The Role of Computer Technologies in Restructuring of Design Education

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Abstract

Today it's possible to create works where interdisciplinary multi-dimensional ideas can be modelled via definite algorithms thanks to parametric design tools. This change in the field of design converts the re-setup of the design education obligatory along with it. For this primarily a literature seach is conducted within the scope of the study in order to determine the advantages to be provided to students by parametric design tools, being totally different from the traditional design sense, and it is seen that the advantages in question are basicly clustered under 25 main topics. In this context is the scope and purpose of the study determined as; to re-scruntinize the advantages provided by the parametric design tools determined in the literature and to test these on real projects and to reveal the necessity to integrate computer technologies into this process during the structuring process of the education with real samples. As the methodology of the study 20 projects, developed with computer technologies, are selected. Then, every project is handled one by one and scruntinized whether the advantages provided by parametric design tools are benefited from during the development process of these projects. As a result of all evaluations performed within the scope of the study, it is determined that the advantages provided by parametric design tools are benefited from at different levels during the development process of these projects. In line with all these determinations, it is revealed with real samples that the integration of computer technologies into the design education will significantly contribute to the professional skills of the students.

Keywords: Design education, Computer technologies, Digital design, Parametric design

Introduction

The design sense has passed much beyond the human creaticity and entered into an extraordinary evolution process along with the developing computer technologies and started to progress in a much faster manner as usual. Today it's possible to create works where interdisciplinary multi-dimensional ideas can be modelled via definite algorithms thanks to parametric design tools. This change in the field of design converts the re-setup of the design education obligatory along with it. It is today no more possible to sustain an educational system, conducted with a traditional understanding. The design process started to change along with technological developments, too. In this context is the necessity to have a transdisciplinary understanding within the design education is emphasized (Çakıcı et al., 2014). For the Szalapaj (2005), he stated that the use within the training process of technologies with calculations based on mathematics and logic aiming to solve the complex nature of design, would make possible for dynamic, relation based and generic designs to be created. Hennessy and Patterson (2006) stressed the fact that up to now the institutions offering digital design practices were international institutions offering post-graduate research opportunities, but now that the design process was beginning to be shaped by new developments, these kinds of approaches had to be integrated at the undergraduate studies level. Wang and Duarte (2002) proposed that digital design instruments be used to transform modern design training studios into areas of experimentation and play, and this kind of transformation would raise the creativity of students to highest level. The integration of correct software into the thought process as a part of training, and experimentation with alternative overtures through various script languages would be important from the point of view of the creation of contemporary conceptions of design (Curl, 2000; Yazıcıoğlu, 2011a). And Oxman

(2008) emphasizes that the utilization of digital technologies in design education will allow the students to experience new design processes.

For this a literature seach is conducted at the first stage of the study in order to determine what the advantages to be provided to students by parametric design tools are. As a result of these conducted searches, it is seen that Verchota and Vogel (2000) noted that the computer technologies operate as synchronous thinking systems with human brain and have an important role at the development of innovative design understandings. And Kolarevic (2003) says that digitally managed design processes are dynamic and open-ended provides positive contribution to the creative process. Beside this, it is possible to create numerous solution alternatives by different limitations thanks to the parametric design (Aish and Woodbury, 2005). Lee et al. (2013) emphasize that digital technologies are an important tool for finding out the hidden creativity of the designer and says that the designer can develop his/her form search much beyond his/her own creativity by diverse script languages. Holzer et al. (2009) noted that engineers and designers can perform the information transfer rapidly thanks to computer technologies and thus find the possibility to work simultaneously during the conceptual design process stage. And Havemann and Fellner (2004) have modelled in the study they conducted gothic window forms in computer environment and developed a formulization regarding the construction of prototypes for these. This study shows that complex forms can ve defined with mathematical expressions in computer environment. Similarly has Burry (1996) handled the triplet arch in Sagrada Familia, one of Gaudi's most important works, as a case study and re-modelled this arch with parametric design tools. By this way, it is possible to discover the mathematical relations used at the creation stage of past forms. A similar study to the study conducted by Bury is performed by Hernandez (2006) has resolved the geometric formations of all columns of the work Sagrada Familia by

Gaudi in computer environment and named this the “Design Procedure”. It is possible to perform an unlimited number of modelling pursuant to the design understanding of Gaudi by utilizing the results of this study. Park et al. (2004) emphasize that the utilization of parametric design tools at particularly the resolving of complex structural systems, coming to the foreground at the design of high buildings, allows the realization of an innovative process which provides the simultaneous control of multiple variables by the designer. Vincent and Miguet (2009) have demonstrated in their study that the limitations regarding the luminuous transmittance of the building surfaces can be defined even during the early stages of the design by utilizing parametric design tools in order to use natural light in an efficient manner. With other words; it is possible to determine with parametric design tools in prior in which direction environmental factors will influence the design. Carlos (2011) says that it is possible to discover the geometric configuration of the relations between the parametres and to produce prototypes in a rapid manner thanks to digital technologies. Numerous alternatives can be created for the solution of design problems by parametric modelling tools. This process, conducted in computer environment, allows also the accurate information flow within the design team (Hudson, 2010). Yazıcıoğlu (2011b) says that thanks to digital technologies the designer can develop his/her own design techniques, that it is possible to experience and test the design in a virtual environment, that it is possible to establish result generating algorithms by utilizing the arithmetic and logic skills of the computer. Beside this, he notes that hybrid materials can be obtained, that it is possible to create designs, which increase the own natural capacity of a material to top level and to develop authentic production systems by parametric design tools. Yazıcıoğlu (2011b) denote in her study that it is possible to convert abstract forms into real designs, that the physical and biological capabilities of the creatures in the nature can be modelled mathematically, that the the design can be produced in

different forms by systems established with the same hierarchic and geometric relations and that the human-design interaction can be experienced in virtual environment and the results reflected on the design with reproducing software. Oxman (2012) noted that it is possible to discover digital materials and to test the performances regarding these materials in parametric environment thanks to computer technologies. And Baek and Lee (2012) have developed in their study a model which allows to create designs in accordance with the human body form and size by utilizing digital technologies. By this model, it is seen that it is possible to generate, totally different from traditional design approaches, results with a high level of accuracy. Linn et al (2013), Mark (2012) and Granadeiro et al. (2013) reveal that it is possible to make correct decisions related to energy efficient green houses during the early stages of the design process by performing diverse simulations in virtual environment. And similarly emphasize Nembrinia et al. (2014) that it is possible to measure the building performance by conducting simulations in virtual environment thanks to parametric design tools and the design problems can be determined in early stages depending on the simulation results. In the manner denote Jaffal et al. (2012) that it is possible to use parametric design tools in order to measure the heating performance of a building and thus the decisions can be made more accurate. Lee et al. (2006) say that it is possible to use the data and limitations of different science branches together during the design process thanks to the parametric design tools. Turrin et al. (2011) emphasize that it is possible to establish different design solutions with complex forms by parametric modelling and genetic algorithms. Wu and Ma (2012) express that it is possible to realize unique designs by utilizing scientific methods with parametric tools. And Hanna and Turner (2006) note that parametric design tools allow the development of different related techniques by the establishment of self-reproducing models of parametric design tools. As a result of all these conducted literature

searches, it is determined that the advantages to be provided to design education receiving students by computer technologies are basicly as indicated in Table 1 (Yazıcıoğlu, 2011a; Yazıcıoğlu, 2011b).

Table 1
Advantages Provided to Design Education Receiving Students by Parametric Design Tools

	Advantages Provided by Parametric Design Tools
1.	That the form search of the designer passes beyond his/her own creativity
2.	The information can be flow quickly within the design team and thus design team can be work synchronously
3.	The possiblity to develop design, where the material can increase its natural capacity to top level
4.	The possiblity to obtain hybrid materials
5.	The possiblity to discover digital materials and to test the performances of these materials
6.	The possiblity of rapid prototyping
7.	The possiblity to create numerous solution alternatives via different limitations
8.	The possiblity to produce the design again and again in different forms by systems established with the same hierarchic and geometric relations
9.	The possibility to establish result generating algorithms by utilizing the arithmetic and logic skills of the computer
10.	The possiblity to express complex forms mathematically
11.	The possibility to handle multiple parameters simultaneously
12.	The possibility to develop new understandings in terms of the design-production-material trio at the sustainability discussions
13.	The possibility to develop the design techniques of the designer
14.	The possibility to develop authentic production systems
15.	The possibility to experience and test the design in virtual environment
16.	The possibility to use the data and limitations of different science branches during the design stage
17.	The possibility to model the physical and biological capabilities of the creatures in the nature mathematically
18.	The possibility to experience the human-design interaction in virtual environment and to reflecte the results on the design
19.	The possiblity to obtain new form by changing the whole morphology of the design with regional deformations
20.	The provision of the design, expression and applicability of objects with complex geometries
21.	The possiblity to create top level sensitive design to environmental factors
22.	The possiblity to convert the data generated by the system into high accurate physical products
23.	The possiblity to create self-reproducing models
24.	The possiblity to create concrete forms with reproducing software and to convert these forms into real designs
25.	Rediscovering the loadability of forms

Purpose and Methodology

In this context is the scope and purpose of the study determined as; to re-scruntinize the 25 different advantages provided to design education receiving students by the parametric design tools determined in the literature and to test these on real projects and to reveal the necessity to integrate computer technologies into this process during the structuring process of the education with real samples. As the methodology of the study 20 different projects, developed with computer technologies, will be selected in line with this defined purpose. Then, every project will handled one by one and scruntinized whether the advantages provided by parametric design tools are benefited from during the development process of these projects.

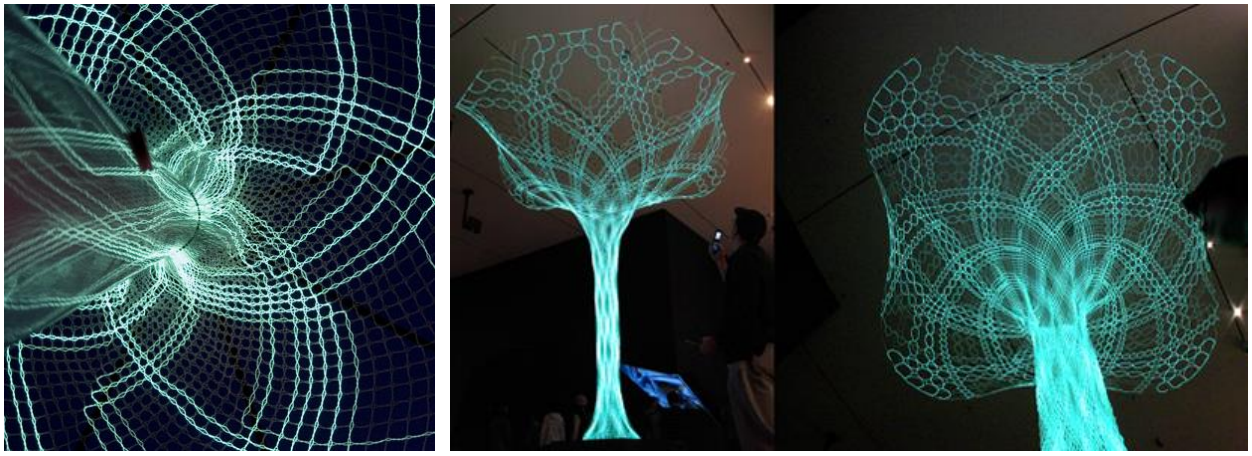
Scrutinization of Project Developed with Computer Technologies

At this stage of the study are primarily 20 different with computer technologies developed projects selected. During the selection is the artificial illumination design topic selected, where people, having a design education but coming from different disciplines, can play solely or as a team together a role.

A Sonic Shade of Light: Sonumbra

The Sonumbra named illumination element designed by the company Loop.pH has the characteristic of a decorative urban furniture, which provides the user interesting experiences (Figure 1-2). This application is like an intermediator between the digital and biologic media. At the design of the project, it is inspired from a simple system of large umbrellas used in Africa, where 80% of the population has no electricity, and which protect the people against the sun during daytime, and converts the collected solar energy into light during the night. The main purpose of the project is to design an ecological and simultaneously an urban environment sense providing product. This product with the look of light shedding textile consists of the combination of multiple electro-radiant fibres and provides its audience different light games by reaction on human voice (Bojovic, 2013).

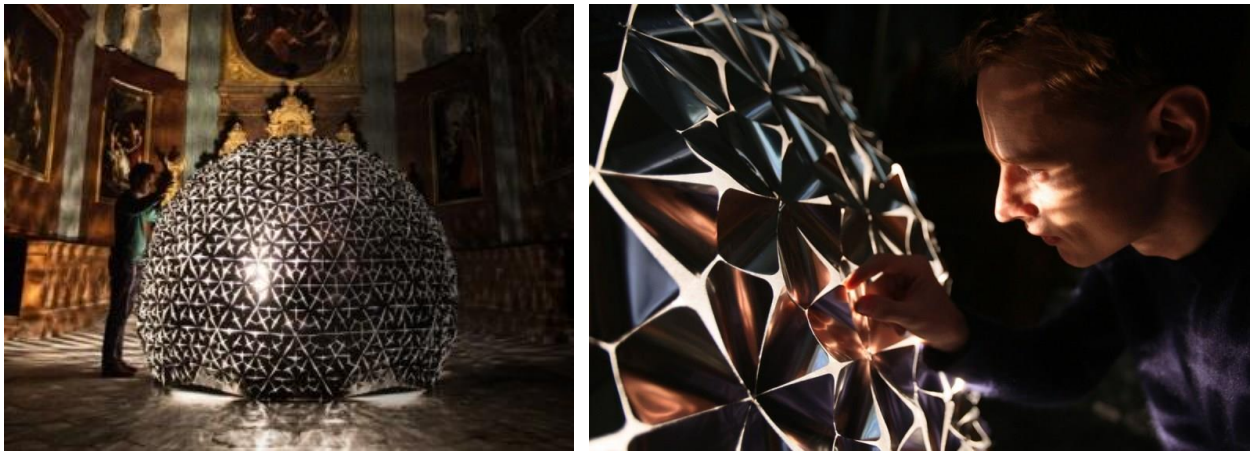
Figure 1-2. A Sonic Shade of Light: Sonumbra



Lotus Dome

The work named "Lotus Dome" which is designed by Daan Roosegaarde and is like an interactive artwork is awarded with the Media Architecture 2012 Award in the category Future Trends (Figure 3-4). The work consists of the accumulation of hundreds of extra thin aluminium flowers which interacts with the persons. These techno-flowers open and close as a reaction to human behaviour and create thus different light games on the surfaces of the location (Archilibs, 2013; Evolo, 2013).

Figure 3-4. Dome Made Out of Hundreds of Ultralight Aluminum Flowers



3D Printed Momentum Light

3D Printed Momentum Light is a light source which generates electrical current by kinetic energy. The shape of this light source, produced from nylon polymere material, provides an angular moment to support its rotation on its own. This rotation is realized by the influence of minor environmental factors like temperature and air streams. The light intensity, radiated by the LED, increases the more the rotation speed increases, too (Figure 5-6). Different rules of physics are taken into consideration at this design and a sustainable illumination element is modelled by utilizing the possibilities of technology (Decodeine, 2013; Evolo, 2012a).

Figure 5-6. 3D Printed Momentum Light

Laboratory For Sensual Experiences Lamps

The illumination element designed by Stefan Wieland is made of an acrylic/polycarbonate material (Figure 7-8-9). The model consists of curved pieces which complete each other when they close. This illumination element, made of semi-permeable material, constitutes different light levels with each change of its form. With its spontaneous form changes allows it the user to experience colour and light games by creating cine-aesthetic effects. The fragmented curvaceous plates have unlimited assembly forms (Chepi, 2013).

Figure 7-8-9. Laboratory For Sensual Experiences Lamps

Cosmic Quilt

"Cosmic Quilt", which is a joint work of the students Adrienne Carducci, Wesley Fulgham, Ryan Fleming, Ryan Griffin, Jonathan Howard, Glorimer Ovalle, Morgane Palacios, Marianne Sodogandji, Sabrina Stefano and Stephanie Zeni, explores the interaction between the user and the constructed environment (Figure 10-11). The sensor controlled motors of the model have an interactive structure, which responds to human. The design and production of the surface, consisting of 3000 pieces, lasted only one week thanks to the parametric design tool (Archdaily, 2013). The main theme of the project is “when architectural elements respond to those in its environment...” This also means that the human recognizes its own existence due to environmental changes. Tools like sensors, micro-control motors which are different advantages provided by the technology during the establishment stage of the prototype by considering the basic principles of traditional handicraft (Grozdanic, 2012a).

Figure 10-11. Cosmic Quilt

Clove-Lamp

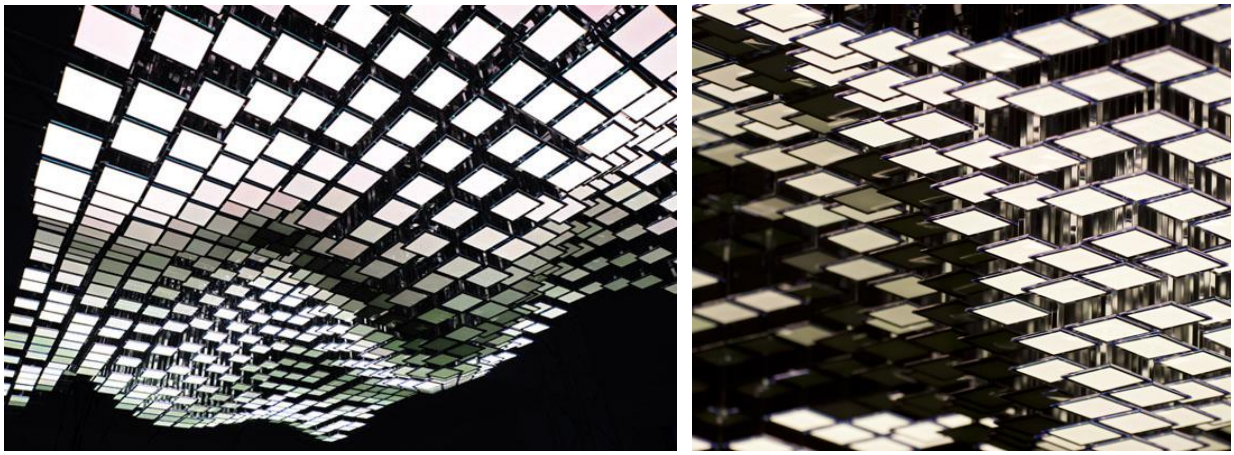
Clove-Lamp, designed by Sucker Punch, is defined as an exercise where parametric alteration alternatives are scruntinized. Also a work flow regarding the production is established parallel in with the design process of the model, inspired by garlic (Figure 12-13-14). In this way is the form and size of the lightening determined such to increase the efficiency to maximal level within the production process. Beside this provides the number of the pieces which constitute this shape, the distances between them and the different distances to the light source the generation of a gradiant light beam (Punch, 2013).

Figure 12-13-14. Clove-Lamp

Living Sculpture 3D Module System

Whitevoid's LivingSculpture 3D Module System designed by Christopher Bauder is produced by the company Philips. The illumination element, which can generate large waves in unlimited variations, is controlled by an iPad (Figure 15-16). The 16 OLED panels, constituting the system, are rectangular shaped and have mirror surfaces. The connection bars of the panels are in different lengths are allow a very rapid generation of three dimensional waves (Grozdanic, 2012b). The number of the base plates can be increased depending on the project requirements and light sculptures in different dimensions can be created. In addition this system can be programmed such to perceive the user (Lumiblade, 2013).

Figure 15-16. Living Sculpture 3D Module System

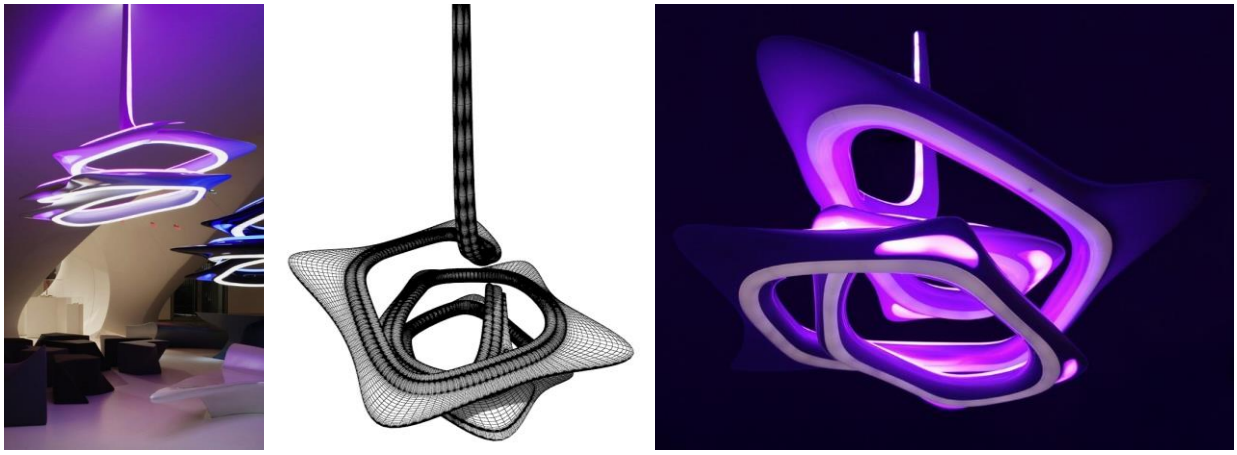


Vortex Chandelier

Vortex Chandelier, designed by Zaha Hadid, Patrik Schumacher and Sawaya & Moroni, looks like a ribbon (Figure 17-18-19). That the light sections are in form of stripes provides that the illumination element is perceived as a double-helix. The colour of the light of the chandelier changes continuously in a vaguely manner. The design with a height of 2 m. and a width of 1,5 m. consists of the combination of 60 different patterns. The bright fibreglass reinforced polyester surface provides a homogenous light distribution and an optimal colour mix. The colour changes

can be programmed and controlled unlimitedly. Beside this, 60 different patterns can be re-established in a rapid manner thanks to computer technologies when it is intended to produce this design in different dimensions (Designalmic, 2013).

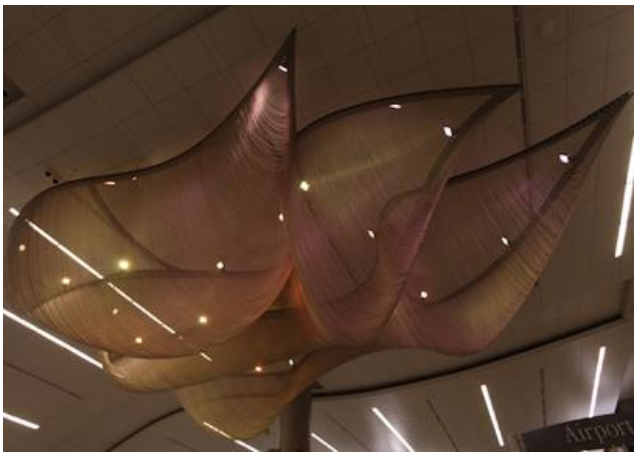
Figure 17-18-19. Vortex Chandelier



The Storm Breaks

The sculpture like illumination element designed by Christopher Moulder is modelled with the RHINO software. The design consists of bead chains with a total length of 8 km. and a weight of approximately 3000 kg. (Figure 20-21). A kinetic RGB LED light fixture consisting of 30 colours is used in an integrated manner with the chains. The product is programmed such to change the colour at different times of the day. Whilst the design provides a sufficient level of light during the night in order to lighten the environment, it provides the look of a cloud by radiating lesser light during daytime (Enlighter Magazine, 2013).

Figure 20-21. The Storm Breaks

Undulus

The Undulus modular illumination system, designed by Scott Javie, is modelled being inspired from cloud formations (Figure 22-23-24). It can be mounted in a sufficient number and one after another depending on the illumination requirement of the location. It is tried to prive a spread illumination by using compact fluorescent tube bulbs inside the shell. Beside this is utilization with a high energy efficiency, low cost and long lifetime targeted by this way. Whilst the product may be overhead mounted, it also can be mounted on desired surfaces as ceiling or floor illuminating elements in stripes (Contemporist, 2012).

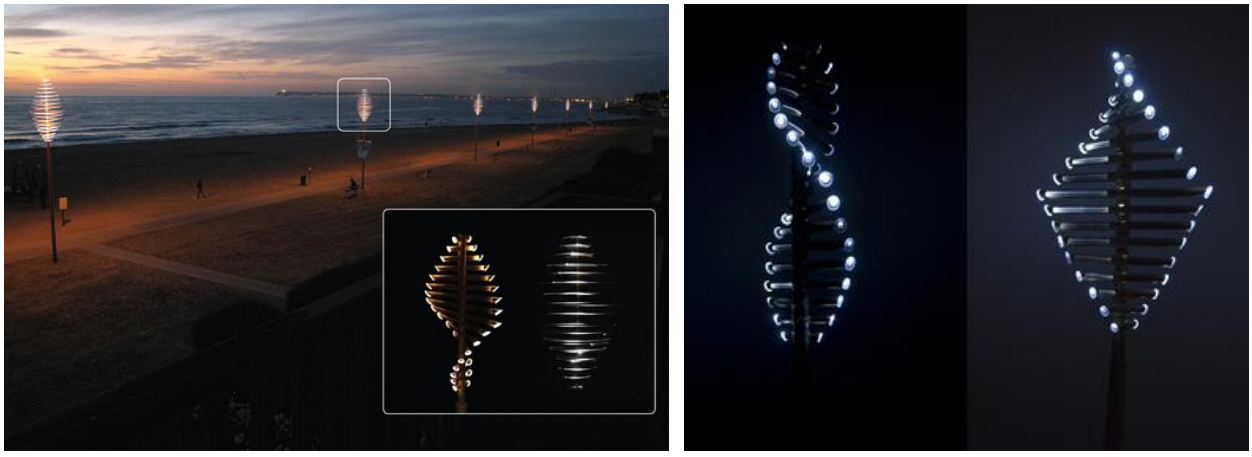
Figure 22-23-24. Undulus



Bamboo Lamp

The streetlight Bamboo Lamp, designed by Alberto Vasquez for public areas, operates like vertival wind turbines (Figure 25-26). The main goal of the project is generate a sustainable solution in order to convert the shores in poor regions safer by lightening them. The main material of the illumination element is the recyclable bamboo, a regional tree. The lamp is designed such simple that it can be even produced by the most unqualified worker. The LED lamps are located at the edges of the bars, which rotate in wind, and generate their own electrical energy. Another feature of the helix structure is such to benefit from ocean winds from all directions. In addition are different light games created due to the rotation of the illumination element (Escobedo, 2012).

Figure 25-26. Bamboo Lamp

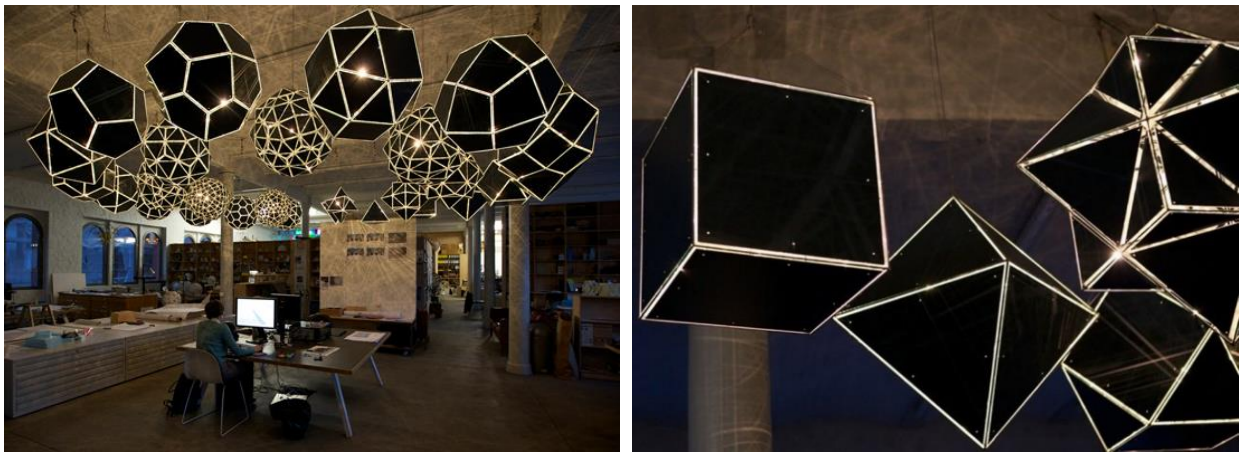


Your Sound Galaxy

Your Sound Galaxy, designed by Olafur Eliasson is a geometric interior location installation established by utilizing mathematical formula (Figure 27-28). This design consists of the constitution of two circles with a joint centre by 27 different polyhedral forms. Each polyhedral form is derived in computer environment with mathematical relations such to be different from

each other. The surfaces of the forms are ordered such to increase clockwise. The black surfaces are separated from each other with LED light stripes. Each piece radiates light in a sensitive manner to the movements within the location (Bozzi, 2012; Pacheco, 2012).

Figure 27-28. Your Sound Galaxy



House Swarming Installation is an Environment-Sensing Device

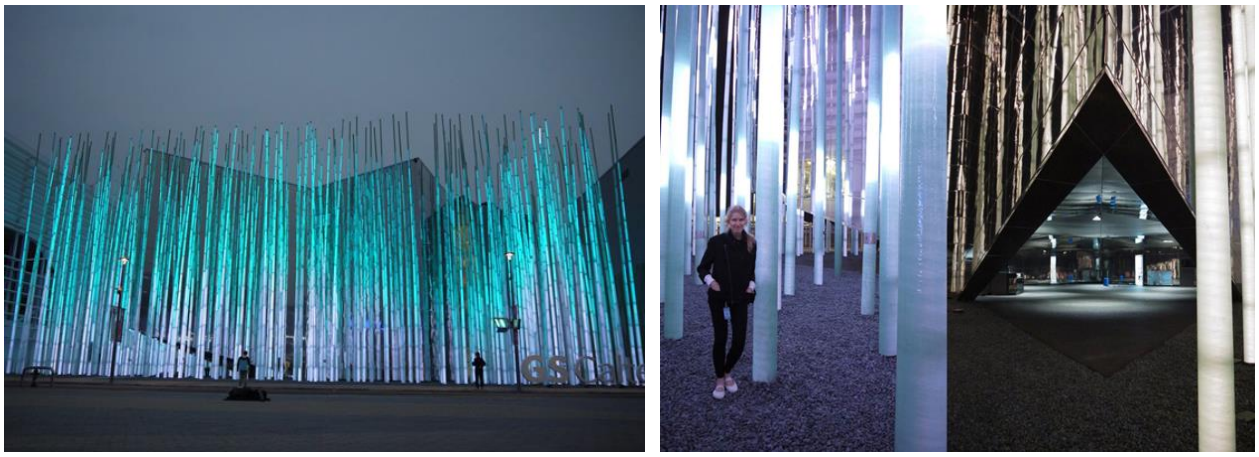
House Swarming, designed by Didier Hess, is projected for The Art Center College of Design in California. It is aimed to convert an environmental recognition device into an illumination element (Figure 29-30). The sensor-node technology is used for this. biomorphic formed green pieces outline the main entrance of the campus during daytime. The green pieces start to illuminate with sunset and provide the visitors information related to the air quality around the building. The sensors perceive the air pollution in the close proximity and generate signals. These signals provide that the lightening sources light up and down in a definite rhythm (93H8-Online Magazine for Designers, 2013).

Figure 29-30. House Swarming Installation is an Environment-Sensing Device

Gs Caltex Pavilion

The "GS Caltex Pavilion", designed by Atelier Brueckner, is created for a Korean oil company. The pavilion consists of 18 m. high and fully independent from each other standing 380 grass type bars (Figure 31-32). Each bar is like an interactive object which lights up or down touch-operated. Beside this varies the lightening level of each bar according to the changing weather conditions like rain and wind (Designboom, 2012; Evolo, 2012b).

Figure 31-32. Gs Caltex Pavilion



Succulent Hispid- Responsive Lighting Structure Inspired by Plants

The illumination element designed by the UCLA students Harlen Miller, Francesco Valente-Gorjup and Jordon Gearhart interacts with the users by the combination of movement sensors and divers electronic components. It is tried to use biological and technological mechanism together. It is inspired from the adaptation of the plant to dry climate conditions and its water retention capability during the establishment of the illumination system with needle leafs. The acrylic infrastructure of the leafage consists of silicon membrane lined plastic (Figure 33-34-35). These surfaces are covered with metal pin bristles. And the LED lamps are hidden in the thick-walled silicon sections. The leafage perceives the human movement and opens and closes. 3D printing, laser cutting, machining, vacuum forming and different casting methods are used during the production process of the illumination element. And computer controlled robot systems and LED illumination sensor technologies are benefited from in order to provide the interaction and kinetic recognition feature of the illumination element (Grozdanic, 2012c).

Figure 33-34-35. Succulent Hispid- Responsive Lighting Structure Inspired by Plants

Chroma (RED) Light Installation

The illumination element designed by Carlos Moncada is an installation which is projected for public and semi-public areas (Figure 36-37). At this project radiates the illumination element light at different levels and brightnesses depending on the distances to persons and helps each individual to experience its interaction with its environment differently. Chroma (RED) consists of 74 components. Each of them is equipped with LEDs which provide light in four different levels. Beside this are sensors and servos placed in order to provide the perceiption of the movements. The interaction of the model, created by utilizing parametric design tools, with persons is experienced in virtual environment (Evolo, 2012c).

Figure 36-37. Chroma (RED) Light Installation

Troika's LED Chandelier

The company Troyka has designed an illumination element with suspending system which takes into consideration the techniques of painting performance by light (Figure 38-39-40-41). Art and digital technologies are combined at this project and it is tried to discover a region where metaphysics cross surreality. The light is re-interpreted in the control of the designer during the development stage of the project and lightening choreographies are established in virtual

environment. Eight different LED series are placed around an axis and a mechanism which provides their rotation around this axis is developed during the application stage (Grozdanic, 2012d).

Figure 38-39-40-41. Troika's LED Chandelier

Cocoon Lamp

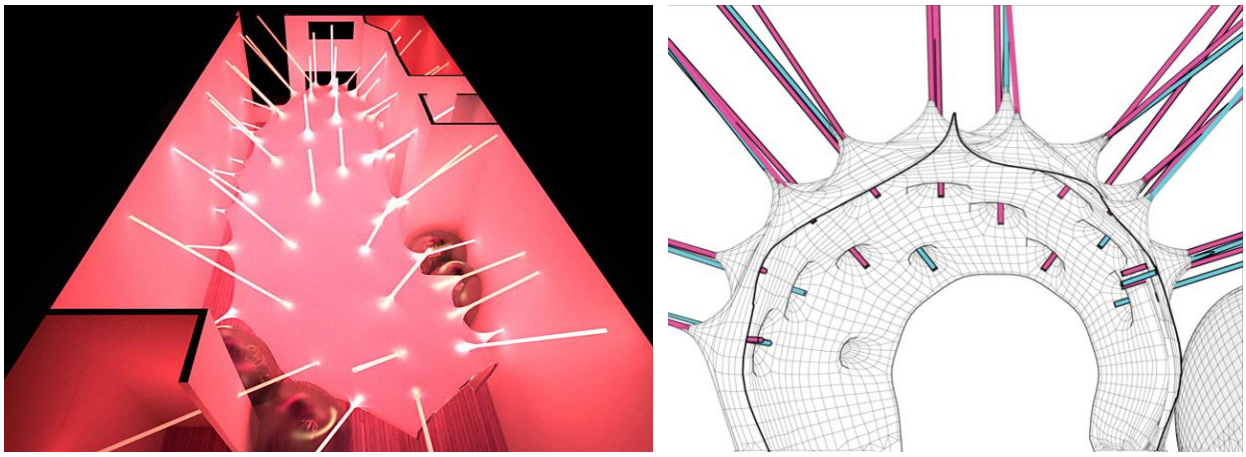
The designer Patric Günther aimed to discover automated production technologies, fast prototyping, innovative materials and new production method when projecting the Cocoon Lamp. Beside this has the designer found the possibility to rediscover "productive techniques and the influence of these techniques on design processes". The light distribution of the product is calculated thanks to 3D modelling programs and the lightening effect could be tested before there was any product (Figure 42-43). The complex form of the lamp could be produced failure-free by the PolyJet technology after the completion of the project (Voxel Studio, 2012).

Figure 42-43. Cocoon Lamp

Prickly Pear

The location from the interior covering shell is modelled by utilizing digital technologies at the store interior design project realized by the design team consisting of Alexandra Barker, AIA LEED AP, Principal Adrien Allred, Phuong Nguyen, Adam Jakubowski and Bridget Rice (Figure 44-45). The fruit of a cactus growing in the Mediterranean Region is taken as the model when establishing this shell and parametric values, which constitute the form of this fruit, are transferred to a computer and the fruit is re-interpreted in a digital environment. In this form it is aimed that designed shell acts at the same time as a single illumination element which covers the location. For this purpose is the shell produced from a semi-permeable, net structured cover. The fixures are integrated into the steel stretching system mounted to the shell, wall and floor. The colour of the location covering changes thanks to the sensors at the fixtures according to the music frequencies, body movements and the objects in the environment. Beside this can these colours differentiated depending on a prior programmed scenario by computer technology, too (BFDO Architectural Plic., 2012).

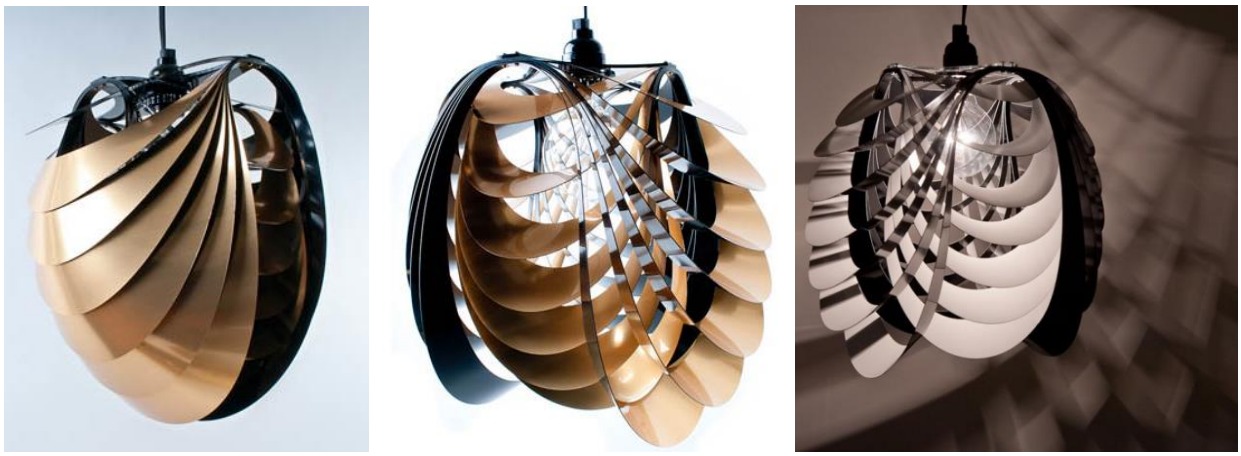
Figure 44-45. Prickly Pear



The Kinema Pendant Luminaire

Stuart Fingerhut tried during the design of the illumination element to create dramatic light and shadow effects within the location by using different layers together (Figure 46-47-48). For this purpose are the light and shadow effects of the movement of each circle shaped piece, which constitute the form, in different angles experienced in virtual environment. The shape of the model is developed and the final form is obtained via the results achieved in this way (Dave, 2011; Grozdanic, 2012e).

Figure 46-47-48. The Kinema Pendant Luminaire



Scrutinization Whether the Advantages Provided by Parametric Design Tools are Used During the Development Process of the Project or Not

It is scruntinized whether the 25 advantages provided by the parametric design tools in Table 1, acquired from the literature, are used during the development process of 20 different projects, indicated briefly in the foregoing stage of the study, or not and the results in Table 2 are obtained.

Table 2
The Scrutinization of the Advantages Provided by Parametric Design Tools via Projects

Advantages Provided by Parametric Design Tools	Projects																				
1. That the form search of the designer passes beyond his/her own creativity	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	
2. The information can be flow quickly within the design team and thus design team can be work synchronously					X			X							X				X		
3. The possiblity to develop design, where the material can increase its natural capacity to top level		X			X			X										X	X		
4. The possiblity to obtain hybrid materials				X				X										X			
5. The possiblity to discover digital materials and to test the performances of these materials					X													X			
6. The possiblity of rapid prototyping		X	X	X	X	X		X	X	X					X	X		X	X	X	
7. The possiblity to create numerous solution alternatives via different limitations						X													X		
8. The possiblity to produce the design again and again in different forms by systems established with the same hierarchic and geometric relations				X		X	X					X				X					
9. The possibility to establish result generating algorithms by utilizing the arithmetic and logic skills of the computer	X	X	X	X	X	X	X	X	X	X		X				X		X	X	X	
10. The possiblity to express complex forms mathematically			X	X		X		X	X	X			X		X	X		X	X	X	
11. The possibility to handle multiple parameters simultaneously.			X		X		X				X		X	X	X	X	X		X	X	
12. The possibility to develop new understandings in terms of the design-production-material trio at the sustainability discussions			X								X		X								
13. The possibility to develop the design techniques of the designer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14. The possibility to develop authentic production systems	X																				
15. The possibility to experience and test the design in virtual environment	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
16. The possibility to use the data and limitations of different science branches during the design stage	X	X	X		X		X				X	X	X	X	X	X	X		X		
17. The possibility to model the physical and biological capabilities of the creatures in the nature mathematically	X					X				X					X			X	X	X	
18. The possibility to experience the human-design interaction in virtual environment and to reflecte the results on the design	X	X			X		X					X		X	X	X			X		
19. The possiblity to obtain new form by changing the whole morphology of the design with regional deformations					X		X		X												

20. The provision of the design, expression and applicability of objects with complex geometries				X	X		X		X	X	X			X		X	X	X	X	X	X		
21. The possiblity to create top level sensitive design to environmental factors			X	X		X							X	X	X	X	X	X			X		
22. The possiblity to convert the data generated by the system into high accurate physical products			X	X	X	X	X	X	X		X			X	X		X	X		X	X		
23. The possiblity to create self-reproducing models	X					X								X				X					
24. The possiblity to create concrete forms with reproducing software and to convert these forms into real designs	X																						
25. Rediscovering the loadability of forms																						X	

When we evaluate the results in Table 2, it is seen that the advantages provided by parametric design tools are used at different levels during the design process of each project. And this result, obtained within the scope of the study, reveals once more via real projects the necessity to integrate during the structuring process of the design eductions the computer technologies into this process.

Results

As a result of all determinations and evaluations, it is seen that extraordinary projects like illumination elements, capable to react to human behavioue and to generate electrical current by kinetic energy, luminaires which can interactively and actively convert into variable surfaces, illumination design which combine art and technology by creating choreographies with different effects can be realized by utilizing the advantages provided by parametric design tools. In line with these determinations, it is thought that the integration of computer technologies into the design education will significantly contribute to the development of the professional skills of the students.

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