Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 93 (2013) 169 – 173
Procedia Social and Behavioral Sciences

3rd World Conference on Learning, Teaching and Educational Leadership – WCLTA 2012

Creativity and solid modeling

Murat Sönmez*

Middle East Technical University Northern Cyprus Campus Mechanical Engineering Program, Güzelyurt/ KKTC, Mersin 10, Turkey

Abstract

Creativity is becoming increasingly important in architecture and industrial design. Creativity at conceptual design stage of a design process is a requirement in today's competitive job market. A development engineer produces concept or model that is passed on to the design engineer for converting into a device, process, or structure. Like the development engineer, the designer should be creative. Today, many major companies and research institutes are using virtual technology. Before prototyping stage, the new product is created virtually in electronic environment with the help of solid modeling softwares. In conceptual design, the object is shaped by making a selection among alternative solutions. This can be easily done in a virtual environment. Education system should be able to feed creative minds by offering some courses and by providing them with opportunities for developing their creativity in art, design, and in servicing. Solid modeling softwares allow students to visualize their creations 3-dimensionally with the associated physical and mechanical properties. The content of engineering drawing courses in engineering curriculum is to be modified for providing solid modeling techniques to engineering students. This may require additional credit. Solid modeling environment can also be used in primary and secondary education in technology and design, visual arts, geometry, 3D art and project preparation courses.

Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı
Keywords: Creativity; solid modelling.

1. Introduction

In today's competitive business world, it is extremely important for companies to create new and useful products. Harris (2009), the author of one of the guiding books on creativity, says that creativity should become a core part of a competitive company's culture. Creative companies can find new routes to market, new types of products and services, and new ways of generating income even in recession periods. The word "creativity" is defined by dictionaries as "the ability to create." "To create" means to turn new and imaginative ideas into reality. "If you have ideas, but don't act on them, you are imaginative but not creative" (Naiman, 2012). Creativity involves two processes: thinking and producing. Creativity is introducing something new and original, not like anything seen before. A product is creative when it is novel and appropriate. Although Harris highlights the reality that everybody is creative contrary to beliefs that only special, talented people are creative, a study at Exeter University (What is Creativity, 2012) concludes that excellence on creativity is determined by encouragement, motivation, opportunities, training, and practice. No one reached high levels of achievement in their field without devoting thousands of hours to serious training. Creation is not linear; it is iterative (Harris, 2009). On creating a new product, alternative designs

*Corresponding Author: Murat Sönmez. Tel.: +90-392-661-2934
E-mail address: sonmez@metu.edu.tr

Selection and peer review under responsibility of Prof. Dr. Ferhan Odabaşı
doi:10.1016/j.sbspro.2013.09.172

are generated that could satisfy the demands and expectations. The options are to be tested and considered against expectations. Today, at the conceptual design, product design, and prototyping stages this work is conveniently done in virtual environments, such as solid modeling environments. Education system should be able to feed creative minds by offering some courses and by providing them with opportunities for developing their creativity in art, design and in servicing. Solid modeling software allows students to visualize their creations 3-dimensionally with the associated physical and mechanical properties. In some of engineering departments 2D drawing programs are used in drawing and design courses. The content of engineering drawing courses via which engineering students are educated on object description in shape and size are to be modified for providing solid modeling techniques. This may require additional credit. Solid modeling environment can also be used in primary and secondary education in technology and design, visual arts, geometry, 3D art and project preparation courses. This article draws the attention to some definitions mentioned by Florida (2005) that make it possible to quantify creativity, summarizes the facilities of solid modeling softwares from engineering and creativity point of view, and aims to introduce solid modeling as a tool to primary and secondary school curriculum.

2. Creative class and education

As it is concluded by the study at Exeter University (What is Creativity, 2012), excellence in creativity is determined by encouragement, motivation, opportunities, training, and practice. There is no doubt universities play an important role in generating creative class by providing an encouraging research and development environment, by offering some courses on art, creativity, conceptual design, and by supporting open-minded, talented graduates and students in their technology incubation centers. Florida, Gates, Knudsen and Stolarick (2006) draw the attention to the changing role of the university in satisfying the demands of creative economy in their article "The university and the creative economy". They say that the university plays a role not just in technology, but in all three Ts of economic development: technology, talent, and tolerance. Universities are often at the cutting edge of technological innovation. Universities affect talent both directly and indirectly. They directly attract faculty, researchers and students, while also acting indirectly as magnets that encourage other highly educated, talented and entrepreneurial people and firms to locate nearby. Tolerance in social life means being open to different kinds of people and ideas. Florida at al. found a considerable correlation between tolerance and the log of students and faculty. Research universities shape a regional environment open to new ideas and diversity by means of their tolerating system. They attract students and faculty of a wide variety of racial and ethnic backgrounds, economic statuses, and national origins. Lucas (1988) argues that economic growth stems from talented people and high human capital, well educated and experienced people. Glaeser (2000), Berry and Glaeser (2005) found a close association between human capital and economic growth. In their study of economic effects of universities, Goldstein and Drucker (2006) found that universities affect economic growth more through the production of human capital than from research and development. Although Florida, who is a best- selling author on creativity (2005), says that every human is creative, he does not deny the effect of environment and education on driving the ability of human to create something, and to quantify the creativity potential of a region or a nation he uses Global Creativity Index. This index is made up of an equally weighted combination of the Talent Index, the Technology Index, and the Tolerance Index. The talent index is a combination of creative class index, the human capital index, and the scientific talent index. He defines creative class in a society as the percentage of the region's employees in the following categories: scientists and development engineers, artists, musicians, architects, engineers, managers. The human capital index is based on the percentage of a country's population holding a bachelor's degree. The scientific talent index represents the number of researchers per million people. The technology index combines the R&D index and the innovation index. The R&D index measures R&D expenditures as a percentage of the Gross Domestic Product. The innovation index measures the number of patent granted per million of people. The global creativity index calculated by using the necessary input data in 2002 is given in the appendix A by Florida, and a selected part of this table is shown in Table 1. Florida states that the USA is truly in danger of losing its main crucial economic advantage – its status as the world's greatest talent magnet, and says:

> America was once the first destination for foreign students and the last stop for creative minds; scientists, engineers, musicians, and entrepreneurs wishing to engage in the most robust and creative economy on the earth, it has now become only one place among many where cutting-edge innovation occurs. (Florida, 2005, front flap).

Table 1. The global creativity index (Florida, 2005)

Global Creativity Index Rank	Country	Global Creativity Index	TALENT				TECHNOLOGY			TOLERANCE		
			Talent Index	Creative Class	Human Capital	Scientific Talent	Tech. Index	R&D Index	Innov. Index (Patents)	Tolerance Index	Values Index	Self-Expression Index
1	Sweden	0.808	0.642	22.93	16.94	5,186	0.819	4.27	195.97	0.964	1.60	2.22
2	Japan	0.766	0.702	---	19.20	5,321	0.785	3.09	261.53	0.811	1.84	0.68
3	Finland	0.684	0.728	24.66	14.80	7,110	0.626	3.40	141.09	0.698	0.80	1.04
4	United States	0.666	0.601	23.55	28.34	4,099	0.827	2.82	307.06	0.571	-0.53	1.64
5	Switzerland	0.637	0.541	22.05	15.83	3,592	0.625	2.64	196.38	0.744	0.77	1.45
6	Denmark	0.613	0.597	21.29	21.50	3,476	0.385	2.09	89.38	0.858	1.11	1.96
7	Iceland	0.612	0.658	24.12	18.85	---	0.463	3.04	67.38	0.717	0.37	1.72
8	Netherlands	0.611	0.643	29.54	20.87	2,572	0.366	2.02	83.05	0.824	0.81	2.05
9	Norway	0.595	0.686	18.77	27.60	4,377	0.279	1.62	58.94	0.819	1.26	1.46
10	Germany	0.577	0.468	20.09	13.48	3,153	0.511	2.50	136.77	0.753	1.13	1.08
36	China	0.230	0.031	---	1.43	584	0.109	1.00	0.15	0.550	1.16	-0.61
37	R.of Georgia	0.219	0.345	15.54	----	2,421	0.030	0.33	0.38	0.282	-0.04	-1.32
38	Argentina	0.199	0.193	11.43	9.12	684	0.045	0.45	1.36	0.357	-0.94	0.40
39	Turkey	0.186	0.212	14.74	8.90	306	0.065	0.63	0.16	0.282	-0.83	-0.35

2.1. Restructuring engineering drawing courses, solid modeling and creativity

Engineering Drawing course is a first- year course in most of the engineering curricula. It is a must course for all correctly defined engineering programs. To its classical content, the objective of this course is to teach the language of industry, which is a graphical language to be used for explaining the shape and providing the size of an object by drawing 2D projections from, usually two or three different sides of the object, orthographically over picture planes. Orthographic projections are 2D views used to define the geometry of an object. Before 1970s, the views projected over imaginary picture planes were to be copied to the surface of drawing papers by using the drawing instruments: pencil, T-square, set squares, case instruments, etc. The introduction of the computer revolutionized engineering drawing. After the development of a computer-based drafting tool by Ivan Sutherland in 1963, during 1970s, computer-aided drafting softwares were commercialized. Classical drawing instruments were replaced by virtual papers on the monitor, line creation tools, editing tools, etc. By the 1980s, computer-aided drafting became fully developed as a standard tool in industry (Fig.1). In 1988, the introduction of solid modeling softwares revolutionized computer-aided design and drawing. Today solid modeling remains the state-of-the-art technology.

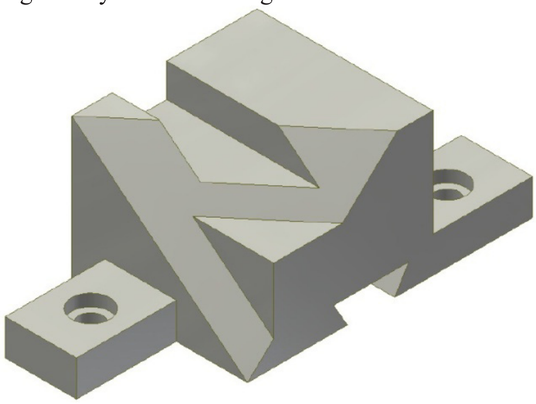

Figure 1.Two-dimensional drawing (orthographic views of an object)

Solid modeling softwares; such as Autodesk Inventor, Catia, Solid Works, ProEngineer, Autodesk Revit, and so on, provide a virtual environment where 3D geometric models of any kind of objects can be created with real physical and mechanical properties. Single solid creations can be assembled to create structures, frames, and mechanism by mating them with the associated geometrical and dimensional constraints and invoking the solid models of standard fasteners from parametric part library of the software. Today, in solid modeling environment one can perform complex strength calculations, analysis by using finite element modules, and can test if the mechanism will perform its function properly by using the simulation facilities of the software. With compatible CAM (Computer-aided manufacturing) programs, the tool paths can be calculated for complex numerically controlled machine tool (CNC) operations. By using the solid model of an object, its necessary engineering drawings, working orthographic views, detail drawings, and pictorial images can easily be created. It is also worth mentioning that a solid model provides additional information such as volume, mass, moment of inertia, surface area, etc. even for very complex objects. It takes a few minutes to create the solid model of an object. After testing the object in the virtual environment to insure that it will satisfy its function properly, if it is determined that the design is to be modified, the geometry and/ or the size of the object can be changed again in few minutes. With the facilities of solid modeling programs briefly mentioned here, it is obvious that solid modeling is a tool that supports creativity of development engineers, design engineers, and even research engineers. Using existing knowledge and new discoveries from research, the development engineer attempts to produce a functional device, structure, or process. Engineer defines the problem to be solved or the function of the object to be created, acquires data, identifies solution constraints and criteria, develops alternative solutions (in a virtual environment this can be done easily by using solid modeling facilities), selects the optimum solution, and communicates the results (if the solid model is available in the environment that can be output and whenever it is demanded, the engineering drawings can be created and shared). The design process is usually iterative. Building and testing models of the creation is the primary means by which the development engineer evaluates ideas. This has been made easier to accomplish with solid modeling software.

When the advantages of creating an object in a solid modeling environment before prototyping stage were considered, it was concluded that the content of 1st year engineering drawing courses should be changed by adding the chapters introducing students to solid modeling environment. In the Middle East Technical University Northern Cyprus Campus, (METU NCC) although the name of the course is still "Computer Aided Engineering Drawing-I", the solid modeling has been thought to its almost all of the facilities, except FEM and CAM modules, at intermediate level to the 1st year engineering students by using Autodesk Inventor environment since 2008. In this course, in addition to the solid modeling software, since majority of architects and civil engineers still use, the 2D AutoCAD environment in professional life, this software is also taught. There is one more must course on solid modeling and engineering drawing for mechanical engineering students. In this course, mainly the standard part library of the software is introduced; assembly and animation methods, working drawing details, including geometrical tolerances and surface texture concept, and the associated CAD applications are taught. To its new content, the 1st year solid modeling and view creation courses encourage and support creativity of students. It is agreed that the solid modeling and drawing courses require more credit in the curriculum compared with the credit of the ones in which still board-pencil method is used.

2.2. Art, technology and geometry courses in elementary and secondary education and solid modeling

Morris (2006) highlights that the roots of a creative society are in basic education. Everybody is creative but his/ her creativity is to be encouraged and supported through education and training. In Turkish education system, it is one of the objectives to develop the creativity of students in 2D and 3D art courses, artistic drawing courses, and handicraft courses. In this article, solid modeling is proposed as a tool that can make life easier in teaching and learning difficult mathematical and geometrical concepts. In the courses mentioned above, solid modeling environment can be used by teachers and students, of course, excluding the engineering calculation part. In Fig. 3e, the solid model of a vase created by an eight year old pupil after 2 hours of training is shown. Teachers can teach some concepts and topics, which are relatively abstract at elementary or secondary school level, such as projection, perspective drawing, intersections, area, volume, mass, etc., much more easily. Students can develop their creativity by designing simple and composite bodies virtually in solid modeling environment. In geometry courses, the content of elementary geometry, descriptive geometry, and even that of analytic geometry can be easily supported by solid modeling softwares.

3. Conclusion

In today's competitive business world, it is extremely important for companies to create new and useful products. Education system should be able to feed creative minds by offering some courses and facilities for developing their creativity in art, design and servicing. Solid modeling softwares allow students to visualize their creations in 3D with the associated physical and mechanical properties. The content of engineering drawing courses in engineering curriculum is to be modified for providing solid modeling techniques to engineering students. Solid modeling environment can also be used in primary and secondary education in technology and design, visual arts, geometry, 3D art, and project preparation courses for developing creative minds.

References

Harris, P. (2009). *The truth about creativity.*UK: Prentice Hall- Pearson.

What is Creativity? (2012). Retrieved 13 Sep., 2012 from http://www.creativityatwork.com/what-is-creativity/

Florida, R. (2005). *The flight of the creative class.* New York: Harper Business.

Florida, R., Gates, G., Knudsen, B., & Stolarick, K. (2006). *The university and the creative economy*. Retrieved 13 Sep., 2012 from http://www.creativeclass.typepad.com/thecreativityexchange/files/university_and_the_creative_economy.pdf

Lucas, R. (1988). The mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3- 42.

Glaeser, E. (2000). The new economics of urban and regional growth. In G. Clark, Maryann P. Feldman, Meric S. Gertler . (Eds), *The Oxford Handbook of Economic Geography* (pp. 83-98). New York: Oxford University Press.

Berry, C., & Glaeser, E. (2005). The divergence of human capital across cities, Discussion Paper No. 2091, *Harvard Institute of Economic Research.*

Goldstein, H., & Drucker, J. (2006). The economic development impact of universities on regions: Do size and distance matter? *Economic Development Quarterly, 20*(1), 22- 43.

Morris, W. (2006). *Creativity: Its place in education*. Retrieved 13 Sep. 2012 from http://www.jpb.com/creative/Creativity_in_Education.pdf