

**DEVELOPING CONCEPT PROTOTYPES FOR ELECTRONIC MEDIA AUGMENTED SPATIAL SKINS**  
(An investigation into aspects of reinforcement and image induction into Fabrics to create a fluid spatial envelope)

AA, EMERGENT TECHNOLOGIES AND DESIGN  
DESIGN RESEARCH THESIS

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## **An introduction to the theme and the research agenda:**

### **1.1 Abstract:**

'Humanity and consequently architecture are on the verge of a major shift in direction. As contemporary technological explorations into both biological and mechanical systems continue, a reassessment of architectural space is occurring'

- Neil Spiller in *Digital Dreams, Architecture and the new alchemic technologies*, 1998.

Usual interfaces in the contemporary are almost entirely confined to the conventional graphical user interface comprising of a key board, monitor and a mouse. Bearing in mind that about eighty percent of information is non verbal, the real challenge however lies in the notion of transforming the entire physical environment as an interface to digital information. Issues of attention, representation and mental representation immediately come to the fore in order to envision an architectural space which we inhabit to be a new form of interface between humans and digital information. The research essentially focuses upon the notion of imparting information by means of tactile variations generated as a resultant of human/environmental intervention. However the modality chosen to present a source of information becomes of vital importance in this circumstance. Mapping of data from information sources (ergonomic/environmental variations) to ambient displays becomes a tricky proposition, since the computer interprets all sources of information as a stream of modules. Carefully assigning the generated data into a display that successfully masks the information into new forms and gestures (by means of the nature of information generated, the tectonic variations etc), in the visual, tactile or audio space is what the research will focus upon. The notion of generating responsive tactile variations through the interface, allows visually sensed information to be channelised in favour of the space under speculation. As proposed by Ishii and Ulmer 1997: towards seamless interfaces between people, bits and atoms, the research will focus on the idea of giving physical form to digital information by coupling the dual worlds of bits and atoms.

The research will look into the notion of integrating physical materials (essentially Fabrics), with the realm of digital, electronic and information media in order to create interactive and responsive interfaces which could be used in architectural applications as innovative claddings and surfaces. This would involve a detailed analysis of integrating dynamic materials that have the capacity to modify their characteristics under different circumstances, for instance piezoelectric materials, that can change their size in response to an applied electric current, or materials that can change colour and shape in accordance with the change in environmental conditions like temperature, light intensity etc. The research will also look into the notion of proposing a monolithic building envelope, which will involve the integration of form, structure, skin, services and finish integrated as one. The distribution of elementary sensors, actuators, and power sources combined with reconfigurable network architectures with fault tolerance and operational longevity will also be researched upon.

### **1.2 Background:**

I will try and break down the argument into 3 main parts in order to understand the proposed context. These parts would respectively be: Material and the digital, Architecture, and Technology

#### **a. Material and the digital:**

The spectrum of technological considerations to equip and to materialize conceptual data is enthralling and perplexing at the same time. The notion of perception, structure, material and the production dialogues are some of the few issues that become critical for the realization of a concept. The contemporary scenario, heavily loaded with information and the constantly recurring relation between perceived phenomenon and spatial organisation is nowadays heavily under speculation.

The reality in which we situate ourselves reveals that the contemporary environment is increasingly being engulfed in the domain of information. They occupy our space at all the times and in all the places, hence rendering a means of escape from its encounter impossible. This notion if perceived from a broader perspective associates immediately with the socio cultural scenario and the increasing desire/need to absorb information from the context in which we situate ourselves. The notion of how the hard edged world of architectural reality could be possibly combined with the softness and fluidity of media content is what specifically is of interest to me. The manner in which structure could be separated from content, and content itself could become a binary problem of creative and technical vision involving increased usage of equipment which in turn would require controlled and highly performative scenarios is where the research

could possibly start articulating itself. What come to the fore are also the practicalities and limitations that the peripheral technological tools have to offer in accomplishing such a simulated scenario.

The manner in which we situate and affiliate our being is a highly simulated condition and the architectural realm is in a way the manifestation of these simulations into the material domain. The information generating tools, which multiply at an enormous rate in the contemporary reality, also build up an intricately abstract system of order of their own. They carry within the power to distort and re-configure the physicality of space. Considering the fast pace of today's life and the transitory nature of space in the contemporary, one tends to absorb information constantly through a highly strategic display of images prevalent in our immediate vicinity. However

this act of assimilating information is a highly subjective notion and hence leads to dissolution of the notion of one single interpretation of space. For instance, the digital world through the usage of complex software's and 3d visualisation tools already possess the capability of creating virtual systems that simulate visually plastic and fluid environments, however to physically realise these systems in the real world, constantly entrapped in limitations of gravity, heat transfer, wind pressure, ambient light conditions and orientation, it becomes highly essential to carefully sample as well as develop new materials, which are equipped better to satisfy various performance criterions like fluidity, flexibility, information display, concavity etc as discussed further, set forth to realise a concept.

What is of more vitality is the act of realising the material possibilities owing to a merger between the fields of electronic and digital media and architecture which could facilitate giving shape to these otherwise highly simulated systems and aid such systems to perform in a much more responsive and advantageous manner. This first and foremost calls for a multidisciplinary approach and includes exploration in the fields of architecture, interactive media, sensor systems, analysing composition of materials at a micro molecular level, to understand the possibilities of refining, reconstructing and enhancing their performance, realising the potential of developing smart systems that could be more efficient, self regulatory and multifunctional in order to create a highly responsive spatial adaptability.

This exploration however has to start from the very root: the material component itself. The research will be an enquiry into one such component: fabric, with the performance criterion limited to the context of information assimilation and data regulation. The research will also look into aspects of enabling technologies, fabrication techniques, for the manufacture of large scale flexible, conformable information systems which can take advantage of large surface areas e.g. walls, ceilings etc. Involving textile manufacturing processes that are appropriately modified to incorporate electronic components, automated or self assembled attachment and interconnection techniques will also be an agenda for the research

## **b. Architecture**

As long as architectural space and for that matter the entire faculty is concerned, in structuring events architectural space has always relied on rationalising subject-object relationships. Architectural surface have always been conceptualised, represented and structured to contain any localised event. Until recently, architecture had never been imagined to contain space beyond the Cartesian dimension and some thing that was beyond the limits of the naked eyes. The discipline of architecture had never been imagined in absence of the body (the object) and the viewing-eye (the subject). The visual constrains of human eye and the functional limits of the human body have ever since been the foundations for various spatial formulas. But as this horizon has shifted from the edge of what is visible to our naked eyes to that which is visible electronically as Virilio argues, that is to say, at the scales of non-Euclidean geometries, what we have overcome are atmospheric and perspectival noise, the constraints of seeing in a straight line, and the constraint of seeing from just one point or in just one direction (Optico-Digital orthographic; lossless clarity, curved omniscience, panoptical omnipresence, a condition of tele-vision/access/control that architecture had never confronted before).

Perceptual limits of the body have now started to drift, with electronic body extensions. Architecture that had its primary function in holding an event has now been faced with new crises as now exactly those grounds, that it had laid its foundations on, are shifting i.e. Visual limits of the eye and anthropomorphic attributes of the body.

The human ambition to dwell in a fantasmatic mythical world is not a new concept. From the descriptions of the Heavenly City, transcending both materiality and nature to the narratives of modern films like the Final Fantasy, Artificial intelligence, Matrix etc have all been pointing towards a singular human desire.

With modern simulation technology this quest for ability to dwell beyond the mundane realities is brought closer to both realisation and realistic experience. This ambition has now grown into a wide industry with developments in hardware, software and networking technologies. Clip-on-Monitors, data glove/suits, and various wearable devices are becoming increasingly common practice. Virtuality as some might say is an inevitable extension, of our age-old capacity and need to dwell in fiction, to dwell empowered or enlightened on other, mythic planes, if only periodically, as well as this earthly one.

One could think of architecture in such contexts that would dissolve materiality, an otherwise inseparable aspect of any architectural space, in devising architecture of the future where the window looks at almost anything and the walls have gestures. Building up a sociable space-envelope appropriated to its time, leaves one with almost no limits to ones imagination.

#### **Perceptual Effects Generated by Architecture:**

'To understand architecture, one had to look at its semiotic abilities... architecture has the ability to represent and to act in a tropic structure, it also has the ability to produce these other affects- graphic design being the ideal example.'

: Jeffery Kipnis, In The Mood For Architecture, Anything.

Architectural effects are often linked with the notion of sensory experience of outer, inner and the world of emotions. These effects can essentially be felt, but cannot be grasped, since they don't fall under the category of bodies, facts or prototypes. The research will focus on exploring architectural repercussions in terms of the perceptual effects generated by the material components constituting the built form. The notion of identity is now situated very much between media and physical infrastructure, providing with the opportunity of creating much more intriguing and simulated material effects. Different aspects of obtaining desired effects by altering the composition/the constituents of the material, or by experimenting with the micro molecular structural organisation of the material under inspection and by creating self regulatory systemic networks etc will also be explored. The notion of indexing our thoughts and information in a singular surface is an interesting proposition and the idea of generating a more meaningful sense of meaning at the level of 'affect' rather than signification needs to be explored through the research.

An attempt will be made to explore possibilities of information sensing, embedding and distribution through the usage of new media, and electronics. These possibilities once realised, will be associated with the notion of material properties and their associated effects enhancing the production of meaning, aesthetics and technological prowess. The creation of architectural space imparting information and promoting a high level of interactivity would actively portray an environment corresponding with the contemporary and will participate in advancing technologically as compared to the traditional conception of space and the subject-object discourse attached with it.

#### **c. Technology**

Within the great technological legacy of global 'diffusion' of space-time, there exists a strong need to re-examine techno-utopia and the promises it claims. Social space is characterised by being in physical proximity with others, despite the complete lack of factual/verbal communication there are factors that evoke a sense of togetherness and comfort. A lot of times it's only the knowledge of the ambient presence of the others that determines this sense. The techno-utopia of the 'electronic cottage' completely out strikes this phenomenon. As information technologies continue to develop various communication options, they still have their own limitations. (For instance, in contemporary online communication patterns, sense of presence is abstracted from its usual meaning of being in shared physical vicinity. Space and presence as observed in any conventional online system are a cognitive compromise of its original meaning and signification). Most systems involve an intrinsic compromise in how human events work in physical spaces. We could deploy technology to transcend language barriers so as to eventually penetrate and operate into multi-lingual-cultural environments. We can think about developing smart objects (and so spaces) that act as sophisticated systems.

In building up concept prototypes, the research would involve studies of technological tools for digital inscription and the representation; of 'body', 'presence' and 'information' and the technologies of information gain, storage, processing, transmission and display onto a fluid and tangible surface.

Elaborate sensing technology could map and record bodily movements and gestural data. Pressure and temperature sensors, eye & motion-trackers and MIDIWEAR are readily available and constantly being

developed that could map body information. Web cams and other optical input devices additional to conventional sound/text input are now established practices. Flexible or foldable LCD screens are next generation output platforms that could help transcending desktop computing. Sensitive fabrics and wearable computers will not be new in the near future. Considerable work is under way and first models are already showing up at various research labs. Digital Projection technology is reaching its peak with developments in CAVE and other interactive visual environments or in developing Holographic projections. Strategic use of technology and the application of relevant metaphors in structuring online environments could enable exactly those intrinsic elements that seem missing in conventional textual landscapes. Miniaturisation of hardware, development of numerous input devices and sensing technologies, advancements in data processing power and the rapid developments in software industry raises potentials for thinking design at a level where innovation could be substituted with an appropriate assembling of rather speculated developments with a logical vision. I would like to read these advancements and sketch out ideas for their social implementation while outlining the design research.

**The project would be, in simple terms, an exploration into drafting possibilities for "an architecture" with electronic and information media tools as its intrinsic 'building' component.**

### 1.3 Scope of the research:

The research agenda would be targeted specifically towards exploring ways in which architecture (broadly speaking: space, installations, design tools etc) can become increasingly responsive, adaptive and interactive in nature. The increasing pace at which certain information generating and modulating tools can be engrained in the creation of advanced materials develops possibilities of creating highly evolved, intelligent forms of architectural space: architectural spaces that will potentially be much more advanced in not only representing conceptions but also be able to actively sense the tectonics of that space and hence adjust and respond to the occupational and activity variations within the space.

The research will essentially focus on the current trends and technological innovations in the field of Fabrics, biomimetics and electroactive gels. The material: fabric is selected on the basis of the complex spatial variations which could be generated by it (fluid environments and highly translucent layered environments suggestive of complex spatial depths). Issue related with Worm designing, the studies related to Turgor pressure in plants and the complex mechanical behaviours in biological systems will also be studied to mimic certain essential kinetic behaviours.

The research will work at two levels, firstly in relation with strengthening the technical database; investigations will be made into the various processes involved in the construction of fabrics, various weaving techniques, production techniques, electronic component embedding techniques, sensing technologies, electro active gels and issues of biomimetics which will aid in the production of real time simulating environments. Secondly an attempt will be made to develop responsive self regulatory systems utilising the technical research carried out.

The research can hence be looked at as a continuation of an ongoing inquiry into one of the many associations of the fields of new media and architecture. Special emphasis would be given to the developments in the field of electronic media, sensor systems and image imbedding techniques.

Apart from this, investigations will be made into the latest material research in the fields of fabrics: for instance the developments in the fields of electro chromic, thermo chromic, gaso chromic, photo chromic, holographic, thermo tropic coatings, photonic fibres, 3 axial weaving, circuits embedding, impregnation, embedding technologies involving sandwiching liquid crystal display, screens between glass panels, foldable liquid crystal displays, application of photovoltaic cells onto fabrics, embedding interactive elements into the fabrics, exploring the realm of how fabric could serve both as structural materials as well as information imparting tools etc. in order to inform the research. The research would hence involve an in-depth inquiry into various sensing, processing, networking and display technologies to direct architectural studies of form, elements and spatial organisation based in socio-cultural contexts eventually optimising architecture appropriated for technology mediated articulations.

The research will be carried out in the field of fundamental technological developments; this will be later followed up with researching upon specific applications that successfully demonstrate electronic fabric capabilities, investigating innovative approaches and techniques leading to advances in the state –of the – art, and finally integrating solution sets that embody significant technological advances.

#### 1.4 Hypothesis:

Referring back to the discourse set up in the Material and the digital section, the rapid developments in the field of the virtual environments, is captivating owing to the perceptual sense of fluid spatial systems that they incorporate. This is achieved through the physicality of non linear entities that they are composed of and by the manner in which the images articulated enhance this gestural quality. The research is an attempt to achieve such simulated systems in physicality rather than in a virtual mode and hence to delve into technological and design related issues which aid in the creation of such systems.

A linear system is the one in which cause and effect are related proportionally. Nearly all linear systems can be defined by differential equations, revealing the fact that the whole is simply the sum of its parts. Hence no matter how complex the system may be, it can always be understood as the conjunction of many simple elements that are present together. Such systems can be analysed by reducing them to their independent components, making them highly predictable systems. Most fields of scientific interests like electronic waves, magnetic, weak and gravitational fields, stresses and strains, heat flow etc. are understood as linear systems.

However non linear systems acquire qualities of unpredictability. It is often thought that unpredictability and indeterminacy go hand in hand, but now it can be seen that this might not be necessarily the situation. One can envisage a completely deterministic universe in which the future is, unknowable. Such non linear, unpredictable yet deterministic conditions in scientific terms are called the deterministic chaos. Hence terms like non linearity, unpredictability, randomness, chaos etc. are related in a fundamental way, and hence though used separately, they refer to different facets of the same basic understanding.

The hypothesis of the research:

**The components of new media and architecture create a possibility of physically generating non immersive (visual) and immersive tectonics, which are involved in the construction of fluid spatial systems.**

The contemporary denotes the realm of virtual space as the architecture of media freed from the constraints of structure, material and gravity. This architecture is supposed to be both simulation and reality, the former proceeding the latter. The two forms of virtual reality systems involved at the moment are: Immersive systems which involve a much greater degree of bodily contact using various devices, which increase the basic sensory perceptions of the body and Non-Immersive systems, which are primarily visual and may involve sound at times.

The engrained qualities of generating visual depths and unexpectedly smooth and organic fluidity could be attained by experimenting with mediums like fabric, gels and various smart composites. The possibility of these material scenarios being combined with the fields of new media (focussing on the idea of the information sensing and electronically programmed kinematics) could create a possibility of the much desired implicit spatiality.

Another interesting phenomenon that can be observed pertains to the realisation that the virtual environments still bear their routes in the past architectures, and in turn produce simulations based on a similar language that we are already familiar with. However the convergence of technologies will tend towards a new a union of artificial intelligence and virtual environments perhaps based on biological models. This will require new arrangements of sensory impressions in synthetic environments quite different from those in which the impressions were taken.

The notion of giving shape to these virtual realms could lead to an extensive research into the field of **immersive technologies**. The research will look at such aspects from a material research point of view and will strategically look at information embedding, generation possibilities from a physical material, hence investigating immersive technologies. The notion of creating the boundaries between the interior and exterior fluid and ambiguous with the possibility of its being interactive and informative lead to the selection of the proposed agenda for the design research thesis.

#### 1.5 Methodology:

An extensive enquiry into both the materials under speculation will be made, in terms of their chemical compositions, the manufacturing techniques involved and the possibilities of experimenting with their chemical compositions in order to create favourable hybrids, having the possibility of inheriting the desired performance criterion.

The field of media and its vital medium: the Image and various resulting architectural effects itself will be explored from both theoretical and technical point of views in accordance with the possibilities it holds for the research.

The tasks can be broadly categorised into two segments:

- a. Hardware development and research
  - b. Information technology research.
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- a. Hardware development and research:
    - Basic yarn component development research
    - Fabric circuits, their printing, manufacturing and powering
    - CAD device manufacturing and simulation
    - Energy generation (electrovoltaics etc)
    - Fabric components and applicability
  - b. Information technology research:
    - System simulation, design and modelling
    - Application analysis and concept demonstration
    - Application of electronic and sensing mechanisms

c. Available medium:

The research would involve detailed analysis of certain case studies of the following:

- Material science and technology division, Washington DC, USA: three dimensional analyses of Microstructures
- Intellimat: Smart materials (piezoelectric, shape memory alloys, magnetostrictors, Magneto/electrorheological Fluids)
- Fashion Lab UK: Smart Fabrics
- Soft Switch UK: Electronic fabrics
- MIT Media Lab: smart fabric and washable computing, wearable computing, interactive systems, photonic fibres.
- Morgan Electro Ceramics: Piezoelectric materials.

The investigation would also involve concentrating on the current on going research work being done in the fabric segments by various material research organisations as well as research oriented institutes and installation artists.

d. Research resources:

The research will be developed after continual discussions and consultations with firms involved with the production and exploration in the fields of glass, fabric, new media and sensor systems.

FTL, Ove Arups and Partners, Soft switch: Smart materials and fabrics.

MIT media lab, the Columbia University, Diller and Scofidio, Leezer Amp, Bernard Tschumi, Oosterhuis.nl, Greg Lynn: Exploring ideas related to the mediums of new media, projection and digital technologies, responsive systems, interactive systems etc.

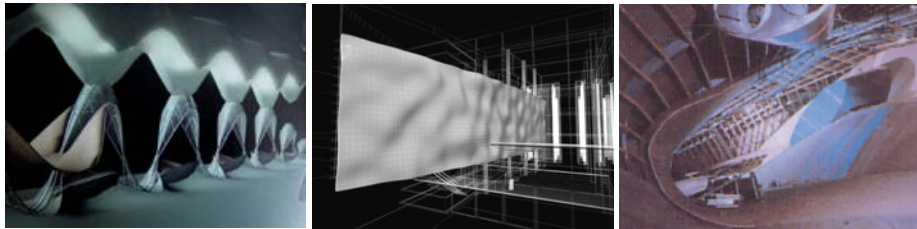
Building centre, London, Stuttgart University, Goldsmiths College, imperial college, Saint Martins college: for collecting relevant data and guidance pertaining to the material research.

The resulting data will be synthesised, in order to develop fabric application and development tools. This will be accomplished by the means of a case study which will act as an experimental tool for the generated data.

### 1.7 Framework of research:

The contemporary, through the technological advancements and with the increasing pace of development of the digital is constantly producing many practises and diverse interdisciplinary fields that are highly interested in experimenting with latest computational tools, technology and production systems as inherent design components rather than taking a figurative approach towards it. Many practises like Herzog & de Meuron, Toyo Ito, Diller & Scofidio, Greg Lynn Form, MVRDV, Ove Arup and Partners just to name a few are dealing with the issues related with the information generation and the qualities of lightness and temporality that they carry with them.

The realm of vision is under constant speculation and exploration in the architectural field in today's context. This exploration is common to a variety of other disciplines especially media, product design etc, where visual aesthetics are of vital importance. Specialised researches guided towards marketing and acceptance of forms in a particular social and cultural arena is also gaining rapid attention.



Changing notion of the architectural spatiality. Projects like the museum of art and technology by Greg Lynn, the Aegis Hyposurface by Decoi and the NOX pavilion by Oosterhuis portray a sudden demise from the

Cartesian world of architectural space.

The research is situated in such a scenario where the shift from the mechanical to the electronic has been accepted. The electronic paradigm has implications for architecture's role in the visual representation of values, especially with regard to ideas of reality, the original and their perception. It is in this context that the research tries to explore the importance associated with the information regulation and the possibilities of creating the much speculated fluid forms of architecture.

The aspect of the image is also something intrinsic to the research in an ornamental sense. The notion of the image has been prevalent in the society since a very long time and in many cultural traditions has been associated with symbolism and ritualistic beliefs as well. However the importance in terms of an abstract system that these signs and images set about is now being explored further. Picking up from the ideas of semiology and the propagation of meaning by the sign and the signified, the intervention of the digital media itself has given a great impetus to the notion of ornamentation. One can also compare works of Herzog & de Meuron, where the embedded image proposes a different role altogether. Many video artists, light artists etc also exploit the qualities of the image by utilising it to create the notion of visual depth, fluidity, transient environments etc which essentially involve playing with perception and spatial interactivity.

The usage of image, sometimes in an abstract sense, while sometimes in a more engrained or repetitive manner (much like Andy Warhol) creates a sudden realization of the manner in which the image can be produced and viewed (differing in each condition according to various surface constraints and surface properties). Another interesting aspect especially in Ando's tower of winds, is the ideal scenario where the architectural object is at once an icon as well as is highly descriptive entity due to the manner in which it generates images of changing light, colour and sound based on the interaction between the wind condition and the architectural object as a whole. The research will actively try to deal with the issues of articulation and ornamentation as a criterion that could be actively thought of while developing a responsive system. The research would prove highly beneficial in the existing time with its increasing urge to create sophisticated systems, creating dynamic spatiality, with the creation of much more fluid and informationally rich interactive environments.