SWISS SYSTEMS ENGINEERING DAY

SWISSED21

THE ESSENCE OF SE

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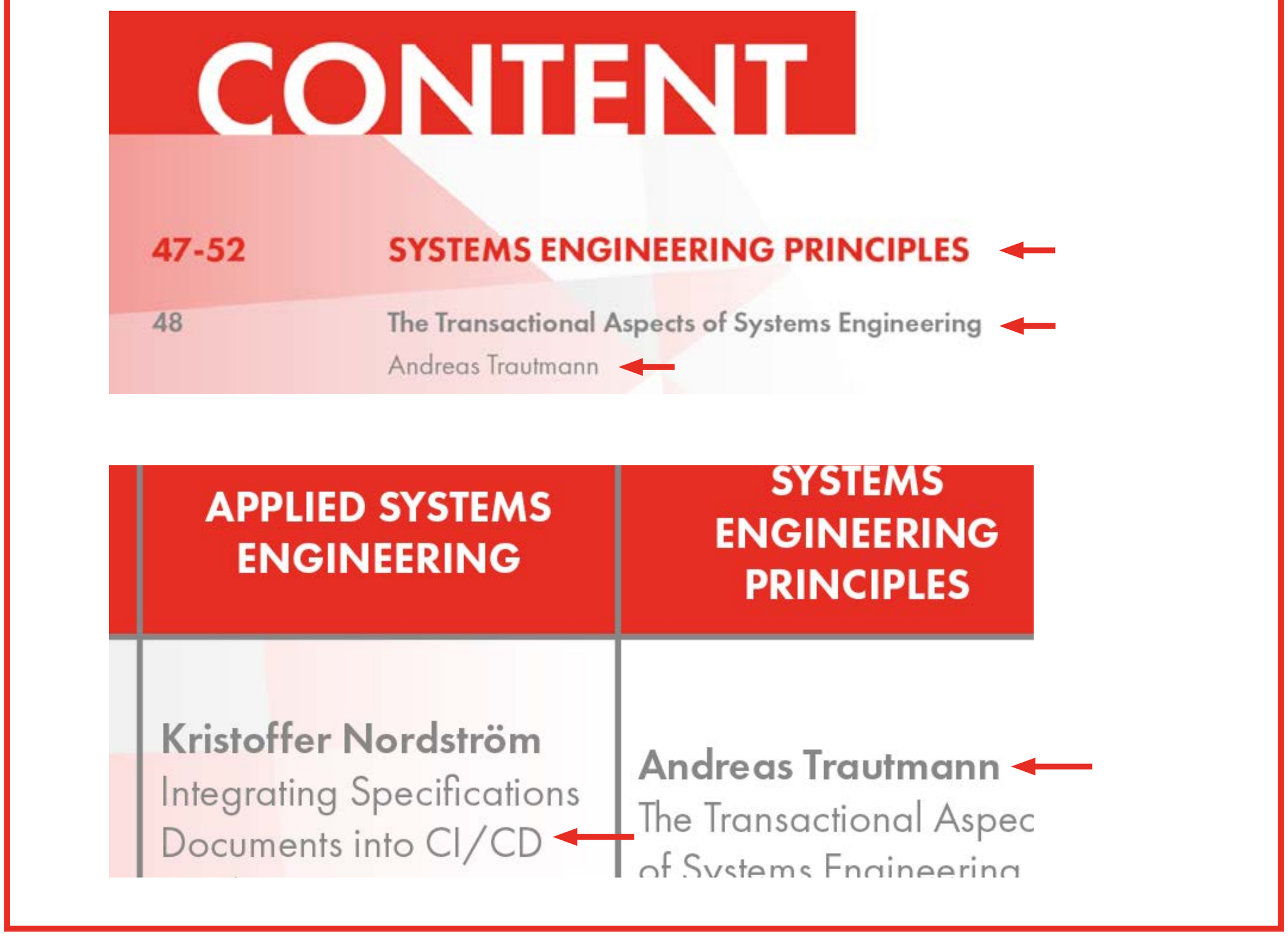

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ABOUT SWISSED

SWISSED20 is the 8th annual symposium of the Swiss Society of Systems Engineering (SSSE). SSSE acts as the Swiss Chapter of the International Council on Systems Engineering (INCOSE).

This one-day event brings together first-class presenters and practitioners, to share knowledge and experience on how to plan, develop and manage systems in an efficient and successful way.

This year, our conference will be run as an in-person event in Zürich, with virtual attendance and live streaming also made possible for those who cannot attend physically due to constraints presented by COVID-19.

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PROGRAMME

Morning Schedule

TIME	STREAM 1	STREAM 2	STREAM 3
8:00	Doors Open and Registration		
8:45	**WELCOME**		
8.55	**Keynote Presentation: The PLM-Driven SE as a Service** Presented by Lars Hagge		
STREAM	**CLIMATE**	**APPLIED SYSTEMS ENGINEERING**	**SYSTEMS ENGINEERING PRINCIPLES**
9:55	**Marco Di Maio and Tim Weilkiens** Tackling Climate Change: A Systems Engineering Perspective	**Kristoffer Nordström** Integrating Specifications Documents into CI/CD Pipelines	**Andreas Trautmann** The Transactional Aspects of Systems Engineering
10:25	**Marco Di Maio and Tim Weilkiens** **Workshop:** Tackling Climate Change: A Systems Engineering Perspective	**Markus Schacher *et al.*** The Magic SE Cube	**Marc Andre Chavy-Macdonald** A New Platform for Innovating System Design: the Concurrent Design & Data Facility (CD2F)
10:55	**REFRESHMENTS**		
STREAM	**CLIMATE**	**APPLIED SYSTEMS ENGINEERING**	**MODEL-BASED SYSTEMS ENGINEERING**
11:15	**Hubertus Ulmer and Frederic Brinkmann** Systems Engineering for eMobility Commercial Vehicles	**Martin Oswald** A Snapshot from The Introduction of Systems Engineering in Industry	**Jinzhi Lu** Design Ontology Supporting Model-Based Systems Engineering Formalisms
11:45	**Moritz Hübel** Optimisation of a Multi-Energy System with Hydrogen Producer and Consumer	**Ivo Locher** Learning from Medical Device Start-Ups Consulting: Why We Should Embrace Systems Engineering!	**Freddy Kamdem Simo** Some Lessons Drawn from Systems Engineering
12:15 - 13:30	**LUNCH**		

PROGRAMME

Afternoon Schedule

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13:45	**Keynote Presentation: Accelerating Product Development: Is the V-Model Still the Answer?** Presented by Alessandro Golkar		
STREAM	**MODEL-BASED SYSTEMS ENGINEERING**	**APPLIED SYSTEMS ENGINEERING**	**ARCHITECTURE**
14:45	**Tim Weilkiens** SysML v2 Update and Practice with a Special Focus in Variant Modelling	**Martin Hoppe** We Are Too Small for (MB)SE!?	**Philip James Donovan** Design Assurance of Safety and Mission-Critical Systems with Open System Architectures
15:15	**Simon Hamel** Lessons Learned from MBSE at ClearSpace	**Sten Grüner** Incremental Migration of Software Product Line Engineering in Conjunction with System Modelling	**Gilles Defo** System-Architecture Engineering
15:45	**REFRESHMENTS**		
STREAM	**MODEL BASED SYSTEMS ENGINEERING**	**SYSTEMS ENGINEERING PRINCIPLES**	**ARCHITECTURE**
16:05	**Konrad Wieland and Daniel Lehner** Sustainable Development and Management of Systems Engineering Models	**David Endler** The Answer Cannot Always Be “Well, It Depends...”	**Anne-Marlene Rüede** An Overview of Systems Architecting Approaches
16:35	**Susan Faust** Model-Based Systems Engineering - Or ‘How I Can Pack My Suitcase’	**Colin Hood and Marco Di Maio** Teaching Systems Engineering to Undergraduates - a Complex Issue?	
17:05	**CLOSING**		
17:20	**Apéro**		

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KEY NOTE PRESENTATIONS

Lars Hagge

Alessandro Golkar

The PLM-Driven SE as a Service

KEYNOTE

Lars Hagge
DESY

Systems Engineering (SE) and Product Lifecycle Management (PLM) help guiding the evolution of engineering processes. They are combining and fueling each other well, with SE emphasizing the multi-disciplinary engineering of complex systems, and PLM offering mature methods and tools for digitizing processes and information in the product lifecycle.

Traditionally, mechanical engineering enjoys a major role in the construction of large facilities, as it develops the physical, tangible parts of the solution and provides early visualization of planned systems. Electrical, automation, civil and general infrastructures then incorporate their contributions into the mechanical facility. Systems Engineering offers a broader perspective on interdisciplinary engineering. It concentrates on aligning and integrating the engineering necessities of the various trades in parallel, providing systematic holistic approaches to requirements, architecture, validation, etc.

But this inter-disciplinary engineering collaboration also needs to be organized. Where SE addresses engineering lifecycle at a generic level, PLM complements mature frameworks for digital processes and product information at an industrial scale. PLM...

provides an effective and reliable foundation for implementing Systems Engineering, a powerful driver for coordinating work, tracking progress, reviewing and approving deliverables, and managing change.

Yet this powerful combination of engineering methods and tools also needs to be brought into practical operation. And despite a plethora of expert consultants, generating acceptance at shop floors for novel procedures remains a serious challenge. Training, coaching and lectures alone do not mark the road to success, people are best convinced by direct services and measurable benefits to their project.

The presentation shares examples and experiences from a steadily growing introduction of SE and PLM practices in the engineering of ever more highly complex large-scale research infrastructures at DESY (Deutsches Elektronen-Synchrotron, Hamburg), one of the world's leading research centers for developing and operating particle accelerators for the decoding of structures and processes of the microcosm.

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Accelerating Product Development

Is the V-Model still the answer?

KEYNOTE

Alessandro Golkar

Skoltech Faculty, Moscow

The V-Model is a consolidated paradigm in structuring and managing the lifecycle of complex systems. Nevertheless, we now live in a digital world where product development has substantially accelerated, especially in highly competitive markets. In order to address these new challenges, engineering teams around the world are experimenting with new Agile approaches in their system development projects. In a certain sense, Agile is at odds with the established practice of rigorous configuration control and structured V-model development processes.

If Agile is indeed effective in developing new products, does it mean that we are departing from the established paradigm of the V-model, or does it mean instead that we are facing new challenges, for which new approaches are required? The answer in my opinion is not obvious. The V-model is not “dead”, and Agile is not a panacea either.

In this keynote speech we will try to shed some light on the question, and propose an analysis of the issue on whether Agile is an effective product development approach, and under which conditions, using the method of scientific research. We will...

compare Agile Scrum with the V-Model, and discuss the conditions under which one paradigm has higher chances of prevailing over the other in terms of effectiveness, cost, and development schedule. We make the case for analyzing the architecture and fundamental nature of the project as key activities to define an efficient product development process.

The goal of the speech will be to circulate new ideas among the systems engineering community, with the intent of fostering dialogue around a topic of prime importance nowadays, as we are facing key challenges with accelerated product developments, in uncertain and evolving environments.

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APPLIED SYSTEMS ENGINEERING

Kristoffer Nordström
Ivo Locher
Martin Oswald
Markus Schacher *et al.*
Martin Hoppe
Sten Grüner

Integrating Specifications Documents into CI/CD Pipelines

APPLIED SYSTEMS ENGINEERING

Kristoffer Nordström
Systems Engineering Consultant

A solution is presented to collaboratively work on and track requirements, all while ensuring full transparency of the specification items' sources.

Furthermore, this solution ensures the traceability over all specification items. Verification and validation (V&V) activities are invalidated when requirements change, i.e. requirements traceability.

This can then be integrated into the CI/CD pipeline for agile development.

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Learnings From Medical Device Start-Ups Consulting

Why We Should Embrace Systems Engineering!

APPLIED SYSTEMS ENGINEERING

Ivo Locher
Konplan

Konplan organizes and moderates product development workshops for individual startup companies on a regular basis. The goal of such workshops is to elaborate a plan how translate the startup's idea into a product and how to bring it on the market successfully. On the technical side, systems engineering provides methods to obtain a holistic view and it plays a crucial role in the development of the right product. The presentation will point out several struggles of startups and potential approaches when confronted with specific investor requests, the demand of systematic engineering while still trying to demonstrate feasibility at the same time.

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A Snapshot from the Introduction of Systems Engineering in the Industry

APPLIED SYSTEMS ENGINEERING

Martin Oswald
Belimo Automation AG

For over 40 years, Belimo successfully focuses on the heating, ventilation, and air conditioning markets providing quality solutions that will increase energy efficiency and reduce installation cost. Our innovative products have always been designed to help achieve objectives better, faster, and more economically.

Belimo's business is that of a device manufacturer and offers sensors, valves and actuators. Thus, our products are system elements in a higher-level system of systems. With the introduction of Systems Engineering, we want to continue to ensure seamless integration of our solutions into the increasingly complex building control applications and be able to better manage the growing interdependencies within our product range.

One challenge is to define the systems engineering methods to fit the company and the culture, but what are the challenges and success factors in empowering a growing workforce to live...

... systems engineering?

The presentation will give you a snapshot of our journey of introducing systems engineering.

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The Magic SE Cube

APPLIED SYSTEMS ENGINEERING

Markus Schacher *et al.*

Behnaz Rouhparvar, Daniel Bommer, Marco Di Maio, Marco Chicherio,
Michael Thalmann, René Auf der Maur, Rolf Claude, Simon Hofmann, Rolf Gubser

Systems Engineering Group Zürich (SEGZ)

Running a business successfully today doesn't imply running the same business successfully in future. Companies may be unaware of emerging trends in their ever-changing environment and face a similar threats as the famous frog in the cooking pot.

The emerging trend of digitization within organizations leverages the rethinking and optimization of the current processes and to consider the whole lifecycle of industrial products. This enables the organisation to integrating a Model Based Systems Engineering (MBSE) approach to stay successful in the future and to deal with the increasing demands of customers. However, introducing such a comprehensive new approach to a proven industrial company doing its business successfully for years, may impose substantial challenges. It requires a shared vision, adequate skills, a new culture as well as adequate tools.

In 2020, the Systems Engineering Group Zürich (SEGZ), consisting of members from various diverse industrial companies, started the development of the "Magic SE Cube" - a framework to systematically introduce MBSE to traditional industrial companies to take advantage of new ways of thinking such as...

... Digital Twins or Digital Threads. This makes companies ready for the future and enables people to focus on the real engineering challenges.

The development of the "Magic SE Cube" is a continuous process and at the SWISSED 21 we would like to share our insights so far with you and engage you in a lively discussion!

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We Are Too Small for (MB)SE?!

APPLIED SYSTEMS ENGINEERING

Martin Hoppe
INTIS GmbH

Systems engineering, including its model-based variants, is seen by many as a methodology for complex, and large-scale projects, e.g. in Aerospace and Defence, that is typically accompanied by highly formal processes and tons of additional documentation.

But is this really the case?

This presentation shines a torch on applying SE procedures in large- and small-scale projects and using an MBSE framework for a project in medium-sized company. Based on this, it seeks to discuss the following statements:

- Is Systems Engineering is a process model for physically large and complex projects (PLC) only?
- Does the application of Systems Engineering necessarily lead to a strong formalisation of the development process and would therefore not compatible with an agile approach?
- Will Systems Engineering always lead to a considerable increase in project documentation?

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Incremental Migration to Software Product Line Engineering in Conunction with System Modelling

APPLIED SYSTEMS ENGINEERING

Sten Grüner
ABB Corporate Research Germany

Current market developments demand industry to produce high quality tailored product variants while simultaneously coping with increased software and hardware complexity. Variant management by means of Software Product Line Engineering (SPLE) is a well-known approach for this challenge within the domain of Model Based Systems Engineering (MBSE). Currently, no step-wise migration process is available, allowing a co-existence of SPLE along with established development processes.

In this presentation, we present a methodology for a non-invasive introduction of SPLE within an agile development process. The methodology was evaluated in a real industrial development environment for low voltage drives. Drives are software-intensive real-time embedded systems, which firmware spans around few millions lines of code and is tightly coupled with electrical and...

mechanical system components. Additionally, we extend to scope from variant management and show how SPLE tools can be coupled with further MBSE modeling domains, e.g., system models expressed in SysML by means of tool connections and annotations with the system model.

Finally, we discuss expected benefits from the introduction of the sketched non-invasive introduction methodology and reflect on our lessons learns after completing first steps of the journey towards model-based variant management.

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ARCHITECTURE

Philip James Donovan

Gilles Defo

Anne-Marlene Rüede

Design Assurance of Safety and Mission-Critical Systems with Open System Architectures

ARCHITECTURE

Philip James Donovan
Diehl Aerospace

The latest generation of civil and military airborne systems use Open System Architectures to greatly increase flexibility and reduce the total cost of ownership for the acquirers of these complex systems. The next generation of airborne systems promises to follow this trend towards open system architectures in order to realise even greater flexibility and cost benefits. The use of Open System Architectures creates new challenges during the development lifecycle and necessitates new development processes for assuring their safe and reliable operation. In this presentation, Open System Architectures are characterised and their benefits discussed using real examples from the experience of the presenter in the Defence and Aerospace sector. The stakeholders involved in the development lifecycle for Open System Architectures are identified and a process for assuring the design of safe and reliable systems with open architectures is presented.

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Systems & Software Engineering

Architectures & Legacy Software Solutions

ARCHITECTURE

Gilles Defo
ALTEN Switzerland AG

In the world of Systems and Software Engineering, Design and Architecture (D&A) is a phase of the development process that does not only involve measurables using systematic analysis and tools based on mathematics and hard sciences, but rather also un-measurables, non-quantitative tools and guidelines based on practical experience. Here the latter are inductive processes that often are less or insufficiently treated like the first deductive (measurables) processes. This is mostly the case for small or large system development projects where increasing complexity can be challenging not only for projects without architecture engineering but also for well-established model-based system engineering projects.

This increasing complexity can be addressed with design approaches and strategies combining business, technology and policies views aspects to better address product needs and development during design phase.

While providing produce emergence as what we need...

architecture engineering for, the present contribution aims at supporting developing companies to master complexity, reuse components and parts, comply with regulations and guidelines, ensure overall system quality and stability while still covering strategic product innovations and alternatives.

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An Overview of Systems Architecting Approaches

ARCHITECTURE

Anne-Marlene Rüede
Ecole Polytechnique Fédérale de Lausanne (EPFL)

With the increasing complexity in systems designed, many different Systems Architecting approaches have been proposed. Choosing the right one is critical in maximising the efficiency of the designed systems. Indeed, most of the performance is captured in the conceptual design stage, and each method has its advantages and disadvantages. Therefore, some approaches are preferentially used in specific industries, based on the type of problem that needs solving.

However, few resources support designers choose an approach or understanding how their methods compare with others. This research aims at composing an overview of the different approaches used in Systems Architecting and in which industries they are respectively used. Leading Systems Architecting approaches are identified and illustrated using a standardised graphical code facilitating their reading, understanding, and comparison.

Finally, they are classified according to which design stages and type of problem they address. Furthermore, they are matched with tools typically used. After being presented with the preliminary conclusions matching industries with approaches looking at the design stage,...

... type of problem and tools, the audience will be asked to share which other factors they consider when choosing the methods with which they work in their respective industry. Composing a panorama of the different approaches used can provide systems architects with 1) visibility of approaches that may be beneficial, 2) understanding of strengths, weaknesses and typical usage of approaches, and 3) comparison of one's approach(s) with others. The outcomes of this presentation will be shared with the audience.

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CLIMATE

Marco Di Maio and Tim Weilkiens

Hubertus Ulmer and Frederic Brinkmann

Moritz Hübel

Tackling Climate Change

A Systems Engineering Perspective

CLIMATE

Marco Di Maio and Tim Weilkiens

Technische Hochschule Ingolstadt | oose Innovative Informatik eG

Climate Change is an unprecedented crisis for the planet, and we need to act fast! But it is a complex problem set in an even more complex environment making it such a fascinating, albeit enormous challenge! Luckily, more and more people, institutions, companies, and governments around the globe are working on solutions, many of them technological. The number of these engineering solutions is growing fast, featuring a broad selection of mechanisms to help revert the current trends in greenhouse gas accumulations in the atmosphere, and global warming in general.

Whatever the solution: It has to be developed for, and applied, tested, and evaluated within the complex contexts that are Earth's atmosphere, its climate, and the many wildly diverse socio-technical and -economic structures existing within it. Sound familiar? Isn't this the kind of problem that Systems Engineers are often claiming as "ours" to solve?

So let's discuss the wider SE perspective on tackling Climate Change:

- Can SE really help developing more sustainable solutions that have less negative impact on their environment?

- Can MBSE help to model the world's relationships and identify the direct (positive) impact of solutions as well as the indirect (positive or negative) impact

- What would be the modelling language for such an "SE World Model"? Are the promises of SysML2's interoperability a step in the right direction?

- Or is such a multi-discipline complexity beyond SE's comfort zone and MBSE's modelling capabilities?

Join us for a lively session to discuss hope, if nothing else!

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Systems Engineering for eMobility Commercial Vehicles

CLIMATE

Hubertus Ulmer and Frederic Brinkmann
IAV GmbH

The Commercial Vehicle industry is facing major changes. In awareness of climate change, global efforts are being made to achieve a clear reduction in greenhouse gas emissions. The European Union stipulates a fleet reduction in CO2 emissions of up to 30% by 2030. In this context it becomes clear, that alternative powertrain systems are essential in order to cope with the target. This implies not only a technological change, but more a transformation of our development culture. Especially eMobility system integration projects are characterized by a high degree of complexity and interconnection: various components from different supplier have to fit together in a holistic vehicle context. Additionally, knowledge of the supplier landscape for off-the-shelf components, an ISO26262 and ISO13489 compliant soft- and hardware architecture, E/E integration, a digital services portfolio as well as adopted verification & validation processes are mandatory.

In this context IAV created an own “Product Creation System” based on Systems Engineering Methods. Starting from scratch on a blank sheet of paper, the first system requirements and architecture concepts are the starting point for following tasks such as module...

development, integration testing, validation and eventually: homologation for the final use.

The proposed paper will give an insight in IAVs "Product Creation System" and the systems engineering process landscape, as well as a detailed presentation of a practical example: a fuel cell, e-axle and hydrogen tank integration into a future truck concept vehicle.

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Optimisation of a Multi-Energy System with Hydrogen Producer and Consumer

CLIMATE

Moritz Hübel
Modelon Deutschland GmbH

For the long-term success of the energy transition and for the protection of the climate, we need alternatives to fossil fuels. Hydrogen will play a key role in the global energy transition of the coming years and huge amounts of money are invested by governments globally to speed up this necessary development. Hydrogen produced in a climate-friendly way can significantly reduce CO2 emissions, particularly in industry and transport, where energy efficiency and the direct use of renewable based electricity are not sufficient.

We will present analysis solutions based on open standards to not only model and simulate various components of the Hydrogen Value Chain but also to optimise individual components for a variety of KPIs individually or as part of a complex system. The models can be applied across industries covering automotive, aerospace, energy and industrial process applications.

The Hydrogen value chain includes the production of both green...

(from renewables) or blue (steam reforming with carbon capture) Hydrogen production, the storage and distribution of Hydrogen as well as its utilisation for combustion, in fuel cells or as feed stock in the chemical process industry.

We present a software demo showing an optimisation workflow for a complex micro-grid, consisting of multiple energy producers (renewables, grid,) energy storage (E-battery, Hydrogen tanks), converters (fuel-cell, electrolyser, gen-set) and consumers. The application optimises operation and design of the microgrid system for minimal CO2 emissions and/or cost.

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MODEL-BASED SYSTEMS ENGINEERING

Konrad Wieland
Susan Faust
Tim Weilkiens
Jinzhi Lu
Simon Hamel
Freddy Kamdem Simo

Sustainable Development and Management of Systems Engineering Models

MODEL-BASED SYSTEMS ENGINEERING

Konrad Wieland and Daniel Lehner
LieberLieber Software GmbH

With the integration of physical and digital aspects of systems leading to Cyber-Physical Systems (CPS), the abilities but also the complexity of such systems increases. Therefore, more and more organizations rely on system models to create and manage their products on a more abstract level. This helps them cope with this complexity and achieve flexibility in product development, with the aim to create individualized products, following the slogan of “lot size 1”.

However, sustainability of such system models is usually neglected during development, evolution and management. As many organizations have established system models over several decades now, their models are of sizes that make manual sustainability improvements very challenging and time-consuming. This leads to a state in many organizations where adapting or even reusing these existing system models becomes a huge challenge. As a result, new products are often developed from scratch, although most...

parts could be reused from existing solutions. Innovation and flexibility are hindered because models that are intended to drive change become its biggest obstacle.

Thus, we aim to develop methods, techniques, and tools to enforce sustainability in system modeling, exploiting potentials of state-of-the-art AI techniques concerning automation and efficiency. We expect that the results will lead to a more sustainable system modeling environment, making production organizations more competitive by allowing them to enforce flexibility and innovation in product development.

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Model-Based Systems Engineering

Or ‘How Can I Pack My Suitcase?’

MODEL-BASED SYSTEMS ENGINEERING

Susan Faust

Siemens Industry Software GmbH

Model-based systems engineering is in the whole world - everyone talks about it, everyone wants to do it, but what is actually behind it?

This question will be outlined by means of a playful approach and a real problem: “I pack my suitcase and take with me...”. Based on this problem, we will successively try to pack the suitcase with the help of SE and finally MBSE using the game and present it with a small demonstration. Let us go together on the hopefully soon again possible journey and pack our suitcase.

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SysML v2 Update and Practice

With a Special Focus on Variant Modelling

MODEL-BASED SYSTEMS ENGINEERING

Tim Weilkiens

oose Innovative Informatik eG

Abstract: The new SysML v2 has been in the works for many years. Now it is on the home stretch. I will give a short insight into the new standard and present the current status.

With SysML v2 basically, the same concepts can be modeled as with SysML v1. However, the implementation is different and there are quite a few more features that SysML v1 does not offer.

I pick out one feature that is different and solves a burning problem of SysML v1: modeling variants. We'll take a look at the problem in SysML v1 and then I'll show you how it's solved in SysML v2.

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Design Ontology Supporting Model-Based Systems Engineering Formalisms

MODEL-BASED SYSTEMS ENGINEERING

Jinzhi Lu
Ecole Polytechnique Fédérale de Lausanne (EPFL)

Model-based systems engineering (MBSE) provides an important capability for managing the complexities of system development. MBSE empowers the formalism of system architectures for supporting model-based requirement elicitation, specification, design, development, testing, fielding, etc. However, the modeling languages and techniques are heterogeneous, even within the same enterprise system, which leads to difficulties for data interoperability.

The discrepancies among data structures and language syntaxes make information exchange among MBSE models more difficult, resulting in considerable information deviations when connecting data flows across the enterprise. Therefore, this paper presents an ontology based upon graphs, objects, points, properties, roles, and relationships with extensions (GOPPRRE), providing meta-models that support the various MBSE formalisms across lifecycle stages.

In particular, knowledge graph models are developed to support...

unified model representations to further implement ontological data integration based on GOPPRRE throughout the entire lifecycle. The applicability of the MBSE formalism is verified using quantitative and qualitative approaches. Moreover, the GOPPRRE ontologies are used to create the MBSE formalisms in a domain-specific modeling (DSM) tool, MetaGraph, for evaluating its availability. The results demonstrate that the proposed ontology supports the formal structures and descriptive logic of the systems engineering lifecycle.

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Lessons Learned from MBSE at ClearSpace

MODEL-BASED SYSTEMS ENGINEERING

Simon Hamel

EPFL Space Centre

The increasing number of objects in LEO threatens Mankind's access to space, tackling this challenge is the mission of Clearspace, a Swiss EPFL-spinoff startup founded in 2019.

To answer ESA's challenging call for a space Active Debris Removal mission, Clearspace needs innovative way of working in all engineering domains, including Systems: implementing Model-Based System Engineering is therefore the obvious solution Clearspace has chosen to ease the design of its servicer and ground segment in an agile and collaborative way.

Last year at SWISSED20, Hannes Bartle presented the first steps in MBSE for the Clearspace-1 mission with a methodology based on the Department of Defense Architecture Framework.
This year's presentation aims to expose how this methodology participated in easing the system's design, how it evolved to fit the mission's need and what lessons can be taken from 1 year of MBSE at ClearSpace. The main topics of the discussion will be the tools used, the needs that drive the definition of a MBSE process in a startup and how they may vary, and the challenge and future development of MBSE in this space startup.

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Some Lessons Drawn from Systems Engineering

MODEL-BASED SYSTEMS ENGINEERING

Freddy Kamdem Simo
Industry and Research

A goal of Systems Engineering (SE) is to help produce a given solution(s) in response to the needs expressed by stakeholders, while respecting or minimising costs/resources, schedules and maximising the match between expressed needs and solutions (expectations). The need for SE is all the stronger as different domains need to come into play, integrate or collaborate enough to produce this solution. Unfortunately, there is no step-by-step recipe (algorithm) or universal approach -- as in the case of some problems -- that would guarantee the achievement of this goal. However, there are several systems engineering methods, techniques, principles and tools that can be used to achieve this goal. They face and raise many challenges.

The objective of this presentation is to show that challenges encontoured with a document-centric approach can also be encountoured with Model-based SE despite the advantages that the latter approach can bring. I shall therefore review those challenges and correlate them with some SE challenges. Then I shall give an overview of related works and focus on the importance and challenges of integrating the programmatic and technical aspects of SE...

In a second part, I shall introduce a computational approach to cope with modelling activities in SE, and show how it can contribute to some SE challenges. I shall conclude with some questions about the development of SE.

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SYSTEMS ENGINEERING PRINCIPLES

Andreas Trautmann

David Endler

Colin Hood and Marco Di Maio

Marc-Andre Chavy-Macdonald

The Transactional Aspects of Systems Engineering

SYSTEMS ENGINEERING PRINCIPLES

Andreas Trautmann
Andreas Trautmann Consulting, Coaching and Training

Further years have passed and Andreas continuously was involved in further exciting and challenging Systems Engineering projects.

Since it is his main passion and business focus to analyze the transactional aspects of projects, you could also say the “soft factors“, he continues to develop models and solution paths for serving his clients and costumers.

He is quite familiar with the many pitfalls and obstacles you might find in almost every project in companies worldwide.

The basic question is, what is really going on aside the technical factors as tools and pocesses and what can we do when projects fail or do not follow the “right path“. What is the right path anyway?

As a consultant, coach and trainer, he again will take you onto a journey leading to exciting insights and surprising clarities, where you might say: “I knew it before, but I have not focused on it“.

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The Answer Cannot Always Be: "Well, It Depends..."

SYSTEMS ENGINEERING PRINCIPLES

David Endler
Systems Engineering Consultant

In Systems Engineering, it's the Systems Engineer's job to make tough decisions. In every system development, there are conflicting interests that must be balanced. Systems engineer have several powerful tools in his toolbelt to support those decisions.

However, in most cases, these decisions are based on assumptions. As we're dealing with complex systems, the problem can not be decomposed in smaller pieces and it is likely that the system has emergent properties that are still unknown. Consequently, many decisions have to be made with a significant degree of uncertainty. The presentation shows several approaches how people typically deal with complexity and which approaches are really needed.

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Teaching Systems Engineering to Undergraduates

A Complex Issue?

SYSTEMS ENGINEERING PRINCIPLES

Colin Hood and Marco Di Maio
Colin Hood SE Ltd | Technische Hochschule Ingolstadt

Teaching Systems Engineering to undergraduates is a challenge: students are generally not familiar with the concepts that underpin Systems Engineering, making progress often unpredictable, which - according to Beale - would indeed suggest a degree of complexity. However, after teaching the subject as a mix of lecture, project, and workshops for 2 years, we are convinced that most of our graduates have taken the core learnings with them and will apply them to their benefit in their future careers.

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A New Platform for Innovating System Design

The Concurrent Design and Data Facility (CD2F)

SYSTEMS ENGINEERING PRINCIPLES

Marc-Andre Chavy-Macdonald
Ecole Polytechnique Fédérale de Lausanne (EPFL)

Concurrent Engineering (CE) is an influential methodology for early-phase system design. CE means forming cross-functional teams, collocated & sharing design information, that follow an intensive structured process to simultaneously design a system concept. It rapidly resolves trade-offs transparently, with a networked design support system. A “Concurrent Design Facility” was established at EPFL Space Center in 2007, and used for teaching and designing the first Swiss satellite, SwissCube. Though used by many firms as best-practice (systems) engineering, our goal is “next-generation CE”. We bring teaching and engineering benefits plus a 3rd: research on design methods, allowing continuous improvements and insights on the nature of design.

Indeed CE exhibits key time & cost savings, but lacks empirical evidence of better “design quality”, because this concept itself is ill-defined. The recent ubiquity of inexpensive sensors and “Big Data” & analytics techniques allows combining a CE facility with a digital “Design Observatory”. Design Observation gathers abundant rich...

empirical data on “design walks”: teams performing design processes. This data is sorely needed to build fundamental knowledge in Design Research, allowing rapid empirical testing & constant advances of CE training, tools, and processes.

We are now building a “version 0.1” “Concurrent Design & Data Facility”: a combined Concurrent Engineering facility and Design Observatory. It is a synergistic platform outputting both (a) new system designs, for teaching and engineering, and (b) novel insights on design methods. We have support from the European Space Agency and EPFL, and seek partners, users, and input from the Systems Engineering community.

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PRESENTER PROFILES

Lars Hagge

DESY

Dr. Lars Hagge is a senior scientist at Deutsches Elektronen-Synchrotron DESY in Hamburg, Germany.

He heads the information management department, which supports research infrastructure projects in the product lifecycle management of complex systems, develops methods for interdisciplinary engineering and operates the central CAD / PLM environment at DESY. He received his PhD in physics from the University of Hamburg.

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Alessandro Golkar

Skoltech Faculty

Alessandro Golkar is Associate Professor and Technology Development Director at the Skolkovo Institute of Science and Technology (Skoltech) in Moscow. Prof. Golkar has been one of the first faculty members of Skoltech, joining the Institute in its first year of operations and working together with MIT in its foundation. From 2017-19 he served as Vice President in the Airbus Group's Technology Roadmapping Leadership Team in Toulouse, France, prioritizing and defining the group's R&D strategy with a $1B annual project portfolio. He designed and developed the Concurrent Design Facility of Airbus CTO, and operated it as its Head during his tenure in Toulouse. He is a member of the Advisory Board of several companies operating in the European

New Space sector. Alessandro Golkar holds a Ph.D. (PhD) from the Department of Aeronautics and Astronautics of the Massachusetts Institute of Technology in Cambridge (MIT), USA, and holds graduate and undergraduate degrees in Astronautical Engineering and Aerospace Engineering from the University of Rome " La Sapienza".

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Kristoffer Nordström

Systems Engineering Consultant

Presenter 1 Biography Kristoffer Nordström has received a MSc in EEIT from ETH Zürich. Since then primarily worked as a design and test engineer in various FPGA related projects in the space and rail industry.

As a supporter of open-source software he's trying to automate the boring parts to make life more interesting for everyone.

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Ivo Locher

Konplan

Dr. Ivo Locher graduated with a degree in Electrical Engineering from the Wearable Computing Lab of the ETH Zurich in 2006. Currently, he is program manager at konplan AG and he is expert for medical device development. In his role, he supports medical device startups on the technical and on the project management side in bringing their product ideas on the market. In his career, Ivo has successfully led several medical device development projects, starting from requirements engineering up to market clearance.

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Martin Oswald

Belimo Automation AG

Martin Oswald is Lean Development Manager at Belimo Automation AG. His mission is to make the Innovation Group Division more efficient and effective and to empower employees for this purpose. He is leading the initiative to introduce Systems Engineering with the aim of not only developing the products right, but also developing the right products. He does this by leveraging his extensive experience in product development in the medical device industry and his experience in establishing a product development center in China. Originally, he studied mechanical engineering at ETH Zurich.

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SE Group Zürich

Markus Schacher, Behnaz Rouhparvar, Daniel Bommer, Marco Di Maio, Marco Chicherio, Michael Thalmann, René Auf der Maur, Rolf Claude, Simon Hofmann, Rolf Gubser

We present as a group ("SE Group Zürich") of experienced system engineers from major industrial companies such as Belimo, Rieter, Schindler, Siemens and V-Zug. Starting in 2019, the members of this group initiated an active collaboration to develop new approaches to systems engineering that focus on leveraging the benefits of technologies to drive digital transformation.

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Martin Hoppe

INTIS GmbH

Martin Hoppe has been working in naval shipbuilding as a certified systems engineer in international project teams for more than 25 years. His responsibilities included the adaptation of the SE process model to the respective customer requirements, the development and support of a self-developed MBSE tool within the scope of the various projects and the training of the project team members in the application of the process and the tool.

He is currently working at INTIS GmbH as a systems engineer in the field of developing inductive charging systems for electromobility.

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Sten Grüner

ABB Corporate Research Germany

Sten Grüner is a senior scientist in the software architecture research group at ABB Corporate Research Center Germany.

His research interests include application on Software Product Line Engineering methods on existing industrial embedded systems as well as information modeling for highly available industrial applications. Along with research work, Sten acts as a project manager in different Industry 4.0 research projects focusing on industrial digital twins and their interoperability. He holds a Ph.D. in automation engineering from RWTH Aachen University in Germany since 2016 and a diploma (M. Sc. equivalent) in computer science from same university since 2011.

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Philip James Donovan

Diehl Aerospace

Philip has over 15 years of experience in Systems Engineering and leading Systems Engineering teams in the defence & aerospace sector internationally.

Philip commenced his career in high-fidelity military aircraft system simulation in Australia and the UK. He has since performed Systems Engineering activities on major civil aircraft avionic developments including for the Airbus A350 and Airbus A380. Recently, Philip has lead systems engineering activities in Australia for complex airborne systems including the Tiger ARH & MRH-90 military helicopters.

Currently, Philip performs high-level system engineering activities for novel air & missile defence systems in Europe.

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Gilles Defo

ALTEN Switzerland AG

Born 1978 in Cameroon the author (Gilles Ngainsi Defo) graduated as electrical and computer science engineer from University of Stuttgart, Germany 2004. He first published 2005 a post-graduate paper on error correcting codes for safety critical applications based on airbag ECU from BOSCH. He worked for last 17 years on various products for different companies and phases also as freelancer for 10 years (requirements, design, tests, management) with certifications. 2020 he joined ALTEN Switzerland AG 2020 as competence center lead and member of technical direction.

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Anne-Marlene Rüede

Ecole Polytechnique Fédérale de Lausanne (EPFL)

Anne-Marlene is a space and extreme environment architect at the Swiss Polytechnic Federal Institute in Lausanne (EPFL), where she studied architecture and space technologies. She has worked on various projects, including satellite design, Mars human exploration mission planning, and space habitat design. She currently works on sustainable space logistics at the EPFL Space Center (eSpace) as a Ph.D. Her interests include decision-making methods for system architecting in space and possible spin-off applications on earth.

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Marco di Maio

Technische Hochschule Ingolstadt

Marco is professor of Systems Engineering at Ingolstadt University. Before that, he was the managing director of projectglobe ltd.; a boutique consultancy firm specialising in Model Based Systems Engineering (MBSE) and Information Management (IM) to support complex and complicated innovation driven engineering projects. Major customers were the fusion research community, automotive, and 3D laser welding and robotics.

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Tim Weilkiens

oose Innovative Informatik eG

Tim is a member of the executive board of the German consulting company oose, an MBSE consultant and trainer, and an active member of the OMG and INCOSE community.

He is co-author of the SysML v1 specification, co-chair of the working group responsible for SysML v1, and a track lead of the teams that works on SysML v2.

As a consultant, he has advised a lot of companies in different domains. His insights into their challenges are one source of his experience that he shares in books and presentations.

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Hubertus Ulmer

IAV GmbH

See Hubertus Ulmer on LinkedIn for further information.

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Frederic Brinkmann

IAV GmbH

Frederic is a Systems Engineer at IAV, E-Mobility Commercial Vehicle specialising in the following :

- Project Management and process optimization at the commercial vehicle department.
- Architecture design, requirements management, integration management and functional safety at system level in various development projects for comercial vehicle and non-road mobile machinery with focus on alternative propulsion systems.

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Moritz Hübel

Modelon Deutschland GmbH

- Modelon Deutschland GmbH - 2019 - present, energy Senior Simulation Engineer

- University of Rostock - 2012 - 2019, PhD Thermodynamics & Powerplant Simulation

- University of Rostock - Mechanical Engineering Diploma 2006 -2011

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Konrad Wieland

LieberLieber Software GmbH

Dr. Konrad Wieland studied business informatics at the TU Vienna until 2008, followed by his PhD at the "Institute of Software Technology and Interactive Systems" on team-based development of models. He has published numerous articles together with SparxSystems and LieberLieber. In 2012 he moved to LieberLieber and initially worked as a consultant for numerous companies in the automotive and defense industries in the area of model-driven software and system engineering. As head of product management since 2016, he used this valuable experience to successfully establish LieberLieber standard products on the market. Since the beginning of 2020 Konrad Wieland is CEO of LieberLieber. He lives with his family in Vienna, Austria.

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Daniel Lehner

Johannes Kepler University Linz

Daniel Lehner received his master degree in Business Informatics from the Vienna University of Technology in 2020. During his studies, he worked as a consultant in the area of software quality assurance. Currently, Daniel works as an university assistant at the Institute for Business Informatics – Software Engineering at the Johannes Kepler University in Linz. His research there focuses on establishing and improving Model-Based Systems Engineering techniques.

As one part of this research effort, he currenty investigates ways to manage and improve sustainability of Systems Engineering models exploiting AI-based techniques.

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Susan Faust

Siemens Industry Software GmbH

After gaining first work experiences in Paris, Berlin, Dubai, London and Ingolstadt in different departments, Susan started studying technical business administration in Hamburg and specified her master degree in Strategic Sales Management in Stuttgart.

During this time, she was working at IBM in software sales for the Application Lifecycle Management portfolio and related AI topics. The focus of her master thesis was the Digital Twin and business model innovations. After graduating University she started as PreSales Solution Consultant at Siemens Digital Industry Software talking with customers about Requirements Management, Systems Engineering, MBSE but also about specific needs in dedicated markets such as medical or automotive.

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Jinzhi Lu

Ecole Polytechnique Fédérale de Lausanne (EPFL)

Jinzhi Lu, CSEP, is a research scientist at EPFL. He received his PhD at KTH Royal Institute of Technology, Mechatronics Division in 2019. His research interest is MBSE tool-chain design and MBSE enterprise transitioning. He is senior member of the China Council on Systems Engineering (CCOSE), China Council on Systems Engineering.

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Simon Hamel

EPFL Space Centre

Simon Hamel is a young system engineer employed by the EPFL Space Center since September 2020.

He works on Model-Based System Engineering for Clearspace, an EPFL-spinoff startup in charge conducting ESA's Active Debris Removal mission. He is also in charge of supervising some of the EPFL Space Center's student projects.

He graduated in mechanical engineering from the ISAE-ENSMA school of aerospace engineering in 2018 and worked for a year on MBSE development at Airbus Commercial Aircraft in Toulouse.

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Freddy Kamdem Simo

Industry and Research

Freddy Kamdem Simo received the PhD degree in Sciences and Technology of Information and Systems, Computer Science, the engineer degree (master's degree) in Computer Science from Université de Technologie de Compiègne (UTC), France in 2017 and 2014. His current research interests tackle the provable foundations and general enablers for Systems Engineering.

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Andreas Trautmann

Andreas Trautmann Consulting, Coaching, Training

Andreas Trautmann has an industry experience of over 25 years and has been working in the regulated industry for over 20 years.

2017 he founded his company Lumicon and currently works as Interim Manager, Consultant, Coach and Trainer.

As a Director for Global Verification & Validation he lead the international company wide Verification and Validation (V&V) activities for the Biotech Global Player QIAGEN in the Automated Systems business branch residing in Hombrechtikon, Switzerland and Washington, D.C., USA...

Before he had worked for 9 years in the Aerospace industry at EADS and Airbus in Germany as a department and project leader in development, integration and testing of complex safety critical aerospace avionic systems.

He began his engineering career 1994 in the automotive industry at the car manufacturer Audi after having studied Aerospace Engineering at the University of Stuttgart in Germany.

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David Endler

Systems Engineering Consultant

Dr. David Endler is a systems engineering consultant, trainer and coach (freelancer). He was INCOSE's Technical Director of INCOSE in 2019 and 2020, is a member of the Swiss Chapter of INCOSE and the lead co-editor of ISO/IEC/IEEE 15288 next revision. In his professional career which started in 2002, David has been involved in various systems engineering projects in the aerospace, marine, automotive and renewable energies industry. Today, he's teaching systems engineering courses to share his lessons learned. He holds a PhD in Physics (Dr. rer. nat.) from University of Hamburg.

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Colin Hood

Colin Hood SE Ltd.

Some of the methods that Colin Hood developed in the 1980´s became known as agile in the 2000´s.

Colin Hood empowers organisations to sucessfully achieve time and cost savings while increasing quality by the education of Systems Engineering Techniques.

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Marc Andre Chavy-Macdonald

Ecole Polytechnique Fédérale de Lausanne (EPFL)

Dr. Chavy-Macdonald is Lead Research Scientist at the EPFL Space Center (eSpace), and co-founder of a successful consultancy. Over 10+ years' research & work experience, he has spent 8+ in systems engineering & design methodology, performing research with ESA, the University of Tokyo, MIT, and ispace Inc, resulting in over 15 refereed papers. Previously, he was a space environment and radiation specialist with ESA.

Passionate about innovation, he has diplomas in technology & innovation management, and experience with several start-ups. Marc-Andre's current interests include System-of-Systems modelling & future planning for space logistics, and Concurrent Engineering methodology augmented by Design Research.

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SWISS SYSTEMS ENGINEERING DAY

SWISSED22

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