Challenges and Research Trends for Drawing Ability in Design Education: A Literature Review

Melissa Di Giovanni, *Programme Leader and Lecturer, Interior Design, University of Derby, United Kingdom*

https://orcid.org/0000-0002-7583-0485

To cite this article:

m.digiovanni1@unimail.derby.ac.uk

Challenges and Research Trends for Drawing Ability in Design Education: A Literature Review

Melissa Di Giovanni, *Programme Leader and Lecturer, Interior Design, University of Derby, United Kingdom.*

https://orcid.org/0000-0002-7583-0485

Abstract

"I can't draw" are three simple words, yet they formulate a statement that might conceal students' feelings of drawing inability and powerlessness. These words also represent the major concern perceived among lecturers in design, that many students lack the necessary drawing abilities to transform ideas into representations. Discussions about this problem occur where drawing is the main language of communicating ideas, particularly in the classroom where the problem reveals its (harsh) reality. What are the roots of the design students' lack of drawing abilities?

In an attempt to formulate an answer to this research question, this paper presents a literature review within the lens of contemporary design production and education. Based on a systematic literature search of conceptual works and empirical studies, this paper employed a narrative approach to discuss the results, with particular attention to design praxis and design education. The main findings revealed that the problem of drawing ability has its roots in a) the use of the computer and loss of design thinking process, as well as the decline of hand-drawing practice; b) reduced drawing tuition and change of the meaning of drawing in higher education. All these factors tend to contribute, explicitly or implicitly, to the lack of drawing ability of design students. The aim of this paper is to invite educators to a critical reflection on drawing ability and its practices in design education and to provide an opportunity where drawing debates are not only encouraged but a necessary part of the learning-teaching paradigm.

Keywords: drawing, drawing ability, drawing decline, design education, drawing research

1. Introduction

Drawing ability is regarded as a fundamental competence to be developed in design education (Graves, 2005; Lawson, 2019). It is fundamental simply because it constitutes the only language for designers to transform an idea into reality, an abstract vision into 'tangible' lines and shapes (Purini, 2017). Yet, in recent years, both the design industry and university design programmes have evidenced students' weakness and low confidence in drawing (Fava, 2020; Kantrowitz et al., 2011; RIBA, 2014). Many professionals and educators, the writer included, would question why. The dialogue between hand, eye and mind, the materiality of the lines on paper, and the senses involved make the process of hand drawing far beyond being a simple act; it is a discovery (Benjamin, 2014; Berger, 2005). The discovery lies in the fact that drawing as a process and an

Corresponding Author: Melissa Di Giovanni, University of Derby, United Kingdom.
m.digiovanni1@unimail.derby.ac.uk

outcome is a state of anticipation of something that is yet to exist, a state that exposes students to unexpected stages and desire for anticipation. Drawing, therefore, is capable of influencing and driving the whole students' design experience (Casey, 2016; Graves, 2005; Maynard, 2005; Nancy & Armstrong, 2013). If drawing is a precondition for succeeding in design education and profession, there is a need to understand the reasons for the decline of drawing ability and to frame the standpoints from which this problem can be discussed and analysed.

This study examines the decline of drawing ability for design students and calls for a critical reflection on drawing practices in higher education. This paper begins with a description of the literature review methodology, followed by a critical discussion of the primary roots of the decline of drawing ability: design praxis and design education. The conclusion section provides recommendations for educators and suggests research lenses yet to be explored in drawing research.

2. Literature Review Methodology

This review employed narrative methods, an approach that seeks to review extant literature for a qualitative interpretation of knowledge on a specific subject area (Paré et al., 2015). This approach tends to be selective by gathering many and varied studies around the same topic with the aim of interpreting common and contrasting concepts and interconnecting the results (Baumeister & Leary, 1997). Although narrative methods focus their attention on specific topics and studies and, therefore, might lack rigorous search processes and explicit sets of search criteria, they can be employed in more systematic ways by a) performing the search and screening the literature, b) identifying pertinent studies, c) extracting relevant information and knowledge, d) analysing literature and writing the review (Levy & Ellis, 2006). This is the systematic approach that this literature review employed.

The review drew on books and articles either in the form of conceptual works or empirical studies. The initial selection was retrieved from multiple scientific databases (DOAJ, Google Scholar, Scopus, Semantic Scholar, Science Direct, Web of Science, JSTOR), and from the OpenEdition Journals platform. The databases mostly allowed for the selection of empirical studies, while the journals platform proved to be the most complete directory for conceptual works.

The search was performed by inputting the following words, either individually or combined: drawing, draw, ability, capability, skills, performance, decline, lack, design, education, technology, digital, and software. The empirical studies were searched within a time frame of ten years, while the conceptual works were scanned without any temporal restrictions to prevent the omission of crucial research conducted in earlier years. Since the researcher is Italian, the search was also performed by selecting the Italian language to enrich the literature. The 34 works selected, among the 117 initially obtained, were analysed according to a fit-to-purpose method by scrutinising the most relevant abstracts or introductions with a focus on drawing, technology, and design education. 83 sources were excluded from the review. Poorly conducted studies and studies whose outcomes were unclear or reported inconsistently were excluded. Reports, interviews, and secondary sources were also excluded, but some helped to frame the discussion. While the author felt reasonably assured that all the search routes had been explored, complete certainty regarding an exhaustive literature coverage could never be guaranteed due to the complex nature of the research topic and a search that focused on drawing in design education only.

3. Decline of Drawing Ability as Reflection of Design Praxis and Education: Results and Discussion

3.1. Digital Technology

The decline of drawing ability might have origins in what has been perceived as a worldwide phenomenon described, unironically, as the death of drawing by American architect David Ross Scheer (2014). As a maker and a witness of contemporary design, he asserts that drawing is seeing huge transformations due to the technological demands of the building industry. He also states that technological tools are not simply digital instruments that add to the traditional drawing media, they are the vehicles that will eventually reshape the nature of design education

and practice. The phenomenon described by Scheer (2014) evidences that the decline of drawing ability is due to three interconnected factors: the market dynamics driving the adoption of simulation and computing into the design process; the characteristics of these technologies able to anticipate the likely appearance and behaviour of a design; and the response of design practices to these technologies.

Scheer (2014) observes that the premature exposure of students to technology-aided design leads to a misunderstanding of the design process and representation. A design process centred on hand drawing progresses methodically from general to specific, with each stage focused on the comprehension of the design decisions taken and their consequences. In contrast, Scheer (2014) states that when using software programs for drawing, every design stage is articulated with automated operations that leave no room for the creative development of the design. Sennet (2009) also stresses that simulation technology induces students to believe that drawing is indeed a simulation of a possible reality, a mere series of digital processes that reproduce (not represent) the design and that narrow the distance between idea and reality.

Turkle (2022), in an attempt to explore the effects of simulation on design, explains that simulation aims to give the user (design client) an experience that is virtual by its nature and that triggers feelings of excitement. Due to its ability to engage vision and mind in a way that is not possible with traditional drawing instruments, simulation makes the experience immersive. This euphoria is not only experienced by the user but also by the creator of the simulation, the designer (Turkle, 2022). This implies that the infinite possibilities through which a student can simulate a project make each idea, even the first one, a seemingly complete solution to a design problem. The persuasive nature of simulation (Oinas-Kukkonen & Harjumaa, 2008) induces students to think that an idea that is apparently perfect or aesthetically pleasing on screen is the only one worth considering.

3.2. Drawing Ownership

Students' reliance on technology has raised important questions about ownership in drawing and design, how the idea is generated and the student's judgment and responsibility for it (Christenson, 2007; Leinss, 2009). Purini (2020) observes that thinking, interpretation, and expressiveness - processes of graphic representation - play a marginal role in the creation of a design nowadays. The power of drawing that gives life to forms is vanishing, he says; the artistic value of design is being replaced by the seductive world of images and simulation. Purini (2020) goes on to observe that without a complete awareness of the hand-drawing process, there is no meaningful intellectual ownership of the design. Drawing, therefore, is central to the creation and realisation of a design idea and craftsmanship supports and contributes to the final product.

3.3. Thinking Process

Together with ownership, the thinking process in design is another aspect profoundly affected by the use of technology. Lawson (2005) cautions about its meaning. Because the words thinking and design are often used together, there is a need to understand how thinking is involved in the process of designing. Designers use imaginative thinking to prefigure the initial forms of an idea; they also use reflective thinking to envision possible solutions and to control the feasibility of those forms on paper as they become the resolution to a problem. Lawson (2005) continues that this thinking process is never linear but cyclical. If a solution encounters obstacles, the designer re-engages in imaginative thinking to explore again the forms by drawing until the obstacles are overcome.

Di Napoli (2011) observes that drawing is the visual expression of the designer's thinking. Drawing demands that the mind, eye, and hand interact in a natural and fluid manner, for which thinking is already seen in the mind and visualised on paper. This mind-eye-hand correlation is the essence of drawing ability and the element that forms the language of a designer. This unique and personal form of expression is lost, and with it, the ability to draw when design is purely produced by computer because technology demands that designers think in terms of digital operations and talk a digital language rather than their own (Lawson, 2019).

Due to technology, "the drawing paper is no longer the privileged space on which and in which an architectural project takes shape" (Contessi, 2019, p. 36), meaning that the moment in which a designer connects themselves to paper through mind and hand is diminishing in time and spirit. The idea that technology has rendered drawing obsolete is also highlighted by Sennet (2009); for him, the intimate dialogue between the designer and hand-drawing instruments belongs to the past. This is not nostalgia, as Sennet remarks, but rather a fact. Computers have separated a designer's thinking and perception from learning and creation.

In the Renaissance, architect Giorgio Vasari (1912) defined drawing as the apparent expression of a concept that comes from the soul and the mind. An idea, proceeding from the intellect and guided by the sentiment, becomes a form. This cognitive process is eventually translated with the hand into what is called a drawing. Di Napoli (2011) asserts that this profound yet linear explanation of drawing is still valid. For designers, there is no difference between thinking and drawing; a thought flows in the mind of the designer as the line flows on paper with the help of the eye (Laseau, 2001).

3.4. Skills development

The comparison between digital and hand drawing interrogates a further factor influenced by technology skills development. Sennet (2009) points out that the major threat that computer poses to drawing relates to the skills students need to develop. By comparing the act of drawing by hand and by computer, the time spent on paper to trace lines, rub them out to refine the composition, and start the same process again if we are not satisfied, trains mind-to-eye-to-hand connections and coordination; most importantly, it involves a thinking process. On-screen, the cyclic repetition of trial and error is replaced by plotted points and mathematical algorithms that recalculate the geometric forms in less than a second; with it, the thinking process is almost null. The skills that Sennet (2009) describes as being under threat are hand control, vision, and imaginative and reflective thinking. The agent of the threat is time management.

3.5. Time Management

Time management appears to be a key aspect of the contemporary design industry and education. Brown (2009) argues that when it comes to describing time management in design, the first technology that we refer to is CAD Computer-Aided Design. In describing the dynamics and processes of working in CAD, Nejadriahi and Arab (2017) outline the key aspects relating to execution time: CAD users can modify lines and shapes quickly yet maintain the accuracy that the technical resolution of a project requires; they can replicate drawings and mirror parts of it through few intuitive commands; they can import and export graphics via cross-platform compatibility; they are also able to speed up the communication of drawings and technical documentation to contractors and clients via a cloud-based environment. In general, the adoption of CAD for students and professionals increases productivity by reducing design time.

3.6. Roles of Drawing and Designer

Scheer (2014) argues that the gradual disappearance of hand drawing from the designers' daily routine has inevitably triggered significant transformations: the range of skills designers have, their new role in the digital industry, the social dynamics in which they operate, and the very definition of being a designer. Neuckermans (2017) emphasises that the same transformations are seen in the schools of design: the ability to draw by hand has regressed; the number of drawing tables in studios has drastically reduced; the availability of prototyping workshops as well as construction laboratories has proliferated; books and design journals have been replaced by ready-to-use design websites, talks, and image sharing and social media. Starting with hand drawing, the craft-based design is disappearing, except for the freehand sketching that is still used by students to start generating ideas on paper.

Accepting that the computer as an epochal change in the history of design was necessary, it should never be considered a substitute for drawing; if a relation needs to exist between the two, this should be a coexistence and integration of two forms of expressions, manual and digital (Migliari, 2004). Belardi (2014) supports the idea that, in future, hand drawing will even be seen

as a privileged discipline, entitled to preserve its role in the creation of design in the digital age. de Rubertis (2018) opines that whether this epochal change is beneficial or not, whether images, computation, and simulation are a temporary fashion or not, the full consequences can only be assessed in years to come. He continues that, at the present time, it is educators' responsibility to defend and preserve the authenticity of drawing.

3.7. Pedagogical Approaches

Are technology and digital culture the only factors responsible for the decline of students' hand-drawing ability? The second root of the problem can be traced to higher education.

According to Soliman et al. (2019), the current pedagogical approaches to design teaching are heavily dependent on the industry's demands and, therefore, on the use of technology. This dependence, in turn, is shaping the whole structure of design curricula. The extensive study that Soliman (2019) conducted aimed to evaluate the integration of computer and software applications into the curricula structure of 28 top undergraduate architecture programmes worldwide - USA, UK, Australia, China, Singapore, Italy, Netherlands, Germany, Canada, and Egypt. The results show that more than 10% of software applications are taught as stand-alone modules or are integrated within studio-based modules. The results also evidence that the teaching of computer application varies between the levels of programmes: overall, these are extensively taught during the preparatory and sophomore years, while they tend to reduce in the final years. Soliman's study (2019) also found that the most studied software applications are CAD (95%) and Photoshop (88%) and that these, as well as many others, are mainly used within the development phase of a design project.

Nineteen years prior to Soliman's study, Earl Mark (2000) had observed that the physical presence of computers alone in design studios would not have been a good measure of the impact of technology on design curricula. Soliman's study (2019) suggests that the current measure that analyses the impact of technology on design curricula is the teaching of software applications and that CAD will inevitably influence students' education as well as the design profession and culture. Although Soliman's study (2019) does not focus on hand drawing teaching, it can be inferred that hand drawing may occupy a relatively small part of the curricula to support the initial stages of the design creation.

3.8. Drawing Tuition and Teaching

Based on a recent study conducted by Fava (2020), UK education is seeing a gradual decline in drawing ability, raising concerns about the traditional understanding of the drawing practice. Over a period of three years, Fava's study (2020) explored the attitudes, values, and concerns of both students and educators surrounding drawing instruction in the UK. Based on the study's phases, participants included: a) 48 academics in the wide range of design disciplines, whose teaching experience ranged from three to forty-five years; b) 18 first-year students from different design programmes; and c) 51 teachers in key stage four.

Fava's study (2020) shows that, within undergraduate programmes in design, the reduced contact hours for drawing, as well as the lack of lecturers' drawing competence, are among the contributing factors to the decline of drawing. Lecturers participating in the study reported that, although drawing is still valued as a discipline and a means of communicating ideas, drawing tuition in undergraduate programmes is drastically reduced compared to their own undergraduate studies or early careers. Lecturers commented that the reduced drawing tuition is due to the tendency of structuring drawing classes as individual-focused rather than group-focused by allowing students to practice drawing out of teaching hours and using scheduled time for individual reviews and planning. While lecturers described this as a negative aspect of the curricula, students commented that this approach enables them to express their drawing individuality and shape their design style, key elements to compete in the design industry. Lecturers, however, argued that being able to draw without teaching and guidance requires confidence and core skills that would only be acquired in class with the support of a tutor.

Another factor that emerged from Fava's study (2020) is the lack of drawing competence of the younger teaching staff. The more experienced lecturers participating in the study reported

that the lack of students' drawing ability is also a consequence of the tutors' drawing expertise, either because they are young or at the beginning of their teaching career or because they are unwilling to teach drawing disciplines. This view implies that generational differences not only influence the structure of the programmes but also the effectiveness of teaching drawing, which compromises students' learning. A further inference is that hand drawing discipline, the ability to teach it, and students' drawing competence may vanish with the old generation of lecturers.

3.9. Meaning of Drawing

Another important factor that Fava's study (2020) highlighted is the change in the concept of drawing ability. Participants, both educators and students, agreed that the traditional meaning of drawing and the skills associated with it have fallen into disuse and that other forms of expressions are accepted even though these do not call into play the hand as a generator of concepts. According to participants' opinions, alternative forms of representing ideas such as collage, digital rendering and digital imaging are adopted in curricula and acknowledged as new forms of drawing practice. Also, CAD software is part of these alternative forms of drawing. Although largely accepted, the convenient use of digital tools was reported as the main factor influencing students' drawing ability. By inference, the use of technology might be expedient for students to avoid the onerous processes of hand drawing and for lecturers to compensate for their lack of drawing competence.

Lecturers from Fava's study (2020) supported the opinion that drawing is no longer essential, which led to reflection on whether this change refers to the operative phases of hand drawing or to more contextual aspects. The accounts revealed that, while hand drawing plays a key role in the developmental phases of a design project, it is no longer used to finalise a work. The inference here is that the current skills that educators prioritise, and those that students need to master, are related to sketching and design thinking. These, lecturers commented, are the high-level skills to showcase in the real world of work when collaborating in real-time with clients and professionals.

3.10. Educational Background

The last factor contributing to the decline of drawing ability that has emerged from Fava's study (2020) relates to drawing provision in secondary school. Lecturers reported that lack of drawing ability is evident in portfolio reviews of design applicants, wondering, therefore, about the quality of drawing teaching and the time spent on artistic subjects during the university preparation years (A Levels, and GCSEs General Certificate of Secondary Education). Lecturers also observed that freshers' hesitation and anxiety to engage with hand drawing and with the more complex stages of a design project is due to the spoon-feeding approach they experienced in secondary school. In relation to drawing-based anxiety, lecturers explained that the fear of drawing appears evident when students focus on the outcomes rather than the process and when they are overly focused on the aesthetic appearance of the drawing at the expense of creative engagement.

School teachers participating in Fava's study (2020) admitted that this decline in drawing ability is connected to the management of the school's curricula and to learning focused on achievements. Teachers observed that the current secondary school's curricula tend to demand a teaching approach in which students are encouraged to work on their areas of interest or their academic strengths to maximise achievement. Teachers continued that drawings prepared for portfolios would eventually show only specific skills or techniques rather than the entire drawing production of a work. The deduction here is that this pedagogical strategy is targeted to rich higher UCAS points (Universities and Colleges Admissions Service) and increase the opportunities to access higher education programmes rather than equipping students with a wider design and drawing knowledge.

4. Conclusion

This paper explored the reasons for the decline of drawing ability for design students in higher education. The proposed literature review designated technology and higher education's design curricula as the main causes for this decline; in particular, it evidenced that the use technology-

aided design lead to a misunderstanding of the real function of drawing in the design process. It also evidenced a general underestimation of the drawing discipline at both curriculum and teaching levels leading to a profound change of the meaning of drawing.

If a student's drawing potential is undermined since secondary school, and if hand drawing is sacrificed to meet the demands of the design industry, the problem of drawing ability finds its biggest impact at university, when a student needs to overcome practical drawing difficulties as well as the fear of drawing.

In addressing the consequences of technology on drawing, educators should revisit the importance of drawing to reaffirm its authenticity in the creation of design as an inheritance and transmission of knowledge to students (Cappa, 2016; de Rubertis, 2018). Furthermore, providing appropriate hand-drawing tuition across the entire programme of study entails reinstating a coherent approach to teaching and learning drawing by a felt and authentic experience (Dewey, 1980), which would not only address the demands of the design industry in a more conscious way but also restore the inherent values of hand drawing in the design process. What enables students to develop drawing ability, to create, and generate design knowledge from it? The anxiety, the fear of drawing, and the misbeliefs accounted by the students participating in Fava's study (2020), as well as the intricate connection, at times imperceptible, between designer and drawing instruments (Di Napoli, 2004; Gregotti, 2014; Laseau, 2001; Sennet, 2009) suggest that drawing ability goes beyond the influence of technology and design curricula. Further research on drawing ability should explore the emotional and motivational aspects as potential determinants of drawing ability. Placing exclusive emphasis on technology and curricula policies would fail to account for vital aspects of drawing ability and for the psychological dynamics implied in its acquisition.

Acknowledgements

Conflict of Interests

No potential conflict of interest was reported by the author(s).

Biographical notes on authors

Melissa Di Giovanni is a Lecturer in Design and the Programme Leader for Interior Design at the University of Derby. She is also a PhD student in Architecture at the University of Derby. Her current research investigates how cognitive and psychological factors influence drawing ability and affect the educational experience of design students. Her research interests include developing pedagogical strategies to respond to the educational and motivational needs of students. She holds an MSc in Architecture with a specialisation in Architectural Drawing from Gabriele d'Annunzio University, Italy. Before moving to England, she worked at Gabriele d'Annunzio University (Italy) and at ABU - Antalya Bilim University (Turkey), where she taught the Science of Representation, Architecture and Interior Design, and Graphic Communication. She is also a Member and Didact coordinator of the non-profit Italian organisation MusAA - Museo Architettura Arte.

Endnotes

This paper has been presented at the SPACE International Conference 2023 on Architectural Culture and Society.

References

Baumeister, R. F., & Leary, M. R. (1997). Writing Narrative Literature Reviews. Review of General Psychology, 1(3), 311-320. https://doi.org/10.1037/1089-2680.1.3.311

Belardi, P. (2014). Why Architects Still Draw (Z. Nowak, Trans.). The MIT Press. https://direct.mit.edu/books/book/2201/Why-Architects-Still-Draw

Benjamin, A. (2014). The preliminary: notes on the force of drawing. The Journal of Architecture, 19(4), 470-482. https://doi.org/10.1080/13602365.2014.953191

Berger, J. (2005). Berger on drawing. Occasional Press.

Brown, P. (2009). CAD: Do Computers Aid the Design Process After All? Intersect: The Stanford Journal of Science, Technology, and Society, 2(1). https://ojs.stanford.edu/ojs/index.php/intersect/article/view/117

Cappa, F. (Ed.). (2016). Eredità dei saperi: Tradizioni e transizioni culturali [Knowledge legacy: Cultural traditions and transitions]. edizioni libraria Cortina Milano.

Casey, S. (2016). A Delicate Presence: the Queer Intimacy of Drawing. TRACEY: What is Drawing For(2016), 1-9. https://www.lboro.ac.uk/microsites/sota/tracey/journal/pre/2016/PDF/sarah-casey-presence-contribution.pdf

Christenson, M. (2007). Ownership and media: The architectural case study as an articulation of theoretical stance. Design Communication Association 20th Anniversary Conference, Muncie, Indiana. https://www.barnesandnoble.com/w/dca-20th-anniversary-conference-michel-a-mounayar/1113675858?ean=9781257358441

Contessi, G. (2019). Per una nuova inattualità [For a new un-contemporariness]. XY, 1(1), 36-43. https://doi.org/10.15168/xy.v1i1.13

de Rubertis, R. (2018). Towards which Representation? diségno, 1(2), pp. 23-32. https://doi.org/10.26375/disegno.2.2018.5

Dewey, J. (1980). Having an experience. In Art as experience. First Perigee Printing. (Reprinted from 23)

Di Napoli, G. (2004). Disegnare e conoscere: La mano, l'occhio, il segno [Drawing and knowing: The hand, the eye, the sign]. Piccola Biblioteca Einaudi. https://www.einaudi.it/catalogo-libri/arte-e-musica/arte/disegnare-e-conoscere-giuseppe-di-napoli-9788806167523/

Di Napoli, G. (2011). Che cos'è un disegno e perché si disegna [What drawing is and why we draw]. Rivista di estetica(47), 61-81. https://doi.org/10.4000/estetica.1955

Fava, M. (2020). A Decline in Drawing Ability? International Journal of Art & Design Education, 39(2), 319-332. https://doi.org/10.1111/jade.12255

Graves, M. (2005). The Necessity for Drawing. In B. M. Ambroziak (Ed.), Michael Graves: Images of a Grand Tour (pp. 235-245). Princeton Archit.Press. https://doi.org/10.1007/1-56898-657-2_9

Gregotti, V. (2014). Il Disegno come strumento di progetto [Drawing as instrument of the design]. Christian Marinotti Edizioni s.r.l.

Kantrowitz, A., Brew, A., & Fava, M. (2011). Thinking through drawing: Practice into knowledge. Symposium on Drawing, Cognition and Education, New York.

Laseau, P. (2001). Graphic Thinking for Architects & Designers (3rd ed.). Wiley.

Lawson, B. (2005). How Designers Think (4 ed.). Routledge. https://doi.org/doi.org/10.4324/9780080454979

Lawson, B. (2019). The Design Student's Journey: Understanding How Designers Think. Routledge. https://www.routledge.com/The-Design-Students-Journey-understanding-How-Designers-Think/Lawson/p/book/9781138328570

Leinss, M. (2009). Making meaning of technology – through Design. Second International Conference on Critical Digital: Who Cares (?), Cambridge, USA.

Levy, Y., & Ellis, T. J. (2006). A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research. Informing Science Journal, 9. https://doi.org/10.28945/479

Mark, E. (2000). A Prospectus on Computers Throughout the Design Curriculum. 18th eCAADe Education and research in Computer Aided Architectural Design in Europe, Weimar, Germany.

Maynard, P. (2005). Drawing Distinctions: The Varieties of Graphic Expression. Cornell University

Press. http://www.jstor.org/stable/10.7591/j.ctv2n7fsz

Migliari, R. (2004). Preface. In R. Migliari (Ed.), Disegno come Modello: Riflessioni del disegno nell'era dell'informatica [Drawing as Model: Reflections on drawing in the digital age]. Kappa.

Nancy, J.-L., & Armstrong, P. (2013). The Pleasure in Drawing. Fordham University Press. http://www.jstor.org/stable/j.ctt13x02tz

Nejadriahi, H., & Arab, K. (2017). A Study on the Impacts of Computer Aided Design on the Architectural Design Process. World Academy of Science, Engineering and Technology, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 11, 1049-1053. https://core.ac.uk/download/pdf/144729804.pdf

Neuckermans, H. (2017). Architectural design in the era of technology. TECHNE - Journal of Technology for Architecture and Environment(13), 33-37. https://doi.org/10.13128/Techne-21130

Oinas-Kukkonen, H., & Harjumaa, M. (2008). A Systematic Framework for Designing and Evaluating Persuasive Systems. Persuasive Technology, Berlin, Heidelberg.

Paré, G., Trudel, M.-C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. Information & Management, 52(2), 183-199. https://doi.org/https://doi.org/10.1016/j.im.2014.08.008

Purini, F. (2017). Elementary Observations on Drawing. diségno(1), 059-072. https://doi.org/10.26375/disegno.1.2017.8

Purini, F. (2020). Random and provisional notes on drawing. diségno(6), 27-34. https://doi.org/10.26375/disegno.6.2020.05

RIBA. (2014). RIBA Appointments: Skills Survey Report 2014. https://cdn.rt.emap.com/wp-content/uploads/sites/4/2015/02/17203356/skills_report_2014.pdf

Scheer, D. (2014). The Death of Drawing: Architecture in the Age of Simulation. Routledge. https://doi.org/10.4324/9781315813950

Sennet, R. (2009). The Craftsman. Yale University Press.

Soliman, S., Taha, D., & El Sayad, Z. (2019). Architectural education in the digital age: Computer applications: Between academia and practice. Alexandria Engineering Journal, 58(2), 809-818. https://doi.org/10.1016/j.aej.2019.05.016

Turkle, S. (2022). Simulation and Its Discontents. In Simulation and Its Discontents (pp. 3-101). The MIT Press. https://mitpress.mit.edu/9780262546799/simulation-and-its-discontents/

Vasari, G. (1912). Lives of the Most Eminent Painters Sculptors and Architects (G. D. C. De Vere, Trans.; Vol. 1). Macmillan snd Co. Ld. & The Medici Society. https://www.gutenberg.org/files/25326/25326-h/25326-h.htm