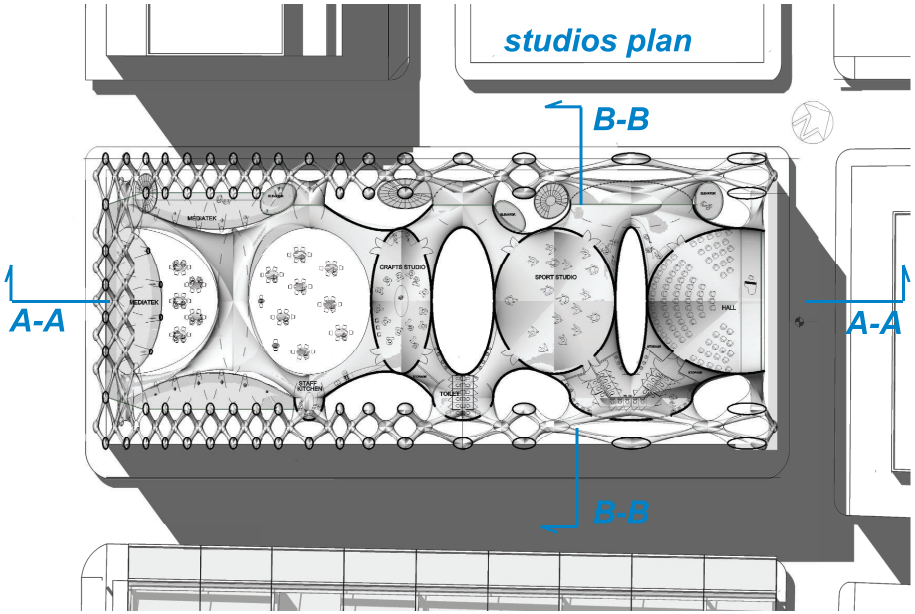


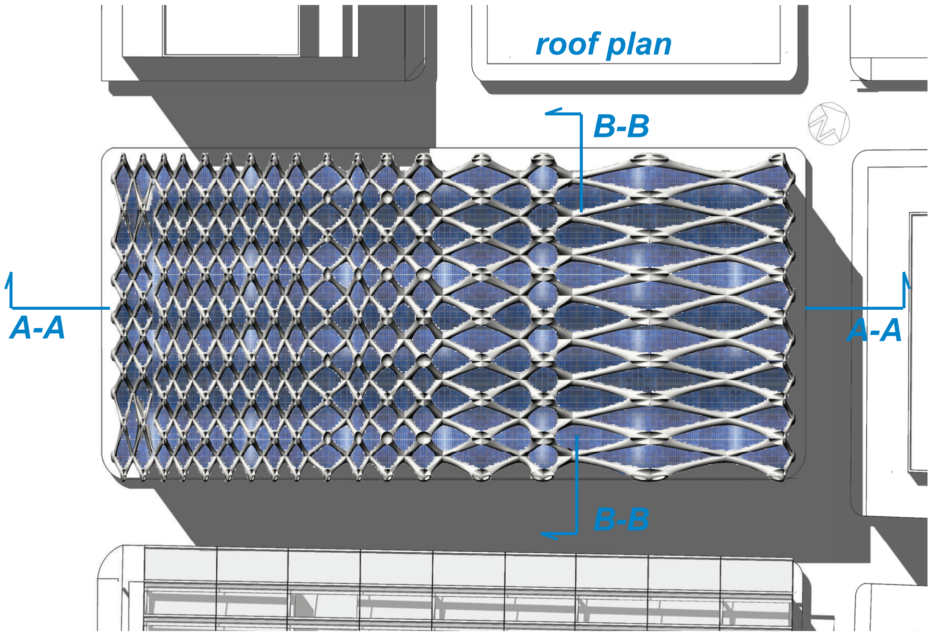


evolution of dual mesh organization

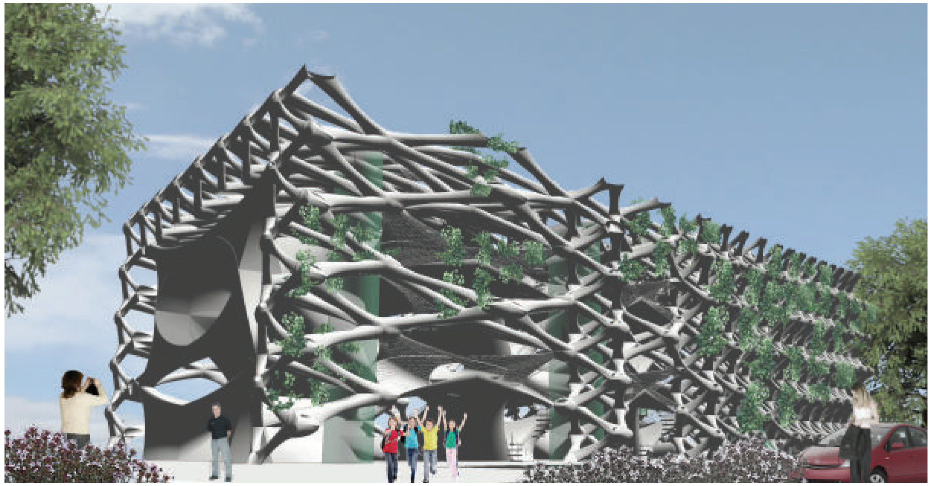

ground plan
B-B
A-A
A-A
B-B
MEDIATEK
CRAFTS STUDIO
SPORT STUDIO
HALL
STAFF KITCHEN
TOILET


middle plan
B-B
A-A
A-A
B-B


studios plan
B-B
A-A
A-A
B-B
MEDIATEK
CRAFTS STUDIO
SPORT STUDIO
HALL
STAFF KITCHEN
TOILET

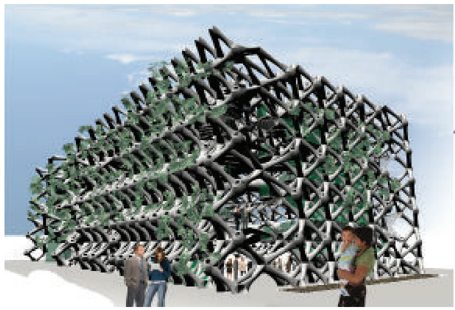

roof plan
B-B
A-A
A-A
B-B

inner view of the mediatek

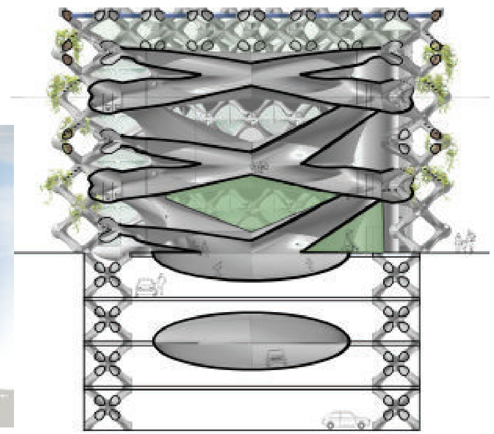


the enterance to the community center on the north-west corner of the site.
the auditorium above faces north, enabling a wide opening of the its' cell.

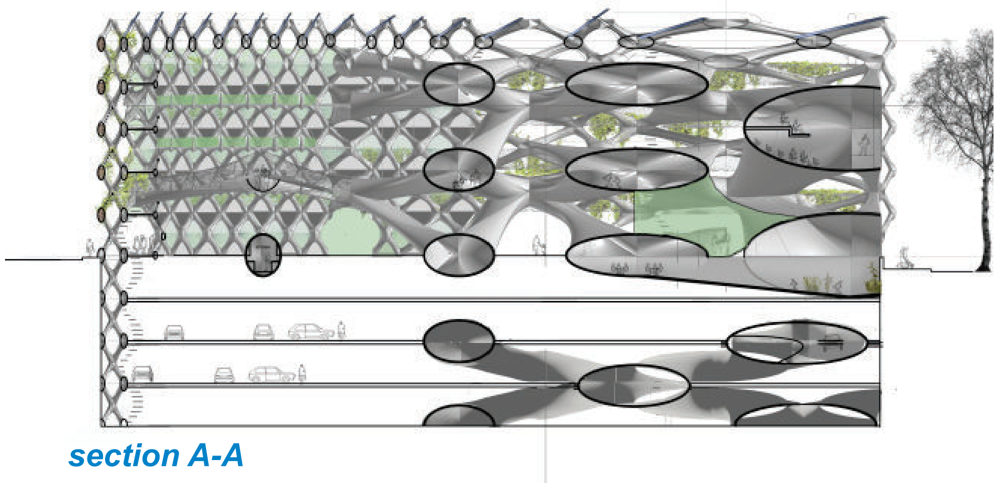
north west view



south-west view



section B-B



section A-A