

Animation of Represented Bodies, Between Science and Design Practises

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Abstract

Most of today's design practices focus on complex form, displaying free-form animated surfaces inspired by the complex geometries and structures of the human body. Nonetheless architectural, product and fashion design tend to employ the same representational tools and methods in order to build artifacts which recall the shape of the human body in motion, as subjected to continuous transformation and hybridization processes, in 3D deformable models. The final purpose of the artifact can often be traced back to a single frame of the whole animated sequence, representing the entire design process consisting of continuously morphing of models or, as in the case of Generative design, it is even possible to rebuild the evolutive processes of the form. The paper investigates theories and methods for an eidomatic description of the body by means of a trans-disciplinary analysis of the state of art, testifying the latest trends in 3D animation, also through the documentation of some specific case studies selected by the submitter. The theories and the latest techniques of digital video representation will be compared and analyzed in order to discuss differences and similarities in design practices that have as a main subject not only the body, but also its communication. Representing the body today implies relating to the scientific innovation that often endows it with coexisting integrated technologies and, meanwhile, researches the performance effects of its image, through transformation processes that present innovative and possible communicative scenarios.

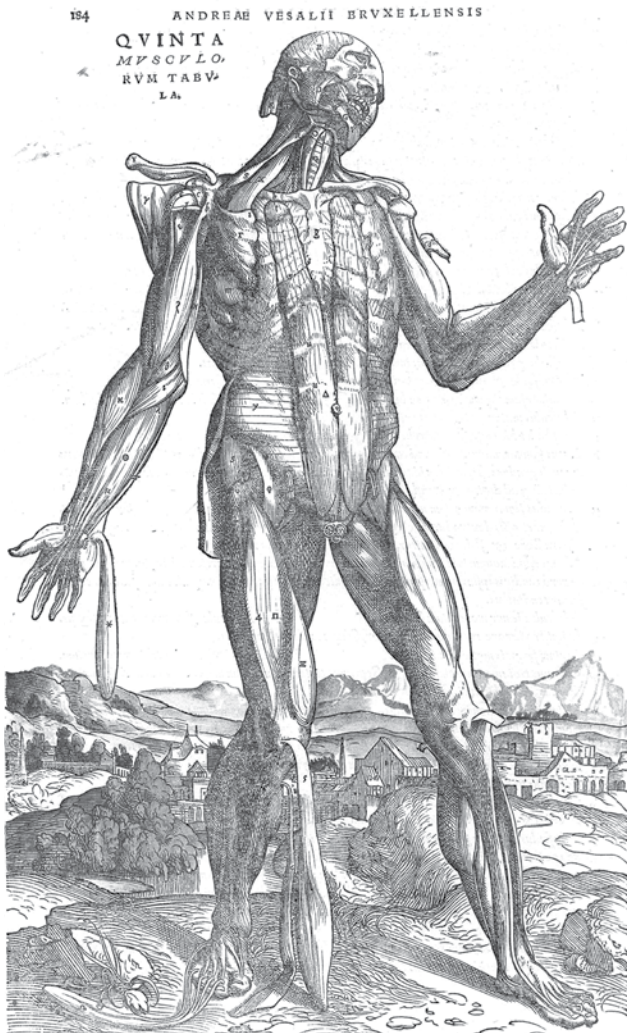
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The digital drawing approach to design is for its very nature animated and manifests itself in continuous movements that orbit the point of view around the shape to be modelled, so that architects and designers, by now accustomed to the information technology tools, work in a dimension that Derrick de Kerckhove defines as an 'extended present', because "The collective technological memory furnishes the means for infinite explorations in different levels of time" [1]. Conversely, the analog drawing tools have reproduced in the fixity of the conclusive image the results of a gestural experience which hides a non reproducible nor reversible time. Yet the image in motion permits to reproduce the experience and to document the results of a process in progress. In both cases, between

digital and analog devices, the available *medium* can guide the actions of the subject who employs it, and according to Lev Manovic [2] the animation, which played a fundamental role in the birth and development of cinema, plays now a central role in computer graphic, by alternating a 'real' collective imaginary to a 'synthetic' one.

Today the study and the observation of dynamism processes are concerned with the human body and design artefacts in general, in such a way as to assume a core role both in the results of practices and in the methods of project representation, which describe them. Rather than focusing on completeness of the *static* form to be achieved, the designer constructs real animated sequences that intertwine and blend the image of the body with the

Figs. 1, 2. Illustrations by Jan Stephan van Calcar, in Vesalio 1543.



images of architecture and product design, in figures that are the result of becoming processes.

In fact, the relationship between body and architecture has always been very present and has, on the other hand, a very long history that ranges from research of proportion and symmetry in a perspective of Vitruvian centrality, to organicism, to anthropomorphism, until reaching the present hybridization and technologization of a body that does not refuse the metamorphosis of prosthetics, either for medical or aesthetic reasons but, as Anthony Vidler [3] suggests, dissects itself and redraws its skin thus continuously testing and experimenting. Then the focus moves from the external completeness of the complex machine of the human body covered by the epidermal lining towards introspection and deconstruction.

Hence, the body undergoes dismemberment and subsequently the bowels are cut.

This paper, therefore, pays attention to the image of the contemporary body, subjected to contamination of any kind, which alters its form and content, questioning the concept of identity itself.

In a sort of non-nostalgic return to classical studies of anatomy, new forms and physical possibilities helped by technical artificialization are experimented, and yet the body image is not static and reveals a pulsating nature, unlike the anatomical representations of Andreas Vesalius [4], that registered scientific discoveries through dissection, as documented by the masterful illustrations by Jan Stephan van Calcar [5] (figs. 1, 2).

Here the static nature typical of this type of representation, which has stratified pieces of information for centuries through a sequence of plane images, must face the three-dimensional representation of the digital clone and with its animated introspection, in line with the endogenous analysis which medicine performs on an alive body through videos, displaying what is usually unseen.

In this sense, the methods of project representation have considerably developed, passing from the traditional languages of drawing that returned the description of the artefacts in a limited two-dimensional projection—dear to Gaspard Monge—to the full control of objects distinguishable in their real three-dimensional features and movements in the cases in which they are present.

For a long time architecture was basically seen as a discipline devoted to the construction of static solid volumes, but since the 1990s, the massive introduction of personal computers available to everyone and the low

cost CAD softwares into the market have transformed the work of the designer, who has become a 'sculptor' capable of modelling complex three-dimensional shapes in space, so that the term 'drawing' ends up by coinciding more and more with the term 'modelling'.

The physical reality of objects can thus be simulated, and so can the dynamism that will hence be somehow prevailing in the project's actions and in its communication.

Rem Koolhaas's approach in the *Jussieu Libraries* [6] design was significant. In it the curve imposed on the floor surfaces defines a continuous path that meanders freely within a transparent box, but the visitors' movements determine the project's representation strategies. These strategies are not reduced to the simple orthogonal projection, which is still in use in the plates of international architecture competitions, but draw a diagrammatic continuous section reminiscent of Marey's studies [7] and of the deconstruction of human motion, summarized in a synoptic image capable of synthesizing the frames of a kinematic sequence through the invention of *chronophotography* (fig. 3).

Concepts such as structure, skin, force, deformation, motion and animation become the key words of an architecture that uses digital technology to represent the complex form through NURBS [8] algorithms—which translate into mathematical models the totality of natural forms through directrix curves along which generatrix curves run for the realization of sinuous surfaces—and not only.

The idea of movement is already rooted in the type of approach offered by solid modelling techniques and the figures employed can be continuously changed, because of their subjection to the action of force gradients; these are vectors that progressively alter the 'figures' geometry while the designer can decide what the final result of a structure that evolves over time will be [9].

A structure uses the properties offered by the inverse kinematic chains in order to self animate. So the techniques of 'rigging', generally used for the animation of 3D human characters in cartoons and video games of the last generation, are applicable to the body of architecture. It is necessary to construct a skeleton and define hierarchies of movement for it, because every single movement of a bone will affect the movements of the bones attached. In particular, we can apply a movement to the last object of the chain, thus defining the intermediate positions of bones connected within the same hierarchy, in order to construct an inverse kinematics chain able to shape the skin of the architectural shell which will take different poses (fig. 4).

However, although Kinematics studies body motions without considering the causes that generated them, further changes to the geometry of three-dimensional models can be implemented by subjecting them to the dynamic action of attractive or repulsive force gradients, to physics laws and gravity.

Very often Kinematics and Dynamics are integrated in the design practices of many architects, but they also interact with other design disciplines, such as Fashion, that necessarily creates moving architectures animated by bodies.

Fashion designers such as Hussein Chalayan redefine the *silhouette* by using digital technology to shape the geometric surfaces of garments directly on the bodies.

These are subjected to the dynamic action of morphing or experiencing microchipped innovative materials [10], on clothes shape-shifters that independently move and open the doors to the *Animatronic Fashion Era* [11].

But the entire design process, from concept to finished product, can be equipped with digital clones, i.e. avatars that reproduce the sizes of real human bodies on which the apparel is modelled, simulating the traditional technique of *moulage* with which designers can drape textiles directly on the dummies.

They are organic models which *mesh* [12] defines as surfaces, generally polyhedra with quadrilateral faces.

These surfaces can be transformed into curves converting the linear profiles into tangents and NURBS directrix and generatrix.

By doing so, the plane surfaces of patterns collide with the bodies, reconstructing the curve shapes and the animated

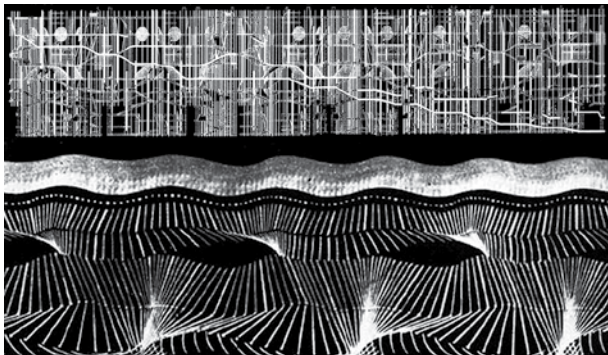
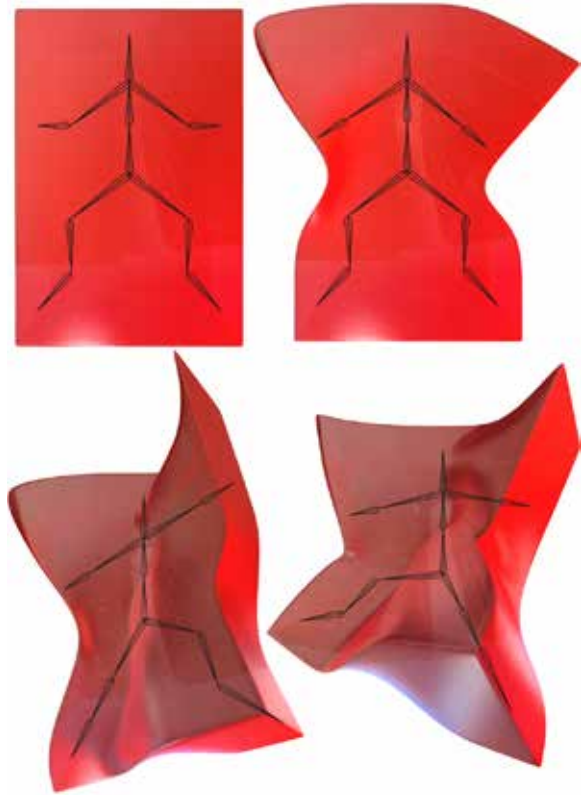


Fig. 3. Graphic scheme development of the National Library in France, designed by OMA in 1992-93 and cronophotography of Soldier Walking, É.J. Marey 1883.

Fig. 4. M. Ciampanella, Rigging the Box, 2016. Invers kinematic chains applied on a subdivision surface.

draping of clothes through the 'clothing simulation'; indeed many softwares allow operators to associate the physical properties of materials to surfaces that make up clothing. The real body and its digital clone are overlapped to adapt to the demands of the project and at the same time the new technologies reflect present and future aesthetic images, actually, even before designing clothes, fashion has always designed the bodies, as stated by Lucy McRae [13], an Australian artist who defines herself a 'body architect.' Her work explores the boundaries of a body that does not reject prosthesis, evolving and reshaping its anatomy. In fact, the parallelism with today's architecture, its complex forms and representation methods which determine its geometry, does not show substantial differences. The movements and the poses of the 'structural skeleton' determine in both cases the variations of a volume covered with an infinitely elastic skin; for Bart Hess [14], a friend and collaborator of Lucy McRae, the animation of the body draws instead the soft surfaces which cover and modify it, in order to understand its evolution and to exploit its potential, between genetic manipulation and redefinition of the beauty concept.

In *Echo* [15] (fig. 5), the body movements of an actor suggest the dynamics of digital surfaces which dress and filter through translucent membranes that vibrate as thin shells. They are fluid skins of an alternative body that perfectly mimics the gestures of a real body and perfectly superimposes on it, thanks to the use of dedicated software to 'camera tracking' [16].

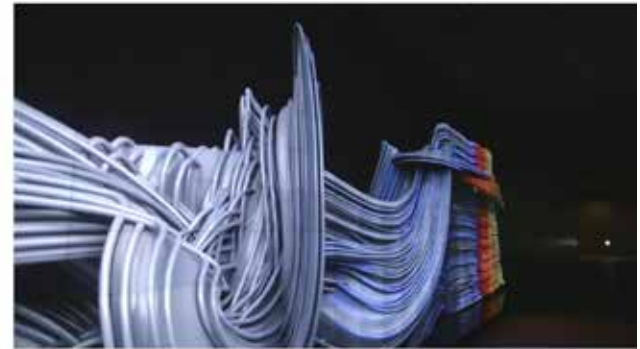
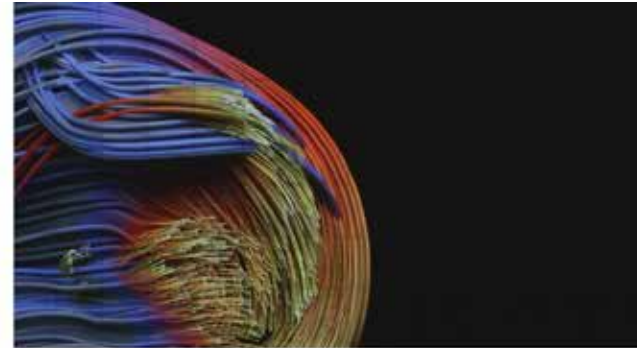
It is easy to understand that digital modelling and 3D animation offer multiple possibilities of expression and they often seem to influence the project.

Architectural product and fashion design get to use the same tools and representation methods to build artefacts that recall the shape of the human body in motion, subject to continuous processes of transformation and alteration. But when the body is the exclusive subject on which the current projects of visual communication and multimedia focus, there are two opposing trends: on the one hand the aim is abstracting it to highlight the traces of its movement that will subsequently allow to recognize it, to the other hand perfect virtual clones are reconstructed in such a realistic and expressive way as to wonder about their real nature. In the first case the capture of a person's movements through repeated scans could be represented on a numerical model which gives back only a cloud of recorded points in place of the body.

Fig. 5. B. Hess, *Echo*, 2011. Video frames
<<http://vimeo.com/40286131>>.



Fig. 6. D. Franke e C. Kiefer, *Unnamed soundsculpture*, 2012. Video frames <<http://vimeo.com/38840688>>.



Consequently, physicality dematerializes and the points follow the sinuous curves drawn by the choreography of a dancer as a swarm, as in *Unnamed soundsculpture* [17], which represents the balance between contextualized form of motion in the virtual space and abstraction of the real subject that determines it (fig. 6). The same thing can be said of *Made by humans*, an installation realized by *Universal Everything* [18], a renowned graphic design studio, whose title announces the endless drawing that the body is able to track when it is not still. In this case, its shape melts and is carried away by sinuous curved surfaces that delimit the space of action of the body and are formalizations of its passage, recorded by sophisticated motion capture instruments (fig. 7).

When, on the contrary, the subject has to become recognizable, the digital representation exhibits hyper-realistic 3D avatars that embody the desired aesthetics.

Their impact is, however, less invasive than a bistoury, although even the image of the most beautiful bodies is changed by the editing software for images, as seen in fashion magazines and advertising posters.

Moreover, the accurate digital clone of the body can be reproduced by means of body scanners, or by using low cost techniques typical of photo modelling, where the subject is photographed simultaneously from different points of view in order to produce a three-dimensional model with ultra high resolution textures; this is made possible by Multi-stereo Matching Softwares [19] more generally used for surveying small size artefacts and in the acquisition of painted surfaces. This methodology has been tested upon a living body—which is difficult to survey because it is never motionless—in the video clip *Memex* [20] by the British band Duologue, where photogrammetry becomes an expedient to investigate the aging processes of the body and the concept of mortality itself (fig. 8).

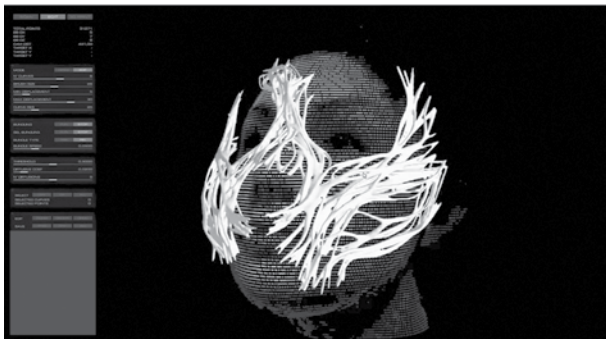
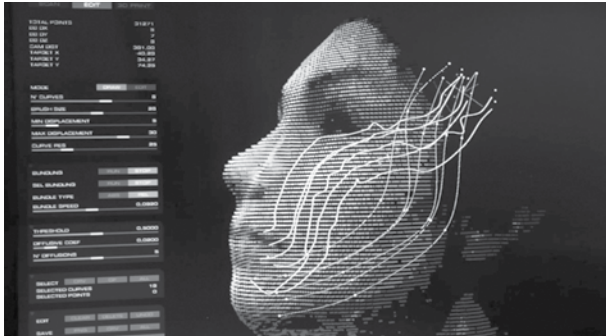
Today representing the body means relating to scientific innovation, that often endows it with coexisting integrated technologies and, at the same time, questions the performance effects of its image through transformation processes that could offer new possible communicative scenarios.

Re-reading and interpreting the traces of its passage means building the basis for designing its action space, but framing its image means relating with a globalized body that aims at surgery artifice in order to move Eastern canons towards the West and vice versa. Architecture too seems to have adapted to these tendencies, relying on parametric

Fig. 8. *Marshmallow Laser Feast e Analog*, 2014. Video frames of *Memex*'s videoclip, Duologue Band <<https://vimeo.com/1104385260>>.



Fig. 9. MHOX, *Collagene*, 2013. Video frames
 <<http://vimeo.com/62662754>>.



modelling with generative algorithms as a process of reunification of a form of living that often repeats itself and tends to make recognizable the software that created it and not the designer's hand.

It is a particular type of 3D modelling, also called 'associative', which does not stimulate the designer to aspire to a sense of formal completeness, because the final shape will be the result of a variable and continuous process, but can also activate a series of interdependent parameters arranged in a schematic configuration.

It is a sort of family tree within which, if one or more parameters are modified, the infinite formal configurations of the project consequently change.

However, the algorithmic logic which uses sliders to modify surfaces and solids in animated sequences is different from the usual practices of digital representation.

In many cases it seems as if the drawing is erased by the aseptic distribution on a plane of components and scripts which require skills more similar to information technology programming than to drawing programming. In this sense, many plug-ins and softwares [21] could be developed by improving the easiness of use, given the innumerable morphological configurations they are able to activate and the great interest in this type of parametric modelling, which not only affects architecture, but design in general.

However, for now the results produced by generative design tend to homologate the definition of intertwined structures that seem to mimic the complexity of bones viewed under a microscope or in the redrawing of the skin on them, which can be cut or covered by repeating patterns.

The final results will be articulated anthropomorphic figures for which the human body can act as a support for new compositions, less invasive than the tattoo, yet reflecting on the strict relationship between physical nature of the body and digital artifice, as can be seen e.g. in *Collagene*, a project by MHOX [22] (fig. 9). In *Collagene* faces are scanned by *Kinect* sensors that represent their numerical model on which one can freely trace the curves along which curved profiles of a complex structure easily prototyping with 3D printers extrude. The group of designers investigates the properties of biological systems in order to develop generative artefacts [23], but here the reasons of growth are arbitrarily related to the free form of a virtual organism crossing the geographies of the face that it engages by redrawing its mask. From all the above considerations the animation of represented bodies taking place at the cross-

roads of science, design practices and communication, is the dominant feature of a system of planning approaches that invest in digital representation methods which focus

on the evolutionary character of a complex shape made up by the free surfaces of a body in constant transformation and the subject of a multidisciplinary open dialogue.

Notes

[1] De Kerckhove 1996, p. 163.

[2] Manovich 2001.

[3] Anthony Vidler says: "It is a body which seems to be fragmented, if not contorted, deliberately torn apart and mutilated almost beyond recognition. Paradoxically, it is advanced precisely as a sign of a radical departure from classical humanism, a fundamental break with theories of architecture that pretend to accommodation and domestic harmony. [...] Its limits, interior or exterior, seem infinitely ambiguous and extensive; its forms, literal or metaphorical, are no longer confined to the recognizably human, but embrace all of human existence, from the embryonic to the monstrous; its power lies no longer in the model of unity, but in the intimation of the fragmentary, the morsellated, the broken": Vidler 1990, p. 3.

[4] Vesalio 1543.

[5] Jan Stephan van Calcar (Giovanni da Calcar; Cleve 1499-Napoli 1546), Painter and illustrator; the artist moved to Venice in 1537 approx, where he worked in Titian's study.

[6] OMA, Rem Koolhaas, design project for the unrealized National Library in France, Jussieu Campus, Paris 1992-1993.

[7] Étienne-Jules Marey (1830-1904), was a physiologist who worked on the study of movement in its different variants. He developed the contemporary work of Eadweard Muybridge, but unlike the editor and photographer; Marey worked with a single photographic camera for the shooting of multiple images, using actors in catsuits and markers for the motion capture.

[8] NURBS: acronym for *Non Uniform Rational B-Spline*, it described mathematical algorithms which represent curves, solids and surfaces of every genre. See: Piegel, Tiller 1997.

[9] Ben van Berkel says: "Move is about redefining organisational structures on all levels [...]. Structures are free to assume different identities" van Berkel, Bos 1999, p. 15. Body skeletons are included, their kinematics could affect the animated morphology of architecture. In this sense, Greg Lynn clarifies the fundamental role of the animation in design processes: "Animation is a term that differs from, but is often confused with, motion. While motion implies movement and action, animation implies the evolution of a form and its shaping forces; it suggests animatism, animism, growth, actuation" Lynn 1999, p. 9.

[10] See e.g.: *Windblown dress* presented at the *Inertia* spring/summer 2009 collection and 2007 spring/summer collection.

[11] Hussein Chalayan: Turkish/Cypriot fashion designer who was among

the first to integrate new technologies into his creations. In particular the spring/summer 2009 woman collection, developed in collaboration with Swarovski, has been defined by critics as *Animatronic Fashion*.

[12] Unlike the NURBS, which are mathematical models since they are described by equations, the mesh surfaces are numerical models because are described by the coordinates of vertices.

[13] Lucy McRae is an artist who explores the limits of human body and its form: <www.lucymcrae.net> (consulted on May 14, 2017).

[14] Bart Hess is a Dutch artist who has collaborated with Lucy McRae in different projects whose protagonist is the body and its form <<http://lucyandbart.blogspot.it/>> (consulted on May 14, 2017). He works primarily with video and has produced the *Slime Art* effects of the video clip 'Born This Way' for the icon of pop-music Lady Gaga, director Nick Knight, 2011. In order to appreciate the work of Bart Hess, refer to its website <<http://barthess.nl>> (consulted on May 14, 2017).

[15] *Echo*: video directed by Bart Hess for the National Glassmuseum in Netherlands, Leerdam, 2011. <vimeo.com/40286131> (consulted on May 14, 2017).

[16] Camera tracking is a procedure able to digitally translate the spatial coordinates and the properties of single perspectives, registered by a real camera. Generally, the video shoots are processed by softwares able to recognize common points on contiguous frames. They will become spatial points of a cloud on which one can define the geometries of simple solids, such as cubes and parallelepipeds, but also flat surfaces recognizable in various frames. The effects of the real video camera will be converted, like contributions of a digital camera, to import into a common 3D animation softwares.

[17] *Unnamed soundsculpture*: video by Daniel Franke and Cedric Kiefer, in which the moves of a dancer were registered by three Kinect depth camera (Microsoft), and subsequently reworked into a 3D modelling software such as 3D Studio Max (Autodesk).

[18] Universal Everything is a famous graphic design studio founded by Matt Pyke. <<http://universaleverything.com>> (consulted on May 14, 2017).

[19] See e.g.: Agisoft PhotoScan <www.agisoft.com>, PhotoModeler Scanner <www.photomodeler.com>, 123D Catch <photomodeler.com> (consulted on May 14, 2017).

[20] The project is a collaboration with the Marshmallow Laser Feast <vimeo.com/marshmallowlaserfeast> and Analog <analogstudio.co.uk> (consulted on May 14, 2017).

[21] See e.g.: Grasshopper <www.grasshopper3d.com>, ParaCloud GEM, <www.paracloud.com>, GenerativeComponents <www.bentley.com> (consulted on May 14, 2017).

[22] MHOX is a generative design lab founded by Filippo Nassetti and

Alessandro Zomparelli on 2012 <www.mhoxdesign.com> (consulted on May 14, 2017).

[23] Do the Mutation, *Collagene*, May 29, 2013, p. I. In: <dothemutation.wordpress.com/2013/05/29/collagene-4/> (consulted on May 14, 2017).

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