ENGINEERING STUDENTS READY FOR A VUCA WORLD? A DESIGN BASED RESEARCH ON DECISIONSHIP

Siegfried Rouvrais
IMT Atlantique, IRISA, UBL, France

Sophie Gaultier LeBris
Ecole Navale, LEGO, UBL, France

Matthew Stewart
City of Glasgow College, Scotland

ABSTRACT

The need to prepare future-ready graduates is now a major concern for educational programme leaders. But the world is changing at a rapid pace, professional and personal life environments are now more than ever volatile, uncertain, complex, and ambiguous. How can vocational and higher education institutions prepare learners for an unpredictable future? This paper presents an iterative design based research method, initiated in 2015. It explores the links between judgement, decision making skills, and reliability of organisations. Within engineering education and training environments, decision making skills are transversal and can be enriched by a multiplicity and variety of experiential learning situations. As a result of the applied iterative method, decision oriented learning situations can now be categorised in a VUCA rubric of perturbation. It permits educators to continuously reinforce reliability and learner proficiency throughout a curriculum.

KEYWORDS

Learning Outcomes, Decision Making, Transversal Skills, Competencies, CDIO Standards 2, 8.

INTRODUCTION

The engineering professional activity is to be respectful of standards and industry norms, but is a procedure always directly applicable, whatever the context, e.g. in an emergency or VUCA situation (i.e. Volatile, Uncertain, Complex, and Ambiguous)? In terms of attributes and outcomes, education institutions must prepare their students to embrace changing working practises; but with globalization, are multiple issues still understandable with rationality for the future engineer? The European Network for Accreditation of Engineering Education sets 8 programme outcomes (ENAEE, 2017). One is specific to judgement, where the learning process should enable graduates at Masters degree level to demonstrate the ability to:

- integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgement;
- manage complex technical or professional activities or projects that can require new strategic approaches, taking responsibility for decision making.

Strategic approaches involve integrating procedures and rules or developing discernment and exploring new rules. How can we approach and overcome the educational challenges so as to prepare graduates for their future responsibilities? In the curriculum, when and how is it best to develop a student's ability to discern; and make good decisions at right times in VUCA environments?

To deal with complex and multifactorial situations, an adaptation of engineering education is required (Kamp, 2016). To reinforce decision making skills in engineering education, several conceptual and methodological questions remain to be answered. As such, for engineering student's competency development in; and for; VUCA contexts, this paper proposes a Design Based Research (DBR), to analyse; design, evaluate and refine iteratively; the collective behaviour variables of student teams, when facing perturbations in complex and unexpected situations. This DBR was initiated with questions such as: what are the theories of reliability? What are the learner's motivational factors? What are the so called *decisionship* learning outcomes? How do we characterise the VUCAlity of learning situations to continuously reinforce learner proficiency throughout a curriculum?

ITERATIVE DESIGN BASED RESEARCH

Design-based research (DBR) focuses on real educational situations (Anderson & Shattuck, 2012), which are potentially more complex than simulated environments. Inspired by the system engineering principles and agile methods implying clients in iterative cycles, DBR aims to continuously enhance practices (Collins et al., 2004; Mc Kenney & Reeves, 2014). Iterative in essence, the approach is ultimately oriented toward creating, rather than testing, theories. In DBR, regular interactions are in place between researchers, practitioners and trainees. Learners are also responsible for the learnings they experience in the Teaching & Learning Activities (TLAs) enhancement loop.

The DBR takes into account several variables: knowledge, skills and competencies, motivational factors, variables of the learning situations and environmental factors. Based on TLAs continuous improvement, we propose a flexible process of analysis; design; evaluation and revision, as well as expected future theoretical contribution. The research process relies on the following phases (McKenney & Reeves, 2014):

0. <u>Definition</u> of the educational needs and problem (strategies to be used for decision-making processes in VUCA situations with higher reliability);

1. Analysis to identify problem sources (phenomena classes) and formulate learning and environmental operation variables;
2. Design & development of a TLA by researchers, practitioners, and learners, anchored in a theoretical model (TLA concepts, methods, processes and tools);
3. Evaluation of the TLA maturity and efficiency with respect to the variables and problem needs. The TLA is operated in real situations, which are collaborative and participative. Evaluations can be qualitative and quantitative. New comprehensions are inferred (e.g. emergent concepts). Design principles and rules are formalised;
4. Revision of concepts and TLA methods and tools, based on success and limitations;
5. Reiterate to phase 1.

THEORETICAL MODELS OF RELIABILITY AS A STARTER

The difficulties of decision-making processes in complex or uncertain environments (Klein 1999, Lipshitz et al., 2001) can raise contradictions. The complexity associated with the need for rapid decision-making can lead to information overload and impair the decision-makers' judgment. The multiplicity of procedures, their contradictory aspects, or simply the quantity of procedures to follow in a complex situation can even lead to an inability to decide. The adapted educational answer would be to mobilize heuristics, but this requires learning time, incompatible with an emergency situation. Mathematical approaches of decision making have their limits when confronted with VUCA variables. If a procedure is not always applicable, what strategy of discernment could be adopted?

Some movement on reliability theory consider that individuals are rather a source of error than reliability (Reason, 1990). Perrow (1994) explains that the increased complexity of systems reduces the ability of individuals to understand, predict or prevent potential failures. Errors derive from the fact that "*either there are no procedures provided for the current situation, or the appropriate planned procedures cannot be implemented and constitute a problem of categorisation*" (Mendoça, Webb and Butts, 2010). The stakes of decision-making can be high: an error can have irreversible consequences. But the role that groups and individuals could play in the readjustment decision processes are underestimated. Errors can come from rigid adherence to the established plan as well as from a plan (Klein, 1999). The cumbersome nature of procedures can have an effect on the organizational performance (Brown and Eisenhardt, 1997).

On a theoretical level, our foundations are in line with the models promoted by the Higher Reliability Organisations (HRO) and the Actionist movements. Very close to each other, they seek to identify sources of reliability where decision-maker roles are crucial. HRO movement focuses on the factors that contribute to maintaining reliability, it links observable factors with the absence of disaster by highlighting the ability of individuals to adapt to unforeseen situations and develop a collective mind (Roberts et al., 1994). HROs are strongly characterised by many rules (e.g. nuclear, medical sector). Cognitive saturation can come from an accumulation of written procedures. The Actionist movement (Weick, 2001) deals with the concept of sense making through the theory of enactment, it analyses the way people act in organizations. Weick considers that strict compliance with rules can compromise reliability. In dynamic environments, there is a link between the number of rules to be followed and the level of organisational performance (Davis et al, 2009): too many procedures reduce the level of performance, as well as too few rules.

FIRST DECISIONSHIP ITERATION: AN EXPERIENTIAL COURSE ON RELIABILITY

A skill is only effective once it has been tested and validated when confronted in reality (Le Boterf, 2006). Decision making courses, including TLAs, permit transfer of theoretical models into skills, however, in the real-life VUCA scenarios; the human factors can generate biases and lead to irrational decisions. Learner experiences and skills in discernment, judgement, and decision making should be studied for these new; unexpected situations.

At IMT Atlantique, the TLA context of our DBR is an inter-semester course called INT (2 ECTS), to train engineering students to take decisions and react in unexpected and unpredictable situations. As published in (Rouvrais and Gaultier Le Bris, 2018), this “one week course has some outdoor elements in the sea environment for novices. The real experiential situations are selected to reflect nautical risk scenarios, with varying levels of complexity pressure (including Man Over Board exercises, MOB). Specific decision skills are to be acquired or reinforced, aside risk and priority management, watchfulness, team management with respectful interactions, judgement and responsibility, etc.

Few engineering courses directly address VUCA situations in a real experiential manner (Lewis & Williams, 1994). The engineering program at Reykjavik University runs a two day “Disaster Week”, early in the first semester (Saemundsdottir et al., 2012). Students are to develop an action plan for dealing with an unforeseen event of some complexity, demanding dynamic, instantaneous decision making based on incomplete information. In the fall semester 2017, the scenario was the eruption of a stratovolcano that is actually clearly visible from the University, and it was decided to analyse the VUCA factors specifically as the event unfolded and the students set to work on finding solutions (Audunsson et al, 2018).

The experiential INT course was first designed and implemented in 2015 to allow students to infer and apply procedures and rules in order to face VUCA situations in real environments (educational needs). A real-life approach on INT was conducted among IMT Atlantique students who - as generalist "Grande Ecole" engineering students - need to develop managerial skills enabling them to obtain positions of responsibility. Training focusing on complexity management; can help the future engineer to be more confident, clear-sighted and allow them to identify the main patterns developed during formal training. Work on the development of the decision-making capacity profile of a decision-maker can be an asset in the future.

To start our DBR, we chose to take into account the HRO models and the complexity aspect of Journé (1999). We took into account operational variables, with a flexible revision of the design

(Campbell et al., 1966); related to the limits identified in some previous experiments we had from the French Naval Academy (Ecole navale).

Prototype design at IMT Atlantique with the meta-rules concept

The selected theoretical framework allows more methodological robustness, based on previous experimental results we had, following the concept of meta-rules (Gaultier Le Bris, 2014). Davis (1980) defines meta-rules as rules which govern a set of lower-level rules, constituting a framework for which priorities might change. While the decision must be made quickly, based on robust knowledge, the complexity of a situation can lead to a risk of information overload. The decision-maker may face conflicts between the priorities of the procedures to be applied. One possible answer may be to mobilise meta-rules in the context of learning to manage complex situations, offering the advantage for the future decision maker to reprioritise the rules if necessary. They offer the advantage of providing a faster diagnosis of the level of control, with a prompt redefinition of the priorities according to the situation. The results of the meta-rules approach show that they are relevant to improve the level of reliability in a context of uncertainty, urgency and complexity. The meta-rules are adapted to work on the management of complex situations with decision-making difficulties when facing contradictory or unenforceable procedures. They offer encouraging prospects for developing the decision-making capacity of the future decision-maker.

The focus of the INT TLA design phase was initially to examine works relating to the strategy of the rules applicable in complex environments and to evaluate the benefits of meta-rules in VUCA situations. The rules and meta-rules approach proposed in the TLA is progressive and experiential. To observe the impact of meta-rules on reliability and the ability of a learner to decide and maintain a discernment capacity in VUCA situations, the level of complexity of the situations is modified, continuously and/or iteratively through several sequences. In a sequence, the first nautical situation proposed to the students is named Simple Situation (application of rules they inferred) with a low level of complexity (variable 1). The second nautical situation is named Complex Situation (same rules but with a higher level of complexity). After each situation where the student or a team is in a position to act, we measure the level of reliability (variable 2). The application of rules and the use of meta-rules are specifically observed; data is collected with questionnaires and there are debriefings with learners after each sequence.

Qualitative evaluation on motivational factors

First qualitative results (Rouvrais and Gaultier Le Bris, 2018), linked to motivational factors of non-experts and the inference of meta-rules during practical experiences, have shown the benefits of meta-rules rather than rules, prioritising procedures which could contradict or not be applicable in VUCA contexts by non-experts. In this iteration, students were first asked to define meta-rules on their own, in an experiential learning model, where they experienced before conceptualizing, but via several MOB scenarios with enhanced complexity. It would now be pertinent to integrate professional experts into our DBR cycle to formalize the collected meta-rules. It may help to anticipate or reduce cognitive saturation of non-experts. In addition, the learners' qualitative feedback emphasises the interest of working on the capacity of discernment and decision, aside the two variables, i.e. complexity and reliability.

SECOND ITERATION: FORMALIZING LEARNING OUTCOMES AS VARIABLES

In engineering education, the XXIst century sees a shift from scientific and technical knowledge to soft and transversal skills. Skills relate to the “ability to apply knowledge to complete tasks and solve problems, and can be described as cognitive (use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments)” (ENAEE/IEA, 2017).

Decision making skills

Inspired by the CDIO syllabus (Crawley et al., 2011) and the ENAEE requirements for graduate engineering profiles (ENAEE, 2017), in this second DBR iteration, five learning outcomes were selected and used for learning activity redesign and student assessments:

- D1: ability to integrate knowledge of the situation context & factors;
- D2: ability to formulate judgements with incomplete or limited information;
- D3: ability to handle the complexity of the situation and during the situation;
- D4: ability to manage complex activities with new approaches, to create new solutions with available resources;
- D5: ability to take responsibility for decision-making.

Quantitative analysis

These decision skills were evaluated quantitatively in 2017 and 2018 on the INT course, offered one time a year. Students were first asked to self-assess on the 5 skills prior to the course. During the experiential TLA, students self-assess several times, individually and collectively, and were formatively assessed by an expert. After each MOB scenario (approx. 7 scenarios in a day), reflective debriefings (Rouvrais, 2013) are in place, in situ. The various sequences provide initial indicators on learning variables to analyse proficiency.

Evaluation showed that the chosen decision skills were to be clarified and normalized for other contexts. A revised analysis to identify new problem sources (phenomena classes) and formulate learning and environmental operation variables is under preparation to explore the links between discernment, judgement, procedures and decision-making. Working sessions with engineering students on discernment and decision skills in VUCA situations, via focus groups, were conducted in the Fall 2017 so as to refine problem sources (phenomena classes) and to reformulate learning environmental operation variables of the DBR. A new analysis is ongoing to refine the learning outcomes referential for a next iteration (Gaultier Le Bris et al., 2017). To refine theories, the researcher and course designer, at national level, attend seminars on discernment & procedure (French Unesco Chair Ingénium network, December 2017) and on complexity (Rochebrune seminar, January 2018). The ongoing DBR will propose a new TLA with its assessment model, in EU institutional contexts for 2019.

ONGOING ITERATION: FORMALIZING A VUCA MODEL FOR CONTEXTUAL LEARNING VARIABLES

The VUCA concepts were to be clarified to link them with learning outcomes and reliability theories. Phenomena classes and complexity experiential variables were to be classified to be linked with reliability.

New design of the T&L offer

For the January 2018 INT session, a VUCA complexity rubric with three levels of magnitude was defined (see Table 1), where an interpersonal dimension was added as it impacts the experiences and reliability of actions. Each sequence of INT are to be positioned in this rubric, by students during the debriefings, and by the experts and practitioners. Each TLA sequence is to enhance the VUCAlity perturbation of the proposed situation to students (project factors, experience resources, etc.) thanks to the previous sequence, e.g. by dynamical perturbation of a data or factor. It relies on a progressive learning cycle, for learner proficiency improvement.

Table 1. The IVUCA perturbation rubric

	Perturbation Rubric of an experiential situation				
Magnitude / variability	***Interpersonal***	***Volatility***	***Uncertainty***	***Complexity***	***Ambiguity***
Weak	Individually or few actors	Low variation of factors, static-ness	Known and formal environment	Simple sources and organization of factors in the environment	Plausible interpretation (a rule or process)
Medium	Small collective or disciplinary team	Predictable change and variance of factors in the environment	Imperfect environment, incomplete and limited information	Several sources and components, high order factors, and low structure	Not obvious interpretation (disambiguation required)
Strong	Interdisciplinary and/or intercultural team	High dynamicity and unpredictability	Unknown environment	Many components and factors, disorganization of factors, no structure	No possible interpretations

The VUCAlity of experienced situations is then to be evaluated as a new set of variables within the DBR, aside the learning outcomes variables (i.e. levels of achievements). Dynamic correlations or interferences between IVUCA rubric elements will be perhaps identified.

DISCUSSION AND INSIGHTS

The world is changing at a rapid pace, and is becoming increasingly VUCA. Now education is about helping students develop a reliable compass and the navigation skills to find their own way through an increasingly uncertain, volatile and ambiguous world (Schleicher, 2015). Embedding decision skills into a curriculum is essential for future engineers to be ready for unforeseen VUCA situations. This paper proposed to analyse the collective behaviours of engineering student teams when facing VUCA situations. The DBR conducted has two main goals for the field of engineering education: (i) to develop innovative TLA solutions to reinforce decision making skills, and (ii) to develop knowledge and open future theoretical contribution. DBR is close to Action Research methods (Järvinnen, 2007). A TLA design in DBR provides concepts, methods, processes and tools transferable to other contexts. The approach presented in this paper, initiated in 2015 with two institutions and since the Fall 2017 thanks to a European project with seven partners, aims at ultimately formalising individual and collective strategies related to the decision-making process in and for VUCA situations, by using innovative and iteratively revised experiential TLAs.

Our findings, derived from TLA problems anchored in real-world settings, demonstrate the relevance of meta-rules in VUCA environments. Decision-making capacities are transversal and can be enriched by a multiplicity and variety of learning situations. Meta-rules offer encouraging prospects for developing the decision-making capacity of the future decision-maker. This approach has a two-fold merit: it defines a framework of understanding in a very fast way for a non-expert; and it is progressive according to the degree of learner's maturity. We see in this approach a way to develop a capacity for discernment when facing many procedures, through training with experiential activities in real situations which the engineer may encounter in a professional context. In addition, learners' feedback from the exercise in real situations highlights work on self-confidence and also the difficulty of optimizing solutions for VUCA situations.

Our works contains limitations: the way to control and measure our variables must be improved, as the prototype design. For transferability, we should also choose other learning contexts for the quantitative analysis. Nevertheless, the flexible and iterative DBR method we used permits to re-formalize decision-making learning outcomes and assessment criteria, in line with the proposed IVUCA rubric. Our research is carefully structured to produce theoretical understanding that can serve the work of others. As theoretical contribution, the approach will allow to propose and make operational a sub-syllabus of decision-making skills for higher and VET education. An assessment rubric of the skills associated with decision-making in VUCA situations will ultimately be inferred and validated in real settings.

Acknowledgments

The authors would like to acknowledge all their colleagues from the DecisionShip Ahoy project, co-funded by the Erasmus+ programme of the European Union (www.dahoyproject.eu, reference 2017-1-FR01-KA203-037301). The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

REFERENCES

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, Vol. 41(16), pp. 16-25.

Audunsson, H., Fridgeirsson, T. V., and Saemundsdottir I. (2018). Challenging Engineering Students with Uncertainty in a VUCA Situation. In Proceedings of the 14th International CDIO Conference, KIT, Kanazawa, Japan, June-July, 2018.

Brown, S. L., & Eisenhardt K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations, Administrative Science Quarterly, Vol. 42, pp. 1-34.

Campbell, D. T., Stanley, J. C., and Gage, N. L. (1966). *Experimental and quasi-experimental designs for research*. Boston: Houghton Mifflin.

Collins, A., Joseph, D., and Bielaczic, K. (2004). Design research: Theoretical and methodological issues. The Journal of the learning sciences. Vol. 13(1), pp. 15-42.

Crawley, E. F., Malmqvist, J., Lucas, W. A., and Brodeur, D. R. (2011). The CDIO Syllabus v2.0: An updated statement of goals for engineering education. In *Proceedings of 7th International CDIO Conference, Copenhagen, Denmark*.

Davis R. (1980). Meta-rules: Reasoning about control. Artificial Intelligence, N°15, pp. 179-222.

Davis, J. P., Eisenhardt, K. M., and Bingham, C. B. (2009). Optimal Structure, Market Dynamism, and the Strategy of Simple Rules. *Administrative Science Quarterly, 54*(3), 413-452.

ENAEE (2017). The EUR-ACE Framework Standards and Guidelines (EAFSG). The European Network for Accreditation of Engineering Education. http://www.enaee.eu/accredited-engineering-courses-html/engineering-schools/accredited-engineering-programs/, accessed 14 January 2018.

ENAEE/IEA (2017). European Network for Accreditation of Engineering Education: Glossary of Terminology. http://www.enaee.eu/engineering-accreditation/accredited-engineering-education-programmes/, accessed 14 January 2018.

Gaultier Le Bris, S. (2014). *Improvisation vs Méta règles comme source de fiabilité : effets sur la fiabilité d'une organisation hautement fiable. Le cas d'une équipe passerelle dans la Marine nationale*. In French. PhD thesis report, University of Rennes.

Gaultier Le Bris, S., Rouvrais, S., Fridgeirsson, T. V., Tudela Villalonga, L, and Waldeck R. (2017). Decision Making Skills in Engineering Education. In Proceedings of the 45th SEFI 2017 Conference "Education Excellence for Sustainable Development", Terceira Island, Azores, Portugal.18-21 September 2017.

Järvinen, P. (2007). Action research is similar to design science. *Quality & Quantity*, vol. 41, pp. 37-54.

Journé, B. (1999). Les organisations complexes à risques : gérer la sûreté par les ressources. Études de situations de conduite de centrales nucléaires. In French. Thèse de Doctorat, École Polytechnique.

Journé, B., & Raulet-Croset, N. (2008). *Le concept de situation : contribution à l'analyse de l'activité managériale dans un contexte d'ambiguïté et d'incertitude*. In French. *M@n@gement, 11*(1), 27-55.

Kamp A. (2016). Engineering Education in a Rapidly Changing Word. 2nd edition, 4.TU Center for Engineering Education, Delft.

Klein, G. (1999). *Sources of Power: How People Make Decisions*. Boston: The MIT Press.

Le Boterf, G. (2006). *Ingénierie et évaluation des compétences*. In French. Organisation Editions, 5th edition, 605 pages.

Lewis, L.H, and Williams, C.J. (1994). Experiential learning: Past and present. New directions for adult & continuing education. Wiley, Vol. 1994(62), pp. 5-16.

Lipshitz, R., Klein, G., Orasanu, J., and Salas, E. (2001). Focus Article: Taking Stock of Naturalistic Decision Making. *Journal of Behavioral Decision Making, 14*(5), 331-352.

Mc Kenney, S., & Reeves, T.C. (2014). Educational design research. In Spector, Merill, Elen and Bishop (dir.). Handbook of research on educational communications and technology, Springer, pp. 771-779.

Mendoça, D., Webb, G., and Butts, C. (2010). L'Improvisation dans les Interventions d'Urgence : les relations entre cognitions, comportements et interactions sociales. *Tracés, Revue de Sciences humaines*, N°18, pp.69-86.

Perrow, C. (1994). The limits of safety: the enhancement of a theory of accident, *Journal of contingencies and crisis management*, Vol.2, pp. 212-220.

Reason, J.T. (1990). Human Error. Cambridge University Press, Cambridge.

Roberts, K. H., Stout, S. K., and Halpern, J. J. (1994). Decision Dynamics in Two High Reliability Military Organizations. *Management Science, 40*(5), 614-624.

Rouvrais, S. (2013). *Développer la pratique réflexive des étudiants par l'autoévaluation : d'une logique de formation diplômante à une logique d'apprentissage responsable et durable, retour sur trois expériences dans une formation d'ingénieur*. In French. "L'évaluation des acquis en formation d'ingénieur : témoignages". Réseau CEFI-Ecoles, 13rd February 2013, Chimie ParisTech, France.

Rouvrais, S., & Gaultier Le Bris, S. (2018). Breadth Experiential Courses to Flexibly Meet New Programme Outcomes for Engineers. In Book: "Engineering Education for a Smart Society", Springer, International Association of Online Engineering, M.E. Auer & Kwang-Sun Sim (Eds), Advances in Intelligent Systems and Computing Series, 627(1), January 2018, pp 326-342.

Saemundsdottir I., Matthiasdottir A., Audunsson H., and Saevarsdottir G. A. (2012). Facing Disaster Learning by Doing at Reykjavic University. In *Proceedings of the 8th International CDIO Conference,* Queensland University of Technology, Brisbane, July 1-4.

Schleicher, A. (2015). Transcript of dinner speech. Global Education Industry Summit, 19th October. Helsinki.

Weick, K. E. (2001). Making Sense of the Organization, Blackwell Publishing Ltd.

BIOGRAPHICAL INFORMATION

Dr. Sophie Gaultier Le Bris is Senior Lecturer. She has been for 12 years responsible for the academic leadership training at the French Naval Academy. She gives courses in team building (collective mind, higher level of reliability) focusing on the decision-making process of leaders. The aim is to prepare cadets to be resilient whatever situations.

Dr. Siegfried Rouvrais is Associate Professor at the CS Department of IMT Atlantique (formerly Télécom Bretagne). His current scholarly interests are in quality enhancement in line with accreditation requirements, and in methods and processes for Higher Education changes. He co-leads the French TREE research group on Engineering Education Research & Development (http://recherche.telecom-bretagne.eu/tree).

Matthew Stewart is Curriculum Head for Marine Engineering at City of Glasgow College. He is in charge of training Merchant Navy Cadets to achieve their first certificate of competency.

Corresponding author

Dr. Siegfried Rouvrais
IMT Atlantique
Graduate School of Engineering
Technopôle Brest-Iroise, CS 83818
Brest, France