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INDUSTRIAL DESIGN / DESIGN ENGINEERING AND THE "FACILITATOR TRAP"

V. Kokotovich

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1. Introduction

Irrespective of whether one looks at literature surrounding the increased number of patents, the increased amount of literature focusing on advancing technology and our technological understanding, or the significant advances being made in science, it can be argued technological change is advancing at an exponential rate. However, a very worrying trend indeed is highlighted in an OECD report [2006]. The report noted over the past fifteen years most OECD economies have experienced rather large increases. Moreover, the numbers of students in higher education, and the absolute numbers of students in the fields of technology and science has decreased as a proportion of the overall student population. Having a science and technology background is often considered to be important for developing industrial designers/design engineers. Essentially over the years there has been a steady decline of interest in technology and science. This does not bode well for the future of our profession. This also resonates in the work of Campbell and O'Connor [2009]. They discuss the fact that in Australia over the past 25 - 30 years there has been a significant decline in the number of senior and secondary students electing to study the core areas of science and math needed for further technical education in areas such as design engineering. In the future this will be very problematic indeed. As technology and science increase exponentially in terms of amount, variety, and complexity, student numbers, student interest and understanding/experience in building new technologies appears to be decreasing. It would appear those future generations responsible for producing next generation products systems environments, is shrinking as an overall proportion of society. Consequently, the simultaneous breadth and depth of technical understanding required of the next generation of industrial designers and design engineers will be significantly increased. In a real sense they can no longer be specialists. It may be argued they could become mere ***facilitators*** in the development of next-generation products and technologies. They may in fact become trapped in this role.

1.1 Scope and significance of the paper/study

While issues raised in this study relate to the larger technological change issues confronting us, this paper will limit its discussions to those surrounding how we may understand and address issues relating to the "Facilitator Trap" and Industrial Design and Design Engineering. The question then becomes how we should address the complex technological change issues facing us. Therefore the central aim of this paper was to explore alternate perspectives being debated and discussed in other Industrial Design/design engineering programs in other parts of the world. With a view towards developing and identifying any common perspectives a scoping exercise was carried out. The specific area of focus within this investigation extends our larger study and on-going research in relation to the development of new educational directions and strategies for teaching Industrial Design and Design Engineering at the tertiary level. The core objectives of the larger study were as follows:

1. To examine and evaluate the variety of teaching perspectives and heuristics that are operationalised by many of the leading industrial design research scholars in Europe and America via an appropriate observational methodology.
2. To examine, evaluate the variety of existing design process strategies for coping with technological change.
3. To develop, in consort with my international colleagues a variety of new design process strategies for coping with technological change.

However, the more focused objective of this paper is to provide a vision of how we may be able to cope as a profession and as educators of Industrial Designers / Design Engineers with the impacts exponential growth in technological change will have on us all with specific focus and attention on the "*Facilitator Trap"* problem with the following aims/goals in mind.

1. Confirm our colleagues around the world perceive the facilitator trap problem indeed is a problem
2. To examine and contextualise the "*Facilitator Trap"* problem, as perceived by our colleagues around the world
3. Identify common core thematic strategies seen as being central to resolving the problem in the future

Original thought is needed from divergent sources to produce a vision that is more than a rehash of what is already known. What we want to know is iwhat experts are thinking as they look ahead towards the technological change issues facing our profession in the future from the present to 2015 then from 2015 to 2020. Therefore this paper is targeted towards Industrial design /design engineering educators. The findings are significant in that design engineering educators will need to consider the findings as they develop their educational pedagogies to meet the needs of their future students. Given these are our aims the subsequent sections will highlight, in general terms, the context of the study. Following that we will cover the study's research methodology where the interviewees discuss their vision of how we prevent the "Facilitator Trap" from occurring within our students and our profession in the future. It is important that these issues be both explored and discussed.

2. Background context

While the discussions above point to the need for this study it is prudent at this point to offer some background in order to place it in some context. In the future it would seem a student's capacity and experience in understanding technology in detail allowing them to make technological advances will diminish greatly. This would appear to accelerate the movement towards entering the "Facilitator Trap". In this future this will need to be addressed as a matter of urgency. This is the main driver for this study. We need to act now if we are to assist Industrial design/Design engineering educators and by extension future students to thrive, survive, and operate in a technologically turbulent future.

In the face of the above, those students, and indeed professionals, who recognise the exponential growth in technological change, need to have access to new tools and different learning experiences.

The current rapid growth of the internet and ever increasing speeds of internet search engines has allowed an almost instantaneous access to extremely large amounts of information. However, in their work relating to technology mining and strategies of technology innovation, Porter and Cunningham [2005] noted that technology information does not equal technology. It can be argued that just because someone understands a physical principle in theory does not necessarily suggest that they would be able to apply that principle in a design context and embody a complex product, system, or environment and make it work in addition to forming a comprehensive understanding of the concomitant sociocultural issues related to their design decisions. Notwithstanding the issues raised in the work of van Aken [2005], relating to the professional design of large and complex design processes making a distinction between *experienced-based knowledge* (learning by doing) and *evidenced-based knowledge* (learning by observation), it can be argued that as technologies become increasingly complex to the point where students do not have experiences in, and knowledge of, designing and making and as the technological change issues become increasingly complex. Consequently, Design/Design Engineering education may need to address this.

A review of the literature surrounding technological change reveals the world within which we live, work, and play is increasing in complexity at an exponential rate. The work of Kurzweil [2005], describes his perspective relating to what is termed the law of accelerating returns. He argues that extending beyond what has become known as Moore's law, the accelerated speed and exponential growth of the products of a technological evolution is advancing beyond an individual's understanding. He asserts, rather graphically, via a series of successive S-curves, relating to the life cycle of a paradigm, moves faster and higher, showing an unending exponential trend. This is true irrespective of the paradigm, be it molecular nano chemistry, biological/cultural issues, or purly technological. The central notion is that there will be a technological convergence as we move through what he suggests is six epochs of change. He is not alone in his discussions relating to technological complexity and convergence, as the work of Schmidt [Schmidt 2008] highlights much of our past has been shaped by a number of convergences having their beginnings as separate and independent fields of inquiry. Schmidt [2008] shows previous generations (even our most recent generations) consider we are living and working in a "science fictional" age continuing to be filled with complex converged technologies.

These complex converged technologies, in a real sense, do not exist in isolation. They exist in a social cultural context. All human cultural advancements are built upon remarkable technological, scientific, educational and moral achievements of the human mind as highlighted in the work of Shavinina and Ferrari [2004]. The literature discussing technological change, in point of fact, clearly argues that technological change is not just about the technologies and patents increasing at an exponential rate, it is a number of other issues advancing at a similar rate. Found in the technological change literature (see: [Porter et al. 1980], [Girifalco 1991], [Karamchedu 2005]), broadly speaking, Technological Change encompasses more than mere changes in technologies it also includes the following Economic-Psychological-Institutional/Political-Social-Technological-Legal-Environmental issues. This notwithstanding, while technology is growing at an exponential rate, it is not just the exponential growth of technologies and our growth in understanding within the sciences we need to be concerned about, but it is also these larger socio-cultural EPISTLE issues which are dynamically interrelated, and need to be embedded in the design processes of our future designers.

Borgmannn [Borgmannn 1992] reminds us, in his discussions relating to the depth of design, the twin tasks of the designer relates to trusteeship (a responsibility to society) of designing products systems and environments and making things [and making things work]. Fundamentally this suggests a need for students, academics, and professionals to develop a deep understanding of an ever increasing technologically and socially complex world. In short, the exponential growth of technology causes turbulent change within society, and indeed within social relationships. Both at present and in the future, the collaborative relationships between individual designers within design teams, the relationships between various design teams, and the broader relationships with non-designers will not be immune to the turbulent changes in the future. Despite the fact the work of Kokotorick [2007], proposed a way of working with and developing creative design teams in this technologically turbulent future, we need to advance our understanding of these issues and their associated relationships as it is the design teams who act as change agents.

Given the above the role of the industrial designer/design engineer will need to change. Moreover, the individual industrial designer and these design teams will need to modify their thinking and working strategies as ever increasing technological changes are introduced. Correspondingly, Kokotovich & Remington [2007] has highlighted how another discipline (Project Management) could shift their creative thinking strategies in order to cope with an increasing complex future. Nonetheless, as the artifacts designers and design teams develop, which fulfill societal wants needs and desires, become more technologically advanced and complex, there is an increasing need to make creative connections between diverse design issues and diverse resources. From both a technical and human perspective these creative connections/collaborations will clearly require alternative perspectives and heuristics. If we are to properly prepare professionals, students, and indeed academics to operate in a new era of technological change we will need to alter our teaching. An example of this discussion, in relation to the benefits of teaching and working across the different disciplines of Industrial design and Nano-Science, may be found in Kokotovich [2008].

As we begin to work across larger and larger teams, confronting larger increasingly complex issues, we may have only a sharp focus to our work and what we once understood may not hold relevance any longer. Moreover, as technological changes occur at an exponential rate we are very quickly made irrelevant or trapped within our very narrow focus. Alternatively, we may find we may become so much of a generalist that we are trapped in the role of being a facilitator who simply makes connexions between specialists.

3. The "facilitator trap"

Given the discussion above, the combination of collaboration/cooperation across differ disciplines and domains coupled with the use of both hard systems thinking and soft systems thinking, as in Checkland [2000], is likely to become increasingly important as technological change gathers pace. On the one hand we have Hard Systems Thinking. Typically this design engineering perspective in relation to systems thinking is adopted and developed within our students and indeed our profession. The designer understands the world as a big system and they understand that system because it can be parsed or deconstructed into smaller systems. For example a clock, which we can parse or deconstruct into a printed circuit board; electronics; a battery; injection moulded case; the kind of materials needed etc… Approximately 300 years of scientific positivist reductionist thinking has led us to making good things and making the thing work. On the one hand this is indeed a positive aspect of hard systems thinking, however, one may get trapped in dealing with the minutia and loses sight of the relationships to larger more complex sociocultural issues and connections. Conversely, there is an alternative perspective, Soft Systems Thinking.

Soft systems thinking tends to include larger more complex sociocultural issues as well as technology issues. This thinking generally relates to the bigger picture holistic systems by accepting and understanding the world is large, complex, and confusing. This is more phenomenological by nature. In contrast to the clock example, this is more analogous to a ball of string with five knots inside of it. While we never see the knots, it's so complex, it has five threads hanging out of it and, even though we know there's two ends to a piece of string, one may be comfortable with that ambiguity because they have ways of enquiring about that and can live in this bigger picture world. So in a real sense it is a big picture, verses small picture perspective in conflict here. Some argue the need to continue to focus on hard systems thinking, while others argue we need to shift towards Soft systems thinking. Some colleagues may argue we do not need to deal with these issues as they are not our responsibility. That is the purview of a social anthropologist, or a lawyer, or an environmentalist. Clearly a positive reductionist perspective embedded in our professions. It can be argued we need to alter our perspectives and relate more to the "bigger picture" as there are those designers who has "moved on". On the other hand, if one moves to far in confronting the larger and larger issues, incremental creep may occur and the industrial designer / design engineer may lose touch with the technical details as technology and exponentially increases. Consequently, they may be trapped by becoming a mere facilitator, a generalist bringing little to the table.

Given the above discussions/context, the main point of this paper relates to developing an understanding of how we may overcome some of these systemic issues relating to what we are calling the "Facilitator Trap". As access to ever increasing amounts of information relating to technology is getting both easier and faster (an exponential growth), this does not guarantee an understanding of neither the information gathered nor a capacity to appropriately use that technology information. If there is a decided lack of in-depth understanding, at a detailed level, the industrial designer/design engineer will need to defer to a "specialist". As technological change is advancing at an exponential rate and the increasing gap between a detailed understanding of technologies and the need to defer to a specialist widens there is a chance the Industrial designer/design engineer may be merely a "Facilitator" between "specialists" and become trapped. The combination of collaboration/cooperation coupled with our need to operate using both hard systems thinking and soft systems thinking, as in Checkland [2000], make this likely to become increasingly important as technological change gathers pace. It may be equally important to embed both these types of thinking within our future Industrial Designers/Design Engineers. The core issue here relates to the fact that as designers it is our responsibility for envisaging and developing innovative, workable, producible products systems and environments, which are often complex. This begs the question, what is in store for our next generation Industrial Designers/Design Engineers and what are some of the future issues we need to address in order to develop these future professionals.

4. Methodology

In order to identify and research alternate perspectives and heuristics in other cultures, thereby forcing a shift in our understanding of the technological change issue facing us, a number of leading Industrial Design and Design engineering programs and researchers from around the world were visited and academic researchers were interviewed (i.e Technical University Eindhoven (TU/e), Technical University Delft TU/Delft, and Illinois Institute of Technology IIT, Stanford University etc…). In all 56 subjects were interviewed. In addition, in order to understand corporate perspective's, leading industrial designers/design engineers from within large global corporations (i.e. Philips Eindhoven, McLaren's UK etc…) were also interviewed. The fundamental research methodology was via a Delphi type survey: The central focus of the Delphi research questions related to Exponential Technological Change and the Grand challenges for Industrial Design and Design Engineering from the present to 2015 then from 2015 to 2020. The study sought to obtain qualitative data via a three stage process. The following form the three stages of the study: Stage 1.). Obtaining the participant's response to a few basic open ended questions while visiting Face to Face; Stage 2.) Once the open ended questions are analysed, a refined questionnaire via Email will be sent to the participants soliciting their responses in the near future; Stage3.) Based on the themes derived from earlier responses, a tick box survey instrument soliciting responses will be sent to the participants (a little further into the future). The subjects were to extend their thinking beyond today's conventional wisdom.

Design and Design Education will be significantly different in both the near and far term. The intent is to sketch in general terms the core themes and profound changes in need of our immediate and longer term attention. The participants were to respond to six general open ended questions and a final general question, forming part of the project in the face to face meetings. As the participants' time was very valuable, the interview lasted approximately one hour. In order to try and divide our time in equal segments for the questions, a timer was used to maintain the pace of the interview. Their thinking was to be expansive. However, for each question they were to limit their input to 3 to 5 most important ideas for later analysis.

All of the participants were experienced researchers and in an excellent position to assist with informing this scoping exercise. The new perspectives will be obtained by closely collaborating with leading industrial design educators/researchers in Europe, America and Australia. The purpose of this research is to generate a scoping study. Consequently, the accurate detailed collection of qualitative data in relation to Cross-cultural perspectives with respect to how creative individuals and technologically advanced collaborative design teams will need to operate in the future, were collected. The results of this investigation will have significant implications for altering Industrial Design and Design Engineering practice and Academia. Consequently, the responses of the participants were recorded using some hardware and software called *Livescribe*. Basically they were to use a pen that has a little video camera inside it and a digital voice recorder. The pen would record what they would say and draw in response to the questions. Should they want to draw to assist in explaining their thoughts they were encouraged to do so. If they needed another page to draw in they were to let the interviewer know and the interviewer would reset the pen for the next page. Once the participant indicated they understood the procedures and tasks the interview began. The six questions were broken down into the following basic themes: Technological Change; Corpus of Knowledge; Learning Environment in the future; Tools and Skills; Hard systems and Soft systems; Facilitator Trap; Additional Thoughts.

However, of particular interest to this discussion is question six, as it is related to issues surrounding the "Facilitator Trap". The detailed question is as follows: Question 6.):

> *"Information relating to technology is not an in-depth understanding of technology and how it works. As access to ever increasing amounts of information relating to technology is getting both easier and faster (an exponential growth), this does not guarantee an understanding of neither the information gathered nor a capacity to appropriately use that*

technology information. If there is a decided lack of in-depth understanding, at a detailed level, the Industrial Designer/Design engineer will need to defer to a "specialist". As technological change is advancing at an exponential rate and the increasing gap between a detailed understanding of technologies and the need to defer to a specialist widens there is a chance the Industrial Designer/Design Engineer may be merely a "Facilitator" between "specialists" as it is often said design is abductive in nature with no buildable body of knowledge of its own.

As designers are responsible for envisaging and developing innovative workable producible products systems and environments outline your vision of how we prevent the "Facilitator Trap" from occurring within our students and our profession in the future. Please limit your input to 3 to 5 most important ideas."

Once all the interviews were completed, all of the tape recordings were transcribed into text for analysis. In order to identify a pattern of responses and common threads or themes emerging from the participants, the responses to each question were grouped. That is to say, for example, all the responses from the interviewees for questions 6 were grouped for analysis. This was the case for all the questions. Once the responses for questions six were entered, all the comments were reviewed and common themes in their responses began to emerge. While, as indicated earlier there were 56 participants, the qualitative data analysis and the results and subsequent discussions in this paper are preliminary as in the future it is intended that more rigorous and robust statistical tools be used (i.e. Factor Analysis). Nevertheless, the results here are valuable as they are indicative of a pattern of responses on the part of the participants.

5. Preliminary results

The transcripts of all the participants' responses to questions six relating to the "Facilitator Trap" were reviewed in detail. Core emergent ideas were identified within the transcripts of each participant. When reviewing the participant's responses to question six it became clear all the participants were aware of this issue. The quote below from one participant is one simple example that reveals a typical insight into the problem based on personal anecdotal experience.

"I have seen many people they are good programmers and they know the packages and they know kinds of tools, and once they get 30 – 35 and new things are coming they cannot deal with that. I know of one computing professor in a famous institution and he was writing down his notes and lessons and has his secretary type them up. He was not even using a computer. He could not cope with change. This is the essence of this research here. That is going to happen faster and faster. So the programming age will go from 35 to 25."

Beyond articulating their understanding of the "Facilitator Trap", a number of interesting perspectives were revealed which led the participants in this study to their individual conclusions. While there were many often complex and dynamically interrelated issues found within the transcripts, owed to the limits of this paper, Table 1 below are only a few of the main emergent strategies and tools that were raised and discussed by a number of the participants. Each subject discussed thematic issues they considered to be significant. A detailed review of the transcripts reveals fourteen major emergent themes that were subsequently designated a number. For example, if a subject had discussed issues surrounding the concept of lifelong learning which was given the designator number (1), or if the participant had discussed issues surrounding the need to develop peer to peer learning strategies and techniques, that discussion was highlighted and given the designator number (13). The number of subjects who raised the issue in their discussions and a percentage as a rating of how many of the 56 participants discussed that theme in their transcript may be found in Table 1 below. It should be noted that this table lists the results by order of the designated number and not the percentages.

Table 1. Emergent themes and percentage of subjects who raised the theme

Emergent Theme	%
(1) Lifelong learning	64%
(2) Enquiring minds and curiosity	13%
(3) Variety of experiences (practice in thinking and making experiences to build analogies)	43%
(4) Practice in connecting a variety of different contexts	25%
(5) Coevolve and Flexibility (professionals, students, and teachers)	25%
(6) Strategic consultative approach (B2B)	2%
(7) Build networks and practice communications (people, solutions)	27%
(8) Practice balancing "Big picture" and "Small picture" (joint projects)	75%
(9) Teach complexity (theory and tools)	2%
(10) Learn to make the complex simple	5%
(11) Practice varying approach to projects/problem types	4%
(12) Creative Innovative Integrator ("Bridge builder" – Mediator – Catalyst –Composer/Producer/Director etc…)	39%
(13) Develop Peer to Peer learning strategies techniques	20%
(14) Develop early a core specialty with a deep understanding of basic principles	55%

The number of subjects who raised the issue in their discussions was noted and the themes were ranked from highest to lowest in terms of the percentage of participants who raised the issue. There were five clear emergent themes, having the high percentage respondent discussion. These are rank listed from highest to lowest in Table 2 below.

Table 2. Emergent themes and ranked percentage of subjects who raised the theme

Emergent Theme	%
Practice balancing "Big picture" and "Small picture" (joint projects)	**75%**
Lifelong learning	**64%**
Develop early a core specialty with a deep understanding of basic principles	**55%**
Variety of experiences (practice in thinking and making experiences to build analogies)	**43%**
Creative Innovative Integrator ("Bridge builder" – Mediator – Catalyst –Composer/Producer/Director etc…)	**39%**
Build networks and practice communications (people, solutions)	27%
Practice in connecting a variety of different contexts	25%
Coevolve and Flexibility (professionals, students, and teachers)	25%
Develop Peer to Peer learning strategies techniques	20%
Enquiring minds and curiosity	13%
Learn to make the complex simple	5%
Practice varying approach to projects/problem types	4%
Teach complexity (theory and tools)	2%
Strategic consultative approach (B2B)	2%

6. Discussion/conclusions

A review of the transcript data reveals the notion of the "facilitator trap" is a real threat. The transcripts also reveal the need for us to alter our perspectives and heuristics with regard to the relationship between technological change and our understanding of the Facilitator Trap". To this end this study has revealed that when reviewing the percentage rankings in Table 2 above 75% of the participants discussed the fact that as technological change is advancing at an exponential rate, there is a need, in both the near and far term, for us to develop strategies allowing us to practice balancing complex "Big picture" and "Small picture" design issues, perhaps via joint projects or changing the types of learning experiences of our industrial design/design engineering students in order to develop rich learning experiences. As a small example this has future implications for how we need to frame and shaped "Industrial Work Experiences" for students. While there are many implications of the findings, one simple example relates to how we frame and shape work experiences. More often than not Industrial design/Design engineering students who have the opportunity to participate in a work experience programs within industry are in junior/subordinate positions. This prevents them from gaining learning experiences which relate to the "Big Picture" issues often discussed at the higher levels within a Company. In the future Work experience students will need to be involved in "Big Picture" discussions. Perhaps one example would be allowing a student to sit in on discussions in a company board meeting relating to the development of a new whole product direction for a company. Additionally, the Work experience students could spend time working in various diverse sections of a company (i.e. marking, or sales as well as manufacturing, and R&D). This would allow the student to relate divergent corporate and customer perspectives to their domain of knowledge.

Following on from this, as highlighted in Table 2 above, 64% of the participants discussed the need to embrace becoming a lifelong learner. This has significant implications for how our educational institutions will need to rethink how they operate in the future. They will need to develop a systems approach for on-going and continued involvement in shaping professional practice, perhaps by conjoining a variety of student cohorts into one class (these may be combinations of Alumni, postgraduate students and undergraduate students). This *"small one room school house"* model would add richness to the learning activities while providing a platform for lifelong learning bring in "real world" and perhaps "Big Picture" experiences via the inclusion of alumni who are participating as part of a lifelong learning program.

Supplementary to the above, given the turbulent changes that are occurring and will only become increasingly turbulent in the future, our study also revealed that 55% of the respondents discussed the need to develop early a core specialty with a deep understanding of basic "first Principles". It can be argued this has implications for the future. Having core working knowledgebase from which we grow our capacity to balance understanding both the "Big Picture" and "Small Picture" issues within design, will greatly assist us as we embrace the idea of becoming a lifelong learner. The implications for the development of a core specialty very early in one's career is that it assists in developing a capacity to build analogies and metaphors allowing us to transfer our detailed understanding of a core principle from one context to another entirely new context. That is to say if the industrial designer/design engineer has a detailed, and well-grounded understanding of first principles, such knowledge is then transferable to any new technologies or contexts they may encounter in the future irrespective of the core specialty they developed early.

Moreover, as indicated above in Table 2, 43% of the participants discussed the need for developing a variety of experiences. This has significant implications for industrial design/design engineering education, in that we will need to move from our current heavy reliance on evidence-based knowledge and move towards developing student experiences that rely on experienced-based knowledge and evidence-based knowledge equally. This implies we need to grow both our thinking and making experiences as we embrace the complex future. Balancing experience-based knowledge and evidence-based knowledge equally allows us to both build and draw upon these experiences to form analogies from which we may shape our future understanding and growth as a designer.

A review of Table 2 above also revealed, 39% of the participants discussed, via common phrases, our need to become what they termed a Creative Innovative Integrator ("Bridge builder" – Mediator – Catalyst – Composer/Producer/Director etc…). When we work in more diverse cooperative/collaborative teams in the future at first blush it may be argued that these terms the respondents used are not unlike that of being a facilitator. However, when critically reviewing the transcripts, it is clear they perceived the background and experiences of a Creative Innovative Integrator (industrial designer/design engineer) allows them to still have a "seat at the table". Consequently, this has implications for how we shape the learning experiences of future industrial designers/design engineers. In the future, we will need to develop educational experiences that ensure industrial designers/design engineers are acting as if they were *composer/producer/director*. This suggests that the industrial designer/design engineer of the future will be as a creative as composer, as productive as a producer making things happen, and as foresighted as a director being able to see "the finished picture".

As the issues in relation to technological change are advancing exponentially, and as a matter of great urgency, we need to begin altering our teaching and professional growth by both developing and validating new strategies which move us towards altering our perspectives and heuristics as we move into the future. If we are to properly prepare our students and professionals to operate in a new era of technological change. It is argued that introducing new innovative strategies and tools which address the thematic issues discussed by the participants, these may have flow on effects and benefits for teaching and working across the different disciplines of Industrial design/design engineering and areas outside our domain as well. These should include strategies such as; reshaping "work experiences" for understanding both the "Big Picture and the "Small Picture"; exploring the implementation of the *"small one room school house"* model to develop lifelong learning; embedding early a core specialty which instils a focus on "first principles"; balancing experience-based knowledge and evidence-based knowledge equally; assisting industrial designers/design engineers acting as if they were *composer/producer/director*.

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Dr Vasilije Kokotovich
Industrial Design Program, Faculty of Design Architecture & Building
University of Technology Sydney
PO Box 123, Broadway, NSW, Australia 2007
Telephone: 61-2-9514-8952
Email:V@uts.edu.au