



# The Future of the Design Studio

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# REGEN OPARCH

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## **I. INTRODUCTION AND OVERVIEW**

The studio is central to the education of a designer, however, as numerous authors (Bender & Vredevoogd, 2006, p. 115; and al-Asad & Musa, 2000, para. 5) have pointed out, the design studio has changed little in the past 100 years. New ways of thinking about education (and about design education in particular) suggest new approaches, many of which have been enabled by rapid advances in technology.

As the following diagram illustrates this document examines the opportunities and challenges of incorporating such innovations into the design studio while at the same time preserving the essential aspects of the traditional studio. These characteristics can then be enhanced by new ideas about design and new ideas about learning enabled by technology. Based on these new ideas it is possible to suggest an infrastructure to support the design studio of the future. While this document often uses examples from architecture, it is also intended to apply to other design professions such as interior, graphic and industrial design.

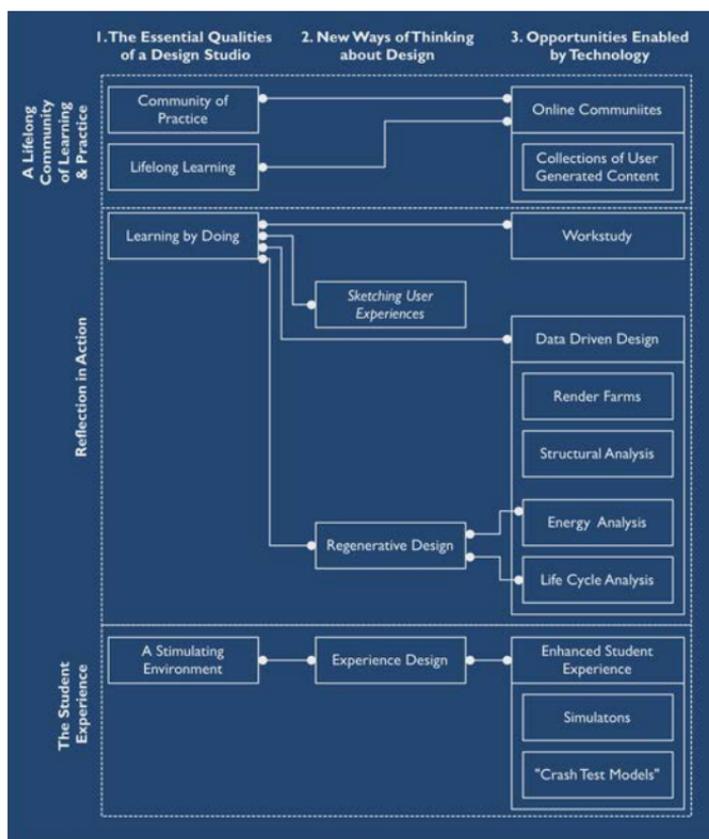


Figure 1: Concept Map

## **2. THE ESSENTIAL QUALITIES OF A DESIGN EDUCATION**

In considering the future of the design studio, it is important to first identify the essential aspects of a design education. These are described below.

### **Developing a Sense of Community**

First and foremost, a good design studio nurtures a developing sense of community. At its best a design studio becomes a network of people learning from each other. Students often learn as much from each other as they do from faculty members. Learning occurs most frequently through informal discussions but also through regular desk “crits” and end of term juries. Visiting lecturers and critics, exhibitions and social events also contribute to this sense of community. Clearly, the design studio depends on providing an environment where both spontaneous and scheduled interactions can occur.

Ideally the community is further enhanced by a culture of sharing. In formal teaching sessions and in spontaneous discussions students are exposed to new techniques, methods and ideas. Slide sets and books in the library, pictures pinned to bulletin boards, framed drawings from previous generations of students, posters taped to walls, late night conversations, chance encounters in the workshop, models on display, magazines left open on a desk and manifestoes nailed to doors are all part of the shared experience. This further implies that those resources should be varied, comprehensive and easily accessible.

It is also noted that first year students often learn from those in upper years. The capacity of human beings to learn from each other through imitation is a very powerful one and the studio should provide many ways for this to occur – not just within a studio but between different studios.

### **Lifelong Learning**

Because of the intensity of the studio experience, profound lifetime bonds often develop between participants. Friendships, marriages and business partnerships often result. Properly cultivated this can result in a lifetime community of practice. It is

through this network of friends and acquaintances that students find jobs, projects and other opportunities.

In other words the impact of the design studio lasts far beyond a single term or semester.

### **Learning by Doing/Reflection in Action**

Many have remarked on the unique nature of design. Describing various kinds of studios, Donald Schön, then the Ford Professor of Urban Studies and Education at MIT, wrote that, “Here the students learn to make or perform. Everything revolves around the acquisition of artistry, through practice and coaching (Schön, 1984, p. 2).” He also noted that, “Architecture is a profession rooted in the artistry of designing, a process I have characterized as a special form of reflection-in-action: reflective conversation with the materials of the design situation (p. 5).”

Others have labeled this special form of reflection as abduction, a term developed by the 19<sup>th</sup> Century American philosopher and logician, Charles Sanders Peirce, as a form of reasoning unique from, and irreducible to, both deduction and induction. Abduction is the idea of making an educated guess or developing a preliminary hypothesis and then testing it. In the vernacular, abductive reasoning can be thought of as following a hunch or making an educated guess. It identifies promising (but not confirmed) theories and explores them rigorously as a means of refinement. In recent years, some researchers, such as Roger Martin, Dean of the Rotman School of Management, have identified design as a critical form of abductive reasoning (Creelman, 2009; Breen, 2005; Martin, 2009).

### *Sketching as a way of thinking*

But to actively test or explore or reflect in action demands a certain skill set. To be a designer it is not enough to draw well but rather to use drawing as a means of exploring ideas or as a means of thinking. Design is thinking through drawing.

Bill Buxton, principal researcher at Microsoft Research, has recently explored the role of sketching in design through his book, *Sketching User Experiences: Getting the Design Right and the Right Design* (Buxton, 2007) and he has gone so far to assert that

sketching is the “archetypal activity of design (Buxton, 2007, p. 111).” Designers often take sketching for granted but it is a skill that remains essential to the design studio.

### **Designing the Design Studio: The Student Experience**

The design of the studio must also be carefully considered. Design can play an important, if capricious, role in our perception and use of space. The noted commentator on design, Donald Norman demonstrates that aesthetically pleasing objects are deemed easier to use (Norman, 2005, pp. 17-18); Daniel Ariely, a professor of behavioural economics, records that “upscale” containers made coffee appear to taste better (Ariely, 2008, p. 160). Richard Florida’s surveys of North American communities show that aesthetics and lifestyle correlate well with overall satisfaction and happiness (Florida, 2008, p. 314). Experiment after experiment has shown that the design of a space has a profound effect on our behaviour in it – and there is no reason to suspect that a design studio will be any different. To paraphrase Louis Kahn, “Designs exchanged by one and another are not the same in one studio as in another.”

This is not to suggest that a design studio should be a sleek, pristine laboratory, but rather it should embody the creative chaos of Alexander Calder’s studio where a thousand bits and pieces scattered around the space may be the spark for a new innovation.

In effect, we need to consider the design of the student experience in the studio – not in a prescriptive manner but rather in a way that allows new opportunities to develop spontaneously.

### **The Essential Qualities**

The three essential qualities of a design education as discussed here can be summarized as:

1. Developing a lifelong community of learning and practice
2. Learning by doing or reflection in action
3. Designing a strong and positive student experience

Of course, all of these things overlap. Developing a community and learning by doing are essential parts of the student experience and students learn by doing within a community of practice. The idealized design studio then can be summarized as a network of people forming a lifelong community of practice in which all members have access to a rich set of resources and where everyone can participate in an ongoing, inclusive and reflective conversation with the materials of the design situation.

### 3. NEW WAYS OF THINKING ABOUT DESIGN

At the same time, innovative ways of thinking about design are emerging that could enhance the essential qualities of the design studio. Three are discussed here:

1. Sketching User Experiences
2. Experience Design
3. Regenerative Design

#### **Sketching User Experiences**

Earlier Bill Buxton's work *Sketching User Experiences* was referenced and it provides a new way of thinking, teaching and learning about design. In 2012 some of his colleagues published the companion volume *Sketching User Experiences: The Workbook* (Greenberg, Carpendale, Marquardt and Buxton, 2012) which consists of a number of innovative design exercises.

Some of these ideas include:

- New (and old) techniques for developing sketching skills
- The 10 Plus 10 approach to design where 10 ideas for a problem are rapidly generated then 10 variations on the most promising one are developed
- Building (both physically and digitally) shareable collections of ideas and precedents
- Creating visual narratives
- Involving the end user

Many of these ideas could easily be translated into a variety of design disciplines, and their associated studios, as a means of augmenting learning by doing and stimulating student creativity and innovation.

#### **Experience Design**

The ideas of Buxton et al are predicated on the concept of experience design. Emile Aarts and Stefano Marzano, Chief Scientific Officer and Chief Creative Director, respectively, of Philips Corporation, provide the most concise meaning of this term: "Although definitions and approaches differ, in essence they all focus on the quality of the user experience and often

signify a shift away from a focus on increasing and improving functionality towards more culturally relevant solutions (Aarts & Marzano, p. 46).”

All design is (or should be) experience design but this renewed interest in the end user is a useful reminder of what design is all about. Moreover, if the student is considered the end user, then the studio should be considered in terms of the quality of their experience.

### **Regenerative Design**

Emerging from the sustainability movement, regenerative design is the idea that the things we design should have a positive (rather than a negative or neutral) impact on our lives and our environment. A building might produce more energy than it consumes or a material might sequester more carbon than is emitted in its manufacture. It also suggests that design can improve the quality of our day-to-day existence. This can be as simple as the use of natural light wherever possible. Regenerative design can be thought of a particular form of reflection in action since students are asked to reflect on the long-term ramifications of their design actions.

Due to the dangers of global warming, it is urgent that ideas such as regenerative design be incorporated into all design studios. A more complicated question is whether the studio itself could be designed to be regenerative. The studio experience is often grueling and stressful. Could it be redesigned using ideas such as those demonstrated in *Sketching User Experiences* to provide a more positive experience?

### **Incorporating New Ideas**

By using new techniques to refocus the design studio on the end user's experience and by incorporating the principles of regenerative design, the design studio can become more relevant, responsive and responsible.

#### 4. OPPORTUNITIES ENABLED BY TECHNOLOGY

The two previous sections provide the context for the appropriate use of technology in the design studio. Recent and rapid advances in technology can both challenge and enhance the design studio, but in many ways digital technology is still in its infancy and we have yet to fully understand how to effectively weave it into the education of a designer.

At first, like many other disciplines, design simply deployed electronic versions of its traditional approaches. Early CAD (Computer-Aided Design) programs were little more than electronic pencils fulfilling McLuhan's idea of the horse-less carriage syndrome where, "every innovation must pass through a primary phase in which the new effect is secured by the old method, amplified or modified by some new feature (McLuhan, 1994, p. 292)."

Building Information Modeling (BIM), Computer Numerical Control (CNC), and their integration, suggest that we are moving into a new phase of digital design that may radically transform the traditional design process.

Again, the challenge is to maintain the fundamental characteristics of the design studio (as outlined above) while taking advantage of the new ways of learning enabled by digital technologies. We also need to learn how to manage and guide (rather than react to) the constant change that is inherent in digital technologies. Design schools must develop a long-term strategy for technology integration.

This strategy begins with the realization that while new technologies such as parametric modeling and 3D printing may dramatically change the buildings we design, it is advances in telecommunications that will revolutionize the way we work and learn. This revolution has altered the time, the space and the speed of the studio and by doing so enabled new forms of learning.

In fact, working and learning online (or virtually) is an option that the design professions cannot afford to ignore. In 2013, the

Canadian Architectural Licensing Authorities commissioned a *Practice Survey* that revealed that of the more than 500 practitioners surveyed, 41% listed their home as their primary business office (Framework, 2013, p. 10). In other words, a high proportion of designers are already working in a virtual studio connecting with their clients, other consultants and the resources they need through the Internet. Given this trend, it would be irresponsible not to provide students with the skills, tools and experience to survive in the digital world.

### **A New Sense of Time and Space (and Speed)**

With an Internet connection, learning can occur anywhere and at anytime. In an online environment, a student may start a studio at anytime of the year. This is asynchronous (or unsynchronized) learning where students may begin, work on and finish a course at different times. This is in contrast to the usual approach of synchronous learning where students proceed through a course together and at the same pace.

The advantages of asynchronous learning are that it provides more flexibility and accessibility for students. In particular, this kind of learning is ideal for those who “time shift.” Time shifting is the idea of moving an activity to a more favourable time of day. Some who work during the day may time shift their learning to the evening or a parent may time shift their learning while their child is at daycare. Those who learn online often cite time shifting, rather than geographic constraints, as their reason for doing so.

Similarly, in an online studio, students are not constrained to a single space. With laptops or tablets and a wireless connection, they may complete their studio activities in an airport, on a jobsite, at home or during a lunch break at work.

Internet access to computing resources also alters the speed at which studio activities can be completed. Casting and rendering a single perspective by hand is time consuming and arduous. With cloud computing (or the idea of online access to computing resources), a student could submit a 3D model to a server farm and generate a complex animation or walkthrough of the design in a matter of minutes. That same model could be

analysed for its structural stability or its energy consumption and provide the student with almost instant feedback on their design.

Learning materials for the studio can now also incorporate real-time graphics and sound. YouTube videos streamed directly to the student's laptop, for example, are often used to explain new ideas and techniques such as a special effect in Photoshop.

In fact, having instant online access to tools and resources is already becoming a part of a contemporary design studio. The noted structural engineers, Fast and Epp, have provided a free smartphone app to estimate the size of beams. (See <http://www.fastepp.com/index.php/en/concept-app>). The portable and mobile nature of these kinds of resources combined with their instant accessibility and their breadth and depth constitute an invaluable collection of information that can support design learning.

The same cloud that provides the renderings can also archive student activities. In this situation, current students can learn from the work of previous generations of students. They can see what was done in the past, what level of expertise was expected and identify relevant resources. The intent is that each generation of a studio could improve on the last one.

### *The Challenges*

This new sense of time, space and speed, however, brings with it numerous challenges to the design studio. These include:

- How do you foster a sense of community with students who may never meet and work at different times of the day, week and year?
- The physical design studio with its drafting tables has traditionally occupied a large amount of space at traditional universities and colleges. What happens to this space when a student can work anywhere?
- How do students find accurate and useful information in the chaos of the Worldwide Web?
- How can plagiarism be controlled and intellectual property be protected when anything can be downloaded?

- In the past, design students were also evaluated on their presentation and graphic representation skills, as it becomes easier and easier to create photorealistic images, how should student design work be evaluated?

### **Online Communities**

Humans naturally form communities and often subvert new technologies (such as the telephone and the Internet) for social purposes. While there is no technology that can replace face-to-face communications, social media demonstrates that it is possible to develop vigorous and sustainable communities online. Facebook, for example, builds communities across time and space, and through such sites every kind of content can be shared. Again the sharing occurs asynchronously. You don't need to be in a specific time or place to receive the latest news.

Every online studio should have a social media dimension. A Twitter feed, for example, can provide breaking news. Blogs provide for an ongoing discussion between the members of the studio. Instagram can be used as a virtual gallery.

Nor is this irrelevant to the current practice of design. In 2009, Bing Thom Architects (BTA) faced a tight deadline for public input on a library to be built in Surrey, British Columbia. They "... launched a library website, a Facebook page, a YouTube presence, a Twitter account, and an RSS feed, and invited all comers to comment. They populated the sites with images of the project and invited viewers to post their own images and text of what they would like the library to look like in an online "ideasbook." Librarians helped the digitally challenged to scan and upload the pictures they wanted the committee to see (Tischler, 2011, para. 3)." It is almost certain that more and more clients will demand this kind of service and students will need to learn how to use social media as a professional design tool.

### *Sharing User Generated Content*

Social media has also changed our perceptions of content. All kinds of digital content, from photos to songs to books to movies, can now be downloaded at no cost – albeit often illegally. In the online world, there is an expectation that content is free. While this wreaks havoc with the business plans of

content producers, it also means that there is an incredible wealth of material about design that is easily accessible. The Google 3D Warehouse, for example, contains free models of a wide range of objects and buildings created in the free software package, SketchUp. As of July 2014 there were over 70,000 models available for downloading (3D Warehouse, 2014) – although of varying degrees of quality. These models can also be edited and modified and some of them are dynamic in the sense that the user can control certain parameters of the object.

Such repositories enable new design possibilities. It would be possible, for example, to create an entire building assembled from the architectural components stored in this online warehouse. What is most remarkable about this site is that it is largely composed of user created content. The cost of digital tools has plummeted while their ease of use has soared and this has enabled talented amateurs to create and share high-quality content.

Some industry associations have realized the value of such repositories. The Masonry Institute of British Columbia, for example, provides downloadable Structural and Veneer Details at no cost which are high-quality 3D models created in SketchUp (See <http://www.masonrybc.org/>). A student can download and rotate these details to gain a better understanding of how a building goes together.

Another, more structured, collection is Archnet (See [www.archnet.org](http://www.archnet.org)) which was created by the University of Texas at Austin and MIT with support from the Aga Kahn Trust for Culture. According to the Trust, “Archnet is a globally-accessible, intellectual resource focused on architecture, urbanism, environmental and landscape design, visual culture, and conservation issues related to the Muslim world. Archnet’s mission is to provide ready access to unique visual and textual material to facilitate teaching, scholarship, and professional work of high quality (Aga Kahn Trust for Culture, 2014, para. 1).” What is perhaps most important about ArchNet is that it provides a robust structure for organizing design information – a structure that could easily be exported and used by other collections.

Given the proficiency of the current generation of students with digital tools it is possible to imagine a number of universities and colleges working together with industrial partners to create a critical mass of student-generated design content. This might include wall-sections, floorplans of famous buildings, image sets, apps, laser scans, animations and videos. Again this collection could grow so that each generation of students had access to a greater set of resources than the previous one.

### **Data Driven Studios**

As noted above, the first generation of CAD packages were “amplified” drafting tools. Two parallel lines on a floorplan might represent a wall but they couldn’t behave like one. The development of Building Information Modeling (BIM) and other tools are changing all that. There is now a data structure behind the graphic representation so that a door in elevation also includes information about its material, its fire rating and its cost. Equipped with this information, a designer, consultant or engineer can run a structural analysis, an energy audit or a cost estimate.

An underlying data structure, such as that of ArchNet mentioned above, is also critical to organizing, storing and finding information online. In fact, the creation of a robust architecture of information that makes it easy to upload, store, organize and find resources is one of the most interesting contemporary design problems.

As information modeling becomes pervasive it will also affect the design studio because such a data structure is also a powerful tool for learning. Students will no longer create mere pictures but interactive models in the full sense of the word. In this world, a student would analyse their design for an appliance against its carbon footprint and its manufacturing cost.

### *Play and Simulation*

In effect, the speed and power of today’s computer resources combined with the data structures allow students to “play” with their designs in a serious way. Mammals are hard-wired to play as their preferred way of learning and, as Einstein maintained

about his own thought process, “... combinatory play seems to be the essential feature in productive thought (Einstein, 1960, pp. 25-26).”

While our educational institutions sometimes seem to constrain this tendency, with the capacities described here, a student can try many alternative designs quickly and simulate their real world performance. This ability to test their ideas in a playful, but still meaningful and realistic way, provides a powerful complement to the idea of abductive reasoning/design thinking described earlier. There is no reason that learning by doing can't be fun.

### *Workstudy and Simulation*

In same CALA study noted above, employers were asked to rate graduates from Canadian schools of architecture according to their satisfaction with their skills and knowledge. Of the top 4 schools, 3 incorporated workstudy into their curriculum (Framework, 2013, p. 33).

A working environment can also be simulated in the studio. The Banff Publishing Workshop provided an invaluable learning experience to those interested in magazine or book publishing by simulating an intense publishing environment over the course of two weeks. Like a variation of today's Integrated Design Process, participants were asked to assume roles such as publisher or editor and create real products. Due to the intensity and immersive nature of these experiences, those in the publishing industry felt the workshops provided participants with the equivalent of one year's experience in the publishing industry. This suggests a design studio could also be a similar kind of “boot camp” for actual work in the field.

### *Crash Test Models*

ACEBIM (Alberta Centre of Excellence for Building Information Modeling; See <http://www.acebim.ca/>) has suggested that the kind of serious play described above could also be incorporated into design learning through “Crash Test Models.” These are virtual models created in BIM software where the student can change various parameters of the design and assess the resulting change in the performance of the building. Using a model of a hospital, for example, they could

change the windows from double-glazing to triple glazing and then watch how its energy consumption changes over the course of the winter. Or they might change the structural system from steel to concrete and simulate its performance in an earthquake.

### *Life Cycle Analysis*

Technology alters the studio's sense of time in terms of sustainability as well. With the data driven approach of BIM it is possible to address the life cycle of any design and even develop (and test) cradle-to-cradle approaches where no waste or ecological damage occurs. This kind of analysis is essential to the practice of regenerative design.

### *Interactive Multimedia*

Ideas like Crash Test Models emphasize that both the learning materials, and the materials that students present, in their design studios, can be media rich and interactive. Yet, the same technologies that enable different kinds of analysis, also demand a new way of evaluating a student's progress. As it becomes easier to render a perspective or analyse the energy consumption of a building, we should expect that students will also demonstrate a deeper understanding of their designs and architecture in general. These materials can radically change the student experience.

### *The Opportunities of the Online Studio*

Just as there are challenges to creating virtual, online studios there are also positive advantages. These include:

- Online studios are flexible in that they permit learning anywhere and anytime and students may start a studio at any time of the year.
- Because of this flexibility, online studios allow students to continue working and allow practicing designers to upgrade their skills.
- Online studios can serve students all around the world.
- Given the wealth of multimedia resources that online studios can embody they can, and should be, more engaging.

- Properly designed to current best practices, online studios can be more accessible to students with disabilities.

## 5. INFRASTRUCTURE: ACCESS TO TOOLS

Implementing any or all of these ideas requires a carefully planned infrastructure. In countries such as Canada and the United States, universities and colleges already have access to significant online computing resources for processing and storage through nationwide research networks. Typically design schools have not utilized these resources but there is no reason why they shouldn't.

The studio of the future can be thought of as a network of people and resources. In terms of telecommunications this network is mix of wired and wireless connections linking all of its members. As the "Internet of Things" develops all manner of objects will also be connected to this network. The Internet of Things is the concept that devices from sensors to refrigerators to cars to houses will have their own Internet address and hence be able to share information.

For the design studio this means that students will be able to use a wide variety of input devices (from smart phones to sensors) to access collections and software tools that will help them explore and develop their designs. They will then be able to output their designs to a similarly large variety of devices (from 3D printers to large format displays) – and by sharing those designs in online galleries they are also augmenting the virtual collections.

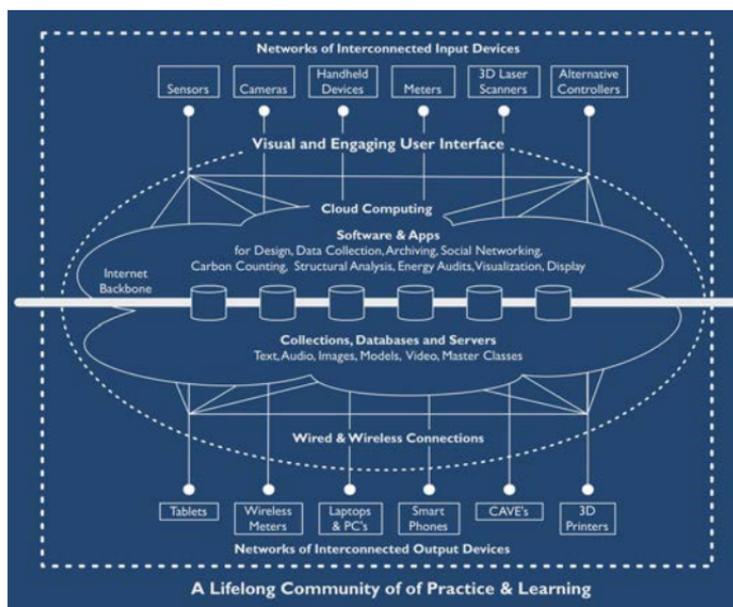
While the emphasis will be on the ability to work anywhere at anytime, there will also be new kinds of learning environments connected to the network that will have specialized capabilities. DIRTT's Green Learning Center in Calgary, Alberta, for example, has 16 interconnected displays, 2 touchscreen displays and a seamless interface to smartphones and tablets (See <http://www.dirtt.net/>). In the future students may also present their designs in immersive environments such as CAVE's (Computer Assisted Virtual Environment).

### **The User Interface**

In fact, the physical and virtual interface to this infrastructure is critical. As noted above, design affects use and the studio is no exception. A carefully designed, engaging interface to all aspects

of the studio is essential to building communities of practice and to the quality of the student experience.

The diagram below shows how these infrastructure components might work together and Appendix A provides a partial list of the nature and kinds of equipment that might be part of this infrastructure.



**Figure 2: Studio Infrastructure**

## 6. LARGER ISSUES/DESIGN

The importance of the design studio cannot be overemphasized because it both impacts and is impacted by larger global issues.

### **Exponential growth in technological capacity**

For the foreseeable future technological capacity will continue to grow at an exponential rate. This means it will be almost impossible to predict what new devices and applications will be implemented in the next few years. We can, however, anticipate this growth with a plug and play or modular approach that will allow new tools and capabilities to be swapped into the system with a minimum of disruption. Here too the data structure behind the future studio becomes critical.

### **Climate Change**

Designers of all kinds share the responsibility (and the opportunity) of addressing the critical global problem of global warming. According to Ed Mazria of Architecture 2030, “Buildings are the largest contributor to climate change (Mazria, 2013),” and the appliances we design for those buildings are consuming larger and larger amounts of energy. It is critical that the designers produced by the design studio of the future have the skills to solve this problem. This is the most urgent design challenge of the 21<sup>st</sup> Century and our studios must focus on its resolution. Some of the tools and approaches described here can play a significant role in this endeavor.

## 7. RECOMMENDATIONS

Given this context of pedagogy and technology, the following recommendations can be made:

1. Universities, colleges and industry partners should work together to build a critical mass of shared, user-generated content and a rich infrastructure of tools and computing resources. This is an expensive proposition and that can only be realized through cooperation. It will be far easier to build a critical mass of content and equipment if various groups can share the cost and the work.
2. Online studios should complement face-to-face ones. By combining face-to-face studios with online, virtual studios we can give students a more complete experience of studio learning and practice. Initial studios may be face-to-face to help build a sense of community but subsequent ones may be completely online.
3. The pedagogy of the design studio should be re-examined in the light of new ideas such as experience design and regenerative design.
4. Technology should be included where appropriate but essential skills such as hand sketching must be preserved
5. The evaluation of students in a design studio should be redesigned to reflect the new possibilities of analysis and simulation.

## **8. APPENDIX A: THE COMPONENTS OF THE INFRASTRUCTURE**

The following is a partial list of the components of an infrastructure to support the design studio of the future. The important thing to emphasize is that we cannot predict the input and output devices that may be developed, but we can design an underlying structure that allows them to be easily plugged in.

### **Input Devices**

1. Computing Devices
  - a. Laptops
  - b. Tablets
  - c. Smart Phones
  - d. Desktop Computers
  - e. Servers
2. Sensors can be used to collect data such as:
  - a. Temperature
  - b. Humidity
  - c. Rainfall
  - d. Wind
  - e. Air quality
  - f. Water Quality
  - g. Volatile organic compounds
  - h. Radon emissions
  - i. Artificial and natural light
  - j. Energy use
  - k. Water consumption (domestic, industrial and agricultural)
  - l. Comfort
3. Scanners
  - a. Flatbed
  - b. Slide
  - c. 3D Laser
  - d. Infrared

### **Output Devices and Environments**

1. Large Format Printers
2. 3D Printers
3. Large Displays
4. Immersive Displays (such as CAVE's)

### **Software and Apps for:**

1. Carbon Counting
2. Structural Analysis
3. Energy Audits and Simulations
4. Rendering and Animation
5. Social Media

### **Collections**

1. Audio
2. Text
3. Images
  - a. Slides
  - b. Photographs
  - c. Sketches
  - d. Drawings
  - e. Renderings
4. Videos
5. Animations
6. Models
  - a. Historical
  - b. Interactive
  - c. Dynamic Components

## 9. APPENDIX B: USE CASE SCENARIOS

The infrastructure described in Appendix A may lead to new kinds of student experiences. Some of the possibilities that could be enabled by the ideas discussed here include:

1. Students from around the world collaborating on projects and engaging experts on various continents.
2. Students assembling a project from components developed by others.
3. Students competing to optimize the performance of a simulation.
4. Students developing their designs through social media.
5. Students continuing the studio through its online presence long after its formal schedule has ended.
6. Students contributing to the collective resources and sharing their expertise as a critical part of the studio experience and assessment.
7. Students simulating a real world building project using an Integrated Design Project where different students take on the different roles of the building team – engineer, client, developer and architect.
8. Students participating in real world building projects through design-build studios.
9. Students presenting flythrough's of their building accompanied by a real-time life cycle analysis for their juries or "crits" rather than pinning up drawings.
10. Students gaining invaluable experience through workstudy studios, specifically designed to meet the needs of working designers.
11. Students forming informal social studios outside of their formal ones.
12. Students learning by doing through hands-on global master classes on key topics.

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## II. ABOUT THE AUTHOR

Douglas MacLeod, PhD, is the Chair of the RAIC Centre for Architecture at Athabasca University. He is a registered architect; a contributing editor to *Canadian Architect Magazine* and the former Executive Director of the Canadian Design Research Network. He has degrees in Architecture, Computer Science and Environmental Design and has taught at universities and colleges throughout North America.

## 12. ABOUT REGENOPARCH

ReGenOpArch is dedicated to the principle that regenerative design can be realized through open source architecture.

Regenerative design proposes that everything we design must have a positive effect on our environment and our lives - rather than negative or even neutral one. A regenerative building, for example, produces more energy than it consumes and improves the quality of life for all its inhabitants.

Open source architectures are design ideas that can be freely shared and modified at no cost. The Internet is the most powerful instance of an open source architecture. As the Internet demonstrates, an open source approach is the best means of fostering innovation.

Similarly, an open source approach to design is the most effective means of making it regenerative.

# REGEN OPARCH

