Subject: Application for Excellent Educator (Meritorious Teacher) Gerrit Muller

Kongsberg, February 2020

L.S.,

In response to the call for Meritorious Teacher, I apply for this role. In this letter, I will describe my development as excellent educator.

Summary

I am passionate about teaching. My focus is fully on the learning of the students, through actively engaging them. My reflective nature helps to turn my industrial experience into a learning context where students learn theory while relating it to practice. A specific research approach lifts the program to an academic level, by involving students and academic staff in the evaluation of the body of knowledge in practice.

I have been teaching over 20 years in which I have been developing my teaching competence qualitatively.

- Since 1999, I developed gaudisite.nl with about 90 publications, ~200 whitepapers, more than 360 presentations, 10 courses on systems architecting, and 45 course modules.
- Since 2009, the systems engineering program publishes 23% of the industry master results (37 papers of 164 master projects in 10 years, 22 of the 101 master projects that I supervised were published).
- Over time, I have developed over 20 courses; three of them are blended courses.

During these 20 years, I have explored teaching and learning approaches and evaluated the in scientific publications

As systems engineering team, we

- developed the industry master model, using industry-as-laboratory for master projects, and reflective practice as binding element,
- promote student-active learning; the focus is on the learning of the students; how to function in complex organizations solving complex problems,
- documented the development in 10 pedagogic publications directly related to my teaching, and
- pursue life-long-learning by engaging alumni and via courses and events for practitioners.

I am the thought leader and driving force behind this approach.

I am engaged with students, industrial partners, academic staff, and active in international networks. I have been actively building the institution's work on educational quality.

- Our efforts culminated in winning the Utdanningskvalitetsprisen for høyere utdanning in 2019.

- I maintain a broad international network, among others as an active member of the international professional society for systems engineering INCOSE, organizer of the System of Systems engineering conferences, facilitator of the Systems Architecting Forum, and associate editor of the Journal of Systems Engineering.
- We maintain a close relation with industrial partners. I have been organizing and shaping the yearly Kongsberg Systems Engineering Event, the twice-yearly Systems Engineering Study Group, the Reference Group with industrial systems engineering experts and managers, and the Industrial Advisory Board with the industrial decision makers.
- I engage the academic staff in formal and informal discussions and meetings, encouraging them to develop an active pedagogic style that fits our industrial-academic audience.
- I support other departments at USN that have an interest in developing an industry master program.

Brief sketch of my background

I studied physics at the University of Amsterdam, from 1974 until 1979. Philips Healthcare employed me from 1980 to 1997 in roles varying from systems architect to chief designer and group leader. From 1997 until 1999, I worked as manager systems engineering at ASML. Then, after 20 years in industrial systems development, I moved into research, starting at Philips Research and later in 2002 at the Embedded Systems Institute (ESI), now part of TNO (a research organization comparable with SINTEF). Since late 2007, I am teaching at USN (then HiBu) and employed as Professor Systems Engineering. I have maintained a 20% position at TNO-ESI, where I am actively involved in the Competence Development Program and in-company courses.

During my entire carrier, I have been involved with education. For instance, as student I have been providing remedial teaching, writing a syllabus for high-energy physics, and been member of the curriculum committee. In industry, I have been teaching professionals to help them moving from physical engineering disciplines into digital disciplines.

In the period 1995 to 1997, I worked with a colleague who was a proficient facilitator. He coached me in facilitation skills. These skills are powerful for systems engineering professionals as well as for educators. These 2 years tremendously influenced my attitude and way of thinking.

My motivation to change from industrial systems development into research was that I observed a great need for systems people. After 20 years in industry, I felt ripe to turn our tacit understanding of the systems field into a discipline. In this way, I could help others to develop this competence, and I started gaudisite.nl in 1999. At this moment, the Gaudi site offers:

- 6 books on systems architecting,
- more than 10 courses on systems architecting,
- examples from a wide variety of domains, including healthcare, lithography equipment, and energy,
- about 90 publications, ~200 whitepapers, more than 360 presentations, and more than 45 course modules.

The site has a steady amount of readers with 1.3 million pdf downloads over 20 years. The most read papers and books have more than 25.000 downloads per paper or book.

During the past 20 years in research and academia, I have been teaching at universities at bachelor, master, and postgraduate levels. I also have been teaching open-enrollment and in-company courses for industry.

In 1999, I offered the Center of Technical Training at Philips a one-week course in Systems Architecting. This course was and is unique; Dana Bredemeyer and Ruth Malan [1] teach the most closely related courses, while Systems Engineering courses tend to focus more on processes. I have taught this course many times. It evolved into today's SESA Systems Architecting course as elective in the master program. In 2011, I transformed the course material in the book Systems Architecting; a Business Perspective, see [2]. Many other teachers are teaching this course in the Netherlands; see [3].

In 2004, I did my PhD at the University of Delft in Technology and Policy Management, transforming 25 years of industrial experience into a PhD thesis [4]. The PhD thesis elaborates the CAFCR model. CAFCR helps in relating the customer value proposition, the business and life cycle proposition, the system specification, and the design and technology of the system. It builds upon Quality Function Deployment, TRIZ, agile, and more methodologies. The PhD thesis forms the foundation for the Conceptual Modeling course.

In 2006, USN started the systems engineering master program by using the systems engineering master program from Stevens Institute of Technology (SIT) in Hoboken, NJ, USA. Teachers from SIT came to Kongsberg for a week to teach their course. The first generations of students got a SIT master's degree or a dual degree from SIT and HiBu.

Since 2008, Merete Ræstad, Rolf Qvenild, Gunnar Berge, Halvor Austena, Silja Sverreson and myself, have invented the industry master program as educational concept for systems engineering. We transformed the original American program into a Norwegian master degree program. We have been developing the program model over the years, where my contributions have been the industry-as-laboratory master project approach, the reflective practice workshops, and the relation between the courses and industrial practice, e.g. via case-based teaching.

Reflective Practice is at the core of the industry master approach. Based on the initial ideas of Merete Ræstad, who did her PhD on this development, I build a set of workshops that gradually expand in scope, following the desired experience path of students. In practice, each workshop nudges students into a broader scope. The course design weaves integrating competences, such as reflection and learning, critical thinking, communication, and academic writing through the sequence of workshops. I developed the pedagogic model, building on my experiences as facilitator and teacher. Over the years, I evolved the course, especially stimulating students to reach out to colleagues and other stakeholders.

Since 2008, Jamal Safi and I teach Systems Engineering to engineering students; see [5]. Initially we taught at the third year mechanical engineering. A few years later, we expanded the course to a 10 ECTS course for all engineering students in the second year. Purpose of this

course is to broaden the students, making them aware of the system perspective, and preparing them for their bachelor project in the third year. Core of this course is that students work in somewhat larger teams (5 to 10 students) on a case.

We got accreditation for the industry master program in 2009, and a few years later for a 90 ECTS experience based variant. Together we have shaped the Systems Engineering Master Degree into a highly successful master program with a strong industrial relation, which is unique in Norway, Europe, and the world. The strong link between education and practice, through the organizational model, the industrial partnerships, and the pedagogic model differentiates this program from other full-time and part-time programs.

My wife got breast cancer in 2013. After full treatment for one year, she gradually recovered. In 2017, she got another type of cancer, and she died in March 2018. In the same period, the mergers with Høgskolen Vestfold and later Høgskolen Telemark took place. These were additional disruptions, causing many organizational changes and pulling attention away from students and industrial partners. This combination of factors made the period from fall 2013 until spring 2018 very stressful. In my opinion, we made less progress than desired in this period.

Since 2018, I am formally the program coordinator for the Systems Engineering Master Program at USN. I have been the driving force behind the program since 2008, however, without being the formal program coordinator. We published the industry master model in University Industry Innovation Network (UIIN) 2018 conference; see [6] (=appendix 1). The Kunnskapsdepartementet highly appreciates the model and likes USN to extend it to other study programs, see [7]. These efforts culminated in winning the Utdanningskvalitetsprisen for høyere utdanning in 2019, see [8].

The systems engineering field as a professional competence is quite young. The international professional society INCOSE was founded in 1990. Academic education started to grow in the beginning of the millennium. Consequently, there are few professionals with formal academic education and the body of knowledge is still heavily practice based and in need of academic scrutiny.

Main challenge for systems engineering in Kongsberg is to grow from zero academic staff members in 2007 into a fully functional academic group. We are working with a relatively large group of part-time teachers, which allows us to cover a broad set of topics. Last few years, we have been building a core team of full-time academic staff at Kongsberg, complementing the part-time staff. Next phase is the development of PhD capabilities. The program currently has 4 full-time and 10 part-time educators, and 2 PhD students.

The exploratory and scientific approach to teaching and learning

During my entire teaching carrier, I have been actively evolving the way of teaching. I have published the pedagogic side of teaching in 10 publications; see [9]. Many of these papers discuss the use of case-based learning.

Core to my way of teaching is the need to get participants actively involved. The design of in-class assignments, often using a case, is crucial; see Figure 1. Most courses are built around

the flow of assignments. Outside the class, participants work on a case. Working on the case with regular feedback from the educator is an integral part of the learning.

Many academics with a science or engineering background may benefit from social skill development to become more effective in their jobs. In many organizations, I observe a gap between managers and scientists or engineers. Managers blame the lack of social skills as cause for this gap. Adding the psychosocial perspective is helpful for systems engineers; most problems they need to solve are not technical, but psychosocial, political or cultural. My wife was psychosocial therapist. Her profession and her coaching greatly influenced my carrier. She inspired and supported my successive carrier changes, which were relatively disruptive changes. In 2016, we co-authored a paper for SoSE [10] on the impact of the workshop communication, and especially the non-verbal communication on the students.

Part of the original Stevens Institute's quality control system is a systematic evaluation using course feedback forms. These course feedback forms have 16 Likert scale questions and a few open questions. We have continued this way of working, allowing us to monitor the quality systematically. SIT uses the Net Promotor Score as evaluation criterion for 2 of the 16 questions; 1 about course and 1 about teacher. We want a positive NPS score for these questions; a negative NPS score indicates that we need to improve. An example of such feedback is in appendix 2, my most recent course at USN.

In the courses I am teaching, I use several monitoring techniques besides the standardized evaluation of the course week. We keep class sizes below 26 students, where optimal class size in my experience is 12 to 16 students. In most editions, I am experimenting with course material and pedagogic format. Direct observation, the 2 to 3 presentations per day per team, and daily simple benefit and concern feedback help to see the effect of changes on the students' appreciation, engagement, and learning. The students clearly appreciate the course, despite the fact that I am continuously stretching them and pulling them out of their comfort zone, see for example Appendix 2.

Figure 1 shows a collection of photos of courses and workshops illustrating the case-based learning approach.

Figure 1. Typical classroom settings

We strive for publication of course results and master project results. The publication [11] (=appendix 3) provides an analysis of published master project results. We publish 23% of the industry master results (37 papers of 164 master projects in 10 years; I supervised 22 of these published papers). Two students won the INCOSE Brian Mar best student paper award at the INCOSE international symposium, the major systems engineering event in the world, with me as (co)supervisor; their papers can be found at [12] and [13] (attached as appendix 4).

An example of a Conceptual Modeling (SEMA) course result that we published is appendix 5. We use the results of this paper regularly in new editions of the SEMA course, but also in in-company courses and in the Reflective Practice workshops.

As a senior research fellow at TNO, we have transformed 3 courses (Architecting for Business Value, Architecting System Performance, and System Integration) into blended courses. For the first course, we closely cooperated with a learning and development expert, who emphasized the need for instructional design. In the later courses, we benefitted from a new in-house learning and development expert. We redesigned existing material such that online “nuggets” are about 6 minutes, which according to literature is optimal from attention perspective.

These courses use an online learning platform with videos and questions for an initial phase. Second phase is a face-to-face workshop, which can fully focus on the interaction, since the theory is part of the online learning. The third phase is an online closure with room for final reflection. We use these courses with industry. One of the benefits for industry is that this form requires less traveling than traditional course formats. The paper [14] provides an evaluation of the blended learning.

Contribution within the academic community as well as the institution’s work on educational quality

I have been part of the original Systems Engineering program accreditation process in 2008 and 2009 (then HiBu), the audit of the program in 2016 (then HSN), and the current program monitoring via course and program definitions, evaluations, and reports, and monitoring meetings with students (programutvalg). We also have regular meetings with our industrial partners, which play a crucial role in our industry master format. We meet the industry as strategic level (Industry Advisory Board (IAB)), tactical level (Reference Group (RG)), and operational (Human Resource Forum (HR)). I participate in the IAB meetings, and play a leading role in the RG meetings.

Since the relation with industrial partners is so important for our pedagogic model, we initiated several networking events, where practitioners, alumni, our students, and our staff meet in an informal setting. These events also serve to stimulate our alumni to refresh themselves and to stay in contact with their peers. We facilitate the events similar to our course pedagogic model. We have brief presentations, and then encourage interaction in breakout teams of 4 to 5 participants. In this way, participation is active and inclusive to all participants through the small breakout teams.

We run the Kongsberg Systems Engineering Event (KSEE [15]) every year in June. The Systems Engineering Study Group (SESG [16]) complements the KSEE and runs in the early spring and the late fall. We also run the Systems Architecting Forum (SAF) twice per year, an international meeting of leading architects in industry (see [17]). I am the driving force behind all three events for more than 10 years.

Through my academic network, I have been member of committees for selecting a professor, reviewing of research proposals, auditing of new master program, auditing of a research program, and many PhD defense events, in Scandinavia, the Netherlands, and the United Kingdom. I am associate editor of Wiley's Journal Systems Engineering. I was program co-chair of the Systems of Systems Engineering (SoSE) conference in 2016 in Kongsberg. These international contexts provide a frame of reference of what is happening in the world, putting our own program into perspective

We have many challenges in the strategic development of the systems engineering discipline at USN. The external world is changing fast, which requires us to adapt the program to fit new needs. Examples are the fast increasing digitalization and the sustainability transition. These external trends affect the systems engineering competence (what do our students need to learn) as well as the pedagogic formats (how do we help our students to develop). I am leading workshops and discussions in our academic staff and with our industrial partners about these developments and the way that our program may respond to them.

Examples of this adaptation process are:

- Discussions with the Industrial advisory board, Reference group, and the academic staff about digitalization and sustainability and the impact on competence needs,
- SESG with digitalization as topic and KSEE 2019 with autonomy and KSEE 2020 with sustainability as topic,
- A new course in Renewable Energy starting in Spring 2020,
- 6 master projects in Spring 2020 in sustainability and 11 master projects related to digitalization,
- Using a sustainability and digitalization related case in the bachelor course systems engineering, and
- Starting to build a network of parties interested in research in these topics.

My specific competence

Systems engineering is a broad field, covering administrative practices, governance and management, life cycle, and technical and analytical aspects. Within this broad field, my passion is *systems architecting* and *conceptual modeling*. Systems architecting entails the understanding of the context, e.g. what do customers need, where will the solution operate, and relating that to potential solution to guide development of such solution. The ultimate goal is to achieve solutions that are fit-for-purpose.

A main challenge for systems architecting is coping with complex problems in complex contexts, with developments created in complex organizations. On top of that, we have to cope with

aspects we are uncertain about, do not know (unknowns), or aspects that are ambiguous and fast changing. Altogether, we have a challenge to cope mentally with all these factors; the main instrument that architects use in coping with that are conceptual models. Conceptual models are simplified representations of reality capturing crucial relations, functions, and behavior. Conceptual models are a mix of diagrams, formulas, graphs, numbers, and other visualizations. Proficient architects seem to create and use such models seemingly without effort. How can we help younger people to develop similar capabilities?

After 20 years working with such conceptual models as systems architect, I transitioned from practitioner into researcher and educator. This transition triggered several additional related interests:

- How to research architecting and conceptual modeling? How to assess its effectiveness in its complex context? How to distinguish the contributions of methods and techniques from the researchers researching them and from the competence of the organizations and individuals applying them?
- How to help individuals and organizations in developing this competence?

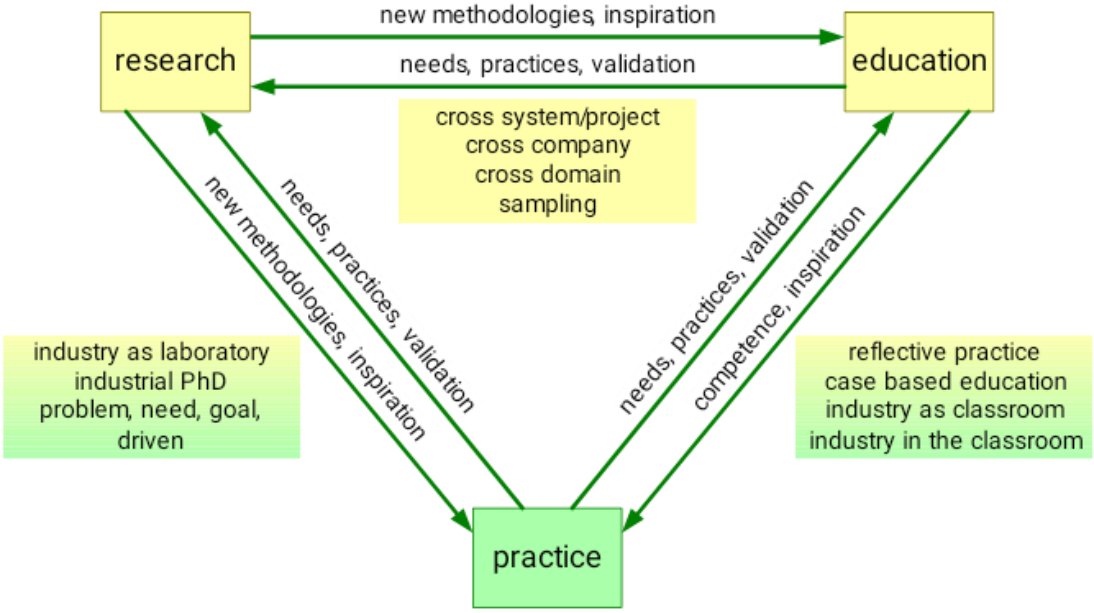

Figure 2. How research, practice, and education mutually reinforce each other.

Over the years, I have developed a way of working where research, practice, and education mutually reinforce each other; see Figure 2. Colin Potts' paper [18] inspired the use of industry as laboratory. We gradually developed the other connections. Many of my publications (see [19]) combine 2 or 3 of these corners.

My strength is to align multiple interests, e.g. to use teaching for research, to use consulting for teaching, to use research for competence development, etc. The trick is to be insatiably curious, to continuously wonder, and reflect. That is what I try to develop in anyone. The systems engineering program at USN has a number of concrete elements for this purpose:

- We developed the industry master model, where students are working and studying concurrently over 3 years. The idea is that the work provides experiences that help in understanding the theory. Moreover, the work provides an environment to try out the theory.
- We developed the course Reflective Practice. This course consists of 9 workshops in 3 years. The course purpose is to help students in connecting theory and practice. See [20] (=appendix 7).
- We encourage the use of cases from practice, from their work situation, in the courses.
- We developed a master project model where students apply part of what they have learned in their own company and evaluate its effectiveness in practice.

The combination of these elements helps our students to connect theory and practice.

My passion for education

Inspired by the stakeholders' perspective as systems engineering is advocating it, I focus on the concerns, interests, and (latent) needs of the primary stakeholders. For education at the university these primary stakeholders are the students and their current and future employers (the customers), and the academic staff (the providers). Fitness-for-purpose of our education requires that:

- We understand these customers and their context. We have to understand what domain they work in, what kind of systems they work with, what processes they use, and what drives their business. Hence, we need to engage in many ways with our industrial partners, so that we have an actual understanding of our students' working context. We achieve this by organizing KSEE, SESG, SAF, and by meeting partners at IAB, RG, HR, seminars, and company visits.
- We see and treat each student as individual. A significant challenge is to balance the prime need to help them to develop, while we also have the role to assess and grade them fairly and objectively. We achieve this by (inter)active teaching, providing frequent and to the point feedback, and by listening and taking all students serious. Students and colleagues know that they will get fast to very fast response from me. Fast response provides students with fast learning.
- We develop the discipline and pedagogic competence of the academic staff. The quality of the education depends directly on the quality of the academic staff. We have regular workshops and informal gatherings, where I am especially emphasizing the need to transform from "lecturing" to "interacting".

The combination of proficiency in and passion for course topics as well as the thorough pedagogic interaction results in a passionate way of teaching that engages the students. Seeing the students growing is the greatest award and energy provider for me.

Documentation of roles and responsibilities

I am professor at USN since 2008; I am program coordinator since 2018.

Informally, I have been the academic lead in systems engineering since 2008.

As professor, I am teaching at USN, the following master courses yearly:

- Systems Architecting (elective in fall semester)
- Conceptual Modeling (elective in spring semester)
- Research Methods (mandatory for Indok/ITM master with systems engineering, co-teaching in fall semester)
- Reflective Practice (mandatory, 9 workshops in 3 years, 3 cohorts concurrently)
- Master Projects (coordination of master projects, preparation with students, e.g. topic selection, supervisor and external assessor allocation)

I am teaching a small part (4 half days) of the bachelor course in systems engineering.

At USN, I am coaching colleagues and facilitating meetings and workshops within systems engineering. I am teaching several brief in-company courses per year for USN, typically ca 10 days per year At ESI, I am teaching various in-company courses, typically ca 20 days per year. I am teacher and coach for ESI employees internally.

I have developed the following courses:

C.1 Systems Architecting (SESA)
C.2 Architectural Reasoning using Conceptual Modeling (SEMA)
C.3 Reflective Practice (SERP)
C.4 Systems Engineering Master Project (SEMP, SETH)
C.5 Systems Engineering Research Methods (SERM)
C.6 Architecting Systems Performance (blended course)
C.7 Architecting Business Value (blended course)
C.8 Systems Integration (blended course)
C.9 Execution Architecture (retired)
C.10 Modeling and Analysis (retired)
C.11 Platforms and Evolvability
C.12 Bachelor course Systems Engineering, the systems architecting part
C.13 Computer Architecture (retired)
C.14 Introduction to Systems Engineering (in several formats, from 2 hours to 5 days)
C.15 Tutorial Software as Integrating Technology in Complex Systems INCOSE 2005
C.16 Tutorial Measuring and Modeling System Performance, INCOSE 2008
C.17 Tutorial Human Side of Systems Architecting INCOSE 2009
C.18 Tutorial Roadmapping for Strategy Support INCOSE 2010
C.19 Tutorial Architectural Reasoning Using Conceptual Modeling INCOSE 2015
C.20 New Energy Systems (SENE, first edition in March 2020)

And many variants of C.1 and C.2 for Professional Doctorate in Engineering (PDeng) in Technical Automation, PDeng automotive, and master in Embedded Systems at Eindhoven University, master Ship Design in Aalesund, and for a wide variety of in-company courses.

I have been teaching:

- at the following companies Philips, ASML, Signify, Oce, Thales, NXP, NeoPost, Thermo-Fischer, Ultimaker, Stork, Nokia, Zeiss, Kongsberg Gruppen, Semcon, TechnipFMC,

Dresser-Rand, Samsung, VanderLande, BD bioscience, St Jude Medical, Roche, and Barco.
- in the following countries: the Netherlands, Norway, Belgium, Finland, Germany, USA, China, South-Korea, Singapore, and India.
- in the following domains: health care, production and measuring equipment, consumer electronics, telecommunications, defense and aerospace, maritime and offshore, and lighting.

The variation of companies, domains, and geographic locations is helping me to have a rich understanding of the industrial context. It provides me with a frame of reference in any course that I am teaching. As educator, I learn from each course that I teach.

Various publications (scientific and other)

3 books, 15 book chapters, 8 journal papers, 77 Conference papers, ~200 papers and 9 books at gaudisite.nl, and 18 papers at architectingforum.org/whitepapers.shtml.

See appendix 11 for the formal publications.

Curriculum and subject evaluations

Appendix 8 is the final report of the 2016 SE program audit, showing the approval of the auditors of the program. Appendix 9 is one of the inputs to the audit, showing the students' appreciation for the SE program as a whole. Appendix 2 shows the specific evaluation for one of my courses.

Results from the "Studiebarometeret"

Appendix 10 shows the results for 2018, which in general are quite positive about the program as a whole.

Peer evaluations; two quotes from the INCOSE Fellows Letter of Support

Dinesh Verma (professor at Stevens Institute of Technology, Hoboken, NJ) and Director of the Systems Engineering Research Center (Washington DC):

> "I do not know of anybody who does this better – link their experience as a practitioner/technical leader into a role as a transformative teacher and applied researcher in the field of systems architecting – than Dr. Gerrit Muller. His impact is visible in substantive ways all over the high-tech industry in the Netherlands, and in the high-tech industry in Norway, where he currently heads the most important graduate program in Norway. Gerrit is a very strong, authentic, and impactful representative for our field on the global scene, with his active engagement within the systems engineering community. I consider him one of the 10 most influential educators globally in our field.
>
> I have had the pleasure of teaching with him, and of watching him teach in a variety of global contexts – US, Europe, Asia – and he is able to mold his message to the context, engage the students, and change mental models in the way he teaches informed by his industrial experience. "

Ger Schoeber (chairman INCOSE Nederland, teacher at High Tech Systems Institute, Manager Innovation & Technology at Hotraco):

> "… Gerrit continued in creating a complete training program called System Architect[ing], which zooms in on the role, task, responsibilities and activities of the System Architect and how the System Architect does his work in high tech industrial organizations. This training has evolved into a very valuable and very popular training in the Dutch industry, and more and more spread over industries in Europe and all over the world. Gerrit Muller produced a huge amount of content regarding this subjects, which he uses, maintains and makes available via his website: www.gaudisite.nl.
>
> I was one of the lucky guys who had the opportunity to take part in one of the training sessions in the early „00s. In 2002, Gerrit helped me to become a teacher myself for his training and since then I am frequently involved as one of the teachers of this training in various variations, from Systems Architecting to Conceptual Modeling. Nowadays I am teaching the training myself about 4-8 times a year.
>
> … Gerrit is one of the few guys in the world who are able to translate complex technical/engineering messages in information that is easily understood not only by Engineers, but also by Management and External Stakeholders."

Participation and presentations at conferences/courses/other forums

Besides presentation of conference publications, I do 4 to 6 other presentations per year at conferences, workshops, special interest groups, seminars, guest lectures, and companies.

Formal pedagogical qualifications

None, I am completely autodidact. However, by reflection, reading, researching, and interactions and collaboration with a wide variety of colleagues, I have a good understanding of today's state of pedagogy. Examples are the use of constructive alignment (Biggs and Tang 2011 [21]), and authentic student achievement (Newmann and Wehlage 1993 [22])

Learning materials you have developed individually or in collaboration with others

I have (co)developed all material for the courses C1 to C20. All material is publicly available at gaudisite.nl. ESI owns the blended course material. A few videos are publicly accessible:

Introduction
Business Context
Architect - Way of Working

Each course has 20 to 25 video nuggets of about 5 minutes per nugget. ESI and a professional video producer facilitated the production of these videos.

Departmental association and applicability

USN has formulated applied research in close cooperation with industry as one of its strategic objectives. USN recognizes how well the industry master format fits in this ambition. I have been

participating and facilitating several Industry Academy meetings to help USN in propagating this model.

USN is exploring several directions for future education and research, such as the sustainability transition (input to the development of the Innovation and technology Management (ITM) master), autonomy, and big data. In our SE staff workshop, we address these directions; see Figure 3, where all these explorations are part of the landscape that we discussed.

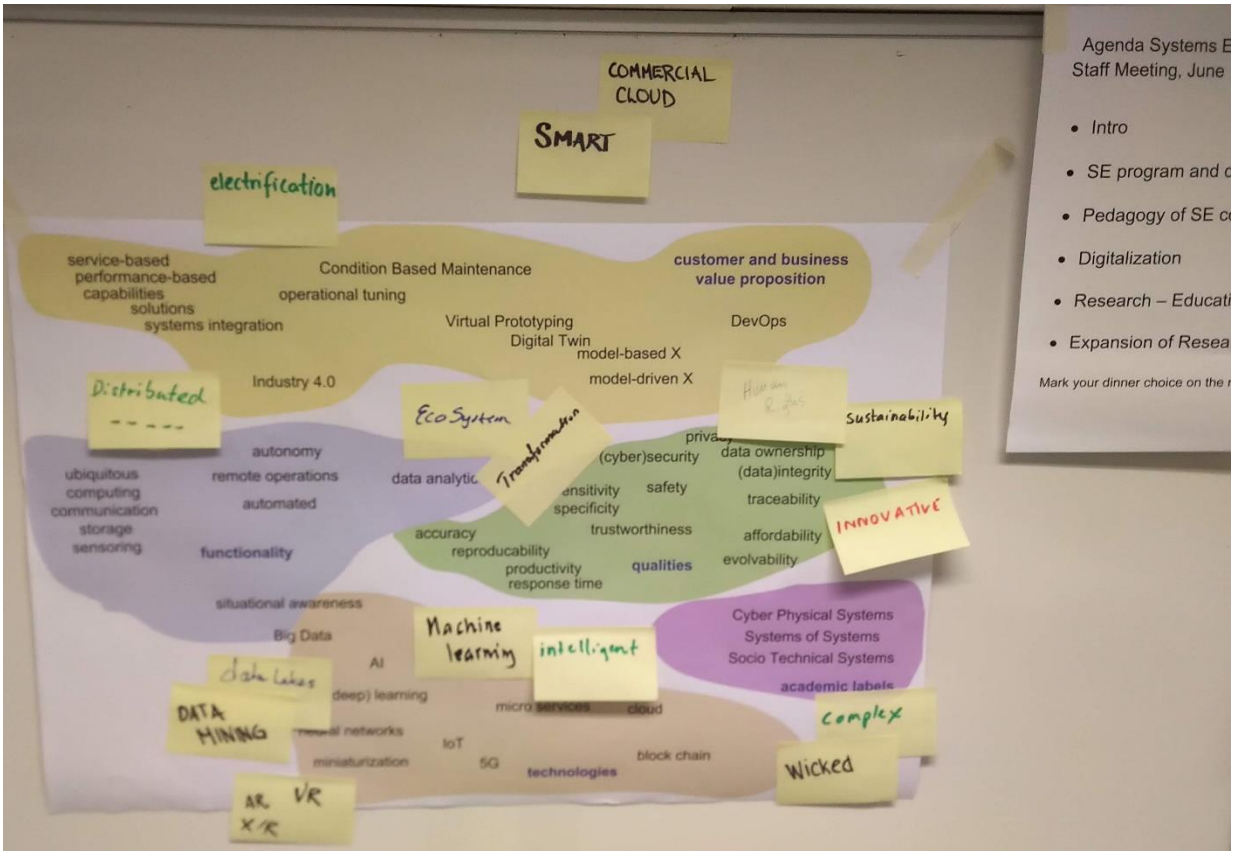

Figure 3. The spring 2019 academic staff workshop, discussion of the digitalization cloud

We used the same cloud in the RG summer meeting, to understand the industrial perspective on digitalization. We used KSEE 2019 to dig further in these topics, facilitated by 8 presentations on autonomy and digital twins. Tentative conclusion is that we need to evolve many courses to cope properly with digitalization. We are looking into the option to have a digitalization, computer science, or autonomy minor (30 ECTS).

In the spring 2019 academic staff meeting, we also worked through the current pedagogic models of various courses, and ways to make these courses more interactive, see Figure 4.

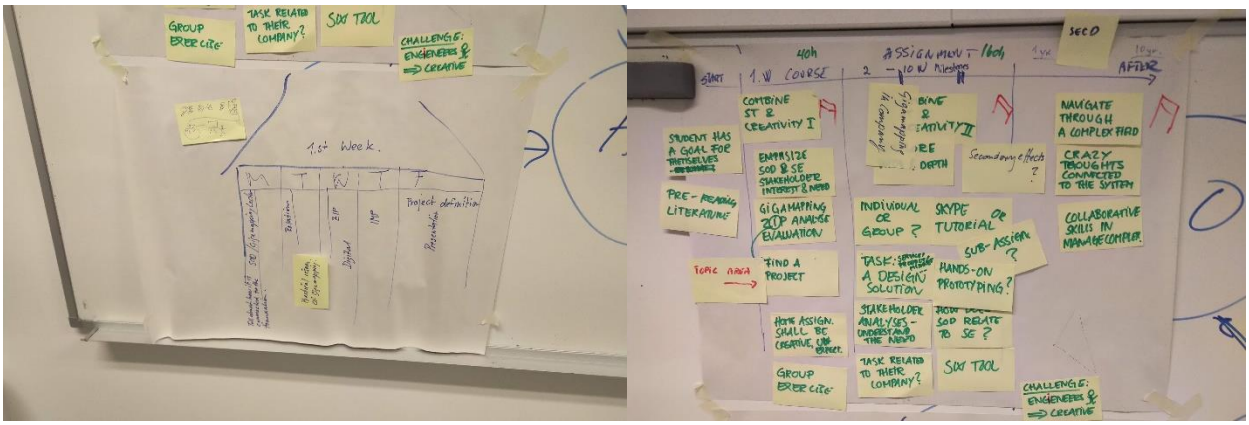

Figure 4. Discussing the pedagogic flow of courses to see how we can improve the interactivity.

The next topic in that spring 2019 workshop was the research agenda and the relation between the research and education. As university, we need to ensure that the education is research-based. Hence, alignment between research and education is essential. In the bootstrapping process of the research, it is in addition important to build the research such that it can profit from the educational strength. A research agenda is a practical instrument to achieve focus and alignment between research, partner needs, and education. Next step is to create a multi-layer roadmap together with the partners. In a workshop in October 2019, we have explored the roadmap creation by looking at visualization of dynamic behavior. In this workshop, we had industrial and academic participants. The plan is to transform the workshop insights, see Figure 5, into a whitepaper (for industry) and a publication (for academia).

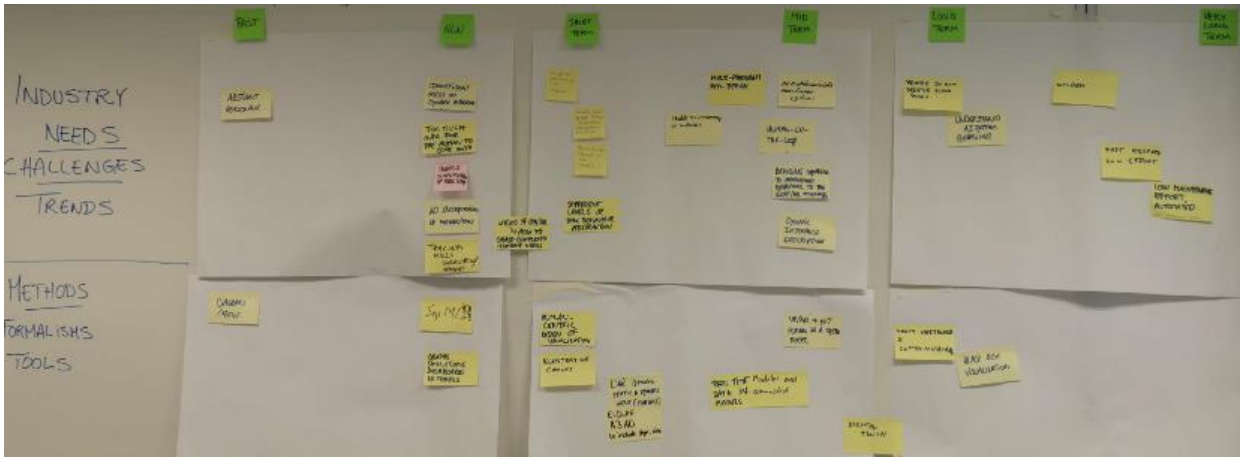

Figure 5. Result of the roadmap discussion at the workshop Visualization of Dynamic Behavior

References and links

[1] http://bredemeyer.com/

[2] https://gaudisite.nl/SABP.html

[3] https://www.hightechinstitute.nl/en/training/system/training_system_architecting/

[4] https://gaudisite.nl/ThesisBook.pdf

[5] https://gaudisite.nl/INCOSE2013_Muller_Bonnema_TeachingSEundergraduate.pdf

[6] https://gaudisite.nl/UIIN2018_Muller_Naess_Sverreson_IndustryMaster.pdf

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