# PROTECTIVE SKINS

## Modelling Symbiotic Protection

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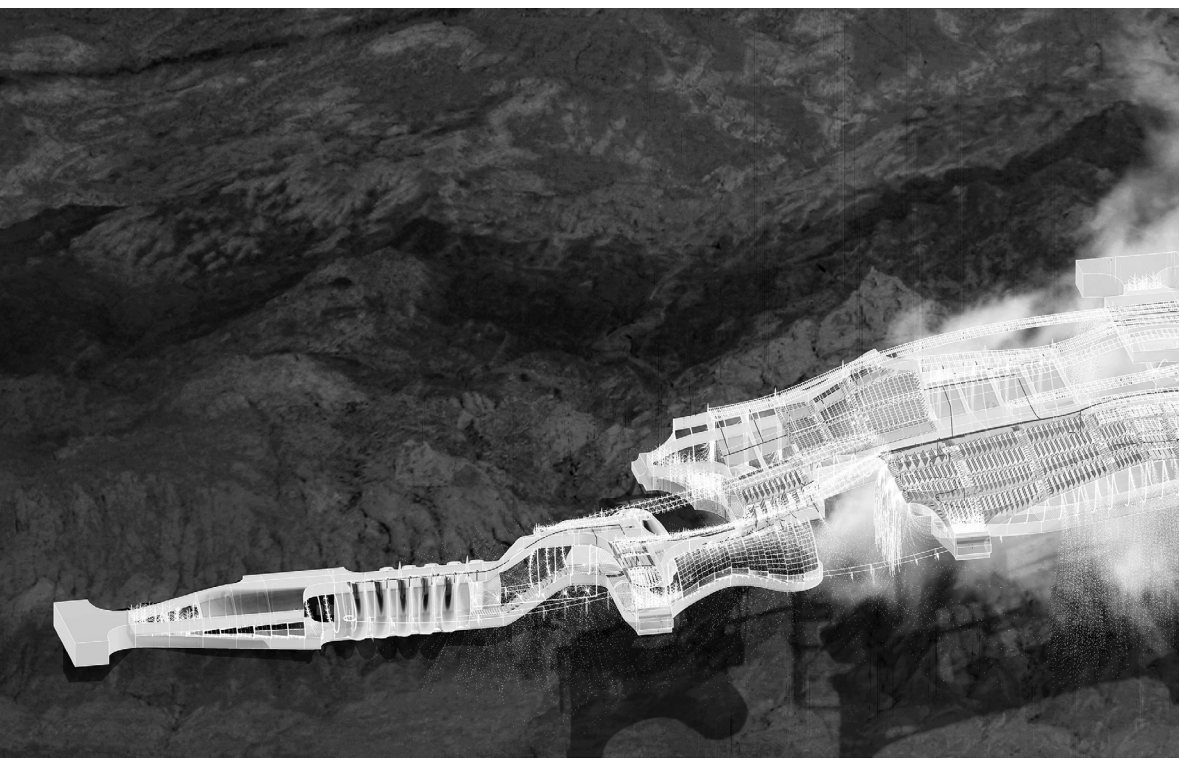
*Abstract*

This project speculates about a public bathhouse for a possible / nearby (dystopian) future, developed around the two UN Goals - "Climate Action & Good Health" and "Well-Being" (Desa, 2016). The proposal is called "Protective Skins", and it is about a divided but related architecture: a private suit and a public bathhouse - both protecting the human body from different kinds of pollutants, including airborne pollution, missing ozone layer, nuclear radiation and acid rain. The proposal is tested in a counterfactual



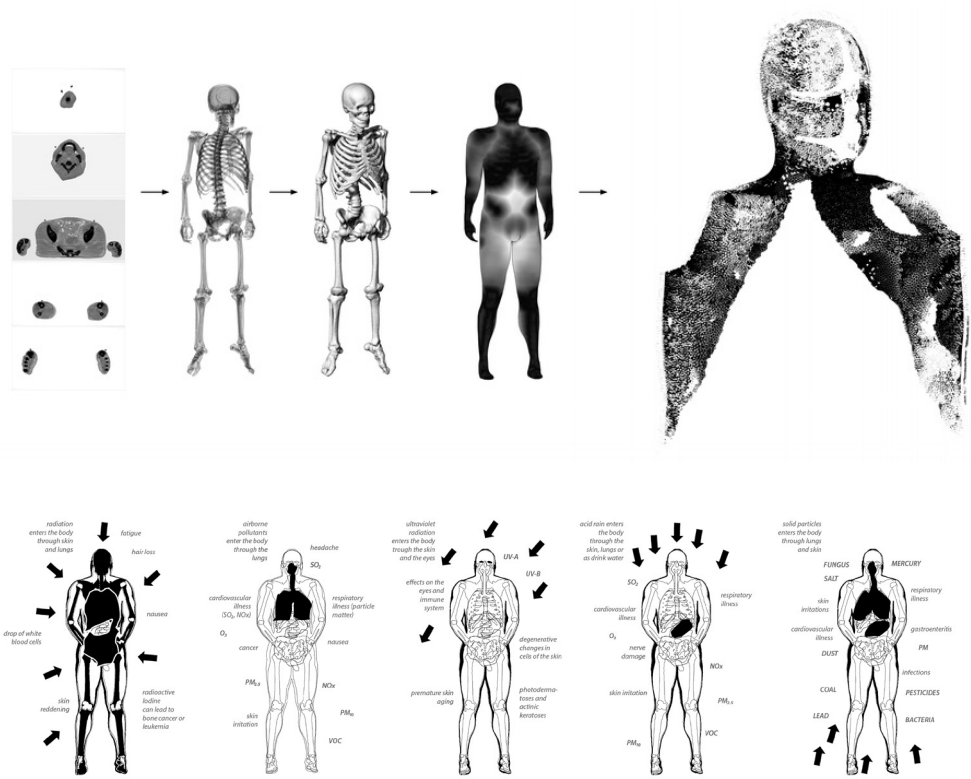
timeline on the Japanese island of Hashima, but represents a general proposal. The building functions as a cleaning machine: cleaning suits, human bodies, the environment, and itself - working as a protection system formed by the symbiotic relationships of the individual actors.

Analytical, computational, bottom-up methods were developed around the human body (informing suit and architectural program) and transferred and adapted to the scale of the building. The skins of protection are blended and allow the building to conceptually mimic the human body with its organs, structure, skin, and metabolism.

The proposal questions the architect's romanticized image of nature and the idea of protection solely as a binary on/off condition, as a possible way to rethink our architectural boundaries in general. Additionally, it asks for a critical incorporation of pollution in design, which moves away from pollution as an image and away from seeing pollution as something remote in terms of time and space. The project promotes the incorporation of measures against pollution into the aesthetic language of architecture, and therefore makes it an integral part of our built environment.

*Prototype Test Site*

The architectural boundary of the proposal is shared across a wearable skin and a building skin, which questions hermetically sealed envelopes of today's buildings; it allows for a filtering of qualities and new kinds of hazards as opposed to blocking them. Hashima Island has a suitable scale for conceptually testing the prototypical building as a filtering device in a polluted

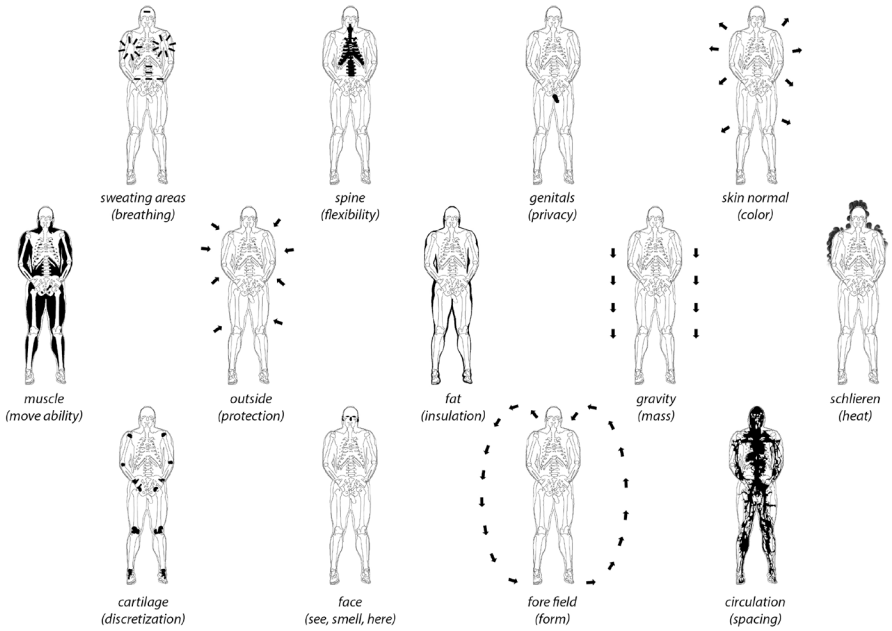



environment. In addition to its cultural relevance for a bathhouse, the site has a history of industrial exploitation – one of the main sources of today's climatic issues.

Hashima Island is positioned 17 kilometers away from the city of Nagasaki. It used to be the home for around 5000 people in 1959, who were mainly associated with Hashima's underwater coal mine . Today, it is mostly known for its post-apocalyptic appearance due to its decaying and abandoned concrete buildings. The buildings were quickly deserted after the coal mine closed in 1974. The island is a symbol of Japan's rapid industrialization (Magnay, 2013). The proposition is situated in a speculative counterfactual timeline where the island was never left due to the change from coal to petroleum in Japan. The proposal both allows new design methods to be tested, while also having the ability to account for historical, cultural and environmental factors, which makes the significance of the building more relevant and potentially more meaningful for the hypothetical people who would use it. In this sense, the building can be seen as a social commentary.

*Wearable Skin*

The human body functions as the starting point for the development of the wearable part of the architectural boundary layer betwe-


sweating areas
(breathing)
spine
(flexibility)
genitals
(privacy)
skin normal
(color)
muscle
(move ability)
outside
(protection)
fat
(insulation)
gravity
(mass)
schlieren
(heat)
cartilage
(discretization)
face
(see, smell, here)
fore field
(form)
circulation
(spacing)

en human and environment. Custom-made algorithms were used to extract different parts of the human body from medical images; conceptually, it serves as the basis for seeing the building as a metabolistic body, and technically, it is the starting point for a geometric exploration of a possible wearable protection suit (Fig. 2). The data-set is a collection of anatomical images, CT scans, and MRI scans of the human body. The discretization of the wearable skin informs the floor plan of the building - related to the ceremonial undressing (Fig. 6) - and the placement of protection filters on the building. The programmatic use of the building is designed as a ceremonial linear progression through the building as a spiritual cleansing journey, designed around the bodily phenomena experienced during the cleaning of different body parts. An incremental undressing process exposes the body to changing water-based experiences such as washing, drinking, steaming and bathing. Therefore the building stimulates the senses and the mind, which potentially creates an atmosphere of deceleration.

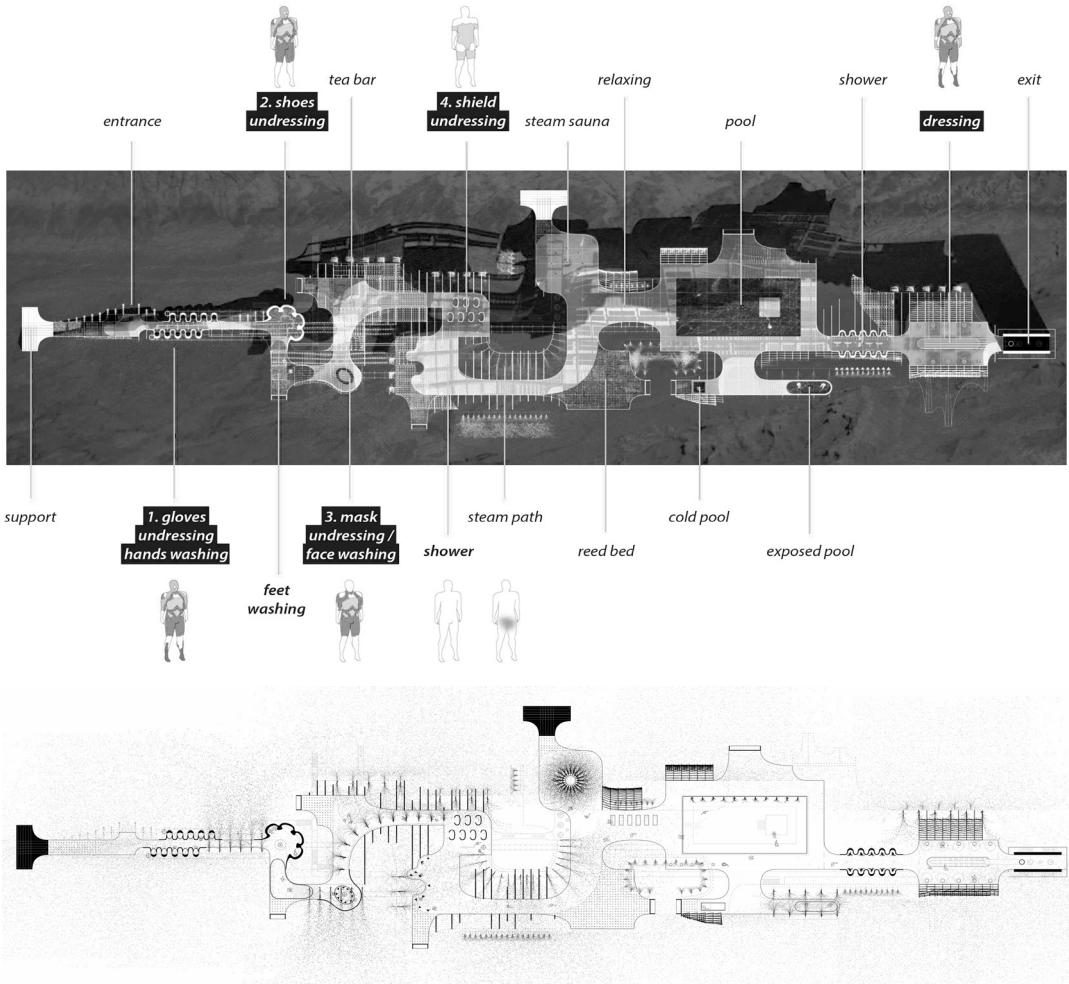
*Building + Skin*

The building is conceptualized as a ceremonial journey through alternating moments of undressing and body cleaning, slowly shifting from a personal experience towards a collective gathering. Additionally, the internal atmosphere changes from polluted / unprotected, cold and dry to clean / protected, humid and hot, due to the increasing filters on the structure which are distinguishable in physical, atmospheric and passive filters. Methods for positioning, quantifying, and qualifying the filtering layers and devices are shared with the development of the suit discretization. The positioning of the filtering devices in a synergistic manner turns the building into a cleaning machine / filtering device on the test site Hashima island: cleaning suit, human body, environment, and itself. Additionally, different shortcuts for staff and visitors as well as the meeting of different systems (programmatic, technical and metaphorical) give the building its own metabolism as it processes water, people, dirt, toxins, clothes and air.

The integration of all systems into the building design, and its basis on the human body in the first place, speculates about an architecture of wholeness, where the integration of the human body and its relationship to the building and to the environment can create a spiritual feeling of universal integrity, enhanced through a phenomenological ceremonial journey.

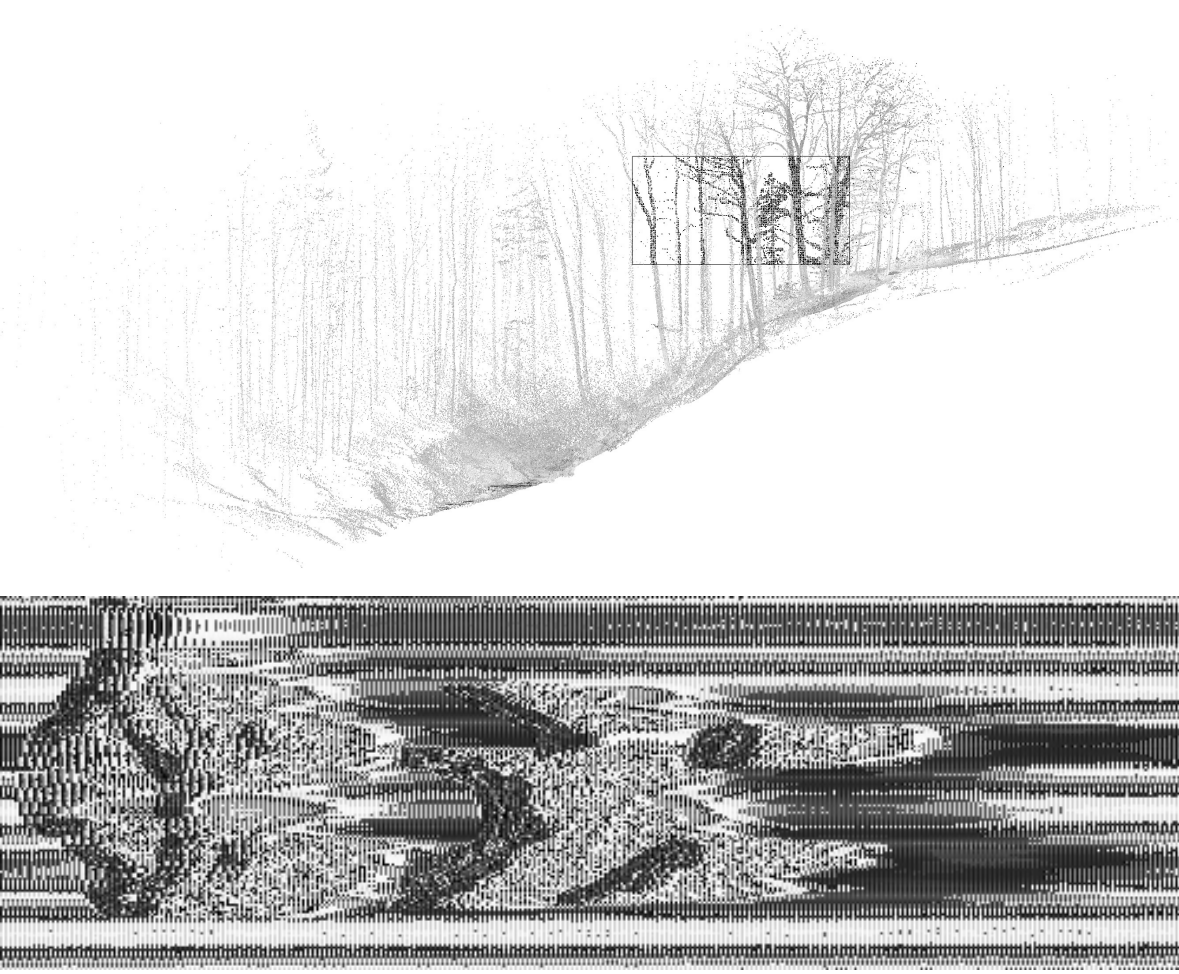
*Skin Modeling Appendix*

The discretization of the wearable skin, and the related programmatic journey through the building, is derived from the exploration of the human body based on an anatomical voxel model of a human body (Massey & Yilmaz, 2016). Nonetheless the project does not fully make use of the aesthetic possibilities of such a method. The following part describes the status quo of an on-



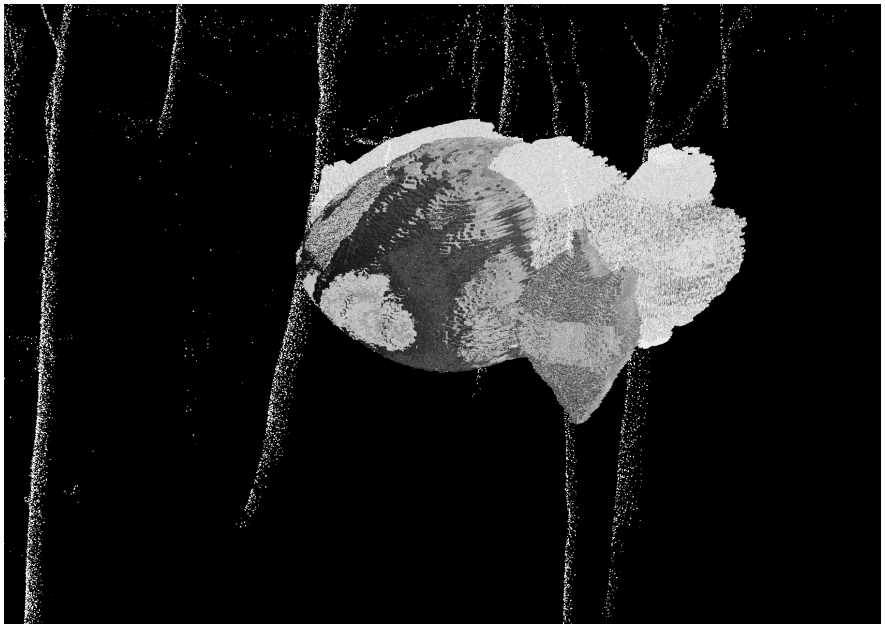

going research related to the findings made in the methods used in the project.

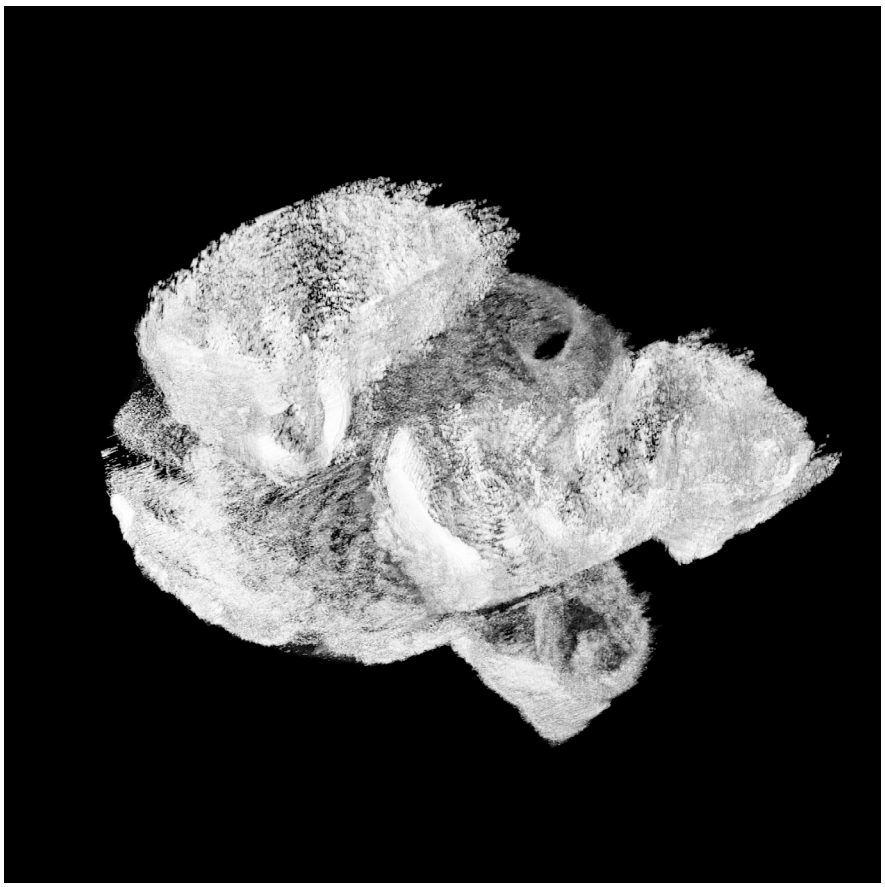
While geometrical architectural site analysis is usually based on measuring and documenting the boundaries of material surfaces, medical analysis of sites (such as the human body) often happens through an image- or voxel-based approach (x-ray / CT- and MRI-scans). The advantage is a data-heavy and rich 3D environment which enables the understanding of complex systems. While in medicine this can be used to understand and document the human body, in architecture it can be used to actively generate forms, spaces, and atmospheres. A voxel-based approach for architectural material generation (Bader, Kolb, Weaver & Oxman, 2016) is conceptually looking toward a logical shift in 3D-(robotic)-printing, away from a layer-based printing approach, and instead towards multi-material spatial printing (Garcia, Soler & Retsin, 2017). Multi-material-printing allows bespoke parts, objects and architectures to react on "hyper-genius-loci" characteristics. Those characteristics can be



based on geometry, materiality, color, temperature, forces, toxins, light, sound, smell, and even culture; every architectural site can be divided into infinitesimal small parts containing quantifiable information as well as more qualitative information about culture, history, and other more intangible elements. Even though such a thorough analysis would be impractical and unnecessary for most cases, it opens up an interesting discussion about new possibilities of data-driven architectural material generation for digital fabrication where different systems are more likely to flow into each other rather than existing as discrete entities.

From an artistic, ornamental, and non-optimizational point of view, such a data-driven modelling environment allows completely new ways of generating shapes and forms. Voxels can be generated and weighted in a bottom-up manner based on mathematical formulae and self-organizing principles such as agent-based modelling (Grimm & Railsback, 2005), cellular automata (Wolfram, 1983) and potentially machine learning / neural-network-based approaches (Hopfield, 1982). It can also be informed by top-down decisions / rules based on arbitrary information (color, distance, weight, etc.) to inform material generation / deposition.





*Glitch Sonification as New Ornament*

Similar to the discretization of the Similar to the discretization of the human body into image slides in computer tomography technology, every space, volume, or geometry can be divided in a similar manner. Image slides themselves can be divided into x- and y-coordinates. Using the image position in an image stack as the z-coordinate allows an easy translation from geometries in conventional architectural model environments into stacks of images. The x-, y- and z-coordinates of pixels can be used as voxel-positions with the edge length of a pixel. Generally, there is a simple way to represent the same position (and arbitrary values connected to it) as pixels in images within images stacks, as voxels, as points in point clouds or as a line of text with the structure "x y z value" (for example: 10 100 12 green / hot / 12kg).

When translating geometries or spaces into images it opens up the world of image analysis (computer vision) and image alteration techniques. The following example uses a combination of a bespoke 3D cellular automata working on voxel-scale and an image-based glitch-art method (Menkman, 2011) to generate architectural ornaments.

Glitch art is a term used to describe the aestheticization of technological malfunction. In its principle it is the digital version of the Japanese concept of wabi-sabi, which itself describes the acceptance or appreciation of imperfection.

The glitching method used for the ornamental voxel alteration is based on the idea of data sonification (Kramer, 2000); images are translated into sound files, which opens up the world of sound manipulation as an image alteration tool (Temkin, 2018). Different sound effects, like echoes, reverbs, and distortion, have different effects on the image. The settings and effect-intensity have an impact on the image distortion. A subtle tweaking of value combinations is necessary to use the sonification as an ornamental effect. Similar to the idea of wabi-sabi, it is the subtle imperfection which humanizes the object and not its breaking.

*Conclusion*

The project describes a design method for architecture which is centered around the bodily experience of its inhabitants. Here in the context of protection against pollution and pleasure in the purifying acts of cleaning and bathing, it touches on the idea that architecture could be developed around quantifiable needs of the human body. It shows an alternative way of designing building envelopes by deconstructing the facade into a wearable and a static part, therefore challenging the idea of industry standards. The proposal introduces the idea of a voxel-based design context exploration which is investigated more artistically in the appendix. The exploration demonstrates a feasible workflow for future data-rich 3D-(robotic)-printing design environments.

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*Author Biography*

Sebastian Gatz is an architect, artist and trained car mechanic, working and teaching at the intersection of art and science - currently at his Alma Mater, The Royal Danish Academy of Fine Arts at the Centre for Information Technology and Architecture. His work explores the relationship of art, architecture, technology and fiction. He worked, taught and exhibited in Germany, Portugal, the United States, Italy and Denmark.

*Image Captions.*

*In order of appearance.*

Figure 1: Architectural Proposal of a bathhouse for Hashima Island

Figure 2: Image-based method for body analysis and form generation of a wearable skin

Figigure 3: On-site hazards and the effects on the human body

Figure 4: Human anatomy and its relationship to architectural concepts

Figure 5: The naked human skin is protected by the subtle layering of physical and atmospheric filters on the building's facade.

Figure 6: The suit discretization forms the basis for the architectural program: the ceremonial undressing of the human body, the building as a spiritual path.

Figure 7: Invisible changing quantitative and qualitative atmospheres of temperature, humidity, pollution, protection and privacy are designed around the phenomenological experience of the human body.

Figure 8: Design space: a part of a 3D point cloud scan of a forest is discretized into voxels / image slides.

Figure 9: Image sonification of a sliced geometry generated by cellular automata

Figure 10: "Glitch shelter" as a proof of concept

Figure 11: Medical image analysis software used to visualize 3D section of the glitch shelter