

DEVELOPING MASTERY IN DIGITAL AGE: LEARNING FROM DELIBERATE FAILURE

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OVERVIEW OF WORKING GROUP

The Fourth Industrial Revolution (4IR) has affected the manufacturing industry in unprecedented ways. Much has been reported on the benefits that new developments in digitalization, machine learning and artificial intelligence (AI) bring to the industry, such as improved productivity, product quality, etc. These rapid and widespread transformations of workplaces also affect the sort of skills and expertise that will be required of the workforce. Hence, the need to better prepare students, especially engineering students, for the workplace of the future has been highlighted in previous studies.

In relation to the above, we can say that digital technology functions as a double-edged sword. On one hand, it can help people thrive in their work by making work processes more transparent and increase the productivity and safety of many occupations. On the other hand, it can also obscure the relevance of expertise by e.g. automating certain practices that are actually at the core of one's professions. The use of sensors in many modern workplaces, for example, has come to substitute the use of human senses in assessing a manufacturing plant or factory floor (e.g. the chemical engineer "tapping the pipes" or "smelling the situation"). Likewise, AI technology recommending the human worker a list of plausible actions on which decisions must be made may obscure the more intuitive decision-making process that engineers employ based on their tacit knowledge. These issues become especially pertinent when technology breaks down and automated processes have to be performed by human workers until the technology is fixed again. In light of this, we observe that while digitalization may reduce human-error we can never rely for systems to be foolproof. Thus, while errors are less likely to happen, technology has in fact made us less prepared for those instances that it does break down, simply because we have had less exposure and practice to deal with exceptional situations.

Education can fulfil a function in addressing this potential dilemma. Within the confines of limited curriculum hours, we need new ways of training engineers so that they can develop necessary workplace competencies as fast as possible. The business concept of "fail fast, fail often" can provide a viable approach. This means to deliberately "build-in" failures into a series of integrated learning experiences, so that students will learn to embrace failure as part of the learning process, rather than something to be avoided, so as to develop a "failure-tolerant" mindset. Developing such a mindset is crucial for two reasons:

- (1) for people working in process/safety oriented settings to practice with exceptional situations in a safe and controlled environment so that if they were to happen in real life engineers know better how to respond and react
- (2) for people working in product development oriented settings to respond to the increasing demand of engineers showing an innovative approach to their work, e.g. being more comfortable with taking risky “out-of-the-box” decisions.

The “deliberate” aspect of our approach highlights the role of educators. Experiencing failures in itself does not lead to superior engineering knowledge; providing the right guidance, instruction, reflection and scaffolds when encountering failures will.

The purpose of this working group is to seek like-minded collaborators to understand how to better prepare students to learn from failure using the CDIO Framework. Collectively, the working group strives to explore ways to introduce innovative learning tasks designed to incorporate “deliberate failure” while imparting the competency needed for the field of study.

Leaders:

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Things to be done before the physical conference

A possible list of what participating members need to do before the conference, and the mode of interaction include the following:

- Data collection (offline, **in-progress**): Each participating member, working independently on each’s own, do a study how programs in one’s institution implement “learning from failure”, if any – by end-**February** 2023
- Literature review (offline, **in progress**): Some articles already available are shown under “Other relevant information” and will be shared to all participating members before the first meeting to start-off the discussion. In addition, each participating member will continue to source for more pertinent literatures and share with the Leaders via emails; who will in turn assign some reading duties to all – by end-**March** 2023.
- Online meeting (hopefully, at least once): Sharing of each other’s practices and insights from reading the literatures, to identify common themes or best practices suitable for adoption in the different fields of engineering – sometime in mid-**April** 2023, and if necessary again in mid-**May** 2023
- Prepare (offline) sample Designing Integrated Learning Experiences for respective field of engineering – by end-May 2023

During the physical International Conference in Trondheim, Norway; a face-to-face meeting will be held among all participating members 1 or 2 days before the start of the conference proper. This will allow the working group to review and fine-tune the draft Integrated Learning Experiences, and the team will also craft possible survey questions to ascertain students’ experience with the “new way of learning: learning from failure”.

How will the finalization of the state of the art paper be organized?

It is envisioned that a State-of-the-Art paper for inclusion in the proceedings (after review by the Program Committee) will outline a plan for the pilot run of a series of "learning from failure" in the participating member institutions for reporting again to the CDIO community at the next International Conference in 2024.

Other relevant information:

Selected Literatures

- Edmondson, A.C. (2011). Strategies for Learning from Failure, *Harvard Business Review*, April Issue
- Henry, M.A., Shorter, S., Charkoudian, L., Heemstra, J.M. & Corwin, L.A. (2019). FAIL Is Not a Four-Letter Word: A Theoretical Framework for Exploring Undergraduate Students' Approaches to Academic Challenge and Responses to Failure in STEM Learning Environments, *CBE Life Sciences Education*, Vol.18, pp.1-17
- Jackson, A., Godwin, A., Bartholomew, S. & Mentzer, N. (2022). Learning from Failure: A Systematized Review, *International Journal of Technology and Design Education*, Vol.32, pp.1853-1873
- Schwarz, G. M., & Bouckennooghe, D. (2021). Repositioning Organizational Failure Through Active Acceptance, *Organization Theory*, Vol.2, pp.1-24
- Sitkin, S.B. (1996). Learning Through Failure: The Strategy of Small Losses, in *Organizational Learning*, Cohen, M.D. & Sproull, L.S. (eds), Thousand Oaks, CA Sage
- Tawfik, A.A., Rong, H. & Choi, I. (2015). Failing to Learn: Towards a Unified Design Approach for Failure-based Learning, *Educational Technology Research & Development*, Vol.63, pp.975-994

BIOGRAPHICAL INFORMATION

Sin-Moh Cheah is the Centre Director of the SP-CDIO Centre for Innovative Teaching and Learning; under the Department of Educational Development, Singapore Polytechnic. He has more than 15 years of experience implementing CDIO in the Diploma in Chemical Engineering curriculum, and had conducted various CDIO workshops for universities in Asia, for various disciplinary programs. His academic interests include curriculum revamp, academic coaching and mentoring, and using ICT in education.

Thijs Willems is an organizational ethnographer and generally interested in the daily work of people in complex and technological organisations, as well as how they experience their work in the broader organisational context. In his work, he draws on rich, ethnographic empirical data analysed via practice and process theories. His latest research project, "Mastery in a Digital Age", studies how professional expertise is changing amidst the digital disruption of workplaces.

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If this topic interests you, and you would like to be part of the working group, kindly provide the details below:

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