Onder Erkarslan is an Associate Professor in the Department of Industrial Design at Izmir Institute of Technology (Turkey). His research and teaching interests are in design semiotics, history of industrial design in Turkey and design communication. He has recently published a chapter in the "Der Film 'Busreisende' Gelesen aus der Perspektive Städtischer Modernisierung", ed., Orhan Esen and Stephan Lanz **Self Service City** (Berlin: B-Books Taschenbuch, 2004) ISBN 3-933557-52-6. Dr. Erkarslan has also numerous articles in scientific journals and presentations in conferences.

Inter-disciplinary Characteristic of Design Profession: Bridging the Gap between Design Education and Industry

Önder Erkarslan (Assoc. Prof. Dr.)
Department of Industrial Design
Faculty of Architecture
Izmir Institute of Technology
Urla Campus, Urla, İzmir, Turkey
ondererkarslan@iyte.edu.tr

Abstract

This paper aims to argue with how to bridge the gap between design education and design practice. It will also make suggestions on inter-disciplinary (or trans-disciplinary) research and design education and methodology.

Key words: industrial design, education, inter-disciplinary studies, design methodology

In Industrial design education students have been expected to combine technology with real problems and a twist of imagination in order to promote creativity in the design studio. Industrial design incorporates the planning, development, and refinement of products for mass-production and sale. It is undeniable that innovative thinking is at the core of good Industrial design. Students are also expected to have a successful collaboration with industry, which is in demand of research based design strategies. Students may not

However, the goals of the real problems of the sector may not always collide with the capacity of the design education. While the industry is in need of fast and refined end-products, the design education, on the other hand, come across with serious difficulties in implementing the rapidly changing expectations of the industry into the curricula. In addition to the demands of the industry, industrial design education has to cope with providing interdisciplinary research and studio which sometimes take a longer time than the industries expectations.

Nevertheless, student research in a real project is a tremendous tool for exercise. Within collaborative projects, design students can practice relevant design research under real conditions. Design education is therefore responsible from finding appropriate solutions for a close collaboration with the industry by concentrating on the following challenges:

- Applying solution-based design methodology in education.

- Providing a flexible time management depending on the needs of the industry.
- Shifting from form oriented goals to technology oriented goals.
- Providing a science based design education on various levels.

Industrial designer is a specialist, equipped with knowledge of interaction and interchanges between person and object. In addition to the above mentioned qualifications, industrial designer also applies methods to investigate this relationship.

The role of industrial design in our present day cannot be isolated from rapidly changing technology. In parallel to the increasing demands of the users for objects, work-tools and work places to be smart and easy to use, industrial design is forced to find new ways to incorporate with engineers and production technicians.

The profile of industrial designer in our day is far beyond its conventional scope. Two decades ago, the task of industrial design was predominantly engaged with aesthetical and ergonomic aspects, whereas today products are being designed by specialists coming from different fields. Interdisciplinary approach in industrial design does not necessarily mean to abandon conventional working methods such as different types of models and mock-ups. Three dimensional, full-scale models in industrial design are still vital for creative, quick and effective method of development. In other words, industrial design process needs team work combining designers and other specialists.

Despite of the crucial role of team work in real industrial design projects, education in this field lacks of giving this opportunity to the students. Although team work takes place in industrial design studio in various curricula, they generally contend with providing students to work in groups, or with a real client. However in order to intersect with demands of real industry, industrial design education needs to bring students and professors from various disciplines all around. Multidisciplinary means- composed of or combining several usually separate branches of learning or fields of expertise while interdisciplinary means, drawing from or characterized by participation of two or more fields of study. The difference between these two lies in the issue of decisiveness and common will which the former lacks of. In multidisciplinary approach, only designers design and other experts put their knowledge and skills into the problem, in a conventional way. However, interdisciplinary approach allows for all members of the group to design simultaneously by raising questions from different aspects of the design problem. Industrial design education is in need of reviewing the existing teaching methods and subjects which would allow interdisciplinary collaboration across many disciplines. (Boyarski, 1998)

When we look at the conditions in the real sector, it is possible to find both tendencies in product development, which is subject to change of the capacity of the companies. While big companies prefer to hire specialists, small sized companies tend to employ generalist designers (Kolko,

2004). Therefore some large companies have divided the ID function into specialization based tasks in the product development process. In the product development process in small sized companies, generalist designers become responsible from the very first stage to the end. On the other hand, big companies seek for specialists such as design researcher, design project manager, CAID designer, package designer, 3D computer designer, etc... (Yang, 2005)

There are some other external developments which effect ID profession and its education, to update traditional skill sets for an industrial designer. There are some trends of the industrial design practice which modified education:

- Presentation methods have changed in parallel with the developments in digital media. Introduction to 3D modeling software into the design studio provided quick access to refine the form from the beginning of concept development phase.
- Despite of specialization trends, the strict borders between industrial, graphic and interior design are melted and intersected with other forms of art such as installation-art or video-art. Designers need to follow developments in other creative fields.
- In addition to the issues of tectonics, user profile has to be known in social, psychological and ideological context.
- Design product has started to be defined as a system, composed of various products and the interfaces among parts.
- Internet communication has altered modes of teaching and learning by introducing interaction and among all parties in the profession.

There are some advantages and disadvantages of interdisciplinary education.

- Interdisciplinary approach creates identical designers, who have no profundity in the field of industrial design; No one can get expertise on any subject in the profession. This is called as “generic design”
- Interdisciplinary approach needs people to expand their knowledge and skills at different fields continuously, which makes the career in design profession tiring and tougher.
- Discipline based approach brings specialization and depth. However it may prevent creative ideas to emerge due to the lack of synergy coming from diverse views which interdisciplinary approach promises.
- Raising specialists in design education may also block mobility in professional career, which would be inappropriate for current tendencies in the human resources departments.
- The formation of interdisciplinary team defines the success of the collaboration, which means good results can never be expected unless the background team members provide enough diversity.

Although design industry may have an inclination towards interdisciplinary or discipline-based approach according to their needs and capacity, design education is not in the position of preferring one or the other. In order to compensate negative consequences of interdisciplinary design teams, it is necessary to integrate it with well-built discipline-based programs. It is possible to have both by asking from each student must to bring depth, expertise and differentiation to the interdisciplinary experience who had previously been provided with discipline-specific proficiency and standpoints. The third way in between two polar attitudes helps to create a new team work understanding in ID education where every member involves into design phases with their knowledge and skills.

On the basis of such an education policy stated above, choosing the best teaching method in the studio becomes central to the discussion. The fundamental skills of industrial design should be given to all students from diverse backgrounds such as design based fields, technical-engineering based fields, or business administration fields. In order to achieve this, the curriculum and faculty has to provide flexible methods, appropriate to the student's expertise.

In order to follow up the developments in new technologies and design practice, design education updates need to be made regularly. It is undeniable, that today's design practice requires advanced computer aided modeling and design skills, at the first rank. Keeping up with the rapid change in the teaching methods, design issues and technologies is a tough job to achieve. Design studio can overcome this problem by underlining the problem definition, process, and technology development, rather than end product. In this way, it is possible to raise students who will easily adapt to changes and challenges in the future. ID education should give notion of flexibility and ability of lifelong learning, since it is simply impossible to cover all sources of information, methods and software that a designer might need along his/her entire career.

Career planning has become a part of education goals in all fields, without exception since business world is becoming more competitive from day to day. Career planning does not only include finding correct expertise field for each, but also helping them to get contacts with the industry and understand the conditions of the professional environment. Providing contacts with real institutions and make joint researches on real problems are the best ways to achieve this. On the way of this aim, either the faculty should have good contact with real industry or alternatively professionals from industry should be invited for participation in teaching. While hiring half-time adjunct faculty is always positive for providing relations with the industry, the companies may not be tolerable for this. It is so, because companies in real sector pay big salaries to their employees who are supposed to be fully committed to the job.

Industrial design has been a trendy profession because of the expanding demand of the market which still offers a wide range of job opportunities for the graduates. Difficulty in offering such graduates therefore has to be overcome. Many students invent their capacity by themselves during the education. The best way for student-based learning is to encourage them to test their

talent and skills in competitions. Design studio problems can be therefore directed towards the aim of the competition which also simulates a real design work environment.

Conclusion

Developments in the design practice and technology become a stimulating factor for us-the trainers to review design education-its goals, education models and teaching strategies. As a result of the review we made in this text- the outcomes can be itemized as follows.

- In parallel to the demands of the real sector, the education models should aim to raise graduates who can develop certain expertise in the design field. In an idealistic setting, ID studios should be capable of engaging students coming from different professional backgrounds together. In order to avoid from the danger of creating generalist designers whose knowledge and design is mediocre, high level of expertise derived from the educational backgrounds of the student should be accentuated.
- Despite of the difficulties in realization, education institutions should explore ways to inhabit links with the real industry by either hiring adjunct faculty or research counterparts from the design business.
- In order to prepare the students fro their future career, the notion of flexibility, and the habit of life-time learning should be injected during the education which may also help them in their career planning.
- Additionally, the education should not be independent on the basis of employment conditions. A competitive atmosphere and vivid work environment in the studio can be introduced with either a real client or a design competition based problem.
- The wide range of job opportunities in the market should be seen as an advantage rather than disadvantage in design education.

References

Boyarski, Daniel (1998) '*Education: Designing Design Education*', SIGCHI Vol 30 No 3 p 2

Kolko, Jon (2004). '*New Techniques in Industrial Design Education*' retrieved March 26, 2007 from the www.jonkolko.com/projectFiles/writing/ead06_id115_2.pdf

Yang, M-You, M-Chen, F (2005) *Competencies and qualifications for industrial design jobs: implications for design practice, education, and student career guidance* Design Studies Vol 26 No 2 pp 173-174

BEYOND VISUALIZATION: AN INTERPREATIVE FRAMEWORK ON THE CHANGING ROLE OF ARCHITECTURAL REPRESENTATION IN DESING EDUCATION

Res. Assistant. Betül Koç
Gazi Universitesi, Mühendislik Mimarlık Fakültesi Maltepe, Ankara/ Türkiye
btlkoc@gmail.com

Abstract

From conceptualization to production, design studies are manifested through the images produced by the architectural students. As a result of this incessant condition, what has been framed through those images is a crucial task both for the young architect to reveal his intentions and to professionals and scholars who will judge and evaluate these products. Representational drawings, in general, are taken for granted as intermediary states of architectural production which are in need of gradual unfolding of design procedure both theoretically and technically throughout the process. They are transitional zones between the ideation of the design student and the materialization of the product. As a consequence of this intermediacy, throughout architectural history, architects developed various techniques and methods to succeed that insurmountable gap. Drawings, sketches, perspectives, models, 3d renderings, animations are some modes of the architect's repertoire to transcribe his very intended objective.

Although, from this wide range of catalogue, projection drawings, i.e. sections, plans, elevations and perspectives have a significant importance for the architect because of their proportional accuracy and abstractness; the changing stipulation in architectural production with the advent in computational technologies now calls for the design student to propose new methods to reveal his ideas and for scholars to develop further criteria for functional, structural and material assessment and aesthetic evaluation.

Now, it is, with the very intrusion of computer aided design and manufacturing technologies that the traditional methods of production, the vital role of architectural representation, and the accepted norms of evaluation have blurred or at least changed state. Therefore, to consider the shifting role of the architect and the changing principles of evaluation have a critical value for to offer further methods and strategies due to the fact that now it became harder for one to judge whether the design work represents considerable effort and wisdom or it is the result of a happy accident. This current situation seems to be an unavoidable consequence of the visualization possibilities of CAAD technologies which highly exceeds the imagination of design students. Although, it is too early to state a finalized shift or to demonstrate a complete replacement since the studies are too premature to illuminate the future position; concerning that these are testing times in many of architectural schools, this study aims at a critical reconsideration of the changing status of architectural production and representation in digital environment with a special focus on how to evaluate the product and the process that a design student encounter while learning by doing.

Keywords: architectural representation, digital design technologies, projective drawings, changing role of the architect, design education.

BEYOND VISUALIZATION: AN INTERPREATIVE FRAMEWORK ON THE CHANGING ROLE OF ARCHITECTURAL REPRESENTATION IN DESING EDUCATION

Architectural images conveyor of both the idea of the architect and the data for constructability is part of a back to fore process. Unlike from the images produced by other visual fields, in architecture, the relation that the image constructs between its content and its object is not a function of correspondence as when the images are produced they don't have any object to correspond yet. And, this is what makes architectural representations unique for to understand the process of design and the creative act of architect.

An architectural image is quite different than a picture in the sense that it is not a representation, imitation or an abstraction of an external object. Therefore highly departing either from the platonic view that sees visual reality as a function of ideal essences or from its Cartesian counter in which an image is assumed to be an internal mental construct of an external reality, architectural images offer a distinctive approach, which denies the presence of the external object yet to construct it further. In that respect, the authority of this construction is a matter of apprehending a reference system between what is internal to the frame and what is external to it. In architectural representations this relation between yet to be unrealized physical reality and what is involved in the image is provided by the technique and method of parallel and perspective projection.

Architectural drawings which are mostly defined as projections that consist of imaginary straight lines either vanishing in one point or going parallel to each other, in order to match the corresponding parts of the drawing and the thing drawn, are seen to be the conveyer of both the idea of the architect and construction data of the product (Evans, 1989). This considerable communicatory role of these flat surfaces not only determines their particular significance through out architectural history but also define the status of the architect since their initial invention by the Renaissance architect. Yet, they enable the architect to give his ideas a definition prior to construction, and the possibility of exchange between different agents of the design process; it elevates the knowledge of designing on the skill or craft of building. This assigned superiority of the theoretical ground of the profession over practical realm is claimed to be a result of the investments in architectural representation techniques, therefore the first part of the study will focus on the antecedent perspectives that prepare the way for the divorce of theory and practice in design education, and the subsequent biases that these dissolution bring forth. On the other hand the second part will direct on the changing role of the architect with regard to the investments in newly introduced digital technologies. The aim of the study is not to make an anachronistic reading of the two quite distinct periods, but to reveal the two paradigmatic shifts both in formation of the profession and in conception of the status and role of the architect in those formations. Because it is through the changes in cultural, social, technical or technologic formations that the curricula of architectural schools are re-adapted to the new systems of thought in order to provide the young architects catch hold of the time dependent requirements of the profession itself, it seems necessary to unveil the prospective change that the newly emerging technologies bring forth.

The material and the conceptual realm of what is represented has always been the center of focus for the historians and the critics of both artistic and architectural field. Although the conceptual field were seen to have a superiority on the material part of the profession,

increasing affiliation with the fabrication or production phase of architectural process calls an urgent attention on the needs and developments in practical field. Therefore the method of abstraction and the technique of presenting it became the main focus of representation beyond its liability of revealing the intention of the architect.

Disregarding the role that the technique has played on the creative aspect of the work of art, technical instruments are mostly seen as prosthesis and almost as superfluous factors which often impede the realization of the most daring artistic conceptions. In contrast to the general assumption made by critics, Focillon states that under the influence of the outworn forms of idealism "the idea of form itself tended to become too exclusively intellectual and dematerialized." For him this dematerialization is a consequence of the achieved sterility of the idealist aesthetic which totally ignorant of the material or the technical aspect of the genesis of art conceives a direct link between ingenuity of the architect and the originality of the product. As a result Focillon offers to 'make a decisive break with the outworn forms of idealism, that is, with the idea of the solidity of matter as opposed to the subtle essence and the creative gift of the spirit.' Taking into account what Focillon offers in relation with the technical aspects of the creative act, the first part of the study will elaborate on the emerging conditions of architectural drawings in Renaissance (Bony, 1963).

Unlike from their contemporary usage, these drawings had an additional importance for the inventers of the projective techniques –that of being the reflection of the ideality of the idea. Since, the understanding of the era, as it is also noted by Martin Jay (1994), directed mostly by the scopic regimes of the emerging techniques and technologies –that of perspective and optics, the focus is mainly on vision and its power of capturing the reality. The conception of reality did not have a temporal state, but an ideal one above time. As a consequence, the subject matter of the architectural production and its representation was to mirror the "essence" and the "ideality" of the world order in its depicted visuality. In belief of a mathematical order inherent in the order of the universe the task and the aim of the young artist or the architect were to follow this ideal order and reveal it in his own studies. It is known by the followers of Alberti that to follow the predecessors so closely is a big fault as to work out independently without any proper model to follow. Under the influence of the general conjuncture of the era Alberti directs his attention on the intrinsic structure of the physical reality as appeared to the eye of the observer. This inner structure to which the external appearances are all depend has to be an order of mathematical kind, for Alberti who believes in the utmost character of geometrical universe. Consequentially, as stated by Vasari, Alberti, deemed to treat nature as a whole, that is as figures and objects in their mutual relation on the basis of a mathematical science (Brown, 1960). And it is not something other than the geometry which holds everything under the unification of one system. Taking the aspect of visibility as the common ground for coalescence, this new method of representation provides the architects the universal language. Vasari further adds that it is a consequence of the developments in representation methods that the modern figure of the artists or the architect who, as scholar and gentleman, holds a place apart from and above the artisan (Brown, 1960).

Besides the increasing awareness on the study of the geometric or proportional relations of the antic ruins, Alberti's stance being a proto-posivistic attitude seems to be a great departing attempt when compared with the general stand. Grounding all his theory of "good architecture" on the observation of the natural order, Alberti founded the initial attempts to externalize the theory of architecture from the practical concerns. This unconditioned trust on the significance of observational knowledge, made him to focus on to develop an objective,

universal technique both for to reveal his investments on visual, physical order and to share them.

Being more than the most accurate technical instrument for exact transcription of the architect's ideas, the changes in the drawing techniques since Renaissance mostly associated with the transformation of the cultural and social organization of the architectural practice. As it is observed by Edward Robbins that the shifts in the use of drawing techniques from ancients through the Middle Ages presaged subsequent changes in the way architecture is produced. Undeniably these changes culminated in the new cultural and social status run parallel with the notion of the gentleman architect of the renaissance. Robbins further asserts that, "the last transformation of the architect from craftsperson to artist was accompanied and, arguably, made possible by the new centrality and importance of drawing as a critical instrument of architectural creation and production (Robbins, 1994)."

Because architectural projections afford the architects to give form their design ideas before construction they consequently enable the designers to use drawings to direct the transformation of the social division of the labor through which architecture was produced. The transformation of the architect's role and status that we begin to witness in the late middle ages and which took its current shape early in the renaissance would be associated with the greater emphasis that the profession set on drawing. With these changes in architectural practice, drawing took hold as the superior instrument of design and the symbol of what makes the architect unique (Robbins, 1994).

Undeniably, the architectural projections have a more substantial meaning for the inventers of these methods. Architecture of the period in trial of identifying itself with the exact sciences, found its definition under the unifying, neutralizing and objectifying system of architectural projections. This provided architecture -which is in need of grounding itself on the bases of mathematical reasoning, the exact way to be accepted as one of the liberal arts.

Formed with respect to the formal resemblance to the method of seeing, architectural drawings utilize straight lines in order to connect representation and the represented object. This however, As Ervin Panofsky (1991) has pointed out, was a unification of the perceptual and the conceptual which means: "… 'aesthetic space' and 'theoretical space' recast perceptual space in the guise of one and the same sensation: in the one case that sensation is visually symbolized, in the other it appears in logical form." Their characteristic of accurately transforming the proportions on the other hand let them to be accepted as the universal and the scientific means of depiction.

What was consequential to the invention of projective methods by the renaissance architect was the appearance of the architectural treatises. Because the architectural drawings that use projective methods provide the architects to easily document canonic orders of the antique ruins and to establish them in their further designs either augmenting or diminishing in size but preserving in proportion, they formed a thorough set of normative rules which should be deployed in order to achieve a good design. Stan Allen (2000) terms the substantiation of the normative codes in written form as a shift from the "ambulant science" of the medieval builder to the regulated culture of the "royal sciences,". For him through this manifestation of architecture via inscription formed a place for abstract thought about architecture which was governed by the codes and conventions of discourse and delineated apart from the building site (Allen, 2000). Royal sciences therefore provided to the arts "constructed, regulated and thus a writable system" which they themselves lack. "The result at the end was an achieved

antagonism between the enlightened discourse of theory (scientific and generalizable) is contrasted to the mechanical techniques of practice" (Allen, 2000). All these change both in the practice and consequently in comprehension of architecture seem to be the result of images that the architect produce to close the gap between his conception and production.

Aware of the very fact that "architecture is reliant on its own images" (Blau and Kaufman, 1989) both in its materialization and in its ideation; architects in advance of the possibilities of "digital morphogenesis"[1] started to criticize not only the inadequacies but also the restrictions of early methodologies. Declaring that digitalization of the design procedure not only requires new methods of production but also necessitates new techniques of representation; architects of present confrontation are making trials for revealing the strategy of new conception.

Although, it is not obviously apparent what the computer might offer to architectural composition since the developments in technological inventions are continuing with great rapidity; the illustrations of experimental forms point out a shift from traditional understanding of "form making" to contemporary appreciation of "form finding" . Since very few of those experimental morphologies were realized yet in reality, what has been discussed on digital technologies incursion of architectural field, made after their representations. In other words, also the discussion of the new era became to be reliant on architecture's own pictures.

Through the discussions, educational experimentations and in the light of few realized examples it could be derived that the newly upgrading technologies' discourse mainly turns around architectural process and its representation not as a final product but as filmic motion that will reveal the whole procedure from its conceptualization to production. This filmic conception of architectural production which unites conceptualization, representation and production designates a new kind of seriality completely different from its prior deliberations. It differentiates from the earlier ones exactly in its two states, one of which points out the role of architect and the other one signals the changing status of architectural representation.

Yet, now the possibility of construction in other words realization of a design idea became directly related with what can be produced conceptually or better visually within CAD technologies. Computability became not only the main issue of design but also manufacture (Kolarevic, 2003). Consequence of this direct correlation between visualizable and constructible, the criteria for any kind of evaluation of architectural edifice seems to have changed state. Therefore, the most overwhelming aspect of contemporary architecture seems to be the new ability to provide construction information directly from the design information through the new processes and techniques of digital design and production.

As a result of the changes in the conception of architectural representation, the definition of the role of the architect has also altered. The architect is now not the composer of the whole process but also the editor of its sequential fragments each of these not only presents itself but virtually reflects the old and future ones. In order to be much clear, each state of production, such as, formation of the diagrams, not only expresses previous information that reflect wide variety of derivations from site, climate, culture, society etc. but also prospectively conveys

[1] The term "digital morphogenesis" has a wide spread usage particularly among current "computational design" discussions. It is utilized especially for signifying the formal generative role of digital technologies. For further information sea; Branko Kolarevich. *Digital morphogenesis*. London and New York: Spon Press, 2000.

indications of manufacture and fabrication. So that, each fragmentary frame of production conveying the information of the whole -with differing operators acting in differing states such as; static engineer, electrician or mechanic engineer with their own specific contribution, turns to be an “instant” in process of motion open to articulation and manipulation of architect. Sola Moralles (1996) defines the changing role of architect with a focus to its historical dissimilarity as such;

> Historically, architecture’s technical and material stability allowed the architect to operate as a medium, as a magician capable of formulating general hypotheses and essential formal decision with the confidence that their materialization could be undertaken without the least difficulty. The degree of integration of the various technical procedures of the building made these mere steps in an immediate relationship between the person who formulated the original idea and the final result.

To sum up, as both conceptualization and materialization phases of design process are united in the body of computer following Mitchell’s account of “architects drew what they could build, and build what they could draw,” (Mittchell, 2001) it could be stated that “architects now try to produce what they could compute, and try to compute what they could produce”. As a result of these changes in architectural production the representations of the era turned from being “made forms” of overlapped imagination to “found forms” of sequentially ordered systematization. All these changes at last, first in techniques then in technologies of architectural representation calls for a new definition of the architect and a reformation in design education to provide the necessities that this new formation require.

REFERENCES

Allen, Stan. (2000), *Practice: Architecture, Technique and Representation*. London: Routledge, p.xiv.

Blau, Eve and Edvard Kaufman. (1989), Eds. "Introduction." in *Architecture and Its Image: Four Centuries of Architectural Representation, Works from the Collection of the Canadian Centre For Architecture*. Montreal: Canadian Centre for Architecture, p.13.

Bony, Jean. (1963), Introduction. In, Henri Focillon. *The Art of West in the Middle Ages.* Volume: 1, London: Phaidon Press, pp.xvi-xvii.

Brown, Baldwin. (1960), Introductory Essay. In, Giorgio Vasari. *Vasari on Technique.* Trans. Louisa S. Maclehose. New York: Dover Publications, p. 13.

De Solà-Morales, Ignasi. (1996), *Differences: Topographies of Contemporary Architecture*. Trans. Graham Thompson. Cambridge, MA: The MIT Press, p.134.

Evans, Robin. (1989), "Architectural Projection," in *Architecture and Its Image: Four Centuries of Architectural Representation, Works from the Collection of the Canadian Centre For Architecture*. Montreal: Canadian Centre for Architecture, pp.19-35

Jay, Martin. (1994), *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought*. California: University of California Press, p.53.

Kolarevic, Branko. (2000), *Digital morphogenesis*. London and New York: Spon Press.

Kolarevic, Branko (ed.) (2003), *Architecture in the Digital Age: Design and Manufacture*. New York and London: Taylor and Francis, p.31.

Mitchell, William J. (2001), "Roll Over Euclid: How Frank Gehry Designs and Builds" in J. Fiona Ragheb (ed.), *Frank Gehry, Architect*. New York: Guggenheim Museum Publications, pp.352-363.

Panofsky, Ervin. (1991), *Perspective as Symbolic Form.* Trans. Chiritopher S. Wood, New York: Zone Books, p.45.

Robbins, Edward. (1994), The Social Use of Drawing: Drawing and Architectural Practice. *Why Architects Draw.* Cambridge and Mass: The MIT Press, p. 19.