Visualization in Design: Is What We Preach Being Practiced?
Exploring Visual Intelligence and Some Realities about Our Tools and How We Use Them

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Introduction

Nearly a decade ago, a study was conducted to explore questions with regard to perspective drawing in industrial design education and practice [Anderson[1]]. The survey included students from a major industrial design program in the United States as well as educators and practitioners across the country. It sought to understand the experiences and needs associated with learning and teaching perspective drawing in education, and the needs of perspective drawing in the practiced environment. What motivated the study were challenges that this particular program encountered with a growing segment of diverse students who were attracted to design but had limited visual experiences. Additionally, there were few faculty who could teach drawing. As a consequence, drawing was left up to adjunct instructors and graduate teaching assistants who had varied approaches and mixed results. Initial investigation found that educators from other programs had similar issues, and there was a general desire by practitioners to see elevated perspective drawing abilities in their entry-level hires.

The results of the survey unequivocally stated that perspective drawing remain an important tool in industrial design education and practice. It also highlighted perceptual gaps and differences in expectations, and suggested there were opportunities to explore alternative teaching approaches to perspective drawing. In particular, no innovations were found to support drawing for the novice, which is where the greatest challenge was found to lie. Rather new thinking, which most often took digital forms, focused on the intermediate and advanced learners. From this data the author studied and developed an approach to perspective drawing using grids as an assistive tool for the novice. Through testing in the classroom and further development, this approach was found to increase understanding, quickly raise confidence, and stimulate critical thinking faster than traditional approaches. Over time, this approach evolved into a drawing system that continues to have positive and consistent results.

In the years that followed the survey on perspective drawing, digital technologies continued to emerge as useful and affordable. Educators, practitioners, and students were naturally questioning the role of traditional tools, such as drawing and physical modeling, for visualizing information. The students represented the generation who grew up in a digital world and engaged more often in the virtual than in the physical. They were unlikely to have had experiences exploring how things work, building models, fixing equipment, or engaging in a number of other activities that could provide experience and meaning to three-dimensional form. As a result, more students showed difficulty perceiving physical information, understanding its complexities, and purposely generating it. Because of the enticement of software tools, and student comfort with technology, convincing them of the value of traditional tools became an ongoing challenge. Seeing an opportunity to address this issue, the author elevated the view of the problem – moving from a micro to a macro focus. This provided an opportunity to more clearly identify overall visual goals and shift the focus from drawing (the tool) to visualization (the process). Anderson defines visualization as a process of mentally constructing, shaping, and understanding varied information, and the ability to externally communicate it. This process extends beyond simply representing information visually using activities such as drawing, imaging (typography, photography, collages), or physical making. Rather it relies on these abilities as methods for thinking, conceiving, exploring, and proposing ideas. In essence visualization is the pathway for design. However, within the process of visualization, when students are unclear about goals or loose sight of them, their thinking and execution becomes linear. Conversations with other educators and some practitioners found accord that when in pursuit of skill development students can loose sight of the intent of tools. It is also not uncommon for students to default to tools of comfort and not develop the understanding of when and how to effectively negotiate between multiple tools to explore and move ideas forward. This can be witnessed in some students over the course of their study where by senior year they are less agile than in earlier years. This deficiency, referred to here as "visual intelligence," lengthens the design process and limits discovery. If visual intelligence is a goal for many undergraduate industrial design programs, are they structured to develop visually intelligent designers, or are they structured to develop designers with visual skills?

Visual Intelligence

Visual Intelligence is defined here as the ability to reason with complex information using varied tools (manual and digital drawing and modeling) and methods to shape mental and external visual experiences. This definition does not imply that designers necessarily need to master tools or methods, but rather that they are proficient enough with them to offer clear and intelligent responses.

Historically, manual drawing and physical modeling were the artifacts generated for and by visual conversations. In industrial design programs, students were expected to develop the skills that produced high-quality representations using the best practices of these two-dimensional and three-dimensional tools to confirm intentions and persuade arguments. In support, many programs tightly wove the development of visual skills into curriculums, and students understood this to be of value during and beyond their education, in part because there were few alternatives. Further, practitioners were generating visual information using similar tools and methods as those in education. However, design programs today have a greater challenge than in years past. Their charge is to assist students in becoming holistic thinkers by broadening curriculums that are often already limited by resources, and to provide students the opportunity for cross-disciplinary study. As a result, more programs find themselves grappling with issues of what stays and what goes, or are simply attempting to achieve more with the chance of jeopardizing quality. Additionally, new students of design are often literate in multiple software programs and not as easily convinced of the value of traditional approaches. Many believe that technology can replace the activities they are asked to perform in the studio. A contributing factor to this belief may be the visual messages they receive about design. Beautiful digital models or high-end prototypes generated from digital files are now the norm in many publications and advertisements. Although the supportive written text can be rich in describing the features and benefits of a product, these works frequently lack explanation of the raw visual development. Publications like *Design Secrets: Products*[2] have done well to showcase the actual development drawings and models of designers and share that the qualities of drawing skills among practitioners range. Interestingly, though digital tools have emerged as another option of support for visual goals, there remains a percentage of students who struggled to voice visual intent and meet visual standards. There is also the student who masters technology and in the process limits him/herself to becoming "a pair of hands." Together, these students may constitute a significant percentage of those who do not achieve visual intelligence or the ability to develop their ideas to the fullest potential. Perhaps it isn't the tools, but the approach.

An additional factor that must be considered in the goals of a visually intelligent class is that of the nontraditional student, who is already part of many programs and may have always been. This student will not contribute to the profession as a form-giver, and may not play a significant role in the development of form. This student represents a growing interest in industrial design, one who is informed, a broad thinker, and has a desire to contribute within the discipline in unforeseen ways, or to transition to other disciplines. This student will more likely seek a balance in their education and have less time and interest in achieving high-level skills. Their need will be for visual intelligence and, new environments where this student can flourish will need to be created. It is time to question whether our curriculums have kept pace with visual needs and opportunities, or remain narrowly focused on skill building for a few.

Are We Doing It All Wrong?

What constitutes a successful industrial design graduate? Skill? Intellect? Vision? All of these and more? Where is the bar on visual intelligence? The IDSA National Education Conference Proceedings of 2003 published 39-juried papers. Of those papers, three focused on visual skill development. The others dealt with equally important subjects such as universal design, ecodesign, human factors, interactive design, branding, business, and research. Yet visualization, one of the largest challenges to design education, may be becoming a low murmur in public discourse and be the challenge that the profession has never quite solved.

The author hypothesizes that students of industrial design classes can be separated into three categories with respects to visualization: 1) those who have a natural understanding and will succeed despite instructor intervention 2) those who have the potential to succeed based on instructor intervention, and 3) those who are unlikely to succeed based on the way visualization is currently approached. Using this line of reasoning, and applying the fraction of 1/3 to each category, it is fair to suggest that many design programs are structured to support only about 50% of each admitted class in pursuit of visual intelligence. This assumes that the better part of the students identified as have the potential to succeed will have inspiring instructors. These figures would adjust for those programs that have mechanisms to “weed out” the weaker students. The further belief is that industrial design classes have always fallen into these divisions. The difference between today’s classes and those prior to digital tools is that there were few options then, and therefore fewer direct challenges to the system.

Survey on Visualization in Design

To test this hypothesis, the author surveyed industrial design educators and practitioners across the United States to discover their perceptions on visual education, and the realities of how their skills transferred into their profession. The online membership directory of the Industrial Designers Society of America (IDSA) was used to identify a sampling of participants. Using the predefined categories of the directory the following categories were generated: Educator Representatives (educators who serve as leaders in each of the five IDSA districts across the country and who also serve on the National Education Council); Faculty Advisors (educator representatives in each of the IDSA recognized schools across the country); General Educators (those in the directory who identified their occupation as educator only); Student Mentors (Practitioner who elected through the directory to be listed as a student mentor); Practitioners in central New York, Chicago, Texas, Boston, central Ohio, southern Ohio, Los Angeles, Philadelphia, and San Francisco (this list focused on members who identified their occupation as designer rather than educator). The goal for practitioner selection was to have a representative sample from across country and amongst some of the larger cities. The directory also allowed a search by “head of office” and in fact represented an overwhelming percentage of the respondents.

An online survey was the tool of choice. It was designed to be as in-depth as reasonably possible given the time and position of targeted participants. It was also structured primarily as a multiple-choice tool but asked probing questions when additional information was needed. By some standards it was lengthy, containing 10 sections that held 45 main questions, most offering three to five response options, each of which required an answer. In total, there were over 100 questions. More specifically, the sections asked question regarding: Early visual education; Undergraduate visual education; Visual intelligence; Visualization experience [practitioner]; Practitioner background and perceptions of visual needs; Educator background and perception of visual needs; and IDSA Student Merit Awards. A master mailing list was created that totaled 405 names. The survey tool allowed names on this list to be contacted by email. Through this communication they were able to click on an embedded link that connected them directly to the survey. Because of the natural ratio of the IDSA society about three-quarters of the list were practitioners and one-quarter was educators. Of those contacted, 151 responded, or a significant 37%. Of the respondents, 89% were males. Thirty percent, or 121 people, completed the survey in full. Fifty-one respondents were educators. Because of the format requirements of this publication only a sample of survey responses are provided below. Those selected speak more directly to the questions raised in the hypothesis. However, the survey asks a range of questions that will provide data for examination over time. The summary here serves as an initial analysis. The full survey can be found at www.andrew.cmu.edu/~ea/index.htm. Where appropriate, comparable responses to the 1996 survey are made, which focused only on perspective drawing. That survey had a sample size of 30: 10 educators, 10 consultants, and 10 corporate designers.

Survey Summary

The survey began by asking respondents to reflect back on their early visual education. The data collected here will be used later to determine whether correlations exist between early exposure and later successes. Using existing research from psychology and the social sciences, an additional goal will be to explore opportunities to create adaptable tools for the visual novice that will stimulate visual and critical thinking prior to post-secondary program considerations. The type of knowledge can help prepare those who are interested in studying design and create a greater awareness for others. This is an area of interest to that the author is beginning to explore.

The second major section (4) begins questions from the point the responded began his/her undergraduate program. Information about the visual goals that guided the respondents is sought. It asks them to assess their perception of their ability, the programs goals, and their class over the course of study. The remaining sections and questions continue to probe personal assessment and professional expectations. Sample questions are below, followed by concluding remarks.

4.8	Assuming that every graduating class can be categorized as having weak, average, or strong skills, identify the percentages of your class for **Perspective Drawing**. Select percentages as closely as you believe. Note all three choices together should total 100%. If your program did not teach this skill click “N/A” for each row.									
	N/A	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Weak	12%	20%	**29%**	16%	11%	5%	4%	3%	0%	1%	0%
Average	4%	6%	10%	**25%**	16%	23%	10%	4%	2%	0%	0%
Strong	3%	14%	**26%**	15%	10%	10%	9%	4%	3%	3%	3%
116 respondents											

4.9	Assuming that every graduating class can be categorized as having weak, average, or strong skills, identify the percentages of your class for **Rendering/Illustration**. Select percentages as closely as you believe. Note all three choices together should total 100%. If your program did not teach this skill click “N/A” for each row.									
	N/A	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Weak	12%	14%	**21%**	17%	16%	9%	5%	3%	2%	1%	0%
Average	4%	3%	15%	20%	21%	**25%**	10%	0%	1%	1%	0%
Strong	4%	16%	**27%**	17%	11%	7%	6%	4%	5%	0%	3%
115 respondents											

4.10	Assuming that every graduating class can be categorized as having weak, average, or strong skills, identify the percentages of your class for **Making stuff/modeling**. Select percentages as closely as you believe. Note all three choices together should total 100%. If your program did not teach this skill click "N/A" for each row.									
	N/A	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Weak	12%	22%	**23%**	20%	4%	7%	5%	4%	0%	2%	1%
Average	5%	5%	16%	17%	**21%**	19%	12%	3%	3%	0%	0%
Strong	2%	16%	17%	**20%**	15%	8%	6%	5%	3%	5%	3%
114 respondents											

The responses for Digital Drawing/Rendering and Digital Modeling were overwhelmingly located in the "N/A" category and therefore not chart here.

5.1-3	Reflecting again back on your undergraduate education, how would you have assessed your level of **Visual Intelligence** [at times below]? When responding, consider your ability at the time to comfortably negotiate between multiple 2D and 3D tools to generate results. (Question modified for display purposes)			
		Beginning 1st year	**By graduation**	**Your class**
	1 [weak]	14%	0%	3%
	2	22%	1%	6%
	3 [moderate]	**46%**	11%	**44%**
	4	12%	38%	30%
	5 [strong]	6%	**50%**	17%
	114 respondents			

6.1	How well did the levels of skill sought by your school match with your needs as an entry-level practitioner?					
	N/A	**1 [Need was lower]**	**2**	**3 [Matched]**	**4**	**5 [Need was higher]**
Perspective Drawing	1%	4%	12%	**48%**	16%	19%
Rendering/Illustration	1%	5%	14%	**43%**	20%	16%
Making Stuff/Modeling	0%	11%	20%	**32%**	17%	19%
Digital Drawing/Rendering	**53%**	7%	4%	6%	14%	17%
Digital Modeling	**56%**	12%	2%	2%	12%	17%
106 respondents						

6.3	As an **entry-level** practitioner, what was the most often needed outcome for your visual skills in the areas below?					
	N/A	1 [Very unrefined artifact]	2	3	4	5 [Highly refined artifact]
Perspective Drawing	2%	8%	10%	27%	26%	**28%**
Rendering/Illustration	1%	4%	12%	22%	28%	**34%**
Making Stuff/Modeling	4%	6%	10%	23%	29%	**30%**
Digital Drawing/Rendering	**62%**	4%	2%	8%	12%	13%
Digital Modeling	**68%**	4%	5%	6%	6%	12%
105 respondents						

7.1	How many years have you been a practicing professional?							
	1-5	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**31-35**	**36+**
2005 answers	3%	10%	**23%**	14%	22%	16%	6%	6%
1996 answers	6%	6%	19%	**25%**	13%	6%	0%	19%

8.1	How many years have you been an education professional?							
	1-5	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**31-35**	**36+**
2005 answers	38%	**19%**	**8%**	**11%**	**11%**	**5%**	**5%**	**3%**
1996 answers	18%	18%	18%	**0%**	27%	9%	0%	9%

8.7	[Educators] When a student enters your program, what are your expectations of their skill in the following areas?									
	1 [very low]		**2**		**3 [moderate]**		**4**		**5 [Highly high]**	
Perspective Drawing	24%	***9%**	16%	***36%**	**43%**	***45%**	14%		3%	***9%**
Rendering/Illustration	27%		**32%**		27%		8%		5%	
Making Stuff/Modeling	24%		19%		**41%**		14%		3%	
Digital Drawing/Rendering	**43%**		27%		22%		3%		5%	
Digital Modeling	**59%**		19%		14%		5%		3%	
37 responses	*** Scores from 1996 Survey**									

8.8	[Educators] At what skill level does the average student enter your program?									
	1 [very low]		**2**		**3 [moderate]**		**4**		**5 [Highly high]**	
Perspective Drawing	30%	***27%**	32%	***63%**	**32%**	***9%**	3%		3%	
Rendering/Illustration	38%		**32%**		27%		0%		3%	
Making Stuff/Modeling	27%		35%		**32%**		5%		0%	
Digital Drawing/Rendering	**46%**		30%		22%		0%		3%	
Digital Modeling	**59%**		19%		19%		0%		3%	
37 responses	*** Scores from 1996 Survey**									

8.9	[Educators] How important are the following skill in your program?									
	1 [very low]		**2**		**3 [moderate]**		**4**		**5 [Highly high]**	
Perspective Drawing	8%		3%		27%	***27%**	19%	***27%**	**43%**	***45%**
Rendering/Illustration	11%		19%		**32%**		22%		16%	
Making Stuff/Modeling	8%		5%		27%		24%		**35%**	
Digital Drawing/Rendering	8%		3%		24%		30%		**35%**	
Digital Modeling	8%		3%		22%		24%		**43%**	
37 responses	*** Scores from 1996 Survey**									

An opportunity was missed to ask educators to assess the skill level of students graduating from their program. This data will be sought from the same respondents updated via the online document.

7.7	[Practitioners] When an entry-level designer is hired by your office, what are the visual skill expectations in the following areas?								
	1 [none]	**1 [weak]**	**2**	**3 [average]**		**4**		**5 [strong]**	
Perspective Drawing	9%	3%	1%	11%	***25%**	31%	***31%**	**44%**	***44%**
Rendering/Illustration	10%	1%	2%	29%		32%		**26%**	
Making Stuff/Modeling	10%	2%	8%	42%		21%		**17%**	
Digital Drawing/Rendering	10%	1%	2%	2%		34%		**50%**	
Digital Modeling	9%	1%	1%	14%		32%		**42%**	
88 respondents	*** Scores from 1996 Survey**								

7.8	[Practitioners] On average, how would you assess entry-level designer's visual skills in the following areas?									
	1 [none]	**1 [weak]**		**2**		**3 [average]**		**4**		**5 [strong]**
Perspective Drawing	9%	8%	***6%**	19%	***25%**	**39%**	***44%**	12%	***25%**	13%
Rendering/Illustration	9%	7%		23%		**40%**		16%		6%
Making Stuff/Modeling	10%	16%		21%		**39%**		13%		1%
Digital Drawing/Rendering	8%	1%		10%		24%		**37%**		20%
Digital Modeling	8%	2%		17%		23%		**26%**		24%

88 respondents	* Scores from 1996 Survey

Further investigation and analysis will need to occur to understand the high percentage of “none” scored in questions 7.7 and 7.8.

10.2	What was your employment desire upon graduating from school?	
	To work in a traditional design environment where physical products are designed and developed	**83%**
	To work in an alternative environment where I could apply my design education to solve different types of problems, not necessarily physical	2%
	To become a researcher	6%
	To teach	5%
	Other	4%
	110 responses	

10.3	Ideally, where do you see your career in the future?	
	In a traditional design environment where physical products are designed and developed	**32%**
	In an alternative environment where I could apply my design education to solve different types of problems, not necessarily physical	26%
	In research	6%
	In teaching	19%
	Other - Some combination of those above	17%
	110 responses	

What percentage of students do you think practice and remain in industrial design after graduating?										
Don’t Know	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4%	5%	**11%**	13%	13%	22%	11%	10%	7%	3%	0%
91 responses										

Preliminary analysis of the data highlights some expected results. For instance, perspective drawing remains high on the list of important skills a designer should possess. More specifically, 60% of respondents indicated that perspective drawing was very important to initial concept thinking/conceptual work. Thirty-four percent found perspective drawing to be very important towards development work, and 49% found this skill to be very important towards presentation work. These figures are not charted here but can be found in the full survey summary. The data further suggest that the importance that education places on visual skills align well with the expressed needs of practitioners. Across the board however, visual skills continue to lag behind practitioner expectations. The percentages are not dramatically different from those of the 1996 survey. Considering that neither the expectations nor skill levels of entry-level students have change in nearly ten years, perhaps it is time for educators and practitioners to work together to determine whether the stated expectations are achievable. It may also be a positive indicator that skill levels have remained relatively stable in view of adjustments that many programs have made to boost digital technology capabilities over the past decade. This area will continue to be explored as data is analyzed.

Several interesting points have emerged from the data that support the hypothesis. When respondents were asked to determine how their classes divide by skill in areas of weak, average, and strong, the results loosely reflect thirds. The exceptions are digital rendering and digital modeling, which both score high in the “N/A” category. With respects to visual intelligence, a majority of respondents agree they would more readily hire a graduate who has demonstrated visual intelligence over visual skill. Twenty-one percent of that group strongly agrees. This followed multiple questions that returned clear answers stating that skill was very important. The next two points are even more telling. First, there is a dramatic shift in employment desires between graduation and having obtained work experience. Eighty-three percent of the respondents indicated that their desire upon graduating was to work in a traditional design environment. Only six percent indicated that they would have wanted to work in an alternative position when leaving school. When the same question is posed as "ideally, where do you see your future?" then 32% indicate working in a traditional design environment; 26% would choose and alternative environment (refer to preceding questions 10.2 and 10.3). The most striking point though emerges from the last question in the survey: "What percentage of students do you think practice and remain in design after graduating"? Twenty-two percent of the respondents indicated they believe 50% of graduates will practice and remain in industrial design. The overall responses however are balanced across the board. If fact if you tally the total responses between 10 and 50%, 68% would indicate that at least 50% of graduating designers will not remain in industrial design. It would be alarming if these figures even close to being accurate. Returning to a statement in the hypothesis, "it is fair to suggest that many design programs are structured to support only about 50% of each admitted class in pursuit of visual intelligence." Further research will need to be conducted to determine if there is a direct correlation.

What one may garner most from this data are the opportunities to having meaningful discussion reevaluating visualization in industrial design education. Such discussion may not be of interest to every program. However, those who look to support a diverse student, whether undergraduate or graduate, but remain entrenched in traditional models, may benefit from such discourse. For emerging models that prove to be inclusive, the larger opportunity will be connections to other disciplines that will want to learn to think and communicate visually. This may provide opportunity for collaborative discussions. Note: Sixty-three of the respondents offered the opportunity for follow-up. This will be the next step in refining the analysis of the rich data returned.

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