Robotic Membranes

Exploring a Textile Architecture of Behaviour

Mette Ramsgard Thomsen and Simon Løvind, Vivisection, Charlottenborg Art Museum, Copenhagen, 2006

The robot and the textile seem like a contradiction in terms – the robot standing for everything that is automated and mechanical, and the textile for sensual materiality. Can it be possible to reconcile the two? Here **Mette Ramsgard Thomsen** demonstrates through her Vivisections and Strange Metabolisms projects, exhibited at the Centre for Information, Technology and Architecture (CITA) in Copenhagen, how it is possible to unite the seeming polarities of the digital and the physical, engaging 'intangible digital data with tactile physical material'.

The relationship between digital and analogue is often constructed as one of opposition. The perception that the world is permeated with underlying patterns of data, describing events and matter alike, suggests that information can be understood apart from the substance to which it is associated, and that its encoded logic can be constructed and reconfigured as an isolated entity. This disembodiment of information from materiality implies that an event like a thunderstorm, or a material like a body, can be described equally by data, in other words it can be read or written.

The following prototypes, Vivisection and Strange Metabolisms, were developed at the Centre for Information Technology and Architecture (CITA) at the Royal Danish Academy of Fine Arts in Copenhagen as a means of engaging intangible digital data with tactile physical material. As robotic membranes, they are a dual examination of computational and material interfaces. By considering these ideas at an architectural scale, the Robotic Membranes project examines how walls, floors and ceilings of the built environment may be regarded as dynamic surfaces acting and reacting to changes of containment, and the contained.

In robotics, digital logics are tied to a physical body through the relationship between sensing and actuation. Thus the computed is always connected to its environment, to the structure and gravity of its body, and its situation in context.

In Robotic Membranes, sensing is linked to actuation through a textile surface. Using textile as a technology as well as a material, the membrane is understood as a means of assemblage, allowing the bespoke specking of complex surfaces.

Weaving, knitting, lacing and felting are technologies that gather separate fibres in order to engineer unified materials with particular local properties. In Robotic Membranes, integrated conductive fibres such as steel threads and carbon-loaded fibres allow the passing of data through the weave, while at the same time using the pliable nature of textiles to enable actuation. The resulting robotic membrane merges the structural properties of architectural enclosure with the variable data of its environment, and once embedded with control potential allows us to propose programmable and dynamic architecture.

Vivisection

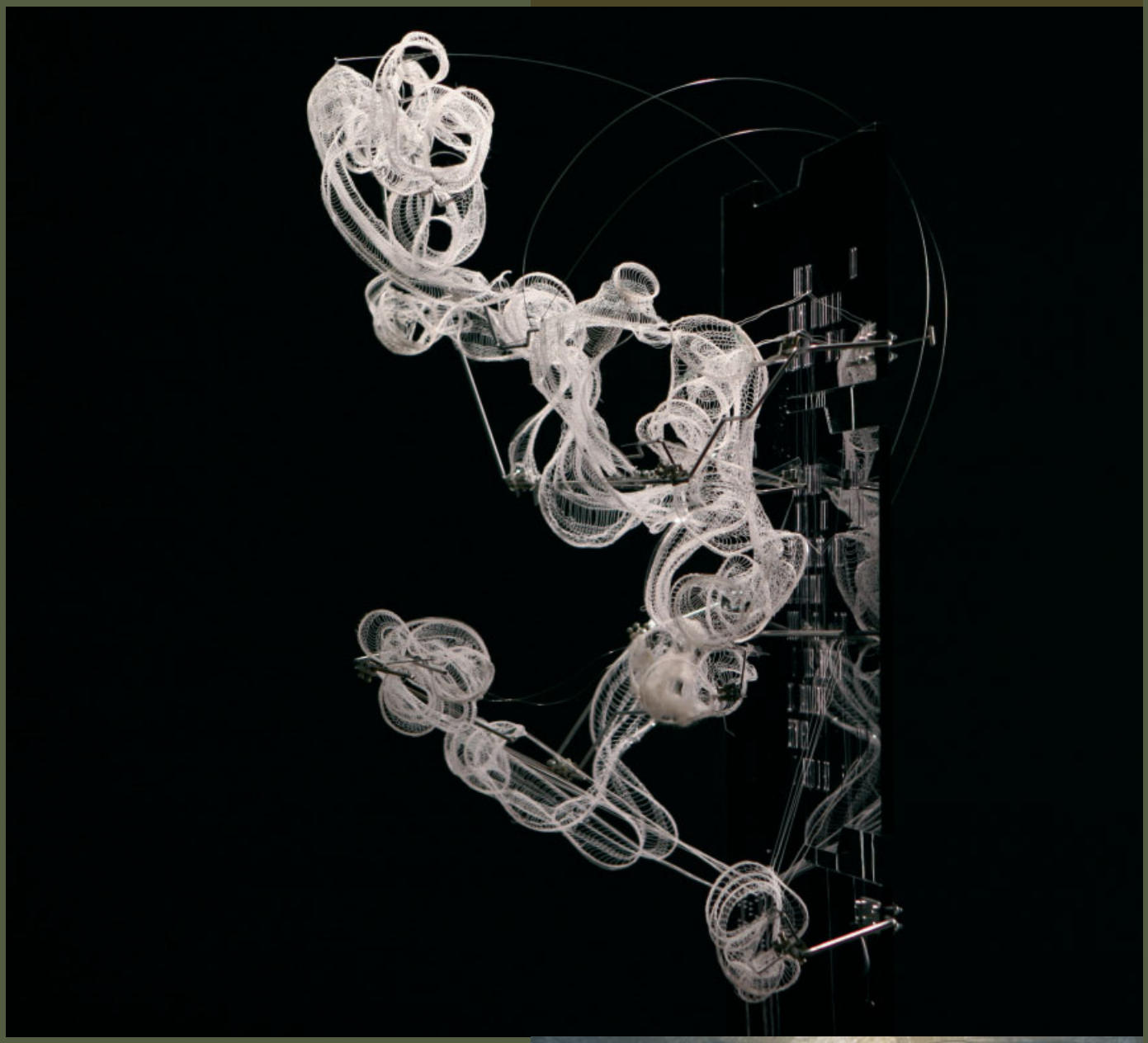
Vivisection is the first prototype in the making of a robotic membrane, and is a collaboration between architect Mette Ramsgard Thomsen and designer Simon Løvind. Vivisection is the making of a live section, a sensing skin that acts and reacts to inhabitation. As a spatial experiment it investigates, firstly, the means of embedding capacity for sensing and actuation within a tectonic surface and, secondly, how intelligent programming paradigms might generate a sense of spatial autonomy from occupation and use. Vivisection is a large-scale installation that defines an interior and an exterior, as well as a volume that escapes inhabitation yet, through the scale of its cavities, relates to the body. Inspired by large-scale textile constructions such as box kites and parachutes, it is constructed from three connected sections that create separate interior chambers. The chambers are inhabited by three 'lungs' which, through their continuous inhalations and exhalations, give the construction an inherent movement and rhythm.

Mette Ramsgard Thomsen and Simon Løvind, Vivisection, Charlottenborg Art Museum, Copenhagen, 2006
Vivisection is made from an organza of silk and steel. The steel weft is conductive, which allows the passing of electronic data through it. The lungs have a silicone coating creating a composite material that can be inflated and deflated.

In Robotic Membranes, integrated conductive fibres such as steel threads and carbon-loaded fibres allow the passing of data through the weave, while at the same time using the pliable nature of textiles to enable actuation.

Vivisection uses a conductive organza as its core material. The organza is a weave of steel and silk. The steel weft is conductive, which allows the passing of electronic signals through it. By connecting an antenna-based sensor chip to the fabric, the material becomes sensitive as it registers changes in the magnetic field around the antennae. As users touch or pass underneath the fabric, they actuate an embedded sensor. A microprocessor subsequently instructs a series of fans to inflate or deflate the assembly's lungs, whose fabric was treated with silicone making the material airtight and inflatable. The silicone also makes the lungs heavy, causing them to collapse when the fans are switched off. Finally, a copper 'nerve path' has been embroidered along the length of the installation allowing the material to pass information between a total of three microprocessors that control the entire installation. As such, Vivisection becomes a sensitive skin that actively engages its inhabitation. The fabric becomes a composite material combining the properties of conductivity, inflate-ability and deflate-ability. It also becomes an interface in which the assembly knows about its environment and communicates its understanding to itself.

Vivisection queries the programming of architecture by adopting computation as a distributed event. The robotic membrane acts as a matrix enabling the communication of multiple cells. Each cell is both independent and relational by acting and reacting to input from its immediate environment as well as that of other cells elsewhere on the membrane. The resulting rhythm of the installation represents the collective and local response of each cell, generating complexity through their overlay. From this bottom-up strategy, reactive behaviours emerge, creating an inherent indeterminacy within the structure. Robotic Membranes asks how computation of environmental behaviour can drive and change behaviour in physical material. It also examines the emergence of behavioural patterns, such as repetition. And it asks how architectural material may give, stretch or deform in such a way as to affect its own motility and presence.



Mette Ramsgard Thomsen and Toni Hicks, Strange Metabolisms, Grand Parade Gallery, Brighton, 2007
Strange Metabolisms uses complex knit structures to make bespoke three-dimensional membranes. The models are animated through dynamic armatures allowing the membranes to collapse and expand the spaces they suggest.

The concepts and technologies of Strange Metabolisms were developed through a series of workshops run by collaborators architect Mette Ramsgard Thomsen and knitter Toni Hicks, here with students from the Royal Danish Academy of Fine Arts School of Architecture and Textiles Design in Copenhagen.

Strange Metabolisms

The second prototype, Strange Metabolisms, speculates on how the bespoke shaping of a membrane prescribes a particular sense of motility. Developed in collaboration with knitter Toni Hicks of Constructed Textiles at the University of Brighton, Strange Metabolisms investigates how knit as a principle of construction can lead to new formal as well as behavioural languages. It operates at scale 1:50, and the models are machine-knitted structures, merging synthetic as well as natural fibres such as plastic, silk, steel and wool, and using the strength and qualities of these fibres to design bespoke skins that change according to their site and occupation.

Strange Metabolisms makes use of the inherent three-dimensionality of knit as a tectonic structure. The models develop surfaces that extend tubular knitting techniques, known from socks and gloves, as well as simple double-knit structures creating complex surfaces with protrusions, folds, layerings and slits. Furthermore, stitch sizes are scaled, changing the density, flex and structural integrity of the material as well as its porosity and translucence. By integrating conductive and resistive fibres, parts of the surfaces can be actuated with heat changes and the switching on and off of embedded LED lights.

Strange Metabolisms is a further speculation on movement and change in Robotic Membranes in which ways of integrating smart memory alloys and smart memory polymers into the knitted structures are investigated. In these test pieces, the membrane is actuated through the state change of the integrated smart material. Here, the scale of actuation and the scale of the project become intrinsically linked.

Conclusion

By engaging the computational with the material, Robotic Membranes examines the possibilities for complex interrelationships between the encoded and the actual. Vivisection and Strange Metabolisms explore how the specking of a material surface with an intelligent weave offers the possibility for space to be activated and behavioural. They also explore and develop ways in which sensing and actuation may be integrated into architectural surfaces. Such responsive systems may be seen as parallel and dynamic auxiliaries to the usually static quality of spatial enclosures, their structure, form, colour, opacity and so on. Both the Vivisection and Strange Metabolisms prototypes create a lab environment for the exploration of how a reactive surface can be imagined. Regarding enclosure as a live and active entity, Robotic Membranes asks how concepts such as distributed computing and intelligent programming can allow for the emergence of complex behaviours. It suggests that we may seek to build beyond the static, and design spaces that evolve across time. AD