Date: Sunday, 05/Jul/2020

1:00pm - 3:50pm General	**Ph.D. Workshop** Session Chair: **Yacine Ouzrout**, University of Lyon, France Session Chair: **Monica Rossi**, Politecnico di Milano, Italy Join Workshop Go to virtual conference room "Ph.D Workshop"
4:00pm - 6:00pm	**IFIP Wg 5.1 Meeting** Session Chair: **Abdelaziz Bouras**, Qatar University, Qatar Session Chair: **Felix Nyffenegger**, University of Applied Science Rapperswil, Switzerland Join Meeting Go to virtual conference room "General"

Date: Monday, 06/Jul/2020

1:00pm - 1:30pm General	**Conference Opening: Conference Opening** Session Chair: **Felix Nyffenegger**, University of Applied Science Rapperswil, Switzerland Session Chair: **Abdelaziz Bouras**, Qatar University, Qatar Join Session Go to virtual conference room "General"
1:30pm - 1:50pm General	**Keynote Honorary Chair: PLM in Swiss industry and education, Prof. Alex Simeon** Join Session Go to virtual conference room "General"
2:00pm - 2:45pm General	**Research Keynote: Product in Industry 4.0, Prof. Dr. Konrad Wegener, IWF, ETH Zürich** Session Chair: **Felix Nyffenegger**, University of Applied Science Rapperswil, Switzerland Join Session Go to virtual conference room "General"
2:45pm - 3:45pm Virtual Room Cheese	**Parallel session 1.1: Smart factory 1** Session Chair: **Alain Bernard**, Ecole Centrale de Nantes, France Join Session Go to virtual conference room "Cheese"
2:45pm - 3:45pm Virtual Room Chocolate	**Parallel session 1.2: Special session on MBSE** Session Chair: **Clement Fortin**, Skoltech, Russian Federation Join Session Go to virtual conference room "Chocolate"
2:45pm - 3:45pm Virtual Room Heidi	**Parallel session 1.3: Special Session on maturity implementation and adoption 1** Session Chair: **Benoit Eynard**, UTC, France Join Session Go to virtual conference room "Heidi"
4:00pm - 5:00pm Virtual Room Cheese	**Parallel session 2.1: Special session on BIM** Session Chair: **Louis Rivest**, ETS, Canada Join Session Go to virtual conference room "Cheese"
4:00pm - 5:00pm Virtual Room Chocolate	**Parallel session 2.2: Analytics in the order fulfillment process** Session Chair: **José Ríos**, TU Darmstadt / Universidad Politécnica de Madrid, Germany Join Session Go to virtual conference room "Chocolate"
4:00pm - 5:00pm Virtual Room Heidi	**Parallel session 2.3: Business Models** Session Chair: **Sergio Terzi**, Politecnico of Milan, Italy Join Session Go to virtual conference room "Heidi"
5:10pm - 6:00pm General	**Open Webinar Day 1: Global PLM at Bühler AG** Join Open Webinar
6:00pm - 6:30pm	**Virtual Apero** Join Session

Date: Tuesday, 07/Jul/2020

1:00pm - 1:10pm General	**Welcome day 2: Welcome day 2** Join Session Go to virtual conference room "General"

1:10pm - 2:00pm	**Community Keynote: Advances in the Smart factory** Join Session Go to virtual conference room "General"
2:15pm - 3:15pm Virtual Room Cheese	**Parallel session 3.1: Smart factory 2** Session Chair: **Paolo Chiabert**, Politecnico di Torino, Italy Join Session Go to virtual conference room "Cheese"
2:15pm - 3:15pm Virtual Room Chocolate	**Parallel session 3.2: Special session on AI in CAx, MBE, and PLM** Session Chair: **Lionel Roucoules**, Arts et Métiers, France Join Session Go to virtual conference room "Chocolate"
2:15pm - 3:15pm Virtual Room Heidi	**Parallel session 3.3: Special Session on maturity implementation and adoption 2** Session Chair: **Mourad Messaadia**, CESI, France Join Session Go to virtual conference room "Heidi"
3:30pm - 4:30pm Virtual Room Cheese	**Parallel session 4.1: Special session on BIM** Session Chair: **Vishal Singh**, Indian Institute of Science, India Join Session Go to virtual conference room "Cheese"
3:30pm - 4:30pm Virtual Room Chocolate	**Parallel session 4.2: Internet of things (IoT, IIoT)** Session Chair: **Sebti Foufou**, New York University Abu Dhabi, United Arab Emirates Join Session Go to virtual conference room "Chocolate"
3:30pm - 4:30pm Virtual Room Heidi	**Parallel session 4.3: Industrial technical presentations** Session Chair: **Felix Nyffenegger**, University of Applied Science Rapperswil, Switzerland Join Session Go to virtual conference room "Heidi"
4:45pm - 5:45pm General	**Open Webinar Day 2: BIM in Retail** Join Session
Date: Wednesday, 08/Jul/2020	
1:00pm - 1:10pm General	**Welcome day 3: Welcome day 3** Join Session Go to virtual conference room "General"
1:15pm - 2:15pm Virtual Room Cheese	**Parallel session 5.1: Circular Economy** Session Chair: **Fernando Mas Morate**, EADS, Join Session Go to virtual conference room "Cheese"
1:15pm - 2:15pm Virtual Room Chocolate	**Parallel session 5.2: New product development** Session Chair: **Monica Rossi**, Politecnico di Milano, Italy Join Session Go to virtual conference room "Chocolate"
1:15pm - 2:15pm Virtual Room Heidi	**Parallel session 5.3: Digital twins** Session Chair: **Frédéric Noël**, Grenoble-INP - G-SCOP, France This session has 5 presentations and will take 15 minutes longer then scedulled. Join Session Go to virtual conference room "Heidi"
2:30pm - 3:30pm Virtual Room Cheese	**Parallel session 6.1: Tools to support early design phases** Session Chair: **Grant McSorley**, University of Prince Edward Island, Canada Join Session Go to virtual conference room "Cheese"
2:30pm - 3:30pm Virtual Room Chocolate	**Parallel session 6.2: Ontologies for interoperability** Session Chair: **Rebeca Arista**, Airbus, France Join Session Go to virtual conference room "Chocolate"
3:45pm - 4:45pm General	**Open Webinar Day 3: Implementing the Smart Factory** Join Session
5:00pm - 5:30pm	

General	**Closing ceremony** Session Chair: **Abdelaziz Bouras**, Qatar University, Qatar Session Chair: **Felix Nyffenegger**, University of Applied Science Rapperswil, Switzerland Join Session Go to virtual conference room "General"

Presentations

Ph.D. Workshop

Time: Sunday, 05/Jul/2020: 1:00pm - 3:50pm · *Location:* General
Session Chair: Yacine Ouzrout, University of Lyon, France
Session Chair: Monica Rossi, Politecnico di Milano, Italy

Join Workshop
Go to virtual conference room "Ph.D Workshop"

Applied ontologies in resource management for the conceptual design phase of an Aerospace Industrial System

Rebeca ARISTA[1,3], Fernando MAS[2,3], Carpoforo VALLELLANO[3]
[1]Airbus, France; [2]Comlux America, United States; [3]University of Sevilla, Spain

Comparison of Building Information Modeling and Product Lifecycle Management Approaches From the Standpoint of Engineering Change Management

HAMIDREZA POURZAREI
École de technologie supérieure, Canada

Data and information valorisation towards Circular Manufacturing adoption

Federica Acerbi
Politecnico di Milano, Italy

IdentifyIT – A Method to Identify Data-Driven Design Use Cases

Simon Rädler
V-Research GmbH, Austria

Intelligent environment for early lifecycle phase concept evaluation and decision-making in the design of complex systems

John Douglas Wilson
I2M, France

Parallel session 1.1: Smart factory 1

Time: Monday, 06/Jul/2020: 2:45pm - 3:45pm · *Location:* Virtual Room Cheese
Session Chair: Alain Bernard, Ecole Centrale de Nantes, France

Join Session
Go to virtual conference room "Cheese"

Integration of PLM, MES and ERP Systems to Optimize the Engineering, Production and Business

Venkat Avvaru, Giulia Bruno, Paolo Chiabert, Emiliano Traini
Politecnico di Torino, Italy

In the era of Industry 4.0, the key factor for the success of a company is the co-operation among its different departments in order to share knowledge and in-formation, thus optimizing time and cost. Three core IT systems are usually pre-sent in companies: Product Lifecycle Management (PLM), Manufacturing Execu-tion system (MES) and Enterprise Resource Planning (ERP). PLM manages product and process design information, MES monitors and controls the execu-tion of manufacturing process on the shop-floor, and ERP tracks business re-sources and the status of business commitments. This paper describes the integra-tion process to optimize the engineering, production, business and management activities in a manufacturing company that operates according to the One-of-a-Kind Production (OKP). It explains the architecture of such integration as well as the methodology applied for the customization of the PLM, MES and ERP sys-tems available in the company. Moreover, the paper highlights the specific solu-tions developed to integrate the data management of the different systems as well as the IoT technology supporting the data communication. Finally, the paper summarizes the results of the integration process evaluating the improvement of specific KPI's for the manufacturing process.

Towards a knowledge-based framework for modular robotic system design

Lucas JIMENEZ[1,2], Fréderic DEMOLY[1], Sihao DENG[1], Samuel GOMES[1]
[1]ICB UMR 6303 CNRS, Univ. Bourgogne Franche-Comté, UTBM, Belfort, France; [2]MS-INNOV company, Belfort, France

A particular challenging task in the context of the 4th industrial revolution con-sists in increasing production system automation in European small and medium enterprises (SMEs). However, automation – often addressed with robotization – represents major investments that are not always accessible for SMEs, in which small batch production requires change in an efficient manner. In fact, software programming and hardware (in terms of reachability and maximum payload) are the flexibility barrier of actual industrial robots. In the other hand, researchers and industry are currently pushing their efforts to develop modular robots (in terms of hardware and software), which are task-specific computable and change-able. In this context, this paper aims to develop a novel design framework com-bining both knowledge representation for task definition and computational tools for structural and logical design using modular units. To demonstrate its suitabil-ity in an industrial context requiring reconfiguration capabilities, specific devel-opments have been made and tested with a simple case.

Towards a machine learning failure prediction system applied to a smart manufacturing process

Tainá da Rocha[1], Arthur Beltrame Canciglieri[1], Anderson Luis Szejka[1], Leandro dos Santos Coelho[1,2], Osiris Canciglieri Junior[1]
[1]Industrial and Systems Engineering Graduate Program, Pontifical Catholic University of Parana, Curitiba, Brazil; [2]Department of Electrical Engineering, Federal University of Parana, Curitiba, Brazil

At a time when the competitive market is operating rapidly, manufacturing industries need to stay connected, have interchangeability and interoperability in their factories, ensuring that there is heterogeneous communication between sectors, people, machines and the client, challenging the manufacturing industry to discover new ways to bring new products or improve their manufacturing process. Precisely because of the need to adjust to these new market demands, factories pursue complex and quick decision-making systems. This work aims to propose applications of Machine Learning techniques to develop a decision-making platform applied to a manufacturing line reducing scrap. This goal will be achieved through a literature review in the fields of Artificial Intelligence (AI) and Machine Learning to identify core concepts for the development of a failure prediction system. This research has demonstrated the problems and challenges faced by manufacturing on a daily basis, and how, through the application of AI techniques, it is possible to contribute to assist in these problems by improving quality, performance, scrap rates and rework, through connectivity and integration of data and processes. This paper contributes to evaluate the performance of machine learning ensembles applied in a real smart manufacturing scenario of failure prediction.

A lean approach for a low cost quality control in additive manufacturing

Francesca Sini[1,2], Giulia Bruno[1], Paolo Chiabert[1], Frederic Segonds[2]
[1]Politecnico di Torino, Italy; [2]Arts et Metiers Institute of Technology, LCPI, HESAM Université, Paris, France

Additive manufacturing is becoming more and more popular not just in the manufacturing industry, but also in the consumer market, because it offers a new world of opportunities, starting from the absence of constraints in geome-try and the reduction in wastes due to material removal typical of subtractive manufacturing. Moreover, it is able to enhance lean manufacturing objectives of reducing activities that do not add any value for customers. However, a wide application is threatened by the lack of consistent quality. Therefore, it is neces-sary to further study defects that affect 3D printed products and to propose new manners to control them. This paper proposes to use a low cost, light weight, portable, device as a scanner to rapidly acquire data from 3D printed products and compare it with the original model.

Parallel session 1.2: Special session on MBSE

Time: Monday, 06/Jul/2020: 2:45pm - 3:45pm · *Location:* Virtual Room Chocolate
Session Chair: Clement Fortin, Skoltech, Russian Federation

Join Session
Go to virtual conference room "Chocolate"

Issues on Introducing Model-Based Definition - Case of Manufacturing Ecosystem

Pekka Uski[1], Antti Juhani Pulkkinen[2], Lasse Hillman[3], Asko Ellman[4]
[1]Etteplan Finland Oy; [2]VTT Technical Research Centre of Finland Ltd, Finland; [3]Tampere University of Applied Sciences; [4]Tampere University

The benefits of Model-Based Definition (MBD) are well known. Considering this there is a need to understand the reasons why MBD is utilized rarely in the manufacturing ecosystems of low volume, customized products. For studying MBD, manufacturing ecosystems and their mutual relations a literature study and a case study of manufacturing ecosystem were applied. It was noticed that there are differences between the maturities of digital product processes between the actors of the ecosystem, while MBD itself is a matter affecting the whole ecosystem. Investing in education and renewing, integrating and harmonizing processes, legacy data and software lower barriers towards adopting MBD. The motivation of the actors of an ecosystem has to ensure investments and commitment to change. The investment decisions require an ecosystem wide value definition and business case for each actor. The role of an actor within an ecosystem, how common or niche the utilized product and production technology is and the economic situation of a company appear to impact companies' willingness to change into MBD. Also, the motivation to adopt MBD depends on the amount of legacy data and the complexity of manufactured parts. Adopting PMI-data can increase the efficiency of manufacturing processes, such as quality control.

A review of behavior and state representation methods in modern PLM systems

Petr Mukhachev, Clement Fortin
Skoltech, Russian Federation

Increasing product complexity, growing importance of software components poses challenges for PLM systems in modern companies and extended enterprises. Today product behavior and its processes drive product value, so companies use sophisticated software to accurately predict it. In this work we argue that state is a natural atomic part of any process. Then we briefly review and compare current methods for behavior and state representation in domain engineering and systems engineering practices. In the end show that the support provided to the engineer by PLM systems in managing and sharing behavioral product properties across an extended enterprise is insufficient in comparison to their significance for successful product development.

Analysis of MBSE/PLM Integration: From Conceptual Design to Detailed Design

Yaroslav Menshenin, Dominik Knoll, Yana Brovar, Clement Fortin
Skolkovo Institute of Science and Technology, Russian Federation

Model-Based Systems Engineering (MBSE) approaches guide complex system/product design and development from the very early stages of the product development process. Its full-scale integration into the Product Lifecycle Management (PLM) would allow to facilitate a better data flow from conceptual design to detailed design. In this paper we discuss such data flow focusing on three core models: Object-Process Methodology (OPM), Core product model (CPM), and STEP. We describe core artefacts of these models and those entities in which they overlap, thus we define which data is critical throughout the entire system/product development. We demonstrate that the fundamental problem associated with the integration of MBSE and PLM is due to the fundamental essence of systems, which needs both explicit representations of time and space to represent completely the system form and behavior throughout the product/system life cycle. An analysis for a CubeSat mission is also presented to illustrate the data correspondences between the various models.

A new agile hybridization approach and a set of related guidelines for mechatronic product development

Sagar Mule[1], Régis Plateaux[2], Peter Hehenberger[1], Olivia Penas[2], Stanislao Patalano[3], Ferdinando Vitolo[3]
[1]University of Applied Sciences Upper Austria, Wels, Austria; [2]Supméca, Laboratoire QUARTZ, EA7393, Paris, France; [3]Fraunhofer J-Lab IDEAS, University of Naples Federico II, Naples, Italy

In industry 4.0, the growing incorporation of cyber-physical systems (CPS) into manufacturing facilities composed of mechatronic products brings forth the need of reducing development cost while maintaining the quality and in parallel the need to adapt changes along the life-cycle of the product development. Most of the traditional development methods fail to solve such new challenges. However, some agile methods, widely used in the software industry, could meet these requirements. It is then essential to identify the criticalities of agile methods regarding mechatronic system development specificities.

As a result, our research work focuses on combining traditional and agile approaches to improve mechatronic products development in a changing market context. The development of hybrid approach is based on the analysis of traditional, agile methods and consideration of challenges in the development of mechatronic products. To illustrate the advantages of such

hybridization, we propose a first hybrid approach consisting of some elements of the Scrum method (the most popular agile approach) into the V-model. Differentiating advantages of this new approach, compared to other agile methods, include the freedom to propagate necessary changes in product architecture during the development of its different modules.

This new approach focuses on the hybridization of traditional and agile methods and the required guidelines to adopt and use for enhanced mechatronic products development. These guidelines are the base for changing the organizational culture and values which were previously associated with traditional development approaches.

Parallel session 1.3: Special Session on maturity implementation and adoption 1

Time: Monday, 06/Jul/2020: 2:45pm - 3:45pm · *Location:* Virtual Room Heidi
Session Chair: Benoit Eynard, UTC, France

Join Session
Go to virtual conference room "Heidi"

Enterprise Architecture Method for Continuous Improvement of PLM based on Process Mining

Eugen Rigger[1], Thomas Vosgien[2], Samuel Bitrus[1], Piroska Szabo[2], Benoit Eynard[3]
[1]V-Research GmbH, Digital Engineering, Austria; [2]Hilti Befestigungstechnik AG, Schweiz; [3]Université de Technologie de Compiègne, Department of Mechanical Systems Engineering, France

The complexity and dynamics of IT landscapes and related PLM strategies of engineering enterprises are continuously growing due to trends such as Industry 4.0 and ever shorting product development cycles. To ensure interoperability, robustness, flexibility and efficiency of the IT systems and PLM, methods are needed that can handle these dynamics and complexities. In this paper, a method is presented that combines principles from enterprise architecture as well as business process mining to enable continuous improvement of PLM processes and the related IT systems. In particular, process mining is applied to validate the alignment of IT systems with related PLM processes. The method is demonstrated using an industrial case study that highlights the requirements from industrial practice and the applicability of the approach for PLM related processes. The method is shown to be particularly beneficial for the enterprise architects to support them with quantitative data as a basis for the design of continuous improvement cycles to make the PLM evolve. Future work will address the application of process mining for PLM related processes with distributed IT systems and the handling of the related complexity.

Towards an expert system for benefit driven PLM implementation

Bas Koomen[1,2]
[1]University of Twente, Netherlands, The; [2]Cadmes b.v., Netherlands, The

Industrial companies face significant challenges when they engage in the implementation of Product Lifecycle Management. Research has shown that organizations have difficulties in defining concrete and measurable goals and relating enabling technology to business benefits. Moreover, implementation service providers rely heavily on tacit knowledge when it comes to operational details. This paper proposes a conceptual framework as a methodology for implementation teams. It allows teams to reuse implementation knowledge on a detailed level, related to contribution to benefits and business goals. The methodology is derived from emerging, set-based product and process development methodologies and also from benefit management strategies for information systems. The goal of this methodology is to increase the probability that Product Lifecycle Management implementation contributes to the business benefits of organizations and therefore lower the economic risks. The paper describes the method and the result of two explorative case studies.

Preliminary Analysis of the Behavioural Intention to use a Risk Analysis Dashboard through the Technology Acceptance Model

Jean-Marc Vasnier[1,2], Nicolas Maranzana[2], Norlaily Yaacob[3], Mourad Messaadia[1], Ameziane Aoussat[2]
[1]CESI, Lineact, France; [2]Arts et Metiers Institute of Technology, LCPI, HESAM Université, F-75013 Paris, France; [3]Coventry University, United Kingdom

In the age of the fourth industrial revolution, the competition between Small and Medium-sized Enterprises (SMEs) is fierce to operate efficiently and hold on to their customers. Due to lack of time and methodology, SME lead-ers are struggling to establish optimized strategies for their businesses. One way is by using dashboards that will proactively help to collect data, make decisions, facilitate the strategy implementation and keep the employees fo-cused. This article aims at determining the suitability of the Technology Ac-ceptance Model to the design of risk analysis dashboard and examining the influence between the model constructs.

Cross industrial PLM benchmarking using maturity models

Philipp Steck[1], Felix Nyffenegger[1], Helen Vogt[2], Roman Hänggi[1]
[1]Hochschule für Technik (HSR), Rapperswil, Switzerland; [2]Zürcher Hochschule für Angewandte Wissenschaften (ZHAW), Winterthur, Switzerland

Maturity models are commonly used to assess a company's position on a roadmap towards a defined mature PLM environment. The models focus mainly on an internal point of view, comparing a current state to a possible future state. The high level of adjustments in these models to the individual companies need-ed, make it difficult to compare companies across industries using existing ma-turity models.

The aim of this paper is to introduce a generic, cross-industrial maturity model suitable for the benchmarking of companies. The model uses an ability-based ap-proach, similar to a case form report.

Using the model, a first benchmarking study has been conducted among ten Swiss companies. This initial study allowed to verify and discuss the suitability of the developed model. Furthermore, the actual results of benchmarking lead to interesting insights into potential success factors to achieve higher PLM maturity. This paper discusses both the maturity model and the actual results.

Parallel session 2.1: Special session on BIM

Time: Monday, 06/Jul/2020: 4:00pm - 5:00pm · *Location:* Virtual Room Cheese
Session Chair: Louis Rivest, ETS, Canada

Join Session
Go to virtual conference room "Cheese"

Enhancement of BIM Data Representation in Renovation Product-Process Modelling

Janakiram Karlapudi[1], Karsten Menzel[1], Seppo Törma[2], Andriy Hryschenko[3], Prathap Valluri[1]
[1]Institute for Construction Informatics, Technische Universität Dresden, Dresden, Germany; [2]VisuaLynk, Espoo, Finland;
[3]School of Engineering, University College Cork, Ireland

Building Information Modelling (BIM) has the potential to become a technology which will help to use a holistic information repository to generate and represent relevant information in different building life-cycle stages (BLCS) to dedicated groups of stakeholders. However, the model components of BIM data (e.g. IFC meta-data) have limited intelligence and cannot conclude how to behave in certain scenarios. This paper aims to address this deficit by identifying the capability to formulate inference rules as one of the major benefits in the ontology-based information modelling approach. However, before one can formulate inferencing rules a detailed and in-depth understanding is required on how stakeholder information needs are defined in different BLCS and on how available, open-BIM meta-data models support these information requirements. Therefore, the research progressed initially on existing definitions for LOD and selected process-modelling standards (BLCS). In the subsequent part, different renovation Activities and the Stakeholder involvements are analyzed. Use cases are defined and used as a grouping mechanism for selected scenarios. Based on these grouping, a methodology of how components of a BIM-model could be classified to support automated inferencing in the future. The outcome of this research is an established 6-dimensional intercommunication framework (with LOD, BLS, Scenarios, Stakeholders, Use cases, BIM model data) based on Linked Building Data approach and focusing on renovation processes optimization. Based on the framework, a renovation Product-Process ontology is developed to connect existing components and to develop new interoperable applications.

Developing BIM Thinking: Pathways To Revisit Theoretical and Conceptual Grounding of BIM Research and Practice

Vishal Singh
Indian Institute of Science, India

This article proposes pathways towards developing BIM thinking as a set of objectives and characteristics that allow revisiting the grounds and principles on which one can reason about BIM, irrespective of the specific applications or tools. The research is based on critical analysis where the familiar topics and discussion around BIM are iteratively followed to their fundamental objectives and characteristics. The research data is collected through literature reviews, classroom discussions, and workshops. The identified fundamental objectives and characteristics to be considered in BIM thinking include representation, documentation, transactions and exchange, decision support, standardization, knowledge and information management, automation, and ecosystem and evolution. Relevance of complementary thinking paradigms including design thinking, computational thinking and systems thinking is discussed. Since the hope of future transformation of the construction industry is largely pinned on a range of digital technologies, BIM thinking should facilitate informed decisions about the ways forward.

Cross-Pollination as a Comparative Analysis Approach to Comparing BIM and PLM: A Literature Review

Hamidreza Pourzarei, Louis Rivest, Conrad Boton
École de technologie supérieure, Canada

Comparison is at the center of many research studies that leads to the interaction between different objects and mostly resulted in significant improvements. Especially, comparing business/technological approaches, such as building information modeling (BIM) and product lifecycle management (PLM), is an activity that is often difficult and complex, and requires particular methodological approaches. One of the biggest challenges through such a comparison is to identify the most effective methodological approach. Previous research studies have introduced cross-pollination as an interesting comparative analysis approach. However, it is important to mention that it remains a relatively untapped approach in the literature. This article provides a review of the cross-pollination variants and related terms and steps. Research findings of comparative analysis methods and approaches are evaluated to demonstrate the similarities and differences. This evaluation leads this research to represents the lessons learned of the existing methods and approaches.

Parallel session 2.2: Analytics in the order fulfillment process

Time: Monday, 06/Jul/2020: 4:00pm - 5:00pm · *Location:* Virtual Room Chocolate
Session Chair: José Ríos, TU Darmstadt / Universidad Politécnica de Madrid, Germany

Join Session
Go to virtual conference room "Chocolate"

i-DATAQUEST : a proposal for a manufacturing data query system based on a graph

Lise Kim[1], Esma Yahia[1], Frédéric Segonds[2], Philippe Véron[1], Antoine Mallet[3]
[1]Arts et Metiers Institute of Technology, LISPEN, HESAM Université, Aix-en-Provence, France; [2]Arts et Metiers Institue of Technology, LCPI, HESAM Université, Paris, France; [3]CapGemini DEMS, Toulouse, France

During the manufacturing product life cycle, an increasing volume of data is generated and stored in distributed resources. These data are heterogeneous, explicitly and implicitly linked and they could be structured and unstructured. The rapid, exhaustive and relevant acquisition of information from this data is a major manufacturing industry issue. The key challenges, in this context, are to transform heterogeneous data into a common searchable data model, to allow semantic search, to detect implicit links between data and to rank results by relevance. To address this issue, the authors propose a query system based on a graph database. This graph is defined based on all the transformed manufacturing data. Besides, the graph is enriched by explicitly and implicitly data links. Finally, the enriched graph is queried thanks to an extended queries system defined by a knowledge graph. The authors depict a proof of concept to validate the proposal. After a partial implementation of this proof of concept, the authors obtain an acceptable result and a needed effort to improve the system response time. Finally, the authors open the topic on the subjects of right management, user profile/customization and data update.

Free Text Customer Requests Analysis: Information Extraction Based on Fuzzy String Comparison

Alexander Smirnov[1], Nikolay Shilov[1], Kathrin Evers[2], Dirk Weidig[2]
[1]SPIIRAS, Russian Federation; [2]Festo SE & Co. KG, Germany

Complex systems (such as automation systems), from here on referred as “prod-ucts” are usually difficult for customers to specify since there are a lot of parame-ters to be defined and the customer should perfectly know what is really needed and important for the supplier in order to provide for a proper system. As a re-sult, creating forms and templates for the customer request specification entry helps only for relatively simple tasks and the completely digital request acquisi-tion and processing is still a matter of future work. Currently, the original request specification comes from the customer in various ways (texts, images, diagrams, a phone or a direct talk to the company’s sales representative) and the results of the analysis of this specification are often forwarded further to the back-office in a form of free or semi-structured text written in natural language. Since this text is the main source of information about the customer request, it is very important to extract as much information from it as possible. The paper reports the research and development work on semantic text analysis for information extraction from customer requests written in natural language. The core of the work is develop-ment of methods for finding a pre-defined list of terms (product parameters that are important for the order specification) in a fuzzy (similarity-based) manner with the help of synonym dictionaries. The results are illustrated on a case study from the automation equipment producer Festo SE & Co KG.

Data relevance and sources for carbon footprint calculation in powertrain production

Simon Merschak[1], Peter Hehenberger[1], Johann Bachler[2], Andreas Kogler[2]
[1]University of Applied Sciences Upper Austria; [2]AVL List GmbH

The purpose of this work is to point out the importance of the production phase for the carbon footprint calculation of powertrain components and to improve the understanding of necessary data for this calculation. Evaluation of lifecycle assessment data from numerous studies showed, that there is often a shift from the emissions in the use phase to emissions in the production phase, when alternative powertrain concepts are used. Therefore, in this work our focus is on the carbon emissions in the production phase of powertrain components. Data of raw materials used, production processes and supply chains is necessary and the uncertainties associated also have to be considered. At present, there is only little sufficient support for design engineers regarding the collection of relevant data for the carbon footprint calculation of powertrain production. In this work a data structure, which supports the collection of relevant data, including possible data sources, is presented.

FMECA-based risk assessment approach for proactive obsolescence management

Imen Trabelsi[1,2], Marc ZOLGHADRI[1], Besma ZEDDINI[1], Maher Barkallah[2], Mohamed Haddar[2]
[1]SUPMECA, France; [2]LA2MP laboratory, ENIS, Tunisia

One of the most critical issues that can affect the useful life of a product is the obsolescence of its components or functionalities. To minimize its effects and bring long-term benefits to systems, obsolescence must be proactively man-aged. A critical step in the process of proactive obsolescence management is the obsolescence risk analysis of critical components or functionalities. However, estimating the degree of obsolescence of multi-component systems is an area that is still under-explored, particularly when interdependencies exist between com-ponents. This estimation can be more complicated in the case where there is no prior knowledge about the interaction between components. We used Weibull's law to model the components' interaction and calculate the obsolescence degree of the global system. This approach is evaluated using a numerical example and the results are presented and discussed.

Parallel session 2.3: Business Models

Time: Monday, 06/Jul/2020: 4:00pm - 5:00pm · *Location:* Virtual Room Heidi
Session Chair: Sergio Terzi, Politecnico of Milan, Italy

Join Session
Go to virtual conference room "Heidi"

Startup definition proposal using Product Lifecycle Management

Bernardo Reisdorfer-Leite, Michele Marcos de Oliveira, Marcelo Rudek, Anderson Luis Szejka, Osiris Canciglieri Junior
Pontifical Catholic University of Paraná - PUCPR, Brazil

Innovative products and services remain the primary drivers in innovation ecosystems. New ventures emerge in these ecosystems, and the number grows by the day. The leading ecosystems actors appoint the new firms as startups, and usually academics, and young entrepreneurs design and estab-lish these recent ventures. Many studies state that startups impact positively in the economy, contribute to its development, explore new market possibili-ties by investigating concrete exponential problems. Nevertheless, there is a missing concept of what a startup is, and even among practitioners, there are a plethora of definitions. As a result, it is an emerging standard without an explicit and universal meaning. This matter is also supported by the lack of definition in scientific literature, that does not define and delimit clearly the boundaries and the exact moments that may nominate an enterprise as a startup. Therefore, an explicit definition could support innovation ecosys-tems actors, like Policy Makers and University and Company Managers to improve the effectiveness of the establishment of startups as the main eco-systems' output. Hence, this study aims to propose a preliminary and generic definition of startups, using the PLM concept perspective as a starting point, since PLM seeks to improve innovation through managing company's prod-ucts across their lifecycles, from the first idea until its discard. To initiate the discussion, this study performs a Systematic Literature Review to seek pieces of evidence from the PLM perspective of what companies' features (metrics and maturity) allow to consider these enterprises as startups. As a result, it is expected a correlation between the startup development phases and PLM.

Rapid sales growth mechanisms and profitability for investment product manufacturing SMEs through pay-per-X business models

Mikko Uuskoski, Karan Menon, Hannu Kärkkäinen
Tampere University, Finland

Manufacturing small and medium enterprises (SMEs) are recognized as a major driving force economically in the European Union (EU). However, manufacturing companies and SMEs have often met with major difficulties in digitalization, and more specifically, in the implementation of novel industrial internet-enabled business models, such as pay-per-X type business. The overall aim of this study is to understand how manufacturing companies (especially SMEs) can make use of PPX business models largely in capital product markets, and how this impacts rapid sales growth and profitability for these investment product manufacturers. The studied two investment product manufacturing companies experienced rapid sales growth and there was an impact on the overall profitability for the companies. Sales growth was significant in both companies and PPX business models opened various new opportunities to extend company businesses. We found four main mechanisms that enabled rapid sales growth through PPX business models: strategic, pricing, financing and risk management mechanisms. Both the SME companies also experienced a negative impact on profitability despite rapid sales growth through PPX business models because of issues related to financing the investment product.

An Analysis of Flexible Manufacturing on the Support of the Development of Smart Product-Service Systems

Athon F. C. S. de Moura Leite[1], Matheus Beltrame Canciglieri[1], Yee Mey Goh[2], Radmehr P. Monfared[2], Eduardo de Freitas Rocha Loures[1], Osiris Canciglieri Junior[1]
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Currently, changes in customer's mindset and increased flexibility in manu-facturing shifted competition between companies to focus on product's val-ue rather than its cost. In this context, Product-Service Systems (PSSs) are an alternative to traditional value propositions (i.e. pure products, pure ser-vices) by combining services with products and providing an experience to customers. In recent decades, PSSs were expanded from solely business as-pects to engineering aspects and technical considerations in their scope, such as the paradigms of Technical PSS, Industrial PSS, Digitalized PSS and Cyber-Physical PSS. More recently, due to the application of Industry 4.0 concepts, there is a significant increase of "smart technologies", i.e. sensors; connectivity; mobile application, in PSSs, naming it a new paradigm on the field, known as Smart PSSs. In this context, this research aims to explore and discuss current issues related to the integration of flexible manufactur-ing processes and Smart PSSs, regarding information sharing, traceability and system reconfiguration based on customer's requirements. Found litera-ture points to gaps in the theme related to semantic issues and design issues regarding the dynamic reconfiguration of the manufacturing process and the Smart PSS. The modern approaches to the theme, as found in literature, are still not able to cope with the semantic barriers and high volume of hetero-geneous information in a holistic manner. Conclusions point that further in-vestigation on the cited issues is required in a systematic manner, as well as the development of models that can cope with the presented issues.

Design of a collaborative business model in cluster operation

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École de Technologie Supérieure, Montreal, Québec, Canada

Innovation is a key skill of companies. The academic literature on innovation in product development is well documented and abundant. However, the one according to innovation at the level of collaborative business models is less available and rarely

addressed. We are going to focus on innovation in terms of collaborative business model, more specifically on companies operating in a cluster. In 2020, it is necessary for companies to collaborate. However, when the time comes to carry out collaboration, they encounter different challenges. In order to act and try to resolve them, we will propose the design of a collaborative business model specifically for companies operating in a cluster. In this article, we will present the state of the art at the level of clusters as well as business models. We will then present our problematic relating to the need to collaborate between the companies belonging to a cluster. As an example, we will be referring to the Quebec aeronautical cluster. We will end with the presentation of a proposal for a collaborative business model, which was developed by using three business model representations and performed validation interviews with key people. The model will be presented according to the Osterwalder and Pigneur business model canvas. Ultimately, the collaborative business model will allow clustered businesses not only to collaborate more effectively with one another, but also to distribute the gains to all businesses in the cluster.

Parallel session 3.1: Smart factory 2

Time: Tuesday, 07/Jul/2020: 2:15pm - 3:15pm · *Location:* Virtual Room Cheese
Session Chair: Paolo Chiabert, Politecnico di Torino, Italy

Join Session
Go to virtual conference room "Cheese"

Smart Learning Factory - Network Approach for Learning and Transfer in a digital & physical set up

Roman Haenggi[1], Felix Nyffenegger[2], Frank Ehrig[3], Peter Jaeschke[4], Raphael Bernhardsgrütter[5]
[1]HSR, Switzerland; [2]HSR, Switzerland; [3]HSR, Switzerland; [4]FHS, Switzerland; [5]NTB, Switzerland

The smart factory promises significant cost savings particularly for high cost labor markets. The challenge in teaching smart factory courses or digitalization of manufacturing is the complexity of the topic. The smart factory is understood as a future state of a fully connected and flexible manufacturing system, operating autonomously or with optimized interaction between humans and machines by generating, transferring, receiving and processing necessary data to conduct all required tasks for producing different types of goods.

Due to this complexity the standard classroom teaching is not achieving sat-satisfactory results. A key element is the understanding of the physical goods process linked to data and IT infrastructure. This digital representation of the physical world is then the base for learning from data for a specific use case for the factory of tomorrow.

This paper describes how the Smart Learning Factory as a sample case at the university of applied sciences OST will be set up as an unique approach with three interconnected locations with a real, daily manufactured product mainly for educational purposes. Over the last years, successful initiatives towards the Smart Learning Factory have been established. This base is the fundament for a significant larger step. We are now approaching this next horizon with strong support by the Canton of St. Gallen and the strategic focus of the entire school. Our goal is to give all students of all technical and economic studies the opportunity to experience the smart factory in the real world. A fully digital twin of the physical world will play a key role in understanding the future of manufacturing. This makes it possible to discuss the conceptual approaches, challenges and success factors to implement a smart factory.

Analyses and study of human operator monotonous tasks in small enterprises in the era of Industry 4.0

Khurshid Aliev[1,2], Paolo Chiabert[1,2]
[1]Politecnico di Torino, Italy; [2]Turin Polytechnic University in Tashkent

Attraction of Industry 4.0 is evolving in academic and industrial community providing new solutions to reduce work load of the human operators by integrat-ing new technologies into manufacturing processes. To reduce human operators' time and/or reduce performance of boring tasks, collaborative robots (cobots) can be integrated into workplaces. The term cobots (collaborative robots) designed for cage-free work or that are robots which can directly work with human work-ers without safety barriers on the manufacturing floor. Recent cobots are human like arms which can be supporting tool for human worker or assist him as co-worker in the same workplace.

This paper provides results of study of human operator's workplaces in small and medium enterprises(SME) to integrate enabling technologies of industry 4.0 and to find new solutions to reduce work load and to increase productivity of production. In SMEs there are many cases where human operators perform mo-notonous tasks. Implementation of cobots and mobile robots to the workplaces can provide a good support for monotonous tasks of human workers, handling the tasks that require high precision or repeatability. The paper describes the inte-gration of cobots into the workplace of a manufacturing company where monoto-nous, cumbersome and stressing activities affect the wellness of the workers. The paper analyzes the current workflow and the ergonomic load of the worker, fur-ther developing the appropriate task distribution between human and robotic op-erators and demonstrates open source technologies to accomplish human robot collaborative application.

Distributed scheduling in cellular assembly for Mass Customization

Elie Maalouf[1,2], Julien Le Duigou[2], Bassam Hussein[1], Joanna Daaboul[2]
[1]International University of Beirut, Department of Industrial Engineering, Beirut, Lebanon; [2]Université de technologie de Compiègne, Department of Mechanical Engineering, Compiègne, France

Industry 4.0 has many objectives; among them is increasing flexibility in manufac-turing, as well as offering mass customization, better quality, and improved produc-tivity. It thus enables companies to cope with the challenges of producing increasing-ly individualized products with a short lead-time to market and higher quality. In Mass Customization, manufacturers are challenged to produce customized products at the lowest possible cost with minimal lead-time. This increased customization in-creases complexity in production planning. The main challenge becomes planning production for lots of one and for high product variety and volatile market demand. Moreover, the customer requires real time update on his order status, and is less toler-ant for delays. Nevertheless, in a make to order or assembly to order supply chain, many disturbances (supplier delay, machine brake-downs, transportation network disturbance …) may highly increase the customer order delay. Hence, production planning in this context becomes more complex requiring real-time information ex-change with all stages of the supply chain. This paper tries to answer this challenge by proposing a distributed production scheduling approach for mass customization in a cellular assembly layout.

A Method to Gaze Following Detection by Computer Vision Applied to Production Environments

Emannuell Dartora Cenzi, Marcelo Rudek
Pontificia Universidade Catolica do Parana - PUCPR, Brazil

The humans have the natural ability of following objects with the head and eyes and identify the relationship between those objects. This daily activity represents a challenge for computer vision systems. The procedure to identify the relationship between human eye gaze and the trackable objects is complex and demands several details. In this current paper we proposed a review of the main gazing following methods, identified the respective performance of them and also proposed an AI based method to

estimate the gaze from 2D images based on head pose estimation. The main important details to be recovered from images are scene depth, head position and alignment and ocular rotation. In this approach we perform a track estimation of the gaze direction without the use of the eye position, and also, the face partial occlusion is considered in the analysis. The proposed approach allows low cost in processing with considerable accuracy at low complexity sceneries, because we don't need to extract the facial features. Gaze tracking is important to evaluate employees' attention to specific tasks in order to prevent accidents and improve work quality. The presented method improves the current knowing workflow by applying the head pose estimation instead face detection for training and inference. The promisor's results are presented, and open points are also discussed.

Parallel session 3.2: Special session on AI in CAx, MBE, and PLM

Time: Tuesday, 07/Jul/2020: 2:15pm - 3:15pm · *Location:* Virtual Room Chocolate
Session Chair: Lionel Roucoules, Arts et Métiers, France

Join Session
Go to virtual conference room "Chocolate"

Participative Method to identify Data-Driven Design Use Cases

Simon Rädler, Eugen Rigger
V-Research GmbH, Austria

Paradigms such as smart factory and industry 4.0 enable the collection of data in enterprises. To improve the design process, computational support that is driven by data seems to be beneficial. With this respect, an identification of data-driven use cases is needed.

Still, the state of practice does not reflect the potential of data-driven design in engineering product development.

With this respect, a method is proposed supporting the business and data understanding to identify use cases for data-driven design based on Product Lifecycle Management (PLM) analysis and corresponding data. Main process tasks are analyzed using SIPOC analysing followed by a process decomposition to further detail and highlight corresponding applications using Enterprise Architecture methods. Thus, value stream mapping and design process failure mode effect analysis is used to identify sources of waste. With this, a feature analysis of given data is proposed to identify use cases and enable to further use standard data science methods like CRISP-DM.

The method is validated using the infrastructure of the Pilotfabrik at TU Vienna. The use case shows the applicability of the method to identify features that influence the cost of a product during the manufacturing without changing the functional specifications.

The result highlight that different methods needs to be combined to attain a comprehensive business and data understanding. Further, a comprehensive view of the processes is yielded that enables to further identify use cases for data-driven design. This work lays a foundation for further research with respect to data-driven design use cases identification in engineering product development.

Data Analytics & Application Challenges in the Childrenswear market- a case study in Greece

Evridiki Papachristou[1], Nikolaos Bilalis[2]
[1]International Hellenic University; [2]Technical University of Crete

Integrating technology solutions like PLM, 3D Prototyping, digital printing, automatic cutting, AR & VR into the fashion product development process can deliver continuous improvement in everyday business and empower fashion companies navigate the challenges and opportunities of Industry 4.0. Leveraging powerful artificial intelligence capabilities that guide the discovery of next-generation - in popularity- fashion product designs, can improve innovation and conceptual design exploration to the clothing companies. This study focuses in the market of childrenswear which is the fastest-growing and one of the most lucrative markets in the garment industry; a growth that had overtaken both menswear and womenswear. At the same time, childrenswear product consumers are fashion conscious, demanding more fashionable designer clothing. Predicting the best appealing and selling product maybe the recent demand of applying AI tools in the design generation phase or decision making process, however comfort, fit for play, rest and safety most of all, are requirements that childrenswear must comply with. This paper aims to identify the challenges that AI technology applications face regarding childrenswear, due to safety restriction and standards by taking into consideration a Greek childrenswear manufacturer and retailer.

Real-time detection of eating activity in elderly people with dementia using face alignment and facial landmarks

Mhamed Nour
ETS, Canada

The aim of this research is to automatically detect the intake of meals for elderly people with dementia living alone by using the product lifecycle management con-cepts (PLM). We use it to create a service based on an Artificial Intelligence product which will reduce the need for a caregiver or a person as medical support, hence less travel (Co2, etc.), less time spent by a third party on a verification/monitoring task, greater autonomy and therefore improve quality of life. Thus, overall, for society, this service based on an AI product is a win-win approach for pollution and an increase in the value of the tasks of the caregiver and the person as a medical support.

The choice of appropriate AI assistive technology was done to satisfy both the el-derly people with neurodegenerative disorders and the caregiver, to verify the ethical aspect, simplify design, optimize code and improve user friendly aspects. During all this process of design of the new service based on an AI product, the PLM concepts were fruitfully applied by involving the different experts concerned (medical, ethical, technological, etc.) and taking into account all the characteristics of the environment of the product from the beginning to the end.

Trusted Artificial Intelligence: On the Use of Private Data

Norbert JASTROCH
MET Communications, Germany

Artificial Intelligence has come into focus anew in the context of digitization and global competition. So has the tension between human ethics, regulation, and the potential gains this technology field offers for economic and societal progress. This paper is intended to contribute to the ongoing debate about opportunities and uncertainties in particular with respect to the use of private data in AI. We discuss the status of AI outcomes in terms of their validity, and of AI input as to the quality of data. In a first order approach we suggest to distinguish between the commercial, public, industrial, and scientific data spheres of AI systems. We

resume the ethical and regulative approaches to the utilization and protection of massive private data for AI. Regarding the currently favoured ways of organizing the collection and protection of data we refer to respective ruling and denominate distributed ledger systems and open data spaces as functional means. We conclude by arguing that governing data privacy and quality by distinguishing different AI data spheres will enable a reasonable balance of these two aspects.

Parallel session 3.3: Special Session on maturity implementation and adoption 2

Time: Tuesday, 07/Jul/2020: 2:15pm - 3:15pm · *Location:* Virtual Room Heidi
Session Chair: Mourad Messaadia, CESI, France

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Go to virtual conference room "Heidi"

Blockchains: A conceptual assessment from a product lifecycle implementation perspective

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PLM systems are heavily distributed collaborative platforms resulting in multiple challenges related to the integrity and reliability of the exchanged information. Such issues are usually difficult to address using traditional software solutions. However, since the introduction of blockchains, such challenges are currently being effectively addressed. On the one hand, traditional PLM systems design philosophy was mainly about centralized proprietary systems that have difficulty to cope with new distributed and open environments imposed by the extensive use of IoT platforms and other Industry 4.0 tools. On the other hand, blockchains address data integrity issues by design, and mitigate some of the trust concerns found in collaborative platforms. Through this paper, we study and evaluate the integration of blockchain technology with PLM systems highlighting the different advantages, challenges, and issues that this integration might induce.

A comprehensive maturity model for assessing the product lifecycle

Philipp Pfenning[1], Hannes Christian Eibinger[1], Clotilde Rohleder[2], Martin Eigner[3]
[1]Siemens Digital Industry Software, Germany & Switzerland; [2]University of Applied Sciences Constances, Germany; [3]Technical University of Kaiserslautern, Germany

Digitalization is one of the most frequently-discussed topics in industry because of new disruptive business models and changes in organization, processes, and tools. The goal is to make a company more efficient, productive and ultimately profitable. However, many companies are facing the challenge of how to approach digital transformation in a structured way and to realize these potential benefits. For this purpose, a novel maturity model is introduced. It encompasses fifty capabilities and core processes along the entire product lifecycle and enables manufacturing firms to assess their current maturity level on a five-tier scale. Product Lifecyle Management will play a key role in future digitalization intends. Therefore, it constitutes a main topic of the novel maturity model. Because this model has been employed almost two hundred times, it allows a company to compare against an industry-specific benchmark to identify strengths and weaknesses. Furthermore, an empirical study produced multi-dimensional correlation coefficients, which identify dependencies between company characteristics and capabilities.

PLM functionalities in the Fashion Industry. Preliminary results of a classification framework

Virginia Fani, Romeo Bandinelli, Bianca Bindi
University of Florence, Italy

As widely known, Product Lifecycle Management (PLM) is a set of busi-ness solutions and tools for the management of the entire lifecycle of a product, from its conception to its disposal. Despite PLM was born in tra-ditional contexts, recently it is increasingly used in other sectors such as the fashion industry, even if it shows several features that distances it from the traditional approach to PLM deployment. Request for customized prod-ucts, rapid changes in customer's preference and the consequent shorter product lifecycles make the fashion environment very complex. Within this scenario, PLM has the potential to enable fashion industry to reduce time to market and to increase competitiveness in the global scenario, but quite often clear guidelines are not available. Literature is not exhaustive, as we can't find articles covering the whole set of functionalities. Quite often only few features have been mentioned and the same functionalities have been differently called. To overcome this gap, the purpose of this research is the definition of a framework on PLM functionalities in fashion, classified according to the macro-processes where they are involved. The result is an overview of the PLM functionalities organized in macroprocesses, moving from the development of the creative idea to the arrival in the stores, validated by experts of PLM software houses working within the fashion industry. From a managerial point of view, it represents a clear guideline to support companies and vendors to identify the whole range of PLM functionalities and the processes positively involved during their implementation.

Challenges of Integrating Social Life Cycle Sustainability Assessment into Product Lifecycle Management - State of the Art -

Jing Lin[1], Clotilde Rohleder[2], Selmin Nurcan[3]
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Despite the importance of Social Life Cycle Sustainability Assessment (S-LCSA), little research has addressed its integration into Product Lifecycle Management (PLM) systems. This paper presents a structured review of relevant research and practice. Also, to address practical aspects in more detail, it focuses on challenges and potential for adoption of such an integrated system at an electronics company.

We began by reviewing literature on implementations of S-LCSA and identifying research needs. Then we investigated the status of S-LCSA within the electronics industry, both by reviewing literature and interviewing decision makers, to identify challenges and the potential for adopting S-LCSA at an electronics company. We found low maturity of S-LCSA, particularly difficulty in quantifying social sustainability. Adoption of S-LCSA was less common among electronics industry suppliers, especially mining & smelting plants. Our results could provide a basis for conducting case studies that could further clarify issues involved in integrations of S-LCSA into PLM systems.

Parallel session 4.1: Special session on BIM

Time: Tuesday, 07/Jul/2020: 3:30pm - 4:30pm · *Location:* Virtual Room Cheese
Session Chair: Vishal Singh, Indian Institute of Science, India

Join Session
Go to virtual conference room "Cheese"

Towards AR/VR maturity model adapted to the Building Information Modeling

Ahlem Assila, Djaoued Beladjine, Mourad Messaadia
LINEACT Laboratory, France

The challenge of improving the efficiency of the different phases of a build-ing or infrastructure life demands considerations of innovative technologies such as Augmented Reality (AR) and Virtual Reality (VR). During this last decade, AR/VR systems for construction started to be emerged. These appli-cations aim to virtualize or augment in real time the content of the Building Information Modeling (BIM) in order to support continuous improvement. To ensure the maturity of these applications, implementing a maturity model is needed. Based on literature, several maturity models for BIM have been proposed. However, it stays generic and needs to be adapted to the AR and VR technologies in the BIM context. To that end, we started in this paper by proposing an adapted AR/VR maturity model for BIM that aims to evaluate the maturity of these technologies according to the BIM lifecycle. This model has been conceived based on a mapping between three existing maturity models corresponding to AR, VR and BIM technologies from the most adapted existing works that deal with our goal. As a result of this mapping, three maturity levels have been identified and a detailed description of each level has been established. This model will be proposed to construction companies in order to evaluate their maturities on the use of AR/VR technol-ogies.

A Quantitative Evaluation Framework for the Benefit of Building Information Modeling for Small and Medium Enterprises leveraging Risk Management Concepts

Christoph Paul Schimanski[1,2], Giada Malacarne[2], Gabriele Pasetti Monizza[2], Dominik T. Matt[1,2]
[1]Free University of Bozen-Bolzano, Italy; [2]Fraunhofer Italia Research

Building Information Modeling plays an increasingly important role in today's construc-tion sector due to its growing prevalence among practitioners and the increasing legal obligation to use it in public projects. The general and most obvious benefits such as improved communication/coordination or rapid generation of various planning alterna-tives are widely accepted. However, there is a lack of a generic framework to quantify these benefits. This is especially important from the perspective of small and medium sized enterprises because larger investments - as they may occur through software and training when implementing BIM - should be balanced against a traceable return-on-investment. With a few exceptions, other research focuses on qualitative or non-monetary assessment parameters to evaluate these benefits. Such an approach may be too vague in the context of small and medium-sized enterprises to justify the necessary strategic decisions on a BIM changeover. In this study we propose a generic framework for quantitative evaluation of the BIM benefit. This evaluation is based on the BIM-impact on contingency estimation in construction risk management relying on Monte Carlo simulations. Semi-structured interviews and questionnaires with practitioners are used to evaluate how risk factors and subsequently contingencies can differ from each other in BIM-projects and Non-BIM projects.

Parallel session 4.2: Internet of things (IoT, IIoT)

Time: Tuesday, 07/Jul/2020: 3:30pm - 4:30pm · *Location:* Virtual Room Chocolate
Session Chair: Sebti Foufou, New York University Abu Dhabi, United Arab Emirates

Join Session
Go to virtual conference room "Chocolate"

Smart Manufacturing Testbed for the Advancement of Wireless Adoption in the Factory

Richard Candell[1], Yongkang Liu[1], Mohamed Kashef[1], Karl Montgomery[1], Sebti Foufou[2]
[1]National Institute of Standards and Technology, United States of America; [2]Universite de Bourgogne, France

Wireless communication is a key enabling technology central to the advancement of the goals of the Industry 4.0 smart manufacturing concept. Researchers at the National Institute of Standards and Technology (NIST) are constructing a testbed to aid in the adoption of wireless technology within the factory workcell and other harsh industrial radio environments. In this paper the authors present a new industrial wireless testbed design that motivates academic research and is relevant to the needs of industry. The testbed is deigned to serve as both a demonstration and research platform for the wireless workcell. The work leverages lessons learned from past incarnations that included a dual robot machine tending scenario and a force-torque seeking robot arm apparatus. This version of the testbed includes computational and communication elements such that the operation of the physical system is noticeably degraded under the influence of radio interference, competing network traffic, and radio propagation effects applied within the lab. Key performance indicators of the testbed are selected and presented which include communication, computational, and physical systems indicators. The testbed includes two collaborative grade robot arms, programmable logical controllers, and high-performance computing devices for situational tracking, alerting, and control. Important topics presented include use case selection, middleware candidate selection (ROS/ROS2), and the selection of protocols for the study of high-reliability, low-latency communication solutions. Data products and machine learning application opportunities are explored. The paper is aimed to provide our contribution to the exploration of industrial wireless testbed design while soliciting feedback from fellow researchers.

Smart Dust in the Industrial Economic Sector – On Applications in Product Lifecycle Management

Manuel Holler[1], Jens Haarmann[1], Benjamin van Giffen[2], Alejandro G. Frank[3]
[1]Zurich University of Applied Sciences, Switzerland; [2]University of St.Gallen, Switzerland; [3]Universidade Federal do Rio Grande do Sul, Brazil

Smart dust is an autonomous sensing, computing, and communication system that can be packed into a cubic-millimeter mote to form the basis of integrated, massively distributed sensor networks. The purpose of this manuscript is to identify potential applications of smart dust in product lifecycle management with a focus on the industrial economic sector. Resting upon empirical data from the European DACH region, we describe six applications: (1) Advancement of requirements engineering, (2) Improvement of manufacturing processes, (3) Enhancement of logistics monitoring, (4) Optimization of operations, (5) Ameliorated maintenance and repair processes, and (6) Augmented retirement planning. Bearing the exploratory, qualitative approach and early-stage character of applications in mind, we can reason that smart dust offers great potentials to both product lifecycle management and research on it.

PLM migration in the era of Big Data and IoT: analysis of information system and data topology

Piers Barrios[1], François Loison[2], Christophe Danjou[3], Benoit Eynard[1]
[1]Université de technologie de Compiègne, France; [2]Gfi Informatique, France; [3]Polytechnique Montréal, Canada

As product lifecycle management is starting to be a standard information system in most companies, a data manipulation issue starts to emerge. Indeed, the information contained in a system often needs to be accessible or even transferred to another one to exploit a new software's functionalities. With the Big Data era, new methods of analysis start to emerge, and the graph visualisation of data enables a better human-understanding of the data itself.
We propose to address the PLM migration issues with a new approach based on analysis of information system and data topology. The data is passed onto a graph and bundles are made thanks to clustering algorithms; this bundling enables a better understanding of the data and ease migration. However, PLM has links between links which complicate the transition to graphs. Finally, the described use-case proves that data bundling eases the data migration and prevents some usual pitfalls and delays.

Parallel session 4.3: Industrial technical presentations

Time: Tuesday, 07/Jul/2020: 3:30pm - 4:30pm · *Location:* Virtual Room Heidi
Session Chair: Felix Nyffenegger, University of Applied Science Rapperswil, Switzerland

Join Session
Go to virtual conference room "Heidi"

Engineering IT management on end-to-end PLM structure in automotive sector

Kaan Doga Ozgenturk[1], Buse Isil Elmali[1], Semih Otles[2]
[1]BMC Otomotiv, Turkey; [2]Ege University, Turkey

As of today, PLM infrastructure has key role on companies' processes with respect to their end-item quality whereas it also practically determines the company culture, validness of the data, complexity, singularity and most of all profitability. Moreover, in order to give birth to these integrated processes, systems of PLM are needed which are administrated by solution architects who are experts on both IT and engineering solutions. Occasionally, single tool is not capable of handling processes from beginning to end. For that rea-son, there occurs a demand in multiple softwares. These diverse programs have characteristic powerful aspects coming with their weaknesses as well and they determine companies' way of work. Nevertheless, they have ten-dency on creating complex flows on data and process. In order to avoid these interruptions and provide a single source of data, it is necessary to cre-ate end-to-end process on a single platform within the company. This is where the solution architects must lead this PLM journey for all departments according to their needs. Particularly in automotive sector, the journey starts with the requirements, which are then driven to functional and logical ob-jects. The further phases are designing, manufacturing, planning and work instructions, which must be led by allocating the resources. It can be under-stood that all these functions require different expertise; however, traceabil-ity can only be handled on a linear flow so that the impact analysis and change management can work smoothly. In order to stand to those needs, so-lution architects should handle both IT and engineering requirements in order to create end-to-end process flow.

Reference Architecture in the Context of PLM on Cloud Adaption

Rajesh Madala, Rameshwar Banore
Tata Consultancy Services, India

Cloud adaption across applications is common in all organizations. The reason for cloud adaption is driven by two fundamental factors: cost and better capabilities. Cloud provides better options with reference to auto scaling based on application usage, on-demand instances creation, easy rehosting and additional capabilities around built-in DevOps, Analytics, AI and Micro-services oriented architecture capabilities.

However, it is important to understand how to utilize these capabilities in an appropriate manner to realize the value in the context of cloud.. However, it is important to understand the PLM tools digital gap using the reference architecture which helps in understanding the possibilities in cloud adaption for different PLM and cloud technologies to maximize the value and straight forward implementation or migration to cloud.

SLIM: Sleek Lifecycle Integration & Management

Purnima Rao[1], Kandhasami Palaniappan[2]
[1]Robert Bosch Engineering and Business Solutoins Private Limited, India; [2]Robert Bosch Engineering and Business Solutoins Private Limited, India

“A techno-domain-driven approach will in all likelihood revolutionize how a product development organization resonates with changing end-user demands and, its vendors in a collaborated and continuous engineering setup, and thereby driving transformational change.”

The increasing convergence of markets and smart products, shifting business models as well as increased customer expectations have created an un-precedented level of complexity for product development organizations. Particularly, in the automotive industry, complexity has literally exploded in the four dimensions of product, processes, tools and compliance. Thereby, product development organizations are under tremendous stress to adopt stringent processes thus, leading to complex tools usage to meet the target compliance. In order to be in a position to cope with this dilemma of new complexity and to safeguard sustainable competitiveness, it is vital for organizations to implement an integrated, holistic approach to manage the different dimensions of product development. As current product development involves hardware, electrical & mechanical (PLM) components and software components (ALM), their respective lifecycle management processes also throw challenges of coordinated and continuous engineering. This means we need a paradigm shift from the traditional practice of disparate lifecycle management to an innovative concept like Sleek Lifecycle Integration & Management (SLIM).

Parallel session 5.1: Circular Economy

Time: Wednesday, 08/Jul/2020: 1:15pm - 2:15pm · *Location:* Virtual Room Cheese
Session Chair: Fernando Mas Morate, EADS,

Join Session
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An innovative methodology to optimize aerospace eco-efficiency assembly processes

Manuel OLIVA[1], Fernando MAS[2], Ignacio EGIA[3], Carmelo del VALLE[3], Emanuel J. LOURENÇO[4], Antonio BAPTISTA[4]
[1]AIRBUS, Spain; [2]COMLUX America LLC, United States of America; [3]University of Seville, Spain; [4]Institute of Science and Innovation in Mechanical and Industrial Engineering, Portugal

Sustainability and eco-efficiency have been researched in multiple scientific papers since the last years. However the literature is not so abundant when ap-plying those concepts to industrial assembly processes. This paper presents an innovate methodology to optimize aerospace assembly processes. Authors pro-pose the introduction of a new element, the eco-efficiency, along with the tra-ditional criteria, cost and time, currently used for optimization. Using a large Aero-Structure as an industrial case of study, the methodology analyzes the eco-efficiency of an assembly process in connection with a Life Cycle As-sessment (LCA) to compute the environmental impact. Results are shown in a dashboard along with the relevant Key Process Indicator (KPI) to help the en-gineers to select the best assembly process.

Towards a data classification model for circular product life cycle management

Federica Acerbi, Marco Taisch
Politecnico di Milano, Italy

Nowadays more than ever, due to the limited availability of resources, the adoption of sustainable practices is gaining importance, especially while dealing with the manufacturing sector that is considered one of the most re-source greedy sectors. Recently a new sustainable and industrial economy arisen. This is called “circular economy” and, it is designed on purpose to be regenerative and restorative. The diffusion of this economy can be eased by the advance management of data and information. Nevertheless, from the extant literature emerged some criticalities regarding data usage and exploitation, especially while dealing with circular economy adoption. Indeed, the present work aims to investigate the decisions that manufacturers have to take to enable the circular product life cycles and thus, the data and information required to take the right decisions in making the product pursuing a circular path. To achieve this goal, the present work relies on scientific literature. This choice enables to grasp the widespread knowledge developed by scholars about these concepts, by individualizing the main decisions that should be taken by the company internal stakeholders, to design and produce circular products, being affected by external stakeholders’ behaviours and decisions along the product life cycle. Therefore, this work aims to support circular product life cycles management and, this objective has been achieved through the development of a data classification model

A Disassembly Line Design Approach for Management of End-of-Life Product Quality

M.-Lounes Bentaha, Nejib Moalla, Yacine Ouzrout
University of Lyon, France

The purpose of this work is to e

ciently design a disassembly
line, as disassembly system, handling variability of End-of-Life (EOL)
product quality as well as uncertainty of disassembly process operations
and provide an optimal revenue of such a system. The main

nding of
this work is the development of a decision tool that allows decisionmakers to choose the best disassembly process and disassembly depth while assigning the corresponding tasks to the line workstations under precedence and cycle time constraints. Task times are assumed to be random variables with known normal probability distributions. The case of presence of hazardous material is studied and cycle time constraints are to be jointly satis

ed with at least a certain service (probability) level set by the decision-maker. The revenue of a product part depends explicitly on its EOL state or quality. Industrial applicability is shown using an industrial case focused on the remanufacturing of mechatronic parts in the automotive industry.

Exploring how design can contribute to Circular Economy through Design for X approaches

Claudio Sassanelli, Paolo Rosa, Sergio Terzi
Politecnico di Milano, Italy

Design plays a strategic role for companies in addressing servitization and Circular Economy (CE) paradigms, to deliver either products, or services or Product-Service Systems (PSSs). Design for X (DfX) practices, belonging to concurrent engineering approach, have revealed great effectiveness in enriching products with functionalities as service supportability and circularity. They have been also used to systematize PSSs components along the design process, enabling and easing design knowledge creation and sharing between product and service designers. Nevertheless, notwith-standing the abundance of DfX approaches related with the End of Life (EoL) stage, they still lack of a CE perspective. Therefore, this paper wants to explore how design can contribute to CE through the use of DfX approaches.

Parallel session 5.2: New product development

Time: Wednesday, 08/Jul/2020: 1:15pm - 2:15pm · *Location:* Virtual Room Chocolate
Session Chair: Monica Rossi, Politecnico di Milano, Italy

Join Session
Go to virtual conference room "Chocolate"

Implementing Secure Modular Design of Configurable Products

Henk Jan Pels
retired from Eindhoven University of Technology, Netherlands, The

Secure modular design is a method to reduce failures in complex configura-ble product. After introducing the theory behind the method in (1), this paper describes the process of implementing this method in a mechanical engineer-ing environment. Much attention has been paid to involving engineers and management in setting up the implementation process, especially in translat-ing the abstract mathematical concepts in the theory to concrete mechanical concepts. Although the method requires additional effort in recording design constraint, the participants in the implementation process expressed confi-dence in the value of the method.

CONCEPTUAL REFERENCE MODEL FOR DFSS-ORIENTED PRODUCT DEVELOPMENT PROCESS

Marta Gomes Francisco[1,2], Osiris Canciglieri Junior[2], Ângelo Márcio Oliveira Sant'Anna[3]
[1]Federal Institute of Education, Science and Technology of Paraná; [2]Pontifical Catholic University of Paraná - PUCPR, Brazil; [3]Federal University of Bahia

Changes in the world market and consumer expectations have changed the way organizations develop new products. Meeting these challenges means doing better since the beginning of product design, avoiding possible failures and adjustments at a late stage in the development process. Design For Six Sigma has been successfully applied in the product development process, with the purpose of ensuring convergence to customer specifications, ensuring reliability in product development, reducing or eliminating operational vulnerabilities and increasing product robustness with use of appropriate techniques and tools. This study showed that there is no systematic DFSS structure integrated with a reference model for the product development process that encompasses the entire process, from observing the consumer's need to discontinuing the product in the market. This paper proposes a conceptual model for the product development process oriented to DFSS, based on a systematic study of existing DFSS methods with the integration of a PDP reference model. The research strategy of this study sought to understand the phases of the existing DFSS methods, as well as to identify the factors that determine or contribute to the application of these methods in the product development process. Results The investigation of the theme showed a lack of standardization of a DFSS method integrated with a reference model for the product development process, which allowed the identification of 11 activities from each phase of the DFSS methods, which were aligned with the 14 activities proposed by the reference model for the MOP&D product development process. This study led to a consensus in the construction of an integrated conceptual model oriented to DFSS concepts with a friendly characteristic for application in the product development process of durable goods.

Addressing Obsolescence from day one in the conceptual phase of complex systems as a design constraint

Sophia Salas Cordero[1,2], Rob Vingerhoeds[1], Marc Zolghadri[2], Claude Baron[3]
[1]ISAE-SUPAERO, University of Toulouse, France; [2]SUPMECA, Quartz Lab, Paris, France; [3]INSA, LAAS, University of Toulouse, France

Obsolescence issues are one of the main costs in the life-cycle of sustainment-dominated systems, those that require support for many decades.

Obsolescence not only occurs when a system element becomes no longer available due to manufacturing updates or production interruption. It also includes the deterioration of the system or component capacity to operate as intended, since it is no longer suitable to fulfil its function, even if it still operates and can be manufactured and supported. As such, it also impacts on the "-ilities" (reliability, functionality, etc. …) which can be even traced to legislation changes, for instance, the anti-pollution legislation updates for automotive.

Obsolescence has so far been mainly addressed from a reactive point of view. Around 70% of the total product cost is committed as a result of decisions in the early design stages. Late changes induce delays in the life-cycle plan and large increases in cost due to re-design and rework. Knowing the impact of the conceptual design phase on life-cycle cost, this paper intends to present a model-based systems engineering approach to proactively assess the obsolescence risks.

The approach uses obsolescence considerations as constraints during the early design phases, to allow the identification of components potentially at risk for obsolescence. Presenting designers with such information allows them to make changes to the design, to make it robust and resilient, or to accept the risk and develop an obsolescence mitigation plan.

It will be illustrated with an example from the automotive industry.

Parallel session 5.3: Digital twins

Time: Wednesday, 08/Jul/2020: 1:15pm - 2:15pm · *Location:* Virtual Room Heidi
Session Chair: Frédéric Noël, Grenoble-INP - G-SCOP, France

This session has 5 presentations and will take 15 minutes longer then scedulled.

Join Session
Go to virtual conference room "Heidi"

Digital Twin Representations of Concrete Modules in an Interdisciplinary Context of Construction and Manufacturing Industry

Detlef Gerhard, Mario Wolf, Jannick Huxoll, Oliver Vogt
Ruhr University Bochum, Germany

Based on the knowledge gained from mechanical engineering and research activities in the context of Industry 4.0, innovative, modular building construction approaches based on flow production methods must be based on a real-time life-cycle-oriented management of information about products, production processes and created systems. To enable rapid, individual, precise, and fault-tolerant production of flexible modules made of high-performance, free-formable concrete, data from the ongoing production process and data describing the current status of the module must be continuously collected, combined and made available. Based on this information, the individual production steps can be fine-tuned and the utilization of the machines better planned. Furthermore, it can be verified, whether the current status of a produced module still meets the previously defined requirements from engineering. A state-of-the-art literature review and comparison for digital twin concepts from both involved domains, construction as well as production, is presented in the paper. The contribution gives insights of the requirements elicitation for the formal description of the product requirements in terms of function and quality, considering the possible uncertainties in the course of production. Furthermore, it shows a draft concept for the administration shell for digital twins comprising integrated and adaptable data and interaction models for the industrialized production of high-performance concrete modules.

Digital Twin and Product Lifecycle Management: What is the difference?

Dmytro Adamenko, Steffen Kunnen, Arun Nagarajah
University Duisburg-Essen, Germany

With the rapid development of modern information and communication technolo-gies as well as infrastructure, the Digital Twin (DT) approach becomes increas-ingly popular and widely used throughout the industry and research. The DT is considered to be the key technology to realize the comprehensive digital descrip-tion of components, products and systems including the information from all lifecycle phases. The Product Lifecycle Management (PLM) strategy has been present in the industry for many years and is considered as the most effective way of managing the components, products and systems of a company all the way across their lifecycles from the first idea of the product to its disposal. The DT is not yet clearly defined. It can be defined as a set of models, linked with each other as well as with the physical product enabling data storage and real-time processing. In contrast to a DT the PLM strategy provides a framework, which serves as single source of truth connecting the partial models, that describe the physical product. The models can receive the data stored in a product data man-agement system (PDM).

The aim of the present paper is to distinguish the characteristics of the Digital Twin and PLM as well to find similarities and differences in the both approaches. The current development of both strategies is presented, and the answer to the question, where is the difference between Digital Twin and PLM is given.

A complete digital chain to enable the digital twin of a shop floor

Frédéric Noël, Gulgun Alpan, Fabien Mangionne
Grenoble-INP - G-SCOP, France

Digital twins, as promoted by Doctor Grives from 2002, are new paradigms as soon as we consider the system as the tuple (physical system, digital twin). In this tuple, the digital twin has obviously no sense without the existence of the physical system, and the tuple has no sense if the digital twin does not correctly represent the physical system. Under this consideration many new challenges and opportunities are open.

The G-SCOP lab has contributed in an industrial project to the construction of a digital twin architecture to manage a shop floor. The experience is a major one since it concerns a complete factory. But to reach the status of digital twin with added value for shop floor management, simulation capacities and a complete digital chain to ensure the real time synchronisation of the real production system with the corresponding model (the core component of the digital twin) are required. Here a discrete event simulation model is integrated within a realistic visual 3D representation of the shop floor.

This paper presents the architecture of the developed digital twin and discusses its added value with respect to production needs. It focuses on the major aspects about key performance indicators synchronisation as observed in the physical world and the anticipation of future events depending on various production decisions. The digital twin, hence, becomes a tool to support collaborative decision-making.

Middle of Life Digital Twin: Implementation at a Learning Factory

Luiz Fernando C. S. Durão, Matheus Morgado, Roseli de Deus Lopes, Eduardo Zancul
University of Sao Paulo, Brazil

In recent years, several IT systems have been applied to collect different types of data concerning the full product lifecycle. As a result of Industry 4.0 developments, the amount of product information collected over the entire lifecycle has been growing. Information and communication technologies are employed to digitally mirror the lifecycle of a corresponding physical product in Digital Twin applications. These applications are middleware architectures that apply physical world information to support real-time decisions. Therefore, a Digital Twin may be applied to enhance simulation, to improve traceability, and to expand the value-

added services offering along the lifecycle. However, studies on Digital Twin applications are mainly focused on the begging of life (BOL) or manufacturing optimization. In this paper, Product Lifecycle Management (PLM) theory and Internet of Things (IoT) solutions and technologies are applied to build a Digital Twin able to collect and cast middle of life (MOL) information to the other lifecycle phases. Based on the scenario implementation in a Learning Factory, the objective is to discuss the information flow that is required for a Digital Twin to be considered for closing the information gap between the product in the use phase and other lifecycle phases. The results show how a middle of life Digital Twin can impact processes and information flow. Future research work should integrate the information of multiple IT systems from the entire product lifecycle in a comprehensive Digital Twin.

Complete and integrated digital within a SME

Léandre Guitard[1,2], Frédéric Noël[2], Daniel Brissaud[2]

[1]Hellomoov; [2]Grenoble-INP - G-SCOP, France

A complete Digital Twin describes an entity following and taking part in the life of a system, from its design during its regular use, up until its end of life. We picture it as a coherent set of modules that are used depending on the state of progress of the system. Modules such as; a design assistance, a simulator, an assembly/manufacturing assistance, an operation training, an ICS, a predictive maintenance module, a reconfiguration assistance, and an end of life estimation. The Digital Twin can be a powerful lifecycle management tool.

It seems too complicated to try integrating all the modules simultaneously. It's important to build an expendable architecture. To define the order in which to integrate the modules, we can; use the benefit/effort matrix, consider the synergies that these modules could generate and the other projects that the company might have underway. Another major criterion is insuring the digital continuity in order to implement a sustainable model for the Industry 4.0.

The modules used after-sales, such as the predictive maintenance module, are harder to implement, because you need to manage the connection/communication with the system after delivery. Therefore, the modules that are the easiest to implement are the ones before-sales, because they are integrally managed internally.

This study is conducted in a medium size enterprise which allows us to address the concrete deployment of a digital twin in the industrial activities. The deployment strategy needs to be combined in order to prevent the features of the digital twin to be perceived as a hindrance. This study focuses on a simulator that links up offer design, detailed design and assembly/manufacturing follow up.

Parallel session 6.1: Tools to support early design phases

Time: Wednesday, 08/Jul/2020: 2:30pm - 3:30pm · *Location:* Virtual Room Cheese
Session Chair: Grant McSorley, University of Prince Edward Island, Canada

Join Session
Go to virtual conference room "Cheese"

3D sketching in VR changing PDM processes

Carsten Seybold, Frank Mantwill
Helmut Schmidt University, Germany

The use of PDM systems is especially in the late phases of product development state of the art. Managing CAD models, bill of materials or technical drawings to name a few strengths of PDM systems. In the early phases there is still a big gap existing. In fact, it is possible to integrate requirements for future products in the meaning of product lifecycle management into a PDM system. Following steps of product developing like principle solutions or initial design sketches are almost not represented yet. The main reason is, that this early design work is currently done without computer assistance. An integration of such handcrafted sketches in PDM systems is in case of digitalization possible, but further use is strongly limited. 3D sketching in Virtual Reality helps to close this gap. It is possible to use these sketches as a template for further use in CAD and integrate them in PDM systems. Certainly, PDM systems are not prepared for integrating such new classes of content in present structures and processes. Therefore it is important to develop new structures and processes to allow a higher use of computer assistance in the early phases of product development. The objective is to reach a traceability for the product from requirements via sketches to CAD models to complete the product lifecycle management approach in companies. During design of different series, new versions, variation or further designs it is key to have access to such knowledge and basic considerations to minimize or even avoid iterations in product design.

Knowledge Graph of Design Rules for a Context-Aware Cognitive Design Assistant

Armand HUET[1], Romain PINQUIE[2], Philippe VERON[3], Frédéric SEGONDS[1], Victor FAU[4]
[1]Arts et Métiers Institute of Technology, LCPI, HESAM Université, 75013 Paris, France; [2]Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, Grenoble; [3]Arts et Métiers Institute of Technology, LISPEN, HESAM Université, F-13617 Aix-en-Provence, France; [4]Capgemini DEMS, Toulouse, France

[Context] The design of a system shall comply with many design rules that help industrial designers to create high quality design in an efficient way. Nowadays, design rules try to consider all product lifecycle's phases leading to an ever-increasing growth. This context makes the management of design rules a difficult but essential task. This is why many research and industrial works try to automate this task [1, 3, 4]. [Problem] The processing of design rules, which are natural language sentences stored in unstructured docu-ments, requires expert software. Moreover, existing tools interrupt the design workflow and slow down the design process. [Proposition] We propose a Context-Aware Design Assistant (CADA) to support designers who have to satisfy some design rules among "Big Data". First, we describe the CADA from the user's perspective. Second, we detail the process for modelling un-structured design rules into a computable knowledge graph that will feed the cognitive design assistant. [Future Work] Once our knowledge graph of de-sign rules will be operational, we will concentrate on its processing to re-trieve, recommend, and verify design rules. Experiments will also help to de-termine pros and cons of the design assistant.

Using BSC and DEMATEL Method to Construct the novel product concepts evaluation system

ZHE HUANG[1], MICKAEL GARDONI[1,2]
[1]École de technologie supérieure, Canada; [2]INSA de Strasbourg, Strasbourg, France

Concept assessment is a complex problem which needs to be evaluated com-prehensively and multiple dimensions. This paper proposes a multidimensional concepts evaluation system based on Balanced Scorecard (BSC) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. BSC provides a reference framework to select evaluation indicators. DEMATEL method can effectively analyze the mutual relationship and structure of components in the system. This methodology can help manager to evaluate from a holistic perspective. This paper identifies and constructs the causal relationships among the critical evaluation criteria. The cause and effect diagram analysis clearly indicate which aspect /criteria is more important to make continuous improvement, so as to enhance competitiveness.

A new method to formulate problem in initial analysis phase

Masih Hanifi[1,2], Hicham Chibane[2], Remy Houssin[1], Denis Cavallucci[2]
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Initial Analysis is one of the most important phases of Inventive Design, where designers apply the existing methods to formulate a problem. One of these methods is problem graph, which is a powerful tool to translate the knowledge, collected from available documents and data, into a graphical model. However, this graph, by considering today's competitive world, does not have the agility to present the essential information for applying in the next phase of Inventive Design. The

aim of this article is to introduce a new method, which makes a designer able to formulate an appropriate problem, according to the objectives, without wasting time. This method, along with TRIZ, could create an agile design process. An example is done to illustrate better the process.

Parallel session 6.2: Ontologies for interoperability

Time: Wednesday, 08/Jul/2020: 2:30pm - 3:30pm · *Location:* Virtual Room Chocolate
Session Chair: Rebeca Arista, Airbus, France

Join Session
Go to virtual conference room "Chocolate"

Ontology matching for product lifecycle management

Alexander Smirnov, Nikolay Teslya
SPIIRAS, Russian Federation

Every product goes through many stages of the life cycle from manufacturing through usage to utilization. Some stages can change its properties, which in turn changes its description. To describe the product and its life cycle many ontologies have been created with varying levels of detail. Ontologies usage at different product lifecycle management (PLM) stages provides a better match to these stages since they provide properties of the product important only for this stage. During the transition between stages, the data should be integrated across all sys-tems in manufacturing domain to provide semantic interoperability. Therefore, an issue arises of matching descriptions presented with ontologies of lifecycle stag-es. This is especially critical if ontologies for different stages are created by vari-ous specialists (for example, designer, technology engineer, retailer, maintainer, etc.). The paper proposes the method of matching ontologies for the formation of a common PLM ontology based on the automatic matching of ontologies referred to PLM stages. It allows to overcome heterogeneity and ensure interoperability in the process of tracking the product through the PLM stages. The matching pro-cess is based on the identification of common concepts by which ontologies will be combined into one. To identify common concepts, the ontology matching method is used, based on a combination of a context-based matching with neural network to find similarities of concepts (name, characteristics names and their string values) and study the ontology structure to identify common design pat-terns.

Initial Approach to an Industrial Resources Ontology in Aerospace Assembly Lines

Rebeca ARISTA[1,3], Fernando MAS[2,3], Carpoforo VALLELLANO[3]
[1]Airbus, France.; [2]Comlux America, United States.; [3]University of Sevilla, Spain.

Industrial ontologies can support the Product Development Process

(PDP) and the product and industrial system lifecycle, to have a seamless collaboration between actors. In this sense, an industrial resource ontology that supports an aerospace assembly line design process is key within the conceptual phase of the PDP. Industrial resources can have a different classification to support the design goal of the assembly line, in terms of process optimization, layout and

space optimization, production time, costs, or even the assembly line capabilities

definition. This work describes an initial approach to an industrial resources ontology,

considering the notions that will describe these resources inside an assembly

line design perimeter.

An Ontology-based Concept to support Information Exchange for Virtual Reality Design Reviews

Stefan Adwernat, Mario Wolf, Detlef Gerhard
Ruhr-Universitaet Bochum, Germany

The current change of traditional products towards intelligent, connected cyber-physical systems (CPS) increases the amount of heterogenous data and models generated throughout the products' life cycle stages, starting from their development and reaching as far as reconfigurations in the product use phase. As CPS are highly modular and often customizable by the user, the management and decision support regarding product variants is critical. Mastering the vast complexity of these product-type and product-instance-related information has become one of the main challenges in modern engineering.

In our previous works, we presented different mixed reality (MR) approaches as suitable tools to integrate product-related information and facilitate the interaction with digital contents such as product manufacturing information (PMI) and inspection characteristics for design reviews or real-time sensor values to support maintenance tasks.

This contribution proposes an ontology-based concept to facilitate the information exchange from distributed data sources for mixed reality usage and vice versa. The goal of this paper is to improve the information provision and interaction within a collaborative Virtual Reality-driven design review process for CPS. The ability of ontologies for querying and reasoning of linked information may support the comparison of design variants and feedback integration from design reviews of previous or existing product generations as well as allocating relevant design review metrics such as requirements, simulation results, costs or product use data. The capability of CPS to call upon services from other Industrie 4.0 components opens up a way to implement said ontology to meet today's engineering challenges.

Supporting Linked Engineering Data Management of Smart Product Systems through Semantic Platform Services

Jonas Gries, Thomas Eickhoff, Andreas Eiden, Jens C. Göbel
TU Kaiserslautern, Germany

The increasing industrial relevance of connected smart product systems, enhanced individualized customer requirements, regulatory boundary conditions as well as advanced value networks and volatile international markets determine a new level of engineering complexity. Current engineering processes are enabled by a large number of IT applications, which are partially orchestrated by product lifecycle management solutions. Considering the dramatically increasing complexity, the IT applications are often not adequately connected as a whole, leading to interrup-tions in the process chains and finally resulting in quality problems, time expendi-ture, and additional costs.

To support seamless engineering processes, a sufficiently linked information system structure is necessary. Due to the often-existing best-of-breed solutions and historically grown IT infrastructures, the direct point-to-point coupling of IT systems among each other requires disproportionately high efforts. As an ap-proach to improve the existing situation, integration platforms utilizing loose cou-pling of individual heterogeneous engineering IT applications by semantic web technologies could be used to create a comprehensive, linked engineering data structure.

This paper presents a conceptual IT-Service approach that utilizes this linked data structure to address problems in the area of information retrieval, data ex-change and data quality. A fundamental service function enables easy access to the information scattered throughout the whole organization. This approach could contribute to a high level of transparency within the company's internal processes and relationships between data across individual engineering IT applications. The proposed concepts for IT platform services facilitate the exchange of data be-tween different software applications and the standardized checking and docu-mentation of data quality.