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Digital Media, What it is? How it Comes?

Digital Media Design, as the developing nature of digital technology, is not quite a domain comparing with architecture and industrial design domain. What digital media is? Is digital media animation, digital game, digital content design or all of above? Is a room full with digital media considered a digital media design? As developing the digital media design research, investigation starts with a broaden approach. Four directions for investigation the boundary of digital media design in this first issue of our journal: Journal of Digital Media Design.

As the definition of digital media design has evolved, we, a group of researchers and practitioners at Taiwan cast this question in 2007 and start a new conference series in the same year 2007: international digital media design conference and form a society called Taiwan Association of Digital Media Design. The first conference is held at National Yunlin University of Science and Technology, Taiwan. Consequently, the third yearly conference (now called DigiMedia Conference) is going to be in December.

The interdisciplinary researches of our journal are divided into five themes: Design Process and Theory for Animation, Intuitive Interface for Digital Content, E-Learning Design theory, Design Theory and Practice of Physical Interactive Game and Design aspects of digital content design. These themes are appeared in DMDC 2007 and then post to call for papers for the journal articles.

The process of reviewing took a very long time since this is our first issue of journal. The papers for including in this journal are evaluated from a pool of international reviewers in two phrases. First, papers submitted to the conference will be reviewed at least twice from a pool of international reviewers. With less than half acceptance rate, the conference papers already have fulfilled the high standard of academic criteria. More than twenty papers are selected for oral presentations with more than seventy submissions are received.

Second stage, is journal review stage. The best eight papers from the proceedings of first year of 2007 International Digital Media Design Conference (DMDC 2007) are chosen according by the editorial boards. Authors further extend the conference paper to the full length and journal quality to submit in this issue. Each article is reviewed by two additional international reviewers after submitted to the guest editor for final submission. By going through significant improvement over conference paper, four articles are accepted and published in this very first issue.

Four articles are 1) Geometric and Material Constraints in Parametric Modelling: The Design to Fabrication Process by Greg Pitts and Sambit Datta; For Pitts and Datta, digital media is a media using digital technology that has rooted in routine design and pattern. Parametric modeling is one of promising digital technologies application in large scale design project. Pitts and Datta provide a mathematical view onto parametric modeling, discussed the material constraints that parametric modeling might encounter.

2) The Use of Modern Aphrodisia: How to Play Video Games by Kuo-Kuang Fan; From cultural and sociophilosophical view, Fan discusses and argues the addiction of game play and how they can proceed in the modern society. How digital media design affects normal behavior is a different dimension looking into the digital culture design research. Addiction to game is also a play after all.

3) A Study on Intuitive Interface in the Context of a Smart Living Space by Teng-Wen Chang, Han-Hung Lin, Jui-Hang Shih; Digital media design here represents a design (smart living space) with supports of digital media. By improving the criteria of intuitive interface, Chang, Lin and Shih incorporate several digital media including sensors and network information into a living space design—a smart living room. With metaphorical design on the fish with associated meaning, this room invokes a skin for dynamic interaction of habitants.

4) Posthumanist Responsive Architecture: Notes on Interactivity by Philip Beesleys. Finally, Beesleys took us to re-visit the concept of huamanist with digital technology. Responsive architecture, applies digital media design in an extreme case: interacting with the architecture directly. The interactivity and associated concept has been re-examined and discussed in this article and provide thoughtful inspiration.

These four articles cover the range from game, digital life to the interactive intuition and the parametric modeling. These articles describe the first definition of digital media design and bring the research to humanity and human-centered research approach that is the new era for the digital design researches.

Guest Editor *Teng-Wen Chang*

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Geometric and Material Constraints in Parametric Modelling: The Design to Fabrication Process

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Parametric modelling, commonly used in the automotive and aerospace industries, has recently been adopted in the architecture and construction fields. The ability to design small repeatable components and apply them to a larger governing surface geometry is one area of parametric modelling that has great design potential. This two level modelling control, of component and overall surface, can allow designers to explore new types of form generation subject to parametric constraints. This paper reports on the design to fabrication process using repeatable components over a governing or carrier surface. The paper reports on our study of the requirements and possible solutions for successfully controlling a repeatable element, known as a Representative Volumetric Element (RVE), using geometric parameters of a larger governing surface geometry and material properties. This modelling process, coupled with Rapid Manufacturing (RM) and Computer Numerically Controlled (CNC) machines has the potential to significantly reduce the interface between design and fabrication.

Keywords: Parametric Modelling, Representative Volume Element, Rapid Manufacturing, Design, Fabrication

✤

1. Introduction:

"Design, practice, fabrication and construction are increasingly becoming networked affairs. The new measures of architecture are connectivity and speed. The architecture of a new world needs to recognize these transformations and think differently" (Senagala, 2007)

The current process of design and building has long been recognised as an inefficient and lengthy process with very little effective networking or collaboration between the parties involved. (Eastman, 2004) The progression of a design travels from architect to engineer to shop fabricator to construction, becoming more compromised and convoluted at each step. Within other industries (such as automotive and aerospace), parametric modelling is used to refine this process and limit endless reworking.

Recently, this form of collaborative design has been employed by Frank Gehry and Associates, who address this issue by adopting CATIA (Glymph et al, 2004) to create 'Digital Projects' for design, lifecycle management, and fabrication of complex building form. While this work relates to the use of parametric strategies for forming complex surfaces with planar facets, it addresses the entire process of construction requirements, design and modelling based around a collaborative system. This form of parametric modelling is also demonstrated (Burry, 2004) in the completion of Antoni Gaudi's Sagrada Familia.

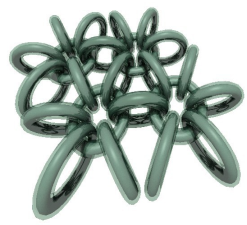

Figure 1: Render of Tessellated Textile Links. The motion of these rigid links in 3-space permit additional flexibility in modelling component-carrier geometries.

A different approach to the parametric design to fabrication process is taken in the area of rapid manufactured (RM) textiles (Bingham et al, 2007). Bingham et al (2007) describe and define the production and modeling requirements of RM textiles. In this work, the problem is seen from the manufacturing point of view as the production of standard repeatable "link" elements that can wrap and conform to body shape. This approach to modeling textiles employs strategies from rigid body dynamics and the behaviour of deformable soft bodies. This approach, in combination with standard parametric strategies, has the potential to extend the applications of geometric and material constraints in architectural design. For example, the ability to deform a repeatable rigid component, based on its geometric and physical properties would offer additional degrees of freedom currently not available in parametric systems.

While the integration of physically based modelling of rigid bodies and soft body deformation techniques into parametric modeling is beyond the scope of this paper, we investigate the possibilities for modeling architectural surfaces based on these ideas.

1.1 Deterministic and Non-Deterministic Parametric Modelling

Parametric modelling can be defined by their process and aims into two broad categories, deterministic and non-deterministic parametric modelling (Senagala, 2007). Non-deterministic parametric modelling refers to the exploration of form through a set of parameters with no definite or predetermined from goal. The work of Gehry and Associates (Lindsey, 2001) and the completion of Antoni Gaudi's Sagrada Familia ((Burry, 2004) are examples of this form of modelling.

CAD programs such as Bentley's 'Generative Components' (GC) have been developed for the purpose of multiplying repeatable geometric elements as arrays on a surface. With the help of non-deterministic parametric programs such as GC, it is relatively easy to apply a cellular component to a surface of any complexity. However, depending on the complexity of the carrier surface, this application can often have unexpected results.

Deterministic parametric modelling uses parameters and formulas to achieve a desired goal. This end goal can either be pragmatic or aesthetic but the process of creation is much more refined and specific than that of non-deterministic parametric modelling. Further, when the end product has deterministic requirements, such as correct scaling and tessellation as well as orientation and even material requirements, these programs are not useful in resolving the array onto the carrier surface. This type of modelling requires forethought of the end product and multi-scale approaches such as the Python based 'TexGen' (Sherburn, 2007).

1.2: Physically based Modelling

Physically based modeling research can extend the above methods of modeling in architecture by incorporating rigid body deformation (based on mass force and energy) constraints. There are two types of physically-based models: mass-spring models () and models based on Finite Element Methods (FEM).

Gibson (1997) has proposed a 3D ChainMail Algorithm, that can rapidly propagate deformation through a rigid volume. The computation of the deformation is done locally (Figure). While the graphics research on deformation reported in the graphics literature is outside the purview of this work, it is significant to note that methods developed for deformation can be incorporated to architectural models for greater flexibility and extensibility of parametric methods.

For architectural applications, there are degrees of intersection between both forms of modelling. Deterministic can still be used to explore the possibilities of form generation within the set of parameters and non-deterministic can still have an end use in mind, whether pragmatic or aesthetic. We apply the principles of deterministic parametric modeling to study the tessellation of a complex surface form using a repetitive element, using a representative volumetric element (Bingham et al, 2007)

The paper describes three requirements for achieving the above goals:

1. the use of a Representative Volumetric Element for representing the repeatable component,
2. the definition of the carrier surface using meshing techniques and
3. the incorporation of manufacturing and production requirements.

Our approach is to combine the lessons of the standard use of parametric modeling in architecture and design and to draw parallels with the approach of rapid manufactured (RM) textiles. To investigate these advances, we limit our attention to architectural surfaces composed of repeatable elements. This method of modeling involves the development of a global carrier surface (usually a surface of complex curvature), the subdivision of the surface into discrete modules (usually quadrilaterals) and their subsititution with component (usually a three dimensional solid geometry). We term these geometries component-carrier geometries (Figure 1). In addition to this formulation, we impose additional degrees of freedom on the components, derived from research on RM textiles. Finally, we investigate the modeling and production requirements of such geometries and their potential for architectural applications.

2. MODELLING AND PRODUCTION REQUIREMENTS

To develop our formulation of component-carrier geometry, we introduce another concept from materials engineering, the concept of the representative volumetric element (henceforth, RVE).

The Representative Volumetric Element is the smallest repeatable element within a given tessellation that can be multiplied without any reorientation (Bingham et al., 2007). This differs from a single component, such as an RM textile link, as a link on its own needs reorientation from vertical to horizontal on a governing surface. The requirements for surface meshing and the use of RVE in the substitution of discrete surfaces with components are discussed.

2.1: Representative Volumetric Elements (RVE)

In this paper we investigate the problem of tessellation through the use of Representative Volumetric Elements (RVE). One of the key differences between an RVE and a standard CAD component is the ability of an RVE to have an awareness of its place within a larger pattern as well as adhering to any set parameters and governing surface geometry. This is an important factor in the creation of both an intelligent RVE and a cohesive and tessellated product that fits within all the required fabrication requirements. (Figure 2)

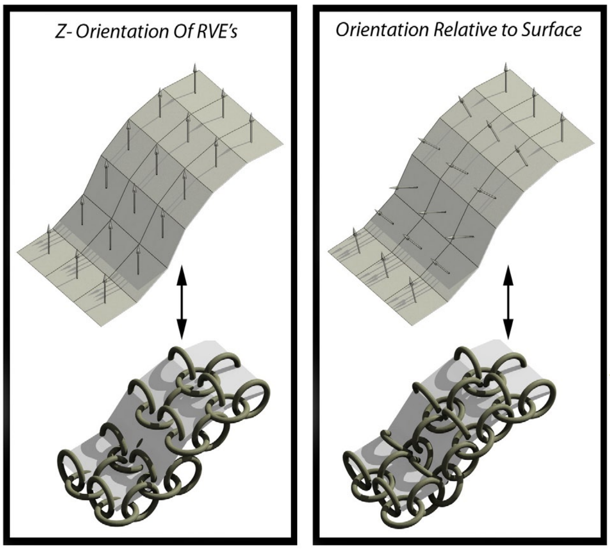

Figure 2: RVE Orientation and Tessellation Control across a Surface.

The Representative Volumetric Element is the smallest repeatable element within a given tessellation that can be multiplied without any reorientation (Bingham et al., 2007). This differs from a single component, such as an RM textile link, as a link on its own needs reorientation from vertical to horizontal on a governing surface. (Figure 3)

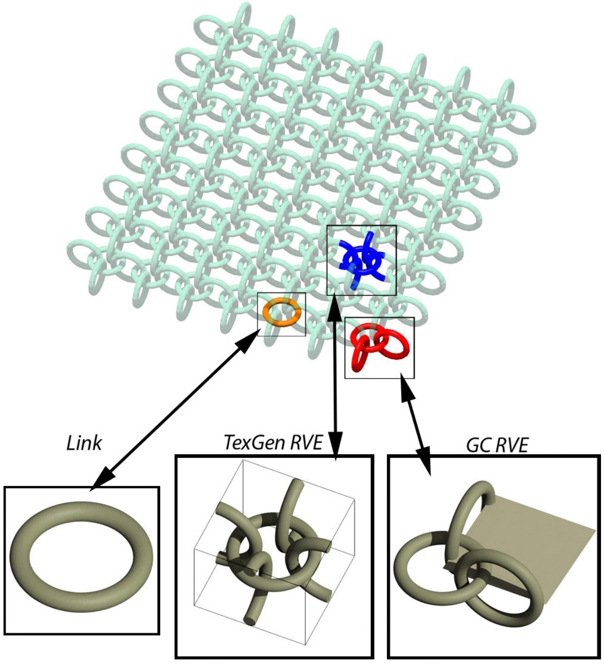

Figure 3: A Tessellated Link Pattern developed as a single repetitive link (left), RVE in TexGen (centre) and in GC (right).

2.2. Surface Meshing

2.2.1. Finite Elemental Analysis (FEA)

Meshing constraints remain one of the biggest issues that need to be addressed in current parametric programs. The uniform meshing of a surface or shape essentially constrains the RVE within its boundaries. If the meshing is not uniform, issues arise with warping and incorrect scaling of the applied RVE (Figure 4). Finite Elemental Analysis (FEA) is the process of dividing any given shape into equal planar or close to equal planar facets of a similar surface area.

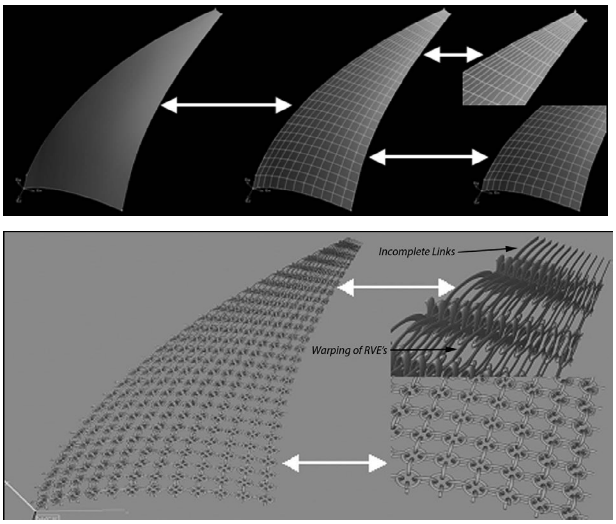

Figure 4: Inconsistencies between FEA Mesh and RVE

Requirements. (Bingham et al, 2007)

While standalone FEA meshing software exist, the current procedure requires the user to export the surface for analysis and then import the solution back to the desired parametric program. Further, FEA meshing for RVE population and fabrication need additional considerations such as Minimum Material Capacity (MMC), uniform facet area meshing and clash detection to prevent unwanted fusing of forms in the production stage.

2.2.2 Levels of Geometric Complexity

To understand the FEA process it is important to firstly understand the levels of geometric complexity that need addressing. To do this, a simplification of complex shapes into their base geometry is required. This will give an understanding of both final shape analysis as well as the creation and exploration of form in CAD software. The process for creating these shapes is in effect an addition of curvature to the previous order of geometry. The shapes demonstrate different degrees of geometry in the following order. (Figure 5)

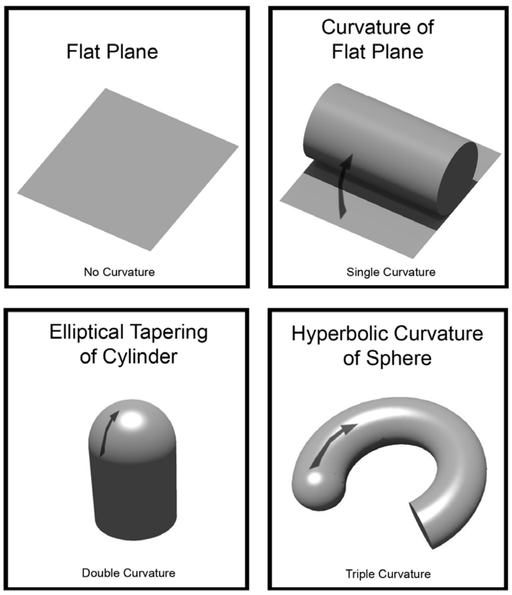

Figure 5: Increasing Geometric Complexity by Adding Curves to a Plane.

The simplest form of geometry is a point which simply indicates a singular position in space. This is followed by the line which is a linear projection of the point. These are both only theoretical definitions within Cartesian space as neither can actually exist in physical space. The plane is the next step in complexity and requires the extrusion of a line to define a two dimensional area. Once again this definition can not exist in physical space but is one of the most useful controls for RVE's in parametric modelling. The next shape in the progression can be one of two shapes. The cube is the first of the three dimensional forms that is created from the addition of a thickness to a planar surface. The second is a cylinder which is defined by the addition of a single curvature to a plane. Although this only defines the outer surface, for the following examples of curvature in CAD a fill (solid) is assumed. A sphere is merely a cylinder with radial scaling from the centre point to form an ellipse. The torus is the final step in the process, comprising of the elliptical curvature of a sphere multiplied to form a hyperbolic curvature.

The creation of complex curved surfaces can be broken down from this basic understanding of geometric definition and is the basis for the analysis and eventual meshing of any form in CAD.

2.2.3 Analysing Curvature with Planar Facets.

FEA meshing of surfaces looks into three dimensional curves or complex shapes and their composition and construction using simpler geometric forms. Using the example of the clothing industry, the make up of a 3D form for a garment can be 'unfolded' and represented in a pattern of its planner components. This happens on three levels-

-the make up of the entire double curved form of the garment

-the complex deformations that make up the garment and their relation to each other

-the simple planer geometric pattern that forms the complex deformations

When assembled without deformation, these simpler geometries, e.g. triangular or quadrilateral, will only give an approximation of a curved shapes area. These are used as mapping geometries that are then applied to models such as Gaussian curvature to create a curved surface. When working with real examples of complex double curved forms, the geometric solutions have to also take into consideration the physical properties and limitations of the material. For example, when forming a double curved shape such as the sphere or torus the planer pattern requires the forming of an ellipse. The greater the angle, the more dramatic the 3D elevation and base radius.

For the sphere, a string of gores can be used to demonstrate the ellipse much the same way the earth is displayed in an atlas. The torus can be segmented in much the same way but requires a shallower angular defect and a quadrilateral base geometry to elongate the form. Both shapes can also be expressed using the Calladine method with rings of stacked platelets, angled to coincide with their radial position. (Marshall and Pengelly, 2005) Both shapes use this quadrilateral base geometry to form an ellipse, but the torus requires the tapering to create the hyperbolic curvature of the shape. This in effect breaks down the Gaussian strings of meridians and parallels of latitude, to express each string as a bottleneck made up of planer quadrilaterals.

2.3 Fabrication Requirements

2.3.1 Minimum Material Capacity (MMC)

The material of a product is an important consideration in the design and modelling phase. Rapid Manufacturing (RM) allows the use of a great range of materials, including metals, plastics and nylons, each with varying properties and levels of performance. The products requirements may determine the type of material, but the allowable sizing and resulting performance of the product will depend on the Minimum Material Capacity (MMC). For this reason the creation of an RVE needs to have MMC as the basis of design. The use of a softer material may mean that it has reduced strength, resulting in a MMC that requires a lager RVE size and thickness. (Figure 6)

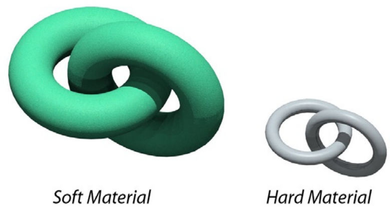

Figure 6: Difference in RVE Scale allowed by the MMC.

2.3.2 Controlling the Z-height

Controlling the height of a rapid manufactured object is an issue that is unique to products requiring a degree of freedom such as textiles. This specific rule would not apply very often in the building industry but demonstrates that the method of fabrication is an essential parameter in the modelling phase.

For RM textiles, the z-height translates to production time. The higher the model, the more layers of material need to be put down and processed. (Figure 7)

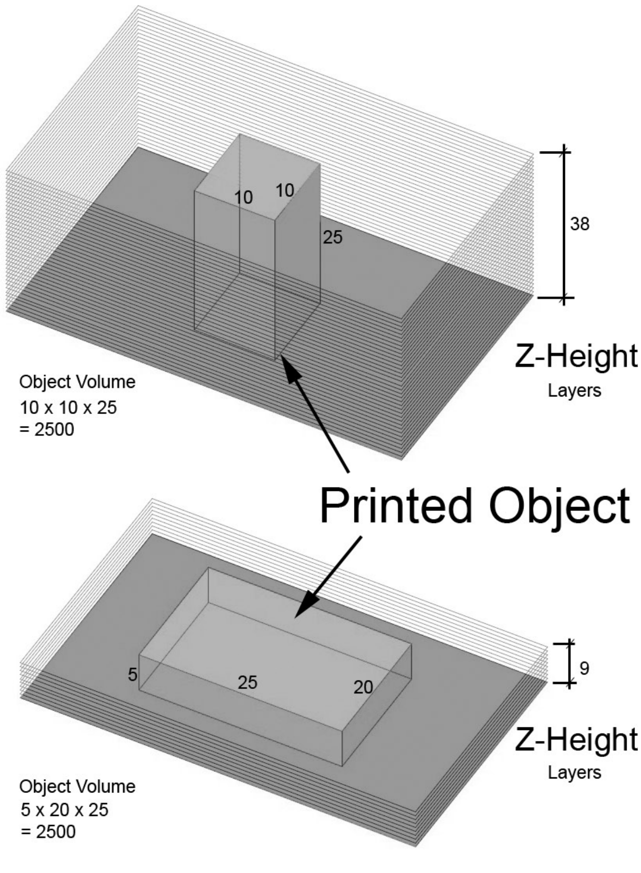

Figure 7: Printing Layers Required for Objects of the Same Volume but Different Z-Heights.

The area of space that the physical elements in RM occupy is minimal compared to the encompassed area of a complete form. This can be solved through a controlled collapse in the 3D environment. This process is like a CAD simulated gravity that reduces the object into its lowest potential energy state. This is where the RVE needs to be carefully detailed so the end product cannot fuse into a solid mass. The degree of freedom inherent in textiles is both an advantage, in its ability to collapse, and a disadvantage in its need to keep a separation between all elements.

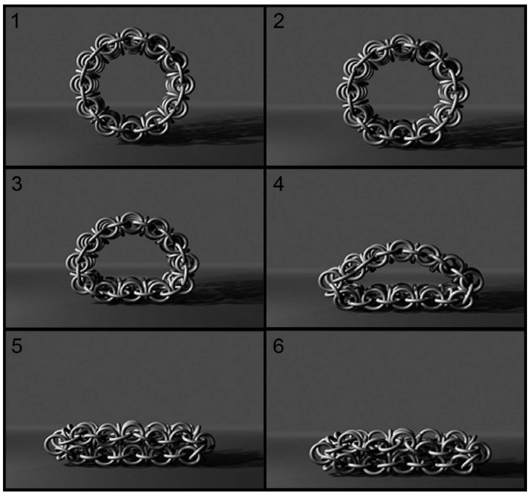

Figure 8: Collapsing an RM Textile Cylinder using Computer Simulated Gravity. (Bingham et al, 2007)

This potential is explored through the parameter requirements of the RVE.

The following equations demonstrate the required product fabrication parameters that will define the RVE. MMC will determine the capabilities and performance of the product while R2 will create a protective shield around the links to prevent fusing during manufacture. (Figure9)

Equation to determine minimum link size

$\frac{MMC}{2} + RMA = R_1$

$RMA \times 2 + R_1 = R_2$

$D_1 \geqslant R_2 \times 2$

$\therefore RMA \times 2 + D_1 = D_2$

$\therefore (R_2 + R_1) \times 2 + D_1 = D_3$

$\therefore D_1 \times 3 = D_4$

2 LINKS - $R_2 \times 4 \leqslant D_1$

4 LINKS - $R_2 \times 5 \leqslant D_1$

6 LINKS - $R_2 \times 6 \leqslant D_1$

MMC = Minimum Material Capacity

RMA = Rapid Manufacturing Accuracy

MMC can be substituted for desired link sizing to suit the end product.
RMA should always be a consideration when collapsing double curved surface to minimize area. RMA will always be a minimum height addition to ensure that links are not created fused together.

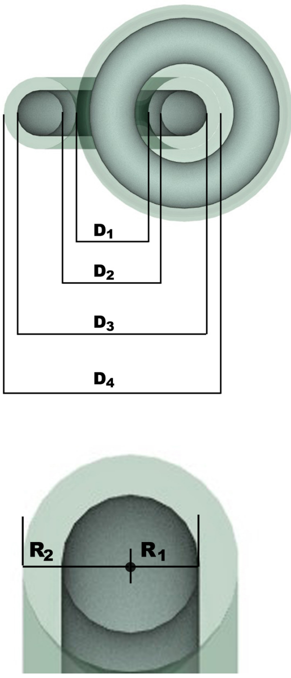

Figure 9: Minimum Production Requirements for Textiles (Pitts, Datta, Kao. 2007)

2.3.3 Application in Building Design

"The continuous, highly curvilinear surfaces that feature predominantly in digital architectures brought to the front the question of how to work out the spatial and tectonic ramifications of such non- Euclidean forms. It was the issue of constructability that brought into question the credibility of spatial complexities introduced by the digital avant-garde." (Kolarevic, 2005.)

The design and subsequent production of curved surfaces requires careful consideration in the translation between the two stages. Creating curve purely on aesthetic principals does not automatically lend itself to the structural integrity of the built form. Therefore certain geometries and modelling techniques have to be applied from a forms conception to its fabrication, to ensure that the load is distributed successfully across the shape. The modelling process for complex surfaces requiring internal and external equilibrium includes both physical (such as RM fabrics) and digital techniques (Solidworks, Generative Components). Construction of these shapes has to consider issues from the economics of labour and materials to the structural performance required.

Traditionally timber formwork was erected temporarily to create the inner surface of the curve and support reinforcing and the poured cement. This technique is time consuming and therefore expensive, requiring an entire temporary wooden structure to form the concrete surface. Pre- fabricated elements employ sacrificial formwork that is cast in-situ to form the underside of the surface. This process lends itself to repetitive forms that are based on simple geometry such as cylinders and spheres, limiting its application in more complex forms. A similar type of sacrificial formwork can also be created from wooden sheets held on temporary supports. Timber can be used on its own to create curved surfaces, offering greater strength to weight ratios but is limited by the difficulty of bending it in two directions.

In terms of parametric application, there is huge potential to unify this type of process into the design.

After defining a curve of any complexity and applying an RVE of particular behaviour, an Element Analysis can be used to explain and test structural behaviour. Prefabricated forms are often created in segments for ease of transport and construction. To do this, the curve of each segment has to be communicated to ensure that the entire surface is cohesive. Shells are rarely of uniform thickness so both the inner and outer surface curves need to be defined to create a solid. From the solid form, a sectional division and subsequent cut can be performed to define each segment. These should then be isolated for ease of production. Another analysis can then be performed to take into consideration material and segment composition.

The inclusion of structural requirements into the CAD process is something already being used by shop fabricators but is still considered very specialized and requires complex programming. This is where the process needs to be simplified.

In terms of RM textiles, the modelling requirements include material performance, degrees of freedom, Z-height and tessellation. Rather than dealing with each of these requirements at a different stage of design GC has been used to create a cohesive and networked set of parameters that automatically restricts the model. Although set within parameters, the design possibilities and form experimentation can be explored more thoroughly while eliminating the need to compromise the product at later stages.

While the example of RM textiles is basic when compared to the requirements for building production, it is still an effective model for testing the potential of parametric programming required to network and simplify the design industry.

3. PARAMETRIC APLICATION

3.1 Generative Components (GC)

The parametric program Generative Components (GC) has been used for the following trials of RVE application within a governing surface geometry. The program is based on a scripting arrangement and as such has very wide scope in its application. This is both an advantage and a disadvantage for the following tests. The wide scope does not restrict the program unnecessarily within a given field but at the same time was not designed for a specific discipline so experimentation with the interface and capabilities is necessary. Unlike traditional CAD software, GC operates on a hierarchy of events demonstrated in the form of a symbolic tree. (Figure 10)

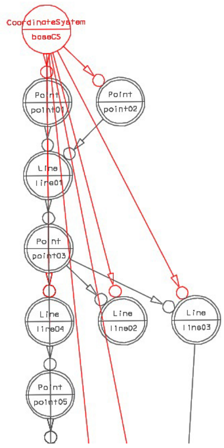

Figure 10: Section of a Schematic Tree Diagram of Events

This setup allows users to view relationships of objects within a model as well as 'go back' and change the defining parameters at any stage of the modelling process. This ability allows the modelling process to be fluid and dynamic as nothing is fixed and anything changed will affect any subsequent elements of the model. Parametric variables can also be inserted at any point to dynamically change the parameters in which an object and reliant objects will exist.

3.2 Populating a Planar Surface.

Dealing with a planar surface is a relatively straight forward process. There is no deviation from the UV axis so most CAD packages could handle creating an array. The only requirements placed on the RVE at this stage were that of link accuracy and the array coordinates or spacing.

Due to this ease in population, a planar surface is often a good way to test the successful tessellation of a given RVE design.

3.3 Populating the Surface of a Cylinder.

The cylinder requires different treatment to that of a plane. The addition of the third dimension to the base geometry means that the RVE has to now be programmed with an understanding of orientation. A flat plane does not require the RVE to rotate or defect in any way but a cylinder requires strict conformity to the surface curvature (as shown in Figure 3). For this to occur, the RVE needs to have its own coordinate system. When attached to the governing plane, the XY axis of the coordinate system line up and follow the UV plane of the defining surface. (Figure 11)

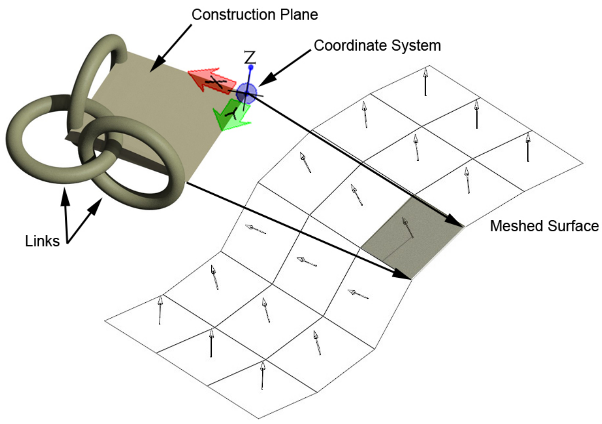

Figure 11: Demonstration of RVE Hierarchy and Application.

The torus links could then be defined based on the dimensions of the portable coordinate system rather than global orientation.

Once the RVE was defined, the governing cylinder had to be meshed. This could have been achieved through the use of stand alone FEA meshing software but for the purposes of this trial GC was used. GC' s inability to be able to deal with FEA meshing automatically meant that an even surface division had to be manually defined. This was achieved by defining a series of points along the spine of the cylinder and another set, of equal spacing, around the defining circles. This gave a quadrilateral planar division of the governing surface.

The definition of the RVE's is based on a formula that allows the links to adapt and scale within a given area. The application demonstrated (Figure 12) shows a surface meshing of 1 unit squared. The RVE automatically fits itself within the facets of the array. To multiply or decrease the number of links on the surface, the base mesh can easily be altered to halve or double the number of facets, and consequently links, around the cylinder.

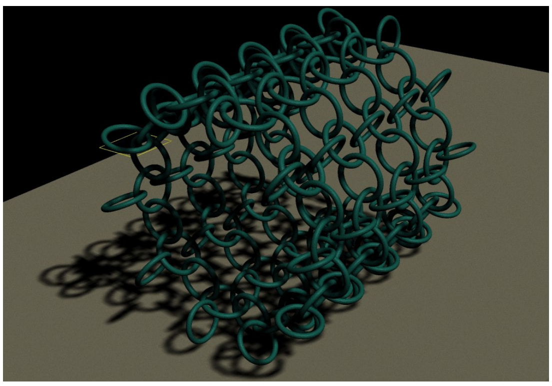

Figure 12: Perspective Render of the Parametrically

Populated Cylinder.

This method, for creating an RM textile cylinder, was successful in its parametrically defined tessellation and uniform scaling. From the GC program, the model can be converted to a STL or a STEP file which can then be used for production by a 3D printer.

3.4 Populating the surface of a Sphere.

The top portion of a sphere was used as the governing surface for the next step in geometric complexity. Once again the meshing process was carried out manually to try and force an even division of facets. (Figure 13) Although controlled by b-spline curves and restricted to an even division, the meshing experienced problems of tapering near the edges of the ellipse. With FEA meshing the quadrilateral facets could have a constrained angle to force a more uniform shape, but GC is not capable of this level of automatic control.

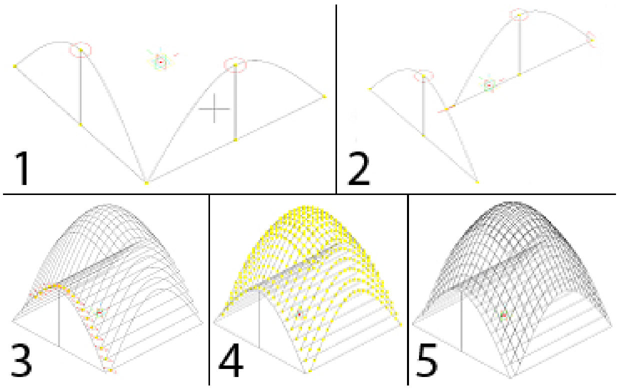

Figure 13: Process of Defining Surface Mesh

The model was still relatively successful, despite the issues with incorrect meshing. Despite some warping and crowding, if links towards the edges of the ellipse, the model still retained it's degree of freedom and could be produced as a freeform textile. (Figure 14)

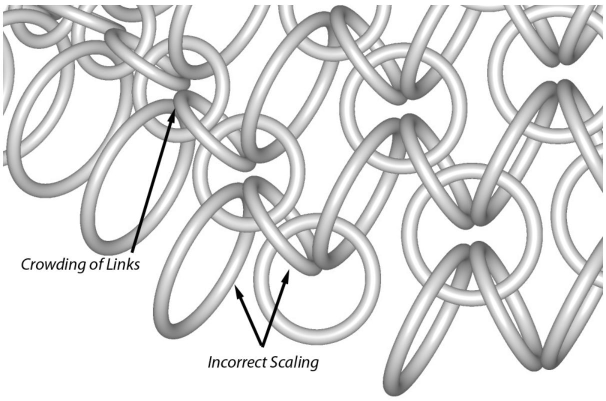

Figure 14: Modelling Issues.

To successfully mesh a spherical or freeform shape, a more accurate method of surface division and RVE control is required. Achieving this in GC is still a lengthy process requiring a lot of user input to define the surface and constrain the component.

3.5 Populating the Surface of a Torus

The creation of a torus surface was to test the application and reaction of the RVE's on a complex surface without the required FEA meshing constraints. Without a completely successful means of populating a spherical surface, the creation of a torus based mesh is impossible. As a result of this trial, RVE reactions can be documented as areas that require further research and experimentation.

For the purposes of this trial, the RVE's were simplified into horizontal elements and vertical elements. (Figure 15)

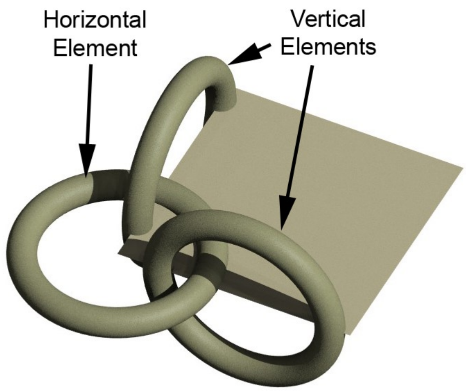

Figure 15: RVE Element Definition.

These could then be applied separately to the torus surface, to test and compare the reactions of each. (Figure 16-17)

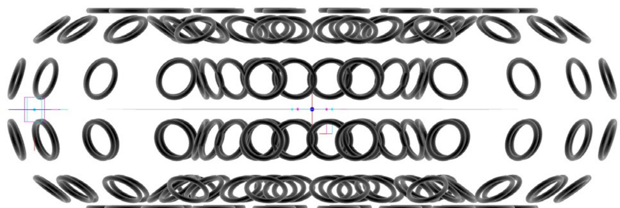

Figure 16: Population by XY Orientated Torus.

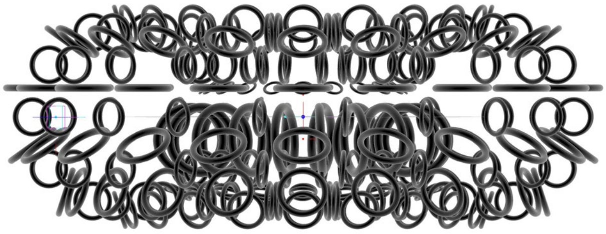

Figure 17: Population by XZ and YZ Orientated Torus.

The results demonstrate that the vertical links are affected more dramatically by a change in the surface than the horizontal links. This is a result of the formula used to create the RVE. The radius of the links is directly linked to the facet length. Due to this, there can be large scaling variations between the links of a single RVE if the length and the width of a facet are different values. The horizontal element's diameter, however, is linked to both the length and width of the facet, resulting in less dramatic deformation.

To successfully mesh and populate the surface of a torus, either triangular facets or a bottleneck made up of planer quadrilaterals of differing scale are required as a basis for RVE application.

This inaccurate process results in the creation of a largely fused form of incorrectly scaled links. (Figure 18)

Figure 18: RVE Populated Torus section.

As a production model, the torus based form is a failure. From the perspective of a research experiment, however, the model demonstrates some interesting programming reactions and highlights areas that require further work.

Firstly, the control of the RVE is determined by a planar facet and as demonstrated in figure 17 does not control the vertical elements to a satisfactory degree. This is because it is difficult to successfully constrain a three dimensional component with a two dimensional plane.

Secondly, as discussed earlier, the meshing of the surface was not successful and did not relate to the RVE correctly. This is, once again an issue of dealing with objects between 2D and 3D space. In an attempt to explore this, a new set of tests are required.

3.6 Constraining the RVE

To successfully deal with a three dimensional RVE, all axis need to be controlled. As with the single plane the orientation through an attached coordinate system is the key. As demonstrated in Figure 19, the RVE is now defined by two surfaces, each with an independent coordinate system to align within the relevant facet regardless of the other.

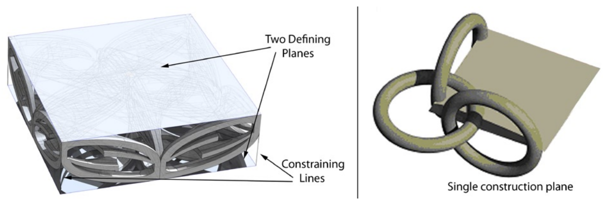

Figure 19: Demonstration of Planar Constraints.

This in effect will pull the RVE into line between any defining surfaces, forcing a correct tessellation angle. This process also requires the definition of two parallel surfaces to constrain the RVE. This process is not ideal in regards to every day building practice as the user has to define both the component and two related surfaces with faceted mesh. This is a good example of the type of intuitive programming that is still required to make parametric modeling a viable process for design and building.

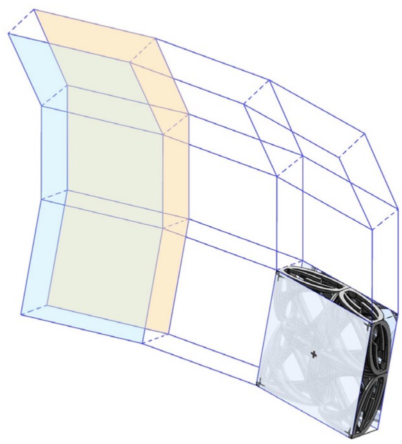

Figure 20: Component Constrained Within Surfaces

A more elaborate component was used to trial the use of two related planes, to demonstrate the application of a micro designed RVE that can be applied to a surface to create a complex screen. This process allows each component to be extrapolated and fabricated to create an exact physical replica.

CONCLUSION

In this paper, the results of a series of experiments in the tessellation of a carrier surface with repeatable components are described. The key aims of the paper are to address the increasing need for seamless and bi-directional connectivity between discrete parts of the design to fabrication ambit.

The well established conventions within the building industry are inexorably changing towards a new paradigm of design aided by computer generated forms and methods of fabrication. With this change comes an added level of complexity in the definition of form and structure in architecture. In order to take these digitized forms and rapid manufacturing in our stride, a new process of building realization needs to be reached. A new specialised and intuitive level of integration between design, modeling and fabrication needs to be implemented. This is not a matter of developing new programming technology as all of the requirements previously discussed are currently available in either separate programs or other industries. To develop a cohesive process, the practice as it stands needs to be understood in all areas from conception to completion.

The paper describes how the tessellation of a carrier surface with repeatable elements can be undertaken in a seamless manner. Using the concept of a representative volumetric element drawn from mechanical modeling, geometric components can be given additional parameters that maintain their orientation and shape within constraints. Using uniform FEA meshing techniques, arbitrary surfaces can be uniformly subdivided for population with RV elements. Finally, production constraints from manufacturing such as material constraints can be integrated in the geometric modeling phase to allow for rapid manufacture (RM).

The combination of element representation, meshing techniques and material constraints will subsequently open up new avenues into form generation and exploration all within the parameters of the fabrication and build requirements. While this level of integration and refinement have not yet been reached, further study into programming and build requirements will begin to bridge the gap between a design concept and design realisation.

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The Use of Modern Aphrodisia: How to Play Video Games

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Video games have been the subject of frequent controversy and censorship due to their depiction as a cause of addiction and even violent behavior. Although many studies (Cover, 2006) undertaking the examination of video games and the gaming culture deny that games are addictive, the stereotype of the game player as addicted continues to catch on in various domains of academic studies and, with increasing impact, in popular culture, news media and governmental rhetoric. The addicted gamers are seen as low-class, proto-violent addicted and dangerous. In this paper, we do not discuss the details of these arguments, but consider the reason why these arguments occurred: Why people denunciate video game addiction? Why addiction is conceived as bad?

By introducing the Bataille's concept of sovereignty (Bataille, 1983) we try to illustrate how playing a video game could be a way to escape from the iron cage of rationality. In last section, we adapt the ideas of aphrodisia and the aesthetics of existence rediscovered by Foucault (Foucault, 1990) in order to explain our viewpoints about the nature of a video game and gamer: to a free gamer, the game is a tool of practice and, playing a game is a way to access the aesthetics of existence. One reason a video gamer might become "addictive" is the deficiency of self-mastery. In sum, this deficiency can only be detected and rectified by the gamer through self-reflection and self-control. The moderation of a gamer's actions should be carried out by her/himself depending on her/his personal situation. Any external judgment and/or rectification will be the operation of a power regime. It will ruin the free subject, and make it a component of the power machine (Foucault, 1980).

Keywords: Video game addiction; rationality; sovereignty; aesthetics of existence

✤

Introduction:

As video games developed in 1958 (Kent, 1991), the majority of the baby-boomer generation considered that the video game caused time-and-money-wasting. It was associated with corruptness, danger and vulgarity and was as much praised as it was blamed. In 2006 the retail sales of U.S. video and PC games are $13.5 billion (http://www.npd.com/press/releases/press_070119.html). This figure means that nobody can neglect video games' influence, no matter it is good or bad, it occupies an important part of the life of human beings in affluent societies.

Video games have been the subject of frequent controversy and censorship like other forms of media because of the depiction of graphic violence, sexual themes, and consumption of illegal drugs or alcohol in some games. Various games have been accused of causing addiction and even violent behavior. Critics of video games sometimes include parents' groups, politicians, organized religion groups, and other special interest groups. However, this kind of controversy and criticism is not unique to video games. It has also been applied to Comic books, motion pictures, dancing and to some extent music (http://en.wikipedia.org/wiki/Video_game). A stereotype of the game player as addicted continues to circulate in various strands of ego-psychology and pedagogical studies and, with greater force and political effect, in popular culture, news media and governmental rhetoric (Beavis, 1998; Thompson, 2002; Young, 1998; King and Borland, 2003). Although the vast majority of studies undertaking the examination of electronic games and the emergence of a gaming culture deny that games are addictive. The addicted gamers are seen as low-class, proto-violent addicted and dangerous kids, learning to express repressed anger and aggression, sociopathically isolated (Cover, 2006). We are not trying to discuss the details of the arguments above mentioned in this essay but simply to discuss the reason why these arguments occurred by citing the viewpoints of both sides: Why addiction is conceived as bad to us? Why people denunciate video game addiction? Then, by introducing the concept of sovereignty, we illustrate how playing video game could be a possible way to escape from the iron cage of rationality. In last, we take the ideas of aphrodisia and the aesthetics of existence rediscovered by Foucault to explain our viewpoints about video game and gamer. To a free gamer, game is a tool of practice, playing game is a way to the aesthetics of existence. The reason a video gamer be "addictive" is caused by the deficiency of self-mastery. The most important things we want to point out are this deficiency can only be rectified by gamer through self-reflection and self-control. The moderation of gamer should be carried out by himself depending on his personal situation. Any external judgment or rectification will ruin the free subject, and make it a component of the power machine.

Video game addiction

The video game addiction related research report had already been advanced in 1990 (Keepers, 1990), but Keepers used the term "pathological preoccupation" to describe the phenomenon he had studied in this essay. The origin of the term "video game addiction" correlates closely with another term, "Internet addiction disorder". By Ivan Goldberg M. D. in 1995, the term "Internet addiction disorder" was first presented, he referred to the part of pathological gambling in Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV)(American Psychiatric Association, 1995), and defined the term "Internet addiction disorder" (IAD). Goldberg did not actually believe that IAD existed; these criteria were originally posted as a joke by Goldberg as a parody of the strict format of the DSM. Subsequently, researchers such as Kimberly Young, Mark Griffiths and John Charlton have investigated the idea of IAD further and attempted to create more accurate diagnostic criteria for Internet Addiction Disorder (http://en.wikipedia.org/wiki/Internet_addiction_dis order; Surratt, 1999). Young developed a brief 8-item questionnaire to provide a screening instrument for IAD (Young, 1996):

(1) Do you feel preoccupied with the Internet (think about previous on-line activity or anticipate next on-line session)? (Salience)

(2) Do you feel the need to use the Internet with increasing amounts of time in order to achieve satisfaction? (Tolerance)

(3) Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use? (Relapse)

(4) Do you feel restless, moody, depressed, or irritable when attempting to cut down or stop Internet use? (Withdrawal symptoms)

(5) Do you stay on-line longer than originally intended? (Tolerance)

(6) Have you jeopardized or risked the loss of significant relationship, job, educational or career opportunity because of the Internet? (Conflict)

(7) Have you lied to family members, therapist, or others to conceal the extent of involvement with the Internet? (Conflict)

(8) Do you use the Internet as a way of escaping from problems or of relieving a dysphonic mood, e.g., feelings of helplessness, guilt, anxiety, and depression? (Mood modification)

Patients were considered "addicted" when answering "yes" to five (or more) of the questions. Parenthetic text is corresponding with Griffiths' criteria (Griffiths, 1998). Griffiths applies this questionnaire to his definition to so called "game addiction" by using these 6 criteria:

(1) Salience: Do you frequently play most days?

(2) Tolerance: Do you frequently play for longer periods of time?

(3) Euphoria: Do you play for excitement or a buzz?

(4) Chasing: Do you play to beat your personal high score?

(5) Relapse: Do you make repeated efforts to stop or decrease playing?

(6) Withdrawal: Do you become restless if you cannot play?

(7) Conflict: Do you play instead of attending to school related activities?

(8) Conflict: Do you sacrifice social activities to play?

These criteria seem strict, yet when "internet" or "video game" is replaced by "love", one could establish similar criteria and one would find no matter adults or children have addicted to someone in certain periods of time (perhaps, children are addicted to their parents; adults are addicted to their lovers). Even some hobbies or ordinary activities such as to go to the gym, reading, rock climbing or even meditation could be addictive. The symptoms of addiction occur when people devote themselves to and persevere in doing certain activities. People even think it is good for them, in stead of opposing these activities the society would encourage in doing these activities. On the contrary, why people strongly against addictions? Generally, the answer would be "it is really bad to you". Taking IAD as an example, it causes damages in aspects of family, school, or career according Young's analysis (Young, 1999):

(1) The addicted spouse could cause his partner becoming a Cyberwidow or Cyberwidower in the aspect of family, even the Cybersex or Cyberaffairs could cause disputes which leads to divorce. Internet addicted children confront with adults; internet addicted adults neglect taking care of children.

(2) The information from internet does not match up with the schoolwork closely since it is not well-organized, that is why it does not help much with the internet addicted students in their schoolwork but causing negative effects.

(3) In the aspect of vocation, more and more managers are concerning about their internet addicted staff working without vigour; they use internet monitoring software to prevent staff from internet resources abusing or to do anything not connected with their work.

Besides, internet addiction causes those abusers physical or mental damages such as carpal tunnel syndrome, back strain, eyestrain, headache, shoulder ache, even the excessive fatigue caused by lacking of sleep may decrease their immune system. Young men could easily commit crimes by exposing under the violent or amorous contents for a long period of time (Young, 1998; King and Borland, 2003; Selwyn, 2003). These arguments above mentioned are usually used to criticize game addiction. Naturally, most video gamers defend video game by addressing its advantages, for example, visible benefits of video gaming are its artistic and entertainment contributions. Steven Johnson argues that video games in fact demand far more from a player than traditional games in his book, Everything Bad Is Good for You. Player must first determine the objectives, as well as how to complete them in order to experience the game. They must then learn the game controls and how the human-machine interface works. Beyond such skills which after some time become quite fundamental and are taken for granted by many gamers, video games are based upon the player navigating (eventually mastering) a highly complex system with many variables. This requires a strong analytical ability as well as flexibility and adaptability (http://en.wikipedia.org/wiki/Video_game; Johnson, 2006). Most of the arguments above mentioned have indicated the critical viewpoints that addiction perhaps would hinder the function of production system of our world, or it may cause the irrational behavior of human being; then it leads to great danger.

In fact, one couldfind that human being is technologically addicted under a more extensive definition of addiction. Addiction towards any technical product: computer addiction (Shotton, 1991), television-viewing addiction, Internet addiction (Young, 1996), video game addiction (Keepers, 1990), technological addictions (Griffiths, 1995) (Technological addiction means the addiction of human-machine interactivity, including, television addiction, video game addiction, and Internet addiction, etc. Technology addiction means the dependence of human being towards technology) are all examples of the entirety. One could imagine if one comes back to one hundred years ago, how strong the withdrawal would be. The heavy users of mobile phones would be uneasy if they cannot use mobile phones for couples of days. Since the technical product has been used (and relied) frequently in everyday life, one would feel uncomfortable such as car-driver to his car, commuter to the public transportation system and so on though, the addiction does not happen to everybody. This is a dependency to physical technical objects. In addition, technology changes the social relation and structure; the delicate labor division of modernization, the power and bulkiness of consumption system let everyone and every organization have its position and function; this phenomenon constructs the global system that supports billions of people in the contemporary era (Wallerstein, 1974, 1980, 1989, 2004). The society generally depends on technology; this society cannot merely endure the withdrawal of one-hundred-year-retrogression; supposing that it exists, it can hardly survive. Technology has not only been used and been relied on, it also controls production and economy; one could say that it is the key of subsistence. he society of high technology enjoys prosperity of materials; on the contrary, the society becomes destitute, starving and hard to subsist without technology.

Technical being

When one is born, one cannot decide how the world looks, he just simply was born at the moment, in certain place of this world. Before the one who has been born, the world is already there; it has its way, its history, culture, technics and everything already exists or created by predecessors. He cannot choose but accept. All of the people are living in a world constructed by technics. Stiegler described this situation precisely (Stiegler, 1998)

Dasein is temporal: it has a past on the basis of which it can anticipate and thereby be. Inherited, this past is "historial": my past is not my past; it is first that of my ancestors, although it is in essential relation with the heritage of a past already there before me that my own past is established. This historial, nonlived past can be inherited inauthentically: historiality is also a facticity.

In general, technics is considered as part of culture but regarding modern technology, does this statement remain true? In fact, since the industrial revolution, technics has advanced enormously, according to two world wars, even the development of science had been influenced by technical needs. Several important inventions and discoveries of modern mathematics and physics were request by the technical demands of war time. Observing those popular disciplines of modern universities and the allocation of research budgets of countries or industries, one could find that technics has dominated the direction of scientific development. Furthermore, the significant influences of modern technics towards economy and politics exists everyday and everywhere. If there is any new technics been presented, it usually relates not only the fate of a single company, but the whole international industrial chain, a series of related countries and the livelihood of the masses. "Each day brings its technical novelty, as well as the demise of things obsolescent and out of date. Innovation is inevitably accompanied by obsolescent of existing technologies that have been superseded and the out-of-dateness of social situations that these technologies make possible – men, domains of activity, professions, forms of knowledge, and heritage of all kinds that must either adapt or disappear. What is true of the largest political and economic structures is true of our life-world as well" (Stiegler, 1998). In the modern world, technics, which appears to be power in service of human being, actually is autonomous and does a disservice to active humanity. This statement is rather clear, for example, the PC, in fact, the functions of its software and hardware distinctly exceed users' demand (such as Microsoft Office, and those continuously upgrading CPU speed and other hardware or peripherals in order to cope with the demands of bloatware). Technics has already leaded its own way, it expands and evolutes continuously for its own existence. No matter individuals, enterprises, industries or even the whole country have to change themselves to adapt the accrual of new technology, and must to learn it and to use it to produce or to consume. If someone dares to defy the trends, and still staying within the old technics, individuals or factories would lose their jobs, countries would lose their competitiveness and become depressed; in the words, technology has dominated the way of existence of individuals and countries. Supposing self-governance is the feature of human being, then, one must ask that technics is still the way to conquer the nature, or while technics dominates the nature, it conquers human being as a part of nature. At this stage, one could realize that culture produces technology but it has been changed even devoured by technology.

As being in the world which exists before his existence, everyone is forced to face this world with no choice. In point of the human being of modern technical era, the worst thing is lost of autonomy. The life style and tempo have been predetermined by technics; and the procedure of development has been restrained by the process of the evolution of technology. The technics that has the mobility possesses the real life. Simondon has indicated (Simondon, 1958; Stiegler, 1998): modern technics as the appearance of technical individuals in the form of machines: hitherto, the human was a bearer of tools and was itself a technical individual. Today machines are the tool bearers, and the human is no longer a technical individual; the human becomes either the machine's servant or its assembler: the human's relation to the technical object prove profoundly changed.

To ordinary people, it seems that human being invents technology but on the viewpoint of philosophers, the real maybe just on the contrary.

Technical rationality

The member of Frankfurt school, Herbert Marcuse, argues that, with modern technics, the meaning and direction of technical power is inverted: once liberating for humanity in his relation to nature, it has become a means of political domination (Marcuse, 1964; Stiegler, 1998). This thesis is supported by an appropriation and recast of the concept rationalization proposed by Max Weber. The process of social rationalization means in the society people use the "rational decision" as a principle in many ways, and people accept immense extension of this principle. Capitalism is the expression of this rationalization. Marcuse indicated that the process of rationalization is, in fact, a hidden system of political domination. Therefore, the division of labour and bureaucratization seem to be a matter of course. Everyone is allocated into a suitable place to elaborate his function to the society. In the society of capitalism, the mechanism of allocation is calculation, calculating to maximize the profit. Under this doctrine, reason has been turned to the ability of calculation. The dominative position is not occupied by reason but a new form of political domination which is no longer recognized as political domination since it is legitimized by technical rationality. That is to say, as Jean-Pierre

Vernant mentioned (Vernant, 1996), reason is a technics of thinking; it changes according to which society it exists, or what question it faces with. Consequently, now the meaning of "reason" not just differs from its meaning in ancient Greece, even in medieval age. In contemporary, reason deviates from oral language to mathematical language; it becomes logic of numeral and quantity instead of the logic of concept and quality. It is also good at timely systematic observation and the meticulous investigation to reality. This is just the right type of technical rationality that can function smoothly in contemporary society of capitalism and it accelerates the rationalization of society. As Gellner pointed out, the rational justification is extended to all life. In conjunction with the desacralization of methods leads to instrumental efficiency. Innovation is adopted without unreason prohibition. No sacred boundary is unbeatable. All of these dovetail with the division of labor. All things are equally sacred, and no proscriptions to inhibit the choice of methods. They only subject to the reasonable considerations of benefit and efficiency. Dealings among people are similarly guided by the rational choice of the coolly assessed advantages inherent in them. Society as a whole is seen by the same light. It is the summation of rational contracts by rational individuals (Gellner, 1992).

According to this observation on could find why video game addiction is considered a critical threat. Video game is a game. And the nature of game is nothing concerned with benefit. When gamers spend lots of time playing game, he comes off the rational arrangement of society. He wastes time without learning the productive skills or producing, it disturbs the smoothness of the function of society; then, it forms an independent, unproductive and essentially the existence without any profit but simply waste. With regard to technical rationality, it is the most unbearable condition. As Derrida responded to drug addiction (Derrida, 1995):

In the end, it is always, I think, under this charge that the interdiction is declared. We do not object to the drug user's pleasure per se, but to a pleasure taken in an experience without truth.

People would against any forms of addiction only if it is experienced without truth. But, what is truth? To people of our time, technical rationality is the truth, so they against drug addiction, video game addiction, Internet addiction etc, under the name of violating the efficiency and profiting principle of technical rationality. To those habitual activities with productivity or good for productivity such as all forms of working or sports, they define them as good habit with glorification.

A society of technical rationality is based on efficiency and calculation: in this society the leading role is no more people but technology. In this kind of society, according to Stiegler, in fact, human being is invented. Since in the technical society, people invent technology within technology; they were born in the technology; they live in the technology; finally, they die in the technology. In inventing technics, human being has been invented (Stiegler, 1998). This society of technical rationality, as Max Weber described the effects of rationalization leading to a "polar night of icy darkness", in which increasing rationalization of human life traps individuals in an "iron cage" of rule-based, rational control (Weber, 1958). Habermas succeeds Frankfurt School's critique to capitalism and rational society; therefore, he indicates that nowadays, in the industrial society of capitalism, technique is not only a kind of domination but also a new ideology. He points out that due to work, human being has developed the interest to control the objective outside world; he called it "cognitive interest" (Habermas, 1971). This interest is to analyze the natural and social environment through the control and operation of techniques, in order to grip the relations among factors and to discover the regular pattern; the aim is to make a proper casual explanation and an effective prediction to the objective world. The control of techniques seizes the phenomenon, then, it forecasts the phenomenon, at last, it masters the world of objects. When this technical control expands to the relations among people, it forms the domination. The effective administration means effective control and losing of personal autonomy. When this technical control bundles with free market economy, people hardly can aware it; since everyone seems to choose his own way of labor or working , in fact, he must find a place to survive within the existing system of labor division. This system of labor division is a bureaucracy which formed by capitalism according to the principle of efficiency and profit optimization. In this system, people seem to choose freely; actually, they choose illiberality freely.

Sovereignty

Human being would be human being, not only because they possess the reason, but the non-rational elements of humanity, as many 20th century thinkers have announced. For example, Nietzsche's "Dionysian world" contrasted with Apollonian notion as a symbol of the fundamental, unrestrained aesthetic principle of force, music, and intoxication versus the one of sight, reason, form, and beauty represented by the latter. Freud's two conflicting desires: the life drive (Eros) (the sex drive) and the death drive (Thanatos). Bataille has gone further, he thinks the irrationality is not only the nature of human being; it also exists in any subsistent activities of human being. The irrationality is the cause of excretion which opposed to appropriation. He is the first philosopher who square up to the irrationality of the world. In his point of view, the rational world is guided by usability, under the choreographed plan, calculation, prediction, people execute their practice, then, this leads to a utilitarian ending. Just like a thrall, his production has never been regaled by himself but consumed by certain master. This is the world of rationalization. Only if human being manifests irrational consumption accords with no usability, they transcend technical rationality. Therefore, human being reveals their identity as human being, then, the independence and sovereignty would be displayed. Sovereignty is the key concept of George Bataille. The following explanations are given by Richardson (Richardson, 1998):

As a concept, sovereignty is never be grasped. That is, if one was ever able to grasp it, then it would at that moment crease to be sovereignty. …In some sense, sovereignty cannot even be named, because to name it would be to bring it within the domain of either project or discourse, both of which destroy sovereignty. … sovereignty is what the opposite of servility and any form of solidity. It is what resists any urge towards an acceptance of what exists. Sovereignty, then, is opposed to any thing that would restrict us or bear us down. In the sovereignty state, we are able determine our own destiny absolutely. … It may pre-suppose a freedom to make choice; it is also a freedom from making choices. In the sovereignty state one is in state of harmony whereby one accept the contingency of the moment, expecting nothing from it, but participating fully in it. … Sovereignty is therefore something that can never be defined: it can only be experienced. It represents life at its most intense. It is fugitive moments, such as the moment of sacrifice.

What identifies sovereignty is the expenditure. Expenditure is consumption without any usage or profit or return. The sovereign individual consumes and doesn't labor. At the antitheses of sovereignty the slave reduce their consumption to necessities which cannot be deficient in their labor. The aim of utilitarism is productive activities; but one who is sovereign does consumption without labor. Life beyond utility is the domain of sovereignty. The sovereign enjoy unlimited possibilities; from the utilitarian viewpoint, this kind of enjoyment is devious. What is sovereign is to enjoy this moment without having anything else in view but this moment. In video gaming, people could reach the state sovereign. In Johan Huizinga's book, he summarizes the formal characteristics of game (Huizinga, 1995):

… We may call it a free activity standing quite consciously outside "ordinary" life as being "not serious", but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in orderly manner. It promotes the formation of social groupings which tend to surround themselves with secrecy and to stress their difference from the common world by disguise or other means.

By its own rules, game constructs a spatiotemporal zone where earthen life has been segregated; it allows gamers to immerse in it and to elaborate their abilities freely but all these behaviours have nothing to do with material benefits. Gaming, like sacrifice, could be sovereign. As Huizinga stated in his book, in fact, sacrifice and game are similar to each other. The sovereign is he who is, as if death were not. He is the one doesn't die, for he dies only to be reborn. He has no more regard for the limits of death than the limits of death, or these limits are the same: he is the transgression of all the limits. In the midst of all the other, he does not perform work but rather play. He is the perfect image of adult play, whereas we ordinarily only have an image of juvenile play. As personified in the sovereign, play is what it would be as personified in God, if we had not imagined His Omnipotence within the limits of the subordinate world (Bataille, 1993). If comparing features of video games and sovereignty, one would find the one of sovereignty is the representation of the gamer who immersed in game. No wonder why video games such as RPG or Sims would be so popular, highly skilled gamer almost plays the role of god in the game. Ordinary people criticize video games let gamers become nonproductive or no profit, but that is the reason why video games could be sovereign. The more rational people is, the more they could be compatible with the function of capitalism, then, the more likely they would become the slaves or servants of the whole plan of capitalism, thus, the distance between them and sovereignty becomes even farer. In this society of capitalism where filled with technical rationality, so called video game addiction is just a concept constructed to homogenize all people's lifestyle in order to raise the productive efficiency.

The moderate subject

Foucault's research of sexuality has indicated that in ancient Greece, any activity which can cause the pleasure (usually, these activities are not restricted, that is to say, the subject of activity is free) will bring many techniques to take care of it. In the aspect of any kind of approved sexual activity, the pursuit of abstention will arise subsequently but instead of the abstention formed by rules, it appears in a way of stylisation. Love is not constrained by any kind of rule but it is attempered by the art of pleasure. For example, on the part of ancient Greeks, the fidelity of marriage is not obligatory (or the adultery is not prohibited) but it is conformed to the chaste life with proper order. To reach the good sexuality, one would not act as a sinner of middle age to obey the general rules of administration, but seeking the proper use of pleasure which cohere with the natural needs and the status of subject. The practitioner of proper use of pleasure must be self-governed and self-constraint in order to reach the art of existence. The ancient Greek virtue is defined as this self-domination by the self. For ancient Greeks, the important thing is that every task of self-govern must lead to the approval of active freedom since only this freedom can be admitted to the truth. Truth is not absolute but free. (Gros, 2004)

As for ancient Greeks, pretty lover is aphrodisia. According to Foucault, there is no term which corresponding with aphrodisia in modern language, it can only be explained as "things or pleasures of love", "sexual relations", "carnal acts", "sensual pleasures" (Foucault, 1990). Usually these kinds of things are established by nature, and it is easy to be abused such as sexual activities, eating and so on. These activities have not been banned but since the strong instinct of human being, the excess (or abuse) becomes fallible. Under this dimension, video game shares the same feature. For gamers, video game is something like aphrodisia. As mentioned before, playing games is a possibility to sovereignty, when playing video games, gamer can become king of universe, he can start from the genesis, he can live after death; in that universe, he gets real freedom, and he is in great pleasure. Foucault indicated, while aphrodisia relation to truth, constitutive of the moderate subject, it did lead to aesthetics of existence. A way of life whose moral value did not depend on conformity with a code of behaviour, but on certain principles in the use of pleasures, in the hierarchy one respected. Through the logos, such a life was committed the ontological order; moreover, it took on the brilliance of a beauty that was revealed to those able to behold it or keep its memory present in mind. Xenophon, Plato, and Aristotle mentioned this moderate existence, grounded in truth, was both its regard for an ontological structure and its visibly beautiful shape. In classical Greek though, sexual practice was concerned as an ethical domain. The elements of this domain were formed by the aphrodisia. The principle according to which this activity was meant to be regulated was not defined by universal law, but rather by savoir-faire, an art that described the modalities of a use that depended on different need, time, status, etc. The individual was urged to give training over himself, had the form of battle to be fought, won to dominate over himself. he mode of this self-mastery characterized as an active freedom, a freedom that was indissociable from an ontological relation to truth. As the sexuality to ancient Greeks, video game to gamer means a desire inclined to excess. The danger of excess brought from aphrodisia is slavery. Diogenes was in the habit of saying servants were slaves of their masters and that immoral people were slaves of their desires (Foucault, 1990). Sōphrosynē is the state where ancient Greeks consecrate to reach. Through the exercise of self-mastery and the restraint of the use of pleasure, they achieve this goal which is characterized as freedom. In Republic, Plato has also mentioned that man should administrate himself in order to preventing excess, violence, and the tyranny to others or the despotism of desire to his own soul. Moderation, justice, courage and prudence are the requirements that can qualify one for the power of dominating others. The most kingly man is king of himself.

Supposing in ancient Greece, the moderation of free sexual activities can form the art of pleasure, the art of existence, therefore, to modern people the moderation of playing game can also form the art of pleasure, the art of existence. Playing game is the nature of human being, indeed, animals like to play game but only human can decide not to play game by his own will. This moderation demonstrates the freedom and power of human being, this is moral. The more moderate one can be the more sublime he will be. For gamer, the moderation should not come from external constraint but it comes from his internal moderation to the impulse of desire. A decent gamer with good lifestyle would play when he could and to stop when he should. Nevertheless, every gamer has his own lifestyle; others cannot say a word on it.

For a real active free life, the pleasure arising act must be restricted by the self. This abstinence should not come from the external rules of rationality of society but the internal continence to desire. It is not for saving time, not for saving productive capacity, but to prove on the aspect of game, gamer can act freely, gamer does not controlled by the game and his own desire, and he is able to enjoy his pleasure properly. Video game itself just like the pretty lover of ancient Greece; the fatalness comes from the gamer or man himself but not from game or lover. As Plato mentioned in his Symposium, the real beauty can only be accessed by abstinent love to lover. When escaping from the constraint of the corporality to lover, one could pursuit the pure beauty expressed by every human figure and every fair. The one who can control his desire is a real free man; only the free man would not be limited by any partial and impure things, pursuing the pure truth. As the moderation of sex can become self-ascent, through the process of game, by continuously retreating and practicing, video gamers can also appreciate self-upgrading and self-transformation. In ancient Greece, this kind of retreating and practicing was called askēsis, according to the explanation of Foucault, it means (and functions) "the construction of connection between truth and subject" (Foucault, 2005). That is to say, in order to grasp and to comprehend the truth, the self must go through the arduous long-term self-restraint and self-training. Through the persistent strict reflection and self-reclamation, the self is not only saying the truth but also practice it, therefore, the self can discuss the truth with others, then, pursuing and executing the truth in the community. This is a kind of aesthetics of existence. It thinks that the basic requirement of truth is the subject which can actualize the truth; anyone without the ability to actualize the truth cannot talk about truth. Consequently, for a truth pursuer, the keystone is to fortify the "techniques of self". Subject is not only confined with the scope of cognition, it also includes the control and perception of self-aspiration; on the premise of the care of the self; the subject has been constructed by self-control and the concordance with others. To a free gamer, game is a tool of practice, playing game is a way to self-transformation, a way to the aesthetics of existence. The essential reason a video gamer be "addictive" is not caused by video game but the deficiency of self-discipline. This deficiency can only be detected and rectified by gamer through self-reflection and self-control. It just like the ancient Greek moderation that is not determined by the universal legislation but by a savoir-fair. The moderation of gamer should be carried out by himself depending on his personal situation. Any external judgment or rectification will be the operation of certain power regime, it tries to ruin the fragile free subject, and let it become a component of the power machine.

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A Study on Intuitive Interface in the Context of a Amart Living Space

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The objective of this research was to develop an interactive framework for an intuitive interface within a smart living space context. The design of this intuitive interface for existing smart living space facilities, and the interface itself, focused exclusively on information/control/awareness. An experimental system called GAIA has conducted to realize the concept of this framework.

Keywords: Intuitive Interface, Information Visualization, Smart Living Space
Relevance to Design Practice : With diverse information of smart living space, an intuitive interface is crucial to get the space working with users, this research provides an approach for tackling this problem with interactive design paradigm.

✤

Introduction

A smart living space is a space that means to be smart and livable for the habitants within the space. Mostly it will involve with the sensor devices and mechanic equipment to amplify and ensure such context. From the habitant's point of view, an intuitive or somehow "smarter" interface is desired and needed for the "livable" purpose. However, the spatial data received as well as the contextual information derived from different domain involved in a building such as facilities management, construction and interior design is complex and sometime conflict with each other. Therefore, it is a difficult task to achieve a universal representation cross these diverse domains. This ends up a further difficult task for create an intuitive interface for the diverse information.

In the information side, the huge numerical data generated by these "smart" sensors is far from being comprehensive for being used for conducting an analysis and assistant for the supporting decision making for the habitant situation such as whether the habitants want to say goodbye to each other or simply want to stretch out the body. Recent researches about interface design have tried to avoid solving all the problems at once. Instead, a contextual situation studies on how to analyze and design diverse and personalize interface has conducted several results.

Therefore, by applying the interface studies onto finding a framework that can suit or at lest allow diverse situation in a normal context in smart space is the approach used in this research. With this concept, an intelligent interface behind the skin of smart living space might be able to be achieved and adapted.

Furthermore, in view of the needed data/information, a total turnkey solution for an intelligent building might not be a feasible option at all, either. Moreover, even with the current available technology, the behaviors of the occupants, or more specifically the personalization needed, make a more intuitive interface for representing partial or particular information an unavoidable problem. We need a new approach.

Finding an intuitive interface

First of all, we need to define what can be an intuitive interface and the scope of this research. Intuitive interface means to us is an interface without interruption of computing mechanism.

For intuitive interface, since the graphical user interface was introduced to the public in the 80s, intuitive interface design has been defined as an interface that can incorporate a window, icon, menu, pointing device (WIMP) style (Cox and Walker 1993) of computing device interface to the desktop metaphor of computing environment. Apart from computing environment, all interfaces are involved with design ideas and studies.

Recently, ambient intelligence (Weber, Rabaey et al. 2005) and ubiquitous computing (Weiser 1993) researches from computer science provide a different aspect on this issue. Without the boundary of computing environment, embedded computing and display devices start to emerge with design itself as part of our living space (Takeda, Kobayashi et al. 1998) that imply that many interior and industrial design will have mediated device embedded and the reflection will be dynamic. This provides the opportunities to re-visit and re-understand the space surrounding us that is the technical base of this research.

In addition, the user-centered approach (Vredenburg, Isensee et al. 2001; Ruyter 2003) and situated interaction studies have also shown its influence in every aspect of design and design research, as well as pointing toward the method used in this research for the design of an intuitive interface.

The Objective

The objective of this research was to develop an interactive framework named uCoS (ubiquitous Co-existing Spaces) for developing the intuitive interface within a smart living space context. The design of this intuitive interface for existing smart living space facilities, and the interface itself, focused exclusively on information/control.

The Approach

While there are several frameworks developed for interactive design and interface about them, there is not sufficient research for the intuitive interface desired for smart living spaces. We start with analysis of case studies, and related design research literature reviews for the purpose of prototyping reification.

Several interactive design models have been reviewed such as Role Interplay, Input-Process-Output along with other user-centered design schenma. For the dynamic and contextual characteristics of the behaviors in focus, user-centered design relation model (Marzano and Aarts 2003) (shown in Figure 1) is used for this research.

We use case analysis for understanding what kind of user-involvement is needed in this research, then, by going through the interactive design and work with

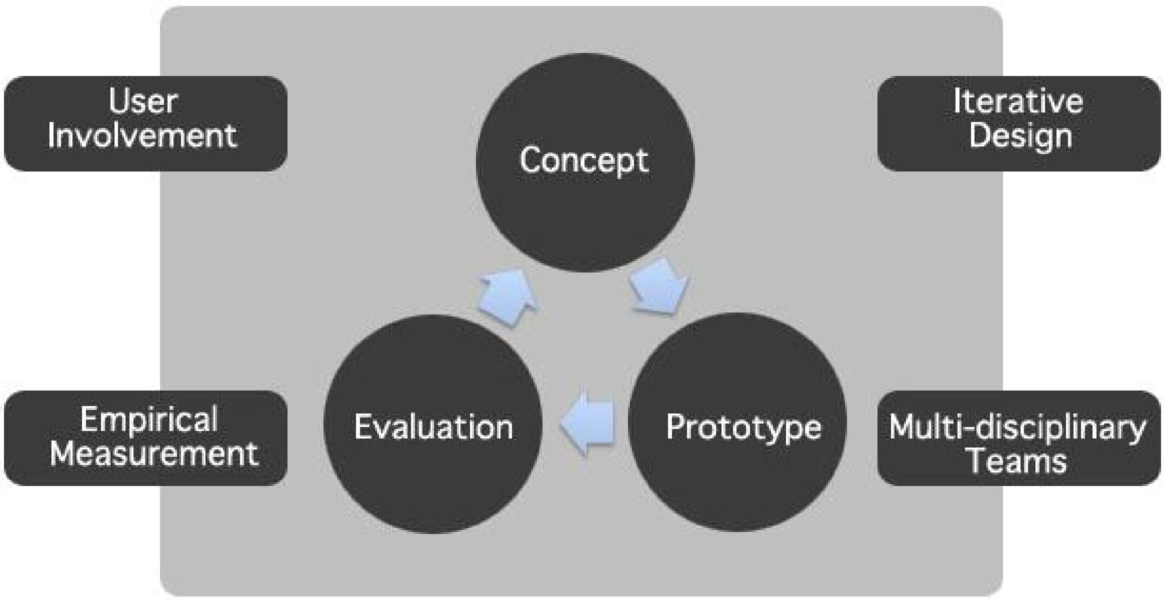

Figure 1: User-centered approach.

multi-disciplinary teams in a research project, we built a working prototype as well as the framework itself. The steps are described as followed.

The approach is 1) finding the patterns of behaviors in smart living space context projects; 2) using user-centered design paradigm to unleash and formulate the process and features of the patterns from step 1; 3) do pilot studies in designing and testing the realization of the patterns and features; 4) framing the framework based on the observation of pilot studies; 5) compose the features and refined pilot studies following the framework as the experimental implementation.

Related Work

Interfaces for Smart Living Spaces

While the human-computer interface is an issue in a smart living space, researchers are still examining the traditional input-output relationship, and are searching for a novel transformation into a new design principle (Marzano and Aarts 2003). Humans and machines are independent entities; a human perceives an environmental stimulus and expresses his feelings and reactions to it, while a machine senses an external condition and displays feedback. To make humans and machines work together in a practical way, two important elements are an interface and the interactions between the humans and machines.

The above issues are important for the creation of a smart living space. Therefore, this research involved a review of some smart living space projects in terms of their user-involvements and possible interactive design requirements.

Project Oxygen

Project Oxygen is a collaborative effort involving many research activities throughout the Laboratory for Computer Science (LCS) and the Artificial Intelligence Laboratory (AIL) at the Massachusetts Institute of Technology (MIT). The Oxygen vision is to bring an abundance of computation and communication within the easy reach of humans through the natural perceptual interfaces of speech and vision so that computation blends into peoples' lives, enabling them to easily do the tasks that they want to do – collaborate, access knowledge, and automate routine tasks and their environment. (Figure 2)

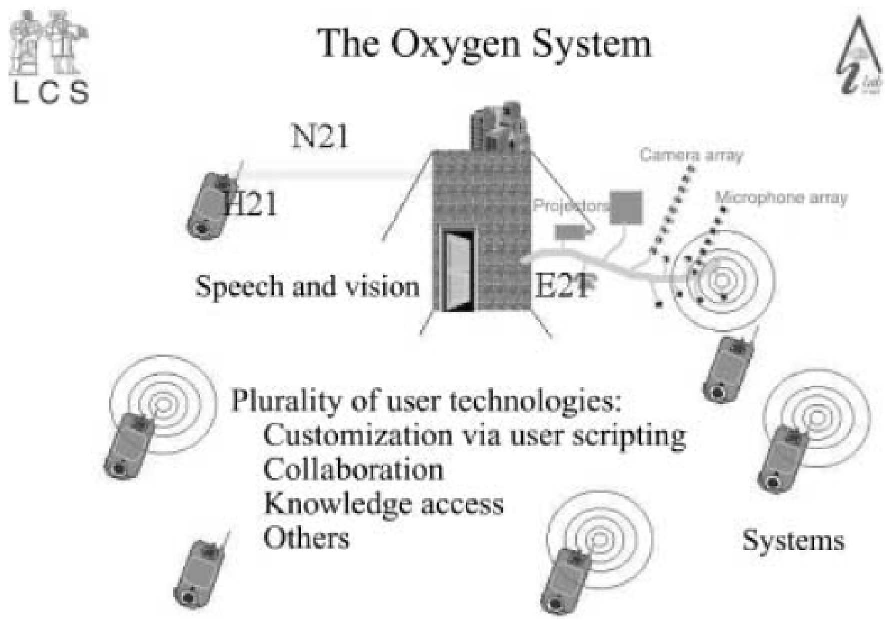

Figure 2: An overview of the Oxygen Infrastructure (MIT Project oxygen).

Oxygen's Software not only adapts to changes in the environment or in user requirements (O2S) but also helps people do what they want when they want to do it. But all of the information is not together and is too messy. The software can also use speech control. However, as of now, speech recognition technology is not yet mature. So mistakes are easily made. Oxygen not only provides inspiration on how these sensory technology can be used also the feasible way to use them and might achieve a somehow intuitive matter. Or, we can say the intuitive behaviors might be captured with the combination of multi-sensory modes to activate one particular task desired.

The Aware Home

The Aware Home (Kidd, D. et al. 1999) has two identical and independent living spaces, each consisting of two bedrooms, two bathrooms, one office, and a kitchen, dining room, living room, and laundry room. In addition, there will be a shared basement with a home entertainment area and a control room for centralized computing services (Figure 3).

Figure 3: One of the Aware Home applications (Kidd, D. et al. 1999).

The Aware Home focused on technologies to accomplish four things: (1) to assist seniors as they age in place; (2) to support the communication and coordination tasks of formal and informal caregivers; (3) to simplify the management of the home and its myriad activities; (4) to provide much needed assistance for individuals at risk and the busy family members who care for them. The system uses sensors installed throughout the house. The distributed operation environment and network assess the indoor situation by sensing and actively identifying the occupants (including status, position, activity, posture, expression and sound). This system has as its goal assisting caregivers with communication tasks and in caring for the security and health of elderly occupants.

As often appeared in smart living spaces, the smart sensoring devices with the surrounding interiors, Aware Home demonstrates one aspect of this approach. Also, by the view of designer, this project also shows how unfriendly can be with modern computing techniques, a mediated representation as well as interface is suitable for solving this issue.

Smart Architectural Surface

The Smart Architectural Surface (Chang, Chung et al. 2004) is a highly integrated planar construct for diversified smart home services. It uses networked smart cell units equipped with various sensing, cognition, and actuation capabilities that would allow run-time polymorphism as the basis for functional changes for various event-driven operation scenarios. The SAS system can demonstrate collective intelligence outcomes that are mediated by various multi-modal interactions. The key applications currently being developed for the SAS system include Dynamic Wallpaper, Digital Calendar, Digital Mirror, and a Context Aware Videophone. Dynamic Wallpaper frames a bigger picture over small cell units by directly manipulating them and assembly together on the wall. Digital Calendar treats each unit as one daily entry and put together to frame a sequential event (Figure 4).

Figure 4. SAS surface Demo (Chang, Chung et al. 2004).

SAS would show coordinated intelligent behaviors by utilizing the computational power distributed throughout the participating smart cell units. The SAS system transforms into different run-time objects to accommodate various functionalities by simply changing the digital states of its components. Therefore, a modularized screen model with intelligent user-behaviors shows its intuition to incorporate dynamic information. A structure framework is essential and the modular design in SAS is promising to our project.

Context-aware Interface

Context-awareness becomes an important design issue when building human computer interactions. Context awareness involves when things will happen, what activities are being performed, and why those actions occur as they do (Abowd and Mynatt 2004).

According to this definition, context may be anything that describes the situation of the user, like the logical or physical position of the user, the current weather, or even the mood of the user, as long as it is relevant to the current application or the interaction with it.

Some researchers (Gross 1998; Dey, D et al. 1999; Leonardo, Chia-Hsun et al. 2005) have seen context as anything that may be used to adapt a user interface to the current needs and situation of the user. The device capabilities of the user interface also need to be adapted to improve its usability. Thus the device capabilities are relevant to the interaction between the user and the application and can be seen as context attributes.

Nebula

Nebula (Marzano and Arts 2003) is an interactive projection system designed to enrich the experience of going to bed, sleeping, and waking up. Through simple body movements and gestures, it provides an intuitive and natural way of physically participating in a virtual experience. There are four main functions in Nebula. First, by placing a smart 'pebble' containing interactive content into a bedside 'pocket,' you can change the ceiling's interactive projection theme or topic. Second, by setting the alarm clock, the system then projects two dots onto opposite sides of the ceiling. Third, you can write a note or sketch something on a piece of paper and place it underneath the alarm clock. Then the note or illustration will be projected on the ceiling. Finally, pebbles can also contain games. Figure 5 shows some examples of this system.

From Nebula project, the interaction is via a central area that is designed as part of environment and contextual interaction between habitants and the enriched environment is through the information sensed by the aura of the surroundings. The analysis of such seamless activities with context is crucial to Nebula and for our project.

Ambient Agoras

The major goal of the Ambient Agoras project (Thorsten Prante 2004) was to transform the physical envelop of a work environment into a social architectural space. It supports informal communication, collaboration, and social awareness within an organization. The Hello.Wall (Thorsten Prante 2004) is

Figure 5. Nebula with reconfigurable ceiling projection (Marzano and Arts 2003)

an example of this project. It is a remote collaboration within a larger organization. (shown in figure 6)

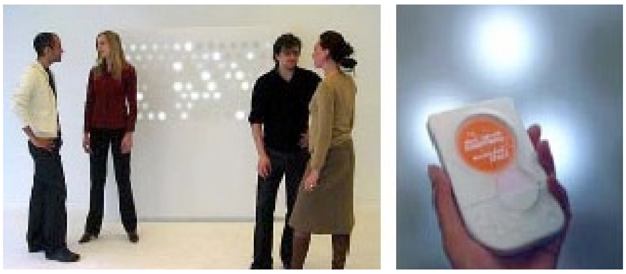

Figure 6. Informal communication around Hello.Wall (Thorsten Prante 2004)

The Hello.Wall contains three different interaction states: Ambient, Notification, and Interaction, and is activated by a user's proximity to it (Figure 7). When someone keeps his/her distance from the Hell,. Wall, it appears to be an atmospheric decorative element.

Ambient Agoras provide not only the seamless contextual interaction but also enlighten the concept of zoning. The behaviors of habitants hint the intention of possible activities. With the location like Nebula centralizes the interaction on a particular area that will provide further contextual information. Further, Ambient Agoras with zoning concepts, habitants are detected the intention by the times and facing direction in the zoning that give chances to allow the system to provide intuitive suggestions.

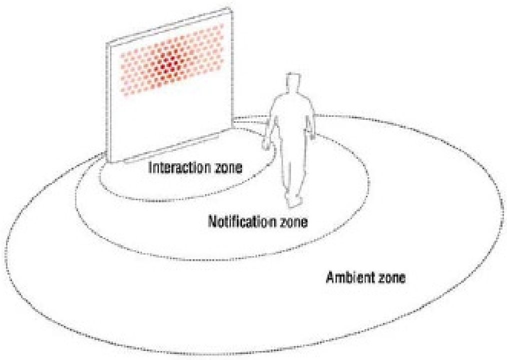

Figure 7. Ambient Agoras with three interaction states

Smart kitchen

Smart kitchen researchers (Leonardo, Chia-Hsun et al. 2005; Leonardo, Chia-Hsun et al. 2005; Leonardo, Ernesto et al. 2005) designed and built a series of discrete context-aware interfaces and systems to monitor and provide information about the most commonly performed tasks in a residential kitchen. Kitchens are natural candidates for augmented reality interfaces because there is a high need for users to remain in contact with physical reality while using a number of advanced tools that benefit from digital information (Gross 1998).

Five systems were designed to collect information from the environment. These include a FridgeCam, RangeFinder, Augmented Cabinetry, heatSink, and Virtual Recipe (Figure 8).

Figure 8. Augmented Reality Kitchen: (1) information projection on the refrigerator; (2) the range; (3) the cabinet; (4) the faucet; and (5) drawers.

This research developed a context-aware interface to help enhance the kitchen experience. Moreover, the researchers proposed that the projection of digital information onto the objects and surfaces of the kitchen could increase user confidence.

In Smart Kitchen project, the combination of virtual and physical information gets even further in every aspect including the furniture and electronic devices in the surrounding context. This took the mediated environment further to include the physical sensible design objects. However, the reason to select which equipment and how to mediate it still remain further investigation. The framework of uCoS and how it can be integrated into the existing smart living spaces is mostly based on the concept from this mediated equipment concept.

Summary

From the interface of smart living spaces, we learned the systematic analysis of smart living spaces with the seamless networks. Each node can sense and return the information and bind with other nodes to frame a bigger concrete idea. The features uncovered from these projects provide the infrastructure of underly uCoS as system division. Additionally, context-aware interface cases show the different setting for approximating the behaviors of habitants.

As stated before, finding the intuitive interface to suit different aspect of activities in the space is the always a difficult task. One of key characteristics is visualization. There is still no a strong theory or process that can clarify or analyze the different activities in the same context or the same activities in different context. The cases we found however show some promising mechanism that can transfer the location information with activities to be seen as a contextual indication as the visualization needed for the intuitive interface.

Finally, while similar but different approach towards smart living spaces, the mechanism has some chances to be unified with the common intelligent behaviors. We are aware that such predication has its limitation, but within our development towards a suitable intuitive interface, we accept these findings as our first attempt for finding the intuitive interface for smart living spaces.

The Framework— Ubiquitous Co-existing Spaces

Ubiquitous co-existing spaces

With the lessons learned from the reviews, we then turn to sketch the skeleton of our framework that is called Ubiquitous Co-existing Spaces (uCoS). uCoS (Figure 9) have three major divisions: Visualization, Computation, and Information that are reflecting the interface, mechanism and the system learned from the reviews above.

The information division provides information input from physical sensors and virtual information, such as web services, to the computation division. Physical means the environment data and virtual represents the contextual or virtual information from the other end. In this division, each node will act as the input devices or storage. The information gathered in each node includes the typical information such as sensory data or physical environment like weather, temperature and daylighting. Along with the physical information, the virtual information such as social network, virtual world and geometric representation are also collected in the respected nodes.

Computational mechanism is the system level that will include the network capability, the virtual representation and the storage to receive and analysis the data received from the information division. Similar to the context-aware interface, the analysis and pattern of intuitive behaviors are pre-analyzed and store as the information analysis components that can is modular for further extension. Therefore, computation division is divided into three components: 1) render engine: these are the visualization mechanisms for supporting the needs of visualization division. The same information can be rendered in different visualization due to different context. For example, the raining weather information can be represented as a umbrella in the refrigerator magnet, and the raining background in a painting on the wall. 2) information analysis: these represent the patterns of information and intuitive activities in terms

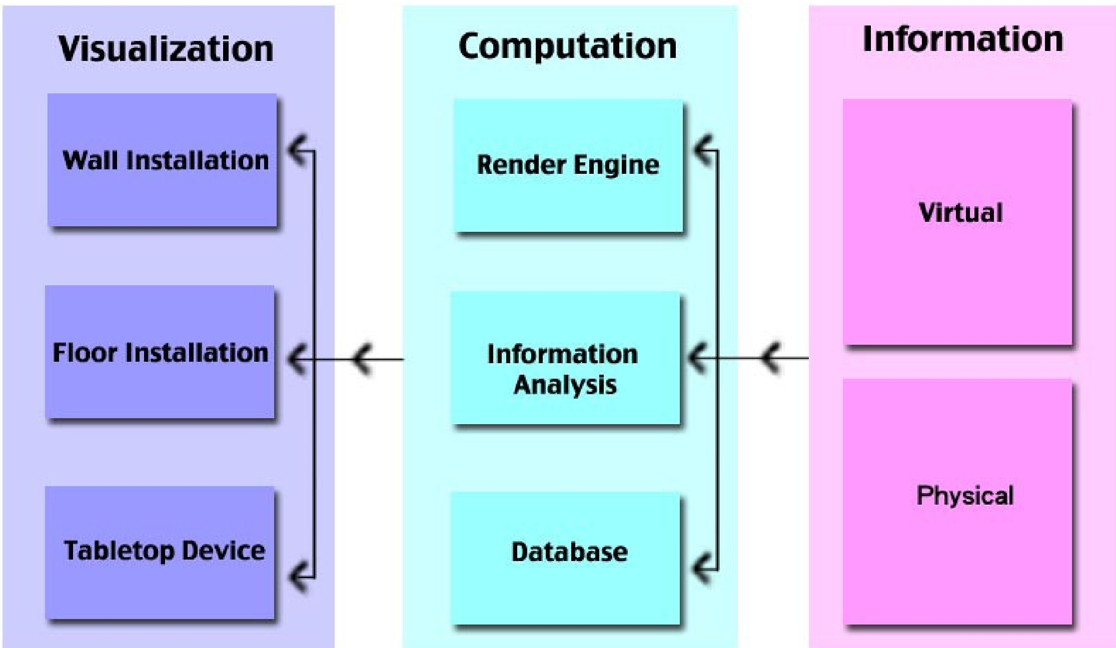

Figure 9. Co-existing interactive spaces

of information received. Context-aware behaviors are stored as different pattens along with different contextual information. These patterns are also modularized and pluggable in different render engine. 3) database: this component is not only to store the information received but also the procedural information such as how habitants interact with different render engine and the decision made. This component is centered and networked. For now, we envision this component as a networked database and can be accessed and retrieval from any networked nodes. (Figure 10).

The third division: Visualization contains the set of interfaces for dealing with habitants' activities to form the intuitive interaction. Based on the computational mechanisms and the information layer, the interfaces are the combination of small widgets like the components in the smart kitchen project or the lamp in the Nebula project described above. Similar to the information division, the interface widgets are also including both virtual and physical ones. Additionally, the complex situation might invoke more than two widgets to work together to provide a seamless interaction. Three main widgets: wall installation, floor installation and tabletop devices are included as examples of what might be the widgets in visualization division. Further, different widgets can also be included in this division.

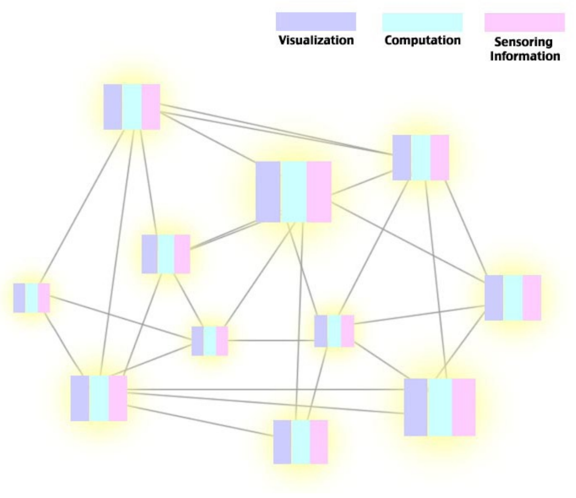

Figure 10. uCoS network

Ubiquitous intelligence space

With the divisions of uCoS in place, each node of uCoS acts as a linked unit in a bigger framework—ubiquitous intelligence space. Ubiquitous intelligence space allows the free distribution of information under some particular environment contexts. From the habitant's perspective, the nodes are designed and stored as receiving the information or interface components and the mechanisms are selected and activated according to different nodes and different combination. We can put different node into different corner of space that can change its behaviors according to the location it has been stored. Therefore, we can share or send information to every single room in which we live. For example, if someone leaves a message in the living room, this message can then transform to one metaphor in that context such as a fish in a undersea world. The fish can "swim" to another space. If that space is a forest metaphor, this fish can then be transformed as a bird in the tree. So someone can receive this message in another space as a bird singing a song, and in turn the other person leaves a message by talking to the fish. Different context can allow the same information be transformed and visualized as different metaphor but connected together.

The Skin

For reifying the framework of uCoS, we implement a prototype to experience and work out the system details of uCoS. The skin is used as the metaphor for the design part. The details are described as follow.

Design concept

Digital media design has brought new and vivid forms of visual experience to people, especially in relation to 3D virtual worlds, which have been strongly influenced by 3D video games and 3D animation. On the other hand, an intelligent building or smart living space is often regarded as one where essential but boring information about the building provides "smart" support to its inhabitants. Of course, the term living space has another meaning—a "liv(e)" + "ing" space, a space that is itself actually living. This means the space, using its own intelligence (the ability to response to the context appeared), can deal with the dynamic activities of its inhabitants.

However, this creates a tricky question such as the nature of intuition does not need a further instruction, but virtual objects definitely need some hints in order to get the overall picture. In the other hand, from the reviews we also notice that there is no universal intuitive behaviors. Most of intuitive interaction requires some form of hints or simple instruction. For further testing our framework, we have applied some common senses and design instincts. Although the design concept still require further investigation, it is suitable for the purpose of this study.

The skin design

The result was a physical device with both physical and virtual components. We called the skin GAIA (GAIA, Gaia the Ambient Interactive Atmosphere). GAIA has had one realization as a contextual interactive skin. It is reconfigurable and placed over the contextual building information, based on sensors/actuators, wireless sensors-network, and 3D information visualization technologies. A systematic diagram of this skin is shown in Figure 11.

The left part of the diagram shows the information division based on the framework mentioned in a previous chapter. The right side of the diagram shows the visualization division. This part represents the data from the information division.

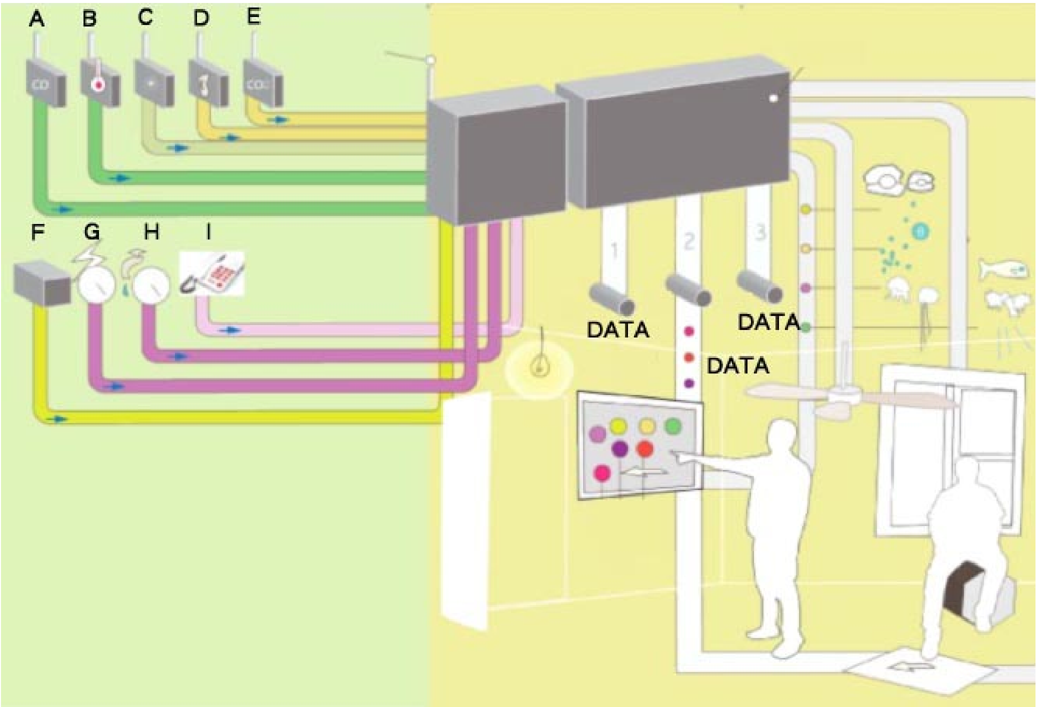

Figure 11. A systematic diagram of the skin. The information is (A) CO, (B) Temperature, (C) Illumination, (D) Weather Forecast

The metaphor

For the skin design, first of all, we need a metaphor to visualize the information received. We have investigated several metaphors including forest, aquarium, with others. Most of appealing concepts is the aquarium due to its calmness (that can map to ambient design) and interaction with undersea creation is more intuitive and vivid. Therefore, we choose under the sea as the virtual space in focus and the sea creatures such as fish and shell are used as the interactive avatars.

Implementation

Physical Components: A Room

For testing the scenario, we built a room for simulating the situation might occur. We took advantage of the bucket as the building material for the room. This kind of bucket has a lot of functions. First, because we use “under the sea” as a metaphor, the bucket can be pictured as a bubble. Second, since buckets are used as wall units, sensors and actuator can be easily hidden. Finally, buckets provided extendibility and adjustability in constructing the room. (Shown in Figure 12)

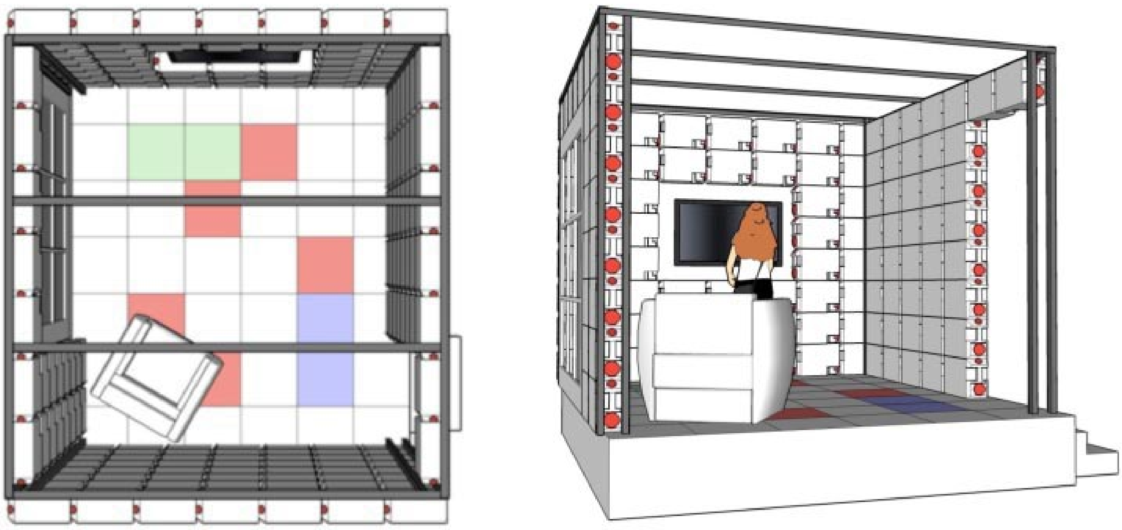

Figure 12. Smart living space simulation picture

The virtual components

These were used for the visualization of the undersea metaphor. For selecting the group of features, we collect most of common features in smart living spaces design cases. By going through the design cases, we pick up the features based on its applicable and the accessibility of the sensors in mind. This is mainly due to the nature of pilot study and can be extended in the future. These features included power consumption, water consumption, a fish clock, thermometer, CO alarm, CO2 alarm, answering machine, phone buzzer, party dancer, light switch, window switch, weather crystal, and RSS reader (Figure 13). For simulation purpose, the prompt words will not normally appear only when asking for help. If you forgot what kind of information a virtual object represented, you could touch the treasure box and the prompt words would show up.

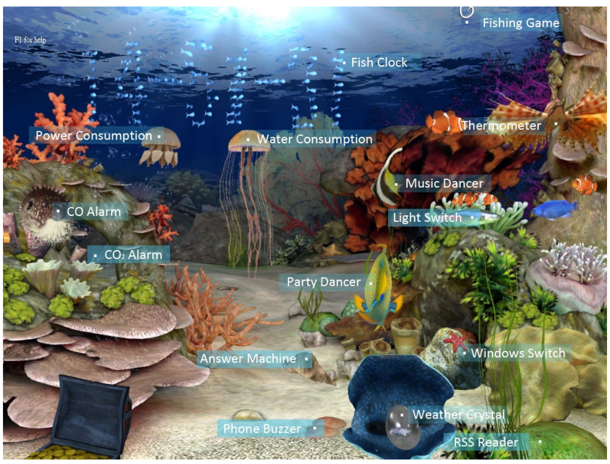

Figure 13. The GAIA interface with prompt words.

Integrated skin

In this section, we propose two examples to show how the system works. The first one involves weather information. The second one involves power consumption information. Both are represented by virtual components of the co-exiting framework.

Example A: Weather Task

In Figure 14, the weather information passes from the left to the right side. By passing through the computation division, the weather information will be stored in a database and analyzed. The user interacts with the system and the visual effect in the visualization division changes. For example, when the system grabs the weather information from the Internet, a user can select the area where he lives. The system then displays the weather information for that area.

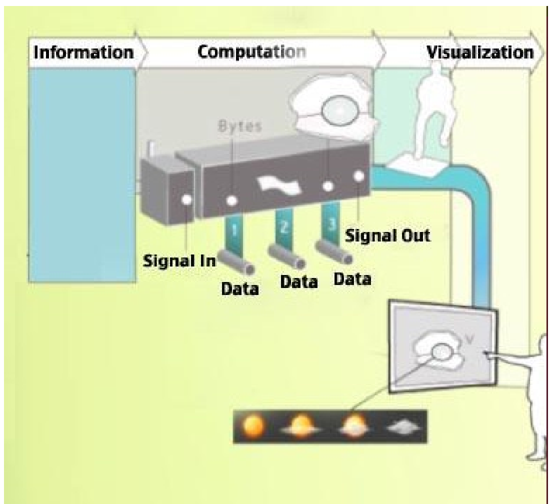

Figure 14. Weather Task

Example B: Power Consumption Task

In Figure 15, power information from the left comes into the database component of the computation division. However, the information has a connection with the virtual jellyfish object.

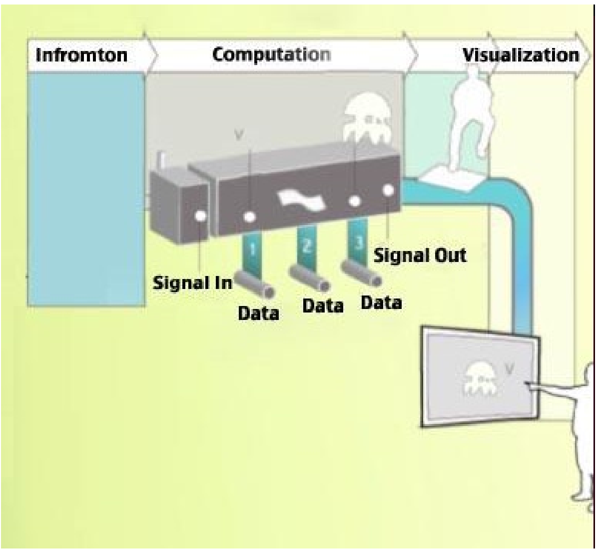

Figure 15. Power Consumption Task

Evaluation

Usability testing

There were three important criteria that were evaluated in the co-existing interactive space implementation: Time and Efficiency. Time is a typical measurement in usability studies, and a typical metric for target system performance. Efficiency means the rate or speed at which an interface enables a user to accurately and successfully complete a task. While a faster response time is usually better, consistent response time is also important. Therefore, we used the task analysis approach (Hackos and Redish 1998) to define the task and the goal of the task, and then to list the steps involved.

Task

Task analysis (Hackos and Redish 1998) is a method that evaluates how people actually accomplish things with software. Through observations and interviews with users, an analyst determines a set of goals belonging to the target user. Then, a set of tasks that support these goals is determined. With this in mind, we can describe the relationships between tasks and goals in our system (Table 1).

Table 1: The relationships between tasks and goals.

NO	Task	Goal
1	Weather Forecast	Recognizing forecast information
2	Location of Lion Fish in the frame	Recognizing temperature
3	Typesetting by Fish	Recognizing time
4	Push-moving by Starfish	Actuating the physical device
5	Light trigger by light fish	Actuating the physical device
6	News in bubbles word by word	Recognizing real time news
7	Touch-follow game	Basic operation
8	CO sensing trigger and transformation of fugu	Recognizing CO warning
9	Jumping activity of shell	Incoming call display
10	Recording within conch	Answering machine operation
11	The size and vibration speed of jelly fish	Recognizing water/power consumption information

From table 1, we also notice the tradeoff on the visualization method used for the task that affects the intuition of interaction such as number 2 location of lion fish in the frame with the goal of recognizing temperature. While such visualization reduces the level of attention on the object itself, it provides a good degree of ambience. Such ambient feature is needed for uCoS and should be able to be picked up in the sense of reminding or simple instruction. The reason might be we are using analog mapping between thejumping actions of lion fish to the temperature.

Pilot Test

The pilot test was for the purpose of verifying whether or not the test itself was well formulated. For instance, a colleague or friend can be asked to participate in a user test to check whether the test script is clear, the tasks are not too simple or too hard, and that the data collected can be meaningfully analyzed (Table 2). We averaged the time that experts and novices finished the tasks.

This experiment was performed at the SOFT Lab, National Yunlin University of Science and Technology, with six participants and a duration time of 30-40 minutes. The environment was the bubble room described above with the proper setting for a smart living space.

Results

As the results show (Table 3), the GAIA interface successfully combined virtual and physical information in an undersea metaphorical environment. You can see from the results table that the task completion times became shorter and shorter. Therefore, we can declare that the GAIA interface was learnable and efficient.

Table 2 :The Pilot test Results

Task completion time (second)	Expert	Novice	Average
Task1	15.49	50.21	32.80
Task2	89.34	203.32	146.33
Task3	5.32	10.29	7.80
Task4	18.93	50.11	34.52
Task5	25.2	30.21	27.70
Task6	57.32	90.03	73.67
Task7	3.91	8.93	6.42
Task8	6.32	15.89	11.10
Task9	7.48	14.56	11.02
Task10	9.23	18.56	13.90
Task11	11.27	22.98	17.13

Table 3: Result table

Task completion time (second)	User1	User2	User3	User4	User5	User6	Average
Task1	8.34	10.21	5.23	20.31	20.2	5.23	11.59
Task2	30.3	23.23	50.23	30.98	35.90	45.11	39.95
Task3	3.22	5.32	12.30	5.32	18.45	8.39	8.83
Task4	10.33	30.72	21.32	32.45	16.32	4.21	19.23
Task5	15.76	20.74	36.69	17.38	17.23	10.30	18.68
Task6	20.47	20.34	19.34	48.23	19.98	22.76	25.19
Task7	3.09	4.23	3.45	4.23	2.43	5.32	3.79
Task8	6.32	4.26	8.93	15.89	18.32	8.32	10.34
Task9	12.4	10.20	9.56	8.29	5.20	8.83	9.08
Task10	8.22	5.37	5.26	9.22	13.28	8.45	8.30
Task11	8.27	12.21	7.28	5.43	12.53	7.45	8.03

Conclusion

Intuitive interface for smart living space is involved both the virtual and physical objects and information along with the mechanism for organizing and evolving. Most of smart living spaces projects provide one way or another interface to achieve some features towards a more useful approach. This research followed the user analysis on the behabior and scenario-based design paradigm provide a systematically method towards finding the intuitive interface of desired. While there is no universal interface paradigm, we start with analysis of case studies that show the benefits as well as drawbacks from different perspectives.

With these lessons from case studies, we turn to frame our first framework called ubiquitous co-existing spaces (uCoS) for a smart living space. Further testing on a prototyping project called GAIA, uCoS provides a simple classification over the view of information objects (virtual or physical). While simultaneously presenting a room embedded with sensors and actuators, uCoS provides an additional networking framework on top of a co-existing framework. uCoS further describes a way to divide the modular components and the contextual information surrounding them.

The implementation (GAIA) developed by following the uCoS concept presents a real time virtual space associated with physical components. Several flaws are discovered by experiencing the real co-existing spaces such as the ambiguious behaviors of intented and ambient purpose. Since we are using user-centered design process. This research revisits the usability test with tasks analysis. The results are not that significant than the implementation itself, but it unleashs a way to finding the small widgets in the contextual environment that provide further intuitive interaction. However, this still remains a further investigation.

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Posthumanist Responsive Architecture: Notes on Interactivity

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"Nothing in the body is made in order that we may use it. What happens to exist is the cause of its use."

–Lucretius, De Rerum Natura

✤

In the following discussion I explore posthumanist ethics as a strategy for working with responsive architectureand attempt to relate this theoretical context to a series of projects developed within my own practice.

Theprojects are designed with the intent of finding renewed, mutual relationships between occupants andenvironments. In these projects are implied methods and theoretical context for designing environments that 'care' for their occupants while resisting functions of pure service.

The research examines new aesthetics and new technologies related to responsive architectures. Fulfilling impressions of kinetic architecture that were the subject of visionary designs throughout the past century, an emerging new generation of architecture is increasingly engaging the new technologies of distributed communication systems, advanced modeling and visualization methods, digital prototyping, and distributed envelope systems. The general term 'performative' has entered current discourse in describing works employing combinations of these innovations. This term tends to be used to imply an architecture that responds to users by 'performing' functions and which might be judged pragmatically, valued according to results. Responsive functions engage a broad contemporary debate that has tended to replace anxiety about instrumentalism with optimism about expanded qualities. However it might be claimed that new generative and parametric design practice have yet to engage significant critical consequences of affective design. Kinetic mechanisms offer significant scope for manipulating the environment, but current strategies for resistance and for introducing sensitivity and 'consequence' accompanying this expanded power appear slight. Contributing to this emerging practice and, I hope, offering critical strategies, I am attempting to develop rudimentary emotional response functions within built environments within my own design work. Within the affects of emotion and empathy, I am pursuing distributed physical environment that might react to the state of occupants within the space, offering responses based on revulsion and attraction. My work involves practical technical development of innovative interactive sculptures and architectural components at Waterloo's Integrated Centre for Visualization, Design and Manufacturing, Kinetic mechanisms based on digitally fabricated textile assemblies, actuation systems and microprocessor-based control systems using open-source coding and design are enabling technologies.

Past generations of 'responsive' architecture have been contested, subjected to substantial ethical debate. In debates of this past century the concept of an instrument was often negatively associated with 'functionalist' rationales that, to critics such as Pevsner, Baird and Rykwert, seemed responsible for erosion of the dignity and freedom of individuals. Those voices, which span some three generations of this past century, tend to align with preceding critics of the Industrial Revolution in suggesting that treating architecture as an 'instrument' comes at a cost, just as the expanded powers achieved by Alfred Arkwright's spinning machines and Henry Ford's assembly lines arguably came at the cost of individual freedom. Perhaps inevitably, today's renewed examination of interactivity treads on similar contested ground. Distinguishing a new generation of interactive architecture, sophisticated functions are emerging that respond to building occupants and surrounding environments, increasingly based on technical innovations that employ distributed communication and control systems, lightweight actuators and sensors integrated within component-based envelope systems. In turn, these new building components are supported by emerging design methods involving cycles of dynamic visualization and prototyping of complex systems, and by emerging design tools employing new generative and parametric design practices. However, while impressions of kinetic architecture have been the subject of visionary designers throughout the past century, it might be said that the ethical implications of new 'responsive' architecture are only beginning to engage critical debate. Recent prominent discussions exemplified by Kolarevic and Malkawi's Performative Architecturei offer building performance as a guiding design principle, adopting new performance-based priorities for the design of cities, buildings, landscape and infrastructures. This emerging architecture places broadly defined performance above form making, and use digital simulations and fabrication strategies in pursuit of comprehensive approaches to the design of the built environment. Immanent, dynamic, open: the qualities focused by voices such as Kolarevic, Leach, and Spiller are marked by a striking optimism about the expanded powers of performance-based architecture. The visionary schemes offered by avant-gardes exploring kinetic modes have tended to remain transcendently positive in such discussions, yielding total visions that appeared to hold only the limits of technical innovation as their restraint. A collective manfesto is implied aspiring to the creation of highperformance architectures that emulate complex natural systems, shaped as flexible 'manifolds' supporting diverse action. With reasonable-cost, durable mechatronics now integrated within many Western industries, restraint now appears indeed slight. Current strategies for critical judgement introducing sensitivity and 'consequence' accompanying this expanded power of mechanisms for manipulating the environment appear in the very early stages of development, seemingly remaining within the long shadow of twentieth-century technological optimism and rooted within the centuries-old humanist tradition.

Yet in contrast to this apparent consensus, design strategies and ethics of related design traditions within the past two centuries have been fraught with argument. Has distance from earlier paroxysmic debates over eugenics and behaviour-programming relaxed the taboo of approaching humanity as mechanism? Have the formidable powers of new digital parametric tools and complex-behaviour modeling methods renewed confidence in the engineering of nature?

When preceding generations of engineers and designers developed analogies that held architecture to be operable like a complex instrument, their arguments tended to be divided. In their famous 1830 debate, Etienne Geoffroy Saint-Hilaire and Georges Cuvier, leading biologists and founders of the Museum of Natural History in Paris, examined the basis of nature. Against Cuvier's rear-guard defence of a Great Design determining individual species anatomy, Geoffrey argued that anatomy determined how a species behaved, opening the door to speculations about nature divorced from theology. Geoffrey implied that there was no particular 'transcendent' destiny involved in individual functions, only concrete and 'immanent' functions that would create particular opportunities for behaviour. The argument of these two biologists threatened foundations of their culture. In turn, similar debates between 'transcendent' and 'immanent' qualities has continued beyond Darwin's conceptions of natural selection and genetic mutation. A recent hinge for this debate is arguably the entry of Michael Foucault's Discipline and Punish within architectural discourse a generation ago. Foucalt dwelt on the oppressive machinery of prisons and madhouses and, perhaps fatally, linked those institutional building types to the spatial mode of radiant symmetries and axial constructions. By implying that symmetrical, crystalline systems of unified geometry in urban architecture were tantamount to Fascism, Foucalt's power analyis lent serious hesitation to the continuous project of the Enlightenment. Insidious qualities embedded within such total visions have widely remarked in postmodern generations of discussion.

In striking contrast to such a critique, a reverently transcendent vision of creation was evoked in American designers such as Louis Sullivan and his pupil Frank Lloyd Wright, building a vision of architecture embedded with the symphonic forces of nature. This late nineteenth-century organicism followdirectly from Haeckel's magisterial illustrated opus 'Art forms in Nature', which illustrated Darwin's vision of the practical evolution of species. Building a new kind of stewardship from this immersion in complex systems of nature, D'Arcy Wentworth Thompson's 1917 opus On Growth and Formii offered methods for manipulation of dynamic forces. While that author's benign influence on design has been repeatedly cited, the political application of his methods to 'improving' human species through eugenics is also poignantly evident.

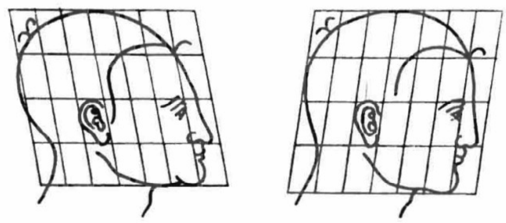


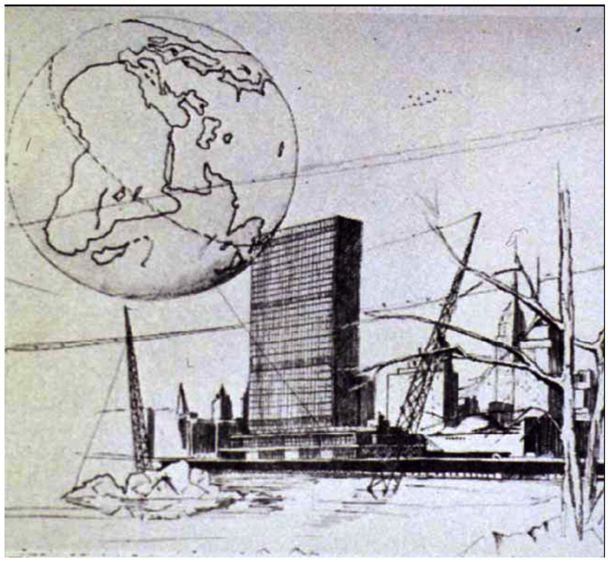
Fig. 139. (After Albrecht Dürer.)

Proportional systems of human physiology, 'After Albrecht Durer', D'Arcy Wentworth Thompson, On Growth and Form, 1917

In a similar vein, the mid-century systems-biologist Conrad Waddington's mid-century conception of an epigenetic fieldiii extended Thompson's biomathematics into an environment organized by intermeshing formcreating forces.

Cell fate switching in an epigenetic landscape, portrayed by Conrad Waddington: dynamics of developmental selection represented as landscape with hills and valleys. The lowest points in the valley correspond to distinct, stable phenotypes within wide repertoire of fates (Waddington, Epigenetic Landscape, detail; Strategy of the Genes, 1957)

Waddington's pragmatic tone might not advertise transcendence, but his vision of an environment that shapes and channels every action is certainly overarching. In turn, prominent voices within a mid-twentieth century generation of designers held the spectre of an orchestrated environment of integrated systems in extraordinary confidence. When Buckminster Fuller proposed his' operating panel for Space Ship Earth' beside the United Nationsiv, he envisioned networked global markets and enlightened individual human agency as a social and political fundament, while B. F. Skinner's mid-century brand of behaviourist psychology attempted to engineer happy, productive subjects.

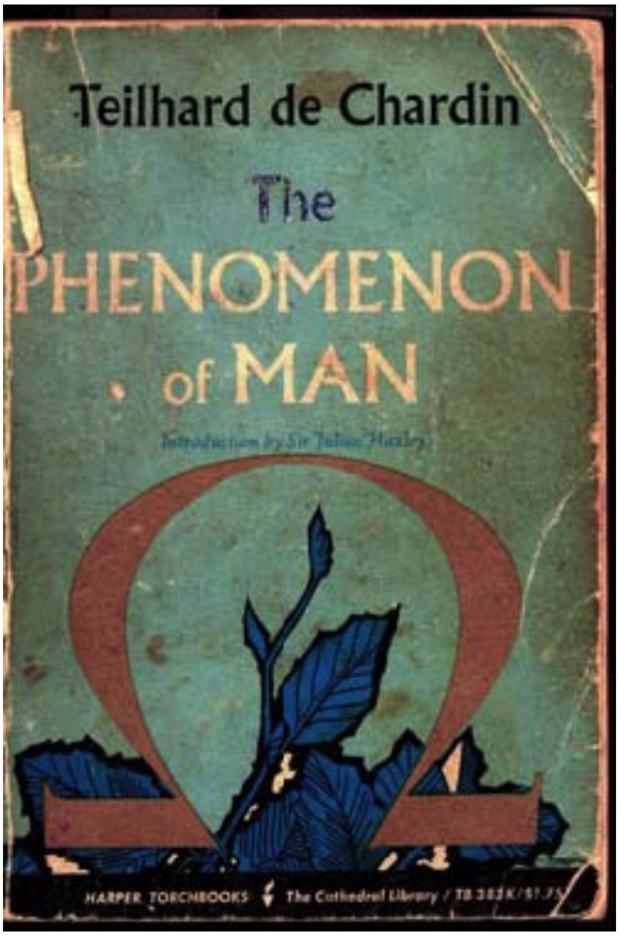


Original concept sketch of Geoscope, R. Buckminster Fuller, 1962, illustrated in Fuller, Critical Path, St. Martin's Press, 1981

The preceding notes might imply that twentieth-century 'confidence' in practical circumstance, taking direct responsibility for building overarching systems of control, has overcome preceding doubt. Yet, compressed review of humanist expressions might suggest that Waddington and Fuller's visions of an orchestrated earth have a long history, consistent with anthropocentric cosmologies announced by Renaissance and Enlightenment iconography. In canonical Annunciation paintings such as Lorenzo di Credi's 1555 Annunciation, graceful figures of Gabriel and Mary appear standing upon a gridded stage, with a carefully ordered garden stretching behind it into the distance. Gabriel and Mary are clearly the masters within this scene, while nature is the servant, its human masters exclusively free to act. Similarly, the nuanced exchanges of figures standing calmly within Piero della Francesca' s Flagellation of Christ emphasize social dimensions. In that scene, historical figures are cast as contemporary Florence citizens, earnestly conversing while standing on an ordered plaza marked by flooring that recedes in meticulously draughted perspective. The parallax of this scene is constructed to coincide with the

viewer's own viewpoint, implying common citizenship. These constructions speak of human domain as a pinnacle of achievement. In turn, it is tempting to draw a parallel between this kind of geography, Enlightenment visions of the late seventeenth century, and twentieth-century control systems. Louis Le Vau and André Le Nôtre's expansions of the great palace and grounds of Versailles, south-west of Paris contained radiating avenues that stretch seemingly without limit allowing the beholder to command the horizon. This transcendent, crystalline territory seems to coincide with the Modern vision exemplified by Buckminster Fuller's radiant 'geoscope', a floating spherical instrument panel connecting to vast networked global systems, focusing the entire world into a coherent, unified vehicle for organized operation.

The geologist and theologian Teilhard de Chardin developed a compelling historical argument that I believe offers resolution of this contested ground. Working between 1920 and 1956, the latter date of his death of release of his heretical writingsby the Catholic church, de Chardin voiced a remarkable hope for emerging qualities of integrated, coherent world organization rooted in the voluntary organization of overlapping networks of individuals. Increasing multiplication and overwhelming density of networks created coherence that might in turn result in a 'noosphere' of collective consciousness.



Teilhard de Chardin, The Phenomenon of Man (Harper, 1956)

Most poignantly, De Chardin hoped that this consciousness would be accompanied by an emerging 'prodigious affinity', a tangible collective sympathy acting at global collective scale.

A series of projects by the author have followed de Chardin's invitation to pursue 'empathy' embedded within the built environment. My use of this term draws upon aesthetic theory that examines nuanced relationships involving projection and exchange. vCombining terms of mechanism and empathy, I hope to develop a stance in an intertwined world that moves beyond closed systems. By drawing upon recent revisionist readings of cultural history, I want to develop a sensitive vocabulary of relationships. In the terms of figure-ground relationships the figures I compose are riddled with the ground. This immersion pursues substantial involvement.

Within the affects of emotion and empathy, I hope to develop paradigms for distributed physical environment that might offer behaviour based on revulsion and attraction, reacting to the emotional state of occupants within the space. Interaction within my current projects strays into parasitic modes involving self-serving injestion and consumption on the part of the environment.

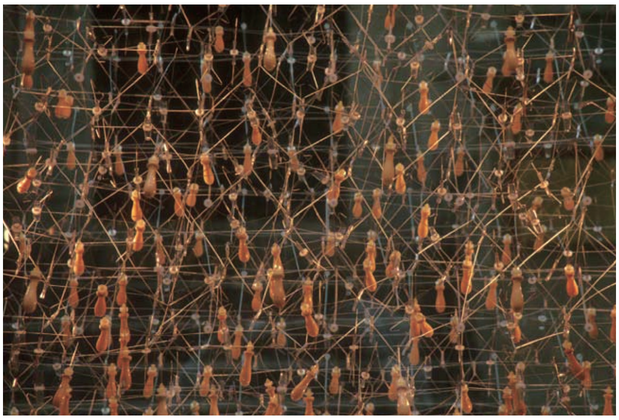
Kinetic mechanisms based on digitally fabricated textile assemblies, actuation systems and microprocessor-based control systems using open-source coding and design are enabling technologies, extending my own developments in these areas and drawing upon generous offerings from collaborators. The physical assemblies in these projects employ a series of natural laws involving energy flow, nutrient cycling and dynamic balance expressed in distinct functions. For example, the snap-fit of a plastic tongue into a mating socket needs just enough friction to grip its mate while staying flexible enough to avoid collapsing the whole surface. The design approach to sub-units is in pursuit of a balance of refinement and economy. This approach is circumstantial and dominated by quite flexible, practical judgment, far from a picture of perfection. The textile strategies I use make intensive labour for adjusting individual parts impractical. There are tens of thousands of parts, so tooling and fabrication motion used in making each piece is compounded. This requires an economy of means.

The primitive cycles of opening, clamping, filtering and digesting in the artificial assembly are inflected by some of the same natural forces that make a coral reef work. Building upon simple motions embedded within individual elements, accumulated actions produce turbulent wave-like reactions.

A number of my installations have been inserted into natural environments. They work to catch and inject matter, accumulating density and eventually forming into a hybrid turf. Like ill-fitting clothes, this work has an uncomfortable relationship with its natural host. The relationship of these object-assemblies contains layers of violence: the violence of a foreign colony imposed on a living host; the forces of dismembering and consuming; the force of will, violating the ethical boundaries that maintain nature as an untouched sanctuary.

Projects

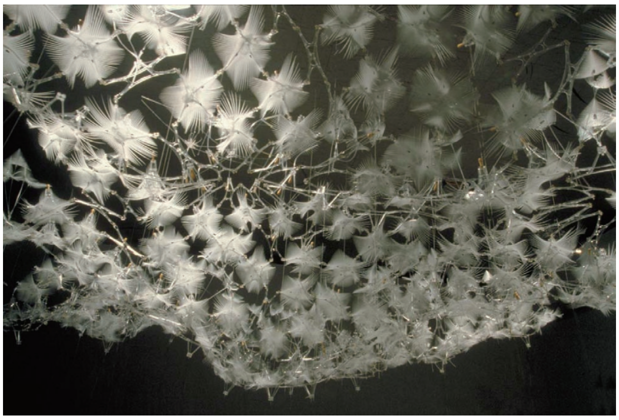
A series of projects may illustrate these approaches. Current work focuses on integrating control systems with decentralized responsive intelligence. The work is based on a program of gradual development moving from individual figures composed of complex hybrid organisms toward immersive architectural environments that include lightweight interior-linings and exterior shading and filtering assemblies.[vi]



Hungry Soil, BCE Place Toronto, 2000

Hungry Soil, a sculpture installed in Toronto in 2000, was conceived as a cousin of benign geotextiles that would shelter and accelerate plant growth. Captured large-scale organic matter fertilizes the system. Thin-gauge spring-wire is bent into wishbone-shaped units that interlink to make an octohedral spacetruss. Expansion of the skeleton truss yields a foam-like mesh spanning large volumes with minimal mass. Slide-lock details accompanied by simple compression-collars formed from biodegradable polymer tubing provide a universal system. Clips integrated in the wire skeleton provide attachment points for collection bladder-needles and twin barb-traps. These active elements saturate the mesh in a dense three-dimensional array. A lurking quality results.

The system was derived from the artificial skin replacement system for burn therapy developed by Toronto's Apotex Industries. In that system, a biodegradable gauze is seeded by gel capsules coated with human skin cells engineered for replicaton and bathed in nutrient solutions. Regenerated skin grows over the affected area, and the scaffold that holds the seed elements is eventually dissolved and absorbed. Hungry Soil envisions a similar approach to landscape regeneration. Springing barbed details encouraging accretive massing and clumping, a slow process of ingestion. Protruding hooks and latex bladders equipped with hollow needles imply mechanical operations on drifting organic matter: capture, injection, ingestion. The work was conceived during a time of personal study of the Kindertransport, organized transport of Jewish children from Germany to the United Kingdom in 1938-9. Details of the Soil work relate to blood and earth imagery, and levels of mechanical repetition raised questions of exchanges between imperial organizations.



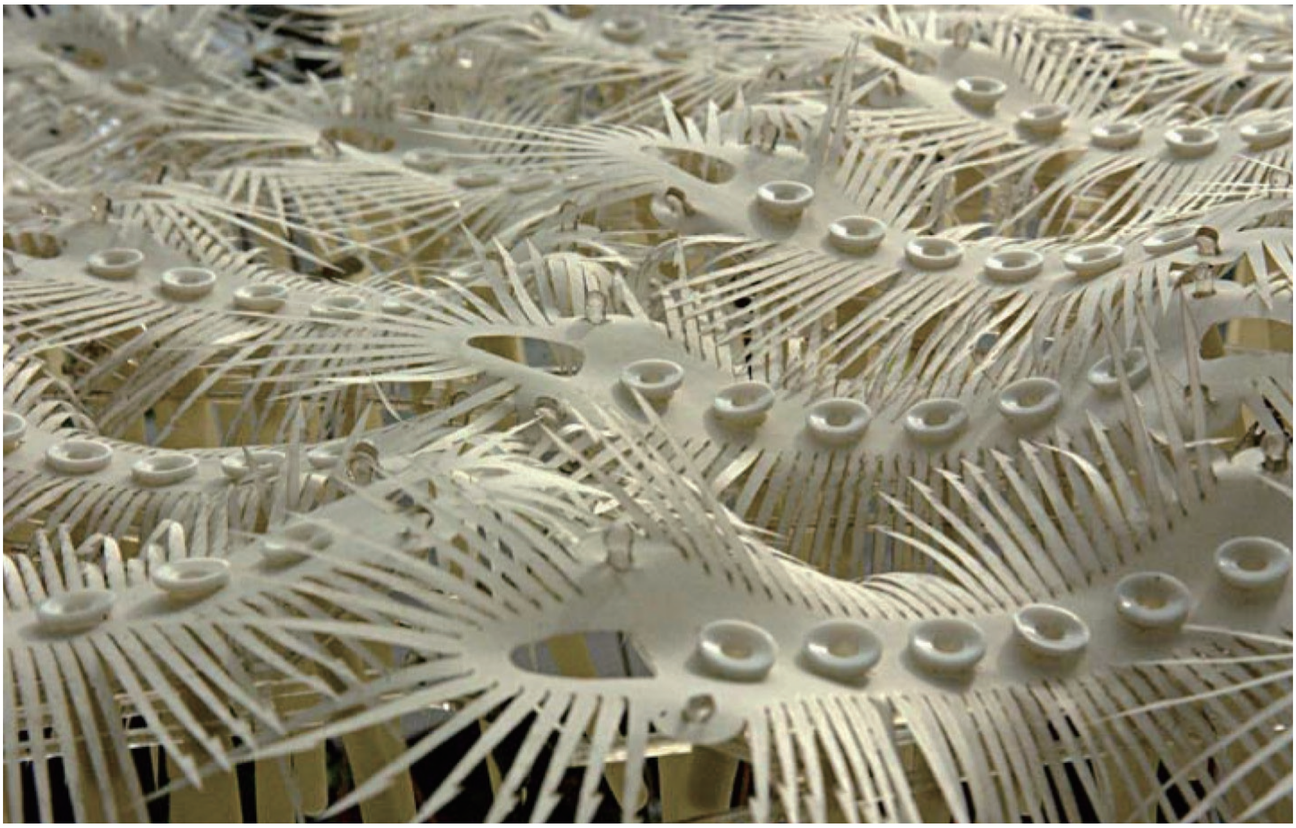
Orgone Reef, University of Manitoba, 2002

Orgone Reef extends the simple wire details of Erratics Net by pursuing hybrid threedimensional elements that gradually pull, push and pump materials within and environment. The sculpture, installed at the University of Manitoba in 2002, is conceived as an artificial reef that could support a living skin. The project is a hybrid geotextile, a new class of materials used for reinforcing landscapes and buildings. The details of this structure are designed to catch and hold the things they contact, accumulating a thick, porous mass. The project functions with aggression, clamping and cutting into neighbours, draining and digesting the things contacted and converting this material into fertile soil. The structure would help a scarified landscape heal and grow new layers.

`Several kinds of rhombic pyramidal structural tiles make this textile, connected by vinyl links that allow flexing and shifts in local relationships. The interlinking system creates a billowing space-truss that alternately arches upward and hangs in catenaries, adapting to locations of intermittent suspended supports. A primary tile, repeated hundreds of times within the topography, includes a pyramidal skeleton that supports a deeply serrated mylar filter configured to provide one-way trapping flows within a fluid medium. Fronds of adjacent tile filters intermesh, yielding a coarse felted membrane. Cutting patterns are designed to release embedded stresses within roll-formed mylar, producing oriented curling of frond-rows within the filter material. Curled elements are arranged in opposing pairs, producing passive mouthlike pores that encourage passage in one direction while resisting reverse passage. This hybrid osmotic function is employed as a design principle at varying scales within the installation. Motions telegraphing through the matrix allow this system to function as a distributed pump acting upon the environment.

Cybele, installed in Cambridge Ontario in 2005, is a self-assembling framework made of delicate laser cut components connected and oriented by miniature rare-earth magnets. A barbed cellulose membrane covers the structure. The membranes ride upon individual snap-fit acrylic frames and create a continuous topography. The rhombic tesselation of this system is reinforced by intertwined felting created by intermeshing of the serrated cellulose material. Through flex and movement in the system the system knits itself together. Tiles are supported by a precarious scaffold akin to a tangled forest canopy whose structure is concentrated at upper and lower levels. Upper spring-clip wire mounts are configured for insertion into quarterpoints of the cellulose tiles. Lower tripod sets include paired needle-stakes that work in concert with a lead counterweight encouraging free rotation prior to settling into final orientation. These details encourage jostling, flexible negotiation between tiles and support formation of densely interwoven felt in the upper layer. Each tile carries a brace of suspended elongated bladders. Funnel-shaped openings for each bladder are oriented upward, for drainage and collection. Salts prime the bladders, anticipating dilution and exchange.

[insert image 8] Implant Matrix was a diffused cloud of interlinked elements that accumulated to make a building skin, mounted in 2006 in Toronto. A lightweight polymer skeleton was cloaked with a quilted mylar tilework fitted with layers of miniature valves and clamping mechanisms. Distributed microprocessors, arrays of whisker-sensors and shape-memory alloy actuators provided a networked control system for the matrix. These elements were arranged in chained, rolling swells that made subtle grasping and sucking motions. The composite motion created billowing 'peristaltic' pumping that filtered humidified air and collected organic matter within the matrix surface. The skeleton was formed from hundreds of slender rhombic cells



Detail of interlocking cellulose burr units, Cybele, Cambridge, 2005

Implant Matrix, Interaccess Gallery, Toronto, 2006

laser-cut from acrylic sheet. This matrix contained a regular array organized as a planar diagrid. At intervals, an additional tile was introduced and created points of three-dimensional hemispherical swelling. These nodes offered compressive shell strength that allowed them to act as toughened gussets within the membrane system, providing points of concentrated structural connection for the assembly as a whole. Additional distortions and fissures in junctions between assembled tilework sections resulted from a collaborative assembly method coordinated among numerous builders.

The cells contain flat profile struts with integrated snap-fit tabs and slots that accommodated transverse stiffeners and junction plates. Each cell contained a meshwork membrane pump unit powered by shape-memory wire actuators. These membrane pumps were composed from thin mylar sheets and contained hinged mouth details that functioned in a similar manner to folded paper mechanisms in pop-up books. Long ciliated fringes containing miniature barbed hooks extended the outer surfaces of these filter membranes and encouraged tangling with adjacent units, making a continuous felted surface. A second filter layer was suspended below the skeleton, attached by spacer-struts containing variable-angle hemispherical rare-earth magnetic joints. Quilted mylar tiles derived from the Orpheus Filter system were used for this installation. Similar to the Orpheus Filter system, a quasiperiodic Penrose tessellation organized these tiles, and a universal geometry of junction holes permitted rotation and layering of the units. A thicket of activated whiskers was mounted within this layer. Fields of secondary glands and collection pores populated the surfaces of the filter. Injector glands contained silicone bladders fitted with long probes for passage of salt deposits into trapped host bodies. Small trapping pores were set to operate with suspended hair triggers hanging alongside the whisker systems. Extended feet for these elements used detailing akin to legs on a water spider, distributing weight and riding on the meniscus of the filter surface.

The whiskers responded to touch with convulsive contractions that were powered by shape-memory actuators pulling along the axis of the wound music-wire whisker cores. When viewers touched a whisker, changes in electrical resistance were sensed by capacitance sensing circuits within subcontrol circuits connected to main node controllers. These controllers would respond with actuation signals that would initiate sequences of opening and closing mouths within local clusters of membrane pumps. Additionally, the controllers emitted communication signals to adjacent nodes in neighbouring pump colonies that initiated secondary responses. Ripples of movement resulted from this sequence of signals. The main control boards used simple Peripheral Interface Controller 'PIC' microprocessor hardware. Each board controlled several dozen actuator and sensor elements in parallel chains, and a communication system using modular connectors and twisted-pair circuitry provided communication functions for coordinated responses through the entire installation.

Hylozoic Soil is a large environment that formed part of the Montreal Beaux-Arts Museum's 'E-Art' exhibition in 2007. The sculpture offers patterns of motion by mechanical components that respond to occupants' movement within the environment. Occupants move within the Hylozoic Soil structure as they would through a dense thicket within a forest. Microprocessor-controlled sensors embedded within the environment signal the presence of occupants, and motion ripples through the system in response, pulling trickles of air through the mesh and drawing stray organic matter through arrays of filters.The microprocessor-controlled system includes Arduino hardware extended by new control boards, shape-memory alloy actuators and space sensors arranged in a distributed interactive system. Lightweight lattice and geodesic organizations form a structural core, employing digitally fabricated lightweight scaffolds that house distributed networks of sensors and actuators. The structures are designed at multiple scales including custom components, intermediate tessellations composed of component arrays, and general structural systems.

The structural core of Hylozoic Soil is a flexible meshwork assembled from small acrylic chevron-shaped tiles that clip together in tetrahedral forms. These units are arrayed into a resilient, self-bracing diagonally organized space-truss. Curving and expanding this truss work creates a flexible grid-shell topology. Columnar

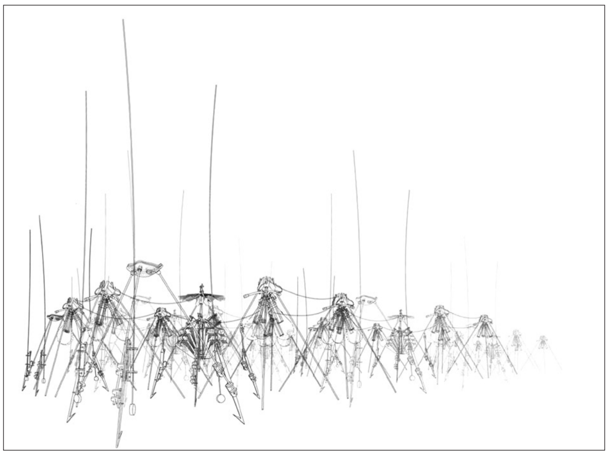
Detail of actuated sensors at column bases, with mounting clamps. Hylozoic Soil, Montreal Museum of Fine Art, 2007

elements extend out from this membrane, reaching upward and downward to a radical minimum by employing optimized form-finding design methods. Strategies include use of efficient tensile forces and textile systems in mesh and shell forms and derivation of three-dimensional forms from thin, two-dimensional sheets of material. Spacefilling tessellations and nested components derived from sheet goods contribute to this hybrid economy. Some eight cubic feet of acrylic polymer, fifty pounds of copper wire, aluminum sheet and handfuls of specialized alloys are expended, while the expanded space formed from these materials occupies some four thousand cubic feet.

Similarly, the control system offers complexity in its behaviour while avoiding large centralized computing. The distributed arrays of inexpensive miniature microprocessors achieve coherent behaviours through their distributed communication network. The intensive repetition of small information packets in the communication network and mass-manufacture of miniature physical components in the physical sculpture are similar in their approach, offering a heterogeneous whole.

Hylozoic Soil, Montreal Museum of Fine Art, 2007

The most recent installation within this series is titled Basal Lamina, and is currently being prototyped for further development. This assembly attempts to move toward an explicit relationship with the natural environment within an urban site that contains passages of sod and pavement. Basal Lamina is conceived as a nearly-living artificial turf, spreading out in a narrow swath spanning a full city block at the edge of Pratt Institute in Brooklyn. This assembly would create a shallow layer covering sterile ground, assembled as a deliberately weak interconnected network to gradually evolve in response to situational parameters and human occupancy. Faint signal-lure lights, microprocessor-controlled burrowing agents and space-filling filter packs provide a matrix that harvests energy and accumulates stray matter to be eventually taken over by new weed-filled growth. The skeletal tripod-field comprises approximately one thousand unit-clusters. It will form a continuous lattice outfitted with faint signal-lure lights, microprocessor-controlled burrowing agents and space-filling filter packs. The matrix accumulates stray matter and will eventually be taken over by new weed-filled growth.



Detail view of part assembly, Basal Lamina, Champ Libre Montreal/Pratt Institute, New York, 2008-9

The construction is characterized by extreme economy and minimal material use. Physical computing circuits using distributed configurations harvest trickling power and accumulate increments sufficient to emit small pulses of light and vibrations at regular intervals. Vibrations are amplified by leverage and resonance in order to create tangible and legible motion within automated mechanical burrowing elements, while significant multiplication and selective focus and amplification details provide legibility for the lighting elements serving both as indicators of the system's 'health' and as lures that encourage human proximity. Large-scale movements generated by the beneficial human interaction, integrated with increments of wind vibrations will further power the automated burrowing functions. Human participation will also provide beneficial spreading of the lightweight filter material populating the structure, and 'feed' the matrix with small residues of organic matter carried in by air currents and thermal plumes cloaking each visitor.

The fragile, minimal physical skeleton and physical resonance-behaviours of this surface could serve as a counter-form to the surging activities of adjacent sidewalk and traffic circulation. Organic power sources embedded within the installation have a finite life and extremely constrained actions. A pattern of simple public contributions akin to medical therapy could foster faint conditions of collective cultural empathy. During the four month duration of the installation, the vinegar electrolyte within several hundred bladder units will be renewed by a pattern of weekly injections. These periodic depletions and renewals of the organic battery will establish definite 'lifetime' intervals, gradually shortened by the increased corrosion of the electrode elements. This will be signalled by the light emitting diodes, whose patterns provide constant indication of the system's welfare. As the basal matrix's activity subsides, the process of natural growth takes over.

Further Steps

From previous projects involving static, site specific landscape-based field installations, the projects described within this essay have evolved towards immersive interior environments that interact with human occupants and that form active, accretive synthetic environments. Previous generations of this work have yielded temporary medium-scale light-duty installations capable of generalized kinetic effects. Close collaboration with mechatronics engineers permit a new generation of sculptures to emphasize subtle motion that approaches a kind of mechanical 'empathy' connoting emotion. In next generations of this work, this expanded sensitivity will be further developed in terms of durability and field testing, supporting intensive public interaction and exposure to the sun, wind and rain in order to rationalize fabrication details and mass production strategies.

Over the course of this next phase, several short term goals will be pursued: networks and systems composed of complex parts assembled into coherent artificial 'organisms', discrete mechatronics offered by shapememory alloy actuator development, new methods for analyzing and creating movement, translation of movement data into digitally automated mechanism design, innovative techniques for creating large volumes out of small amounts of material, implementation of digital fabrication and advanced modeling, and simulation and visualization techniques. The long term goals of this research suggest future building linings and skins that can provide local mechanized reaction to subtle changes in the building's occupation. This work draws on existing work in the area of mechanism synthesis and pattern languages.vii Traditional approaches to understanding human movement is the starting point for investigation into methods of coding movement quality into a suitable space on which a metric can be defined in order to support distinct 'emotion' based sensing and kinetic response systems. Design for emotion is a comparatively new practice that draws especially on gaming practices and marketing paradigms, extending traditions of behaviourism established over the past half century of research in psychology and neurology. A central design practice that is established within emotion studies remains quite primitive, preoccupied with individual figures, and facial gestures divorced from surrounding environments. Limited work relating to environments has, however, proceeded including universal colour schemes, textile patterns, and general 'body language' postural systems. Laban dance analysis offers a relatively rich vocabulary for describing the quality of mechanical movement and for exploring novel control strategies. The quality of motion will be classified in terms of the main descriptors of Laban analysis including time, space, flow and weight.viii Work on automated reading and generation of Laban notation for applications in dance and in simulationix will provide support for this research, and context will come from work exploring the relationships between the dynamism of dance and architecture.x This generalization of the description to

distributed mechanical forms is new. The work will draw upon the evolutionary-based psychologist Paul Ekman, who developed the Facial Action Coding System which systematizes emotional expression into 'Action Units', allowing labelling and recognition of emotions based on individual muscle movements. This accretive approach to muscular combinations has been translated into in computer-based recognition of emotions using Facial Action Coding System metrics, demonstrating that - basic emotional expressions appear to exist in all culture as innate and non-learned instincts. In turn, current research extends emotional respsonses into a systematic understanding of 'body language', where entire musculature and skeletal position is directly related to emotional stimulus and response. The psychologist Nico Frijda: has conducted research into 'action tendencies' rooted within the body, suggesting that emotions are broadly-based mental states which influence specific situational processing, particularly constraining appropriate appraisals & actions. These sources will be used to inform a general approach that attempts to embed emotion-connoting and affecting kinetic responses within immersive textile environments.

I hope, by describing these projects, to provide notes that might serve as an emerging practice for interactive systems. In contrast to instrumental systems that work in reliable service to human domains, the basic relationship here is prosthetic, employing alien appendages to nature's body. Prosthetics are always accompanied by some tinge of revulsion. An artificial heart causes the host body to recoil and attempt to reject the intruder, no matter how 'good' the addition is for the host's health. New burn technologies involving delicate nutrient-infused lattices that strengthen the skin and allow new skin to grow depend on drugs to mute the rejection impulses that we react with. A dynamic that integrates revulsion as well as attraction might lead toward mutual relationships.

These projections are large, and translate into action that risks violence. Reaching de Chardin's goal of a 'noosphere' of collective consciousness accompanied by tangible collective sympathy remains distant. Inevitably, a project that pursues synthetic collective consciousness is, no less than earlier visionary reaches, utterly fraught. Yet these projects might, I hope, demonstrate certain steps that engage the affects of emotion. These terms imply steps toward paradigms for distributed physical environments pursuing 'empathy' embedded within the built environment.

Biography

Philip Beesley practices digital media art and experimental architecture in Toronto. His work in the last two decades has focused on field-oriented sculpture and landscape installations. He teaches architecture at the University of Waterloo School of Architecture in Cambridge, Ontario and co-directs Waterloo's Integrated Centre for Manufacturing, Visualization and Design.

His publications include North House (CDRN 2008), Maison Solaire (CDRN 2008), Mobile Nation (OCAD, 2007), Hylozoic Soil (Riverside, 2007), Ourtopias: Cities and the Role of Design (Riverside, 2007), Future Wood (CDRN, 2006), Responsive Architectures (Riverside, 2005), a chapter of Extreme Textiles (Smithsonian/Cooper Hewitt, 2005) and AD cover Design through Making. (Wiley Academy 2005). Beesley co-chaired Expanding Bodies (ACADIA Halifax 2007), Responsive Architectures: Subtle Technologies (Toronto, 2006); Fabrication: Examining the Digital Practice of Architecture (Waterloo and Toronto, 2004), On Growth and Form: The Engineering of Nature (Cambridge, 2002). Distinctions for his work include the Prix de Rome in Architecture (Canada).

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