11th Global Conference on Sustainable Manufacturing

Innovative Solutions

Berlin, Germany
23rd – 25th September, 2013

Abstracts

Günther Seliger
Editor

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Sponsored by the International Academy for Production Engineering (CIRP)

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Technische Universität Berlin
Insitut of Machine Tools and Factory Management
Fraunhofer IPK
Global Production Engineering
CRC 1026: Sustainable Manufacturing – Shaping Global Value Creation
Sponsored by the German National Science Foundation (DFG)

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Preface

The 2013 11th annual Global Conference on Sustainable Manufacturing (GCSM) sponsored by the International Academy for Production Engineering (CIRP) is committed to knowledge gains about how to create value by sustainable products and processes. The increasing international research community from emerging and early industrialized countries meet to exchange their ideas on how to save energy and natural resources, avoid negative impact upon the natural environment and society, and adhere to the core principle of sustainability by considering the needs of the present without compromising the ability of future generations to meet their own needs. To promote this noble goal, there is a strong need for greater awareness in education and training, including dissemination of new knowledge on principles and practices of sustainability applied to manufacturing.

Every year, a country is selected to host the Global Conference on Sustainable Manufacturing, building effective links among the international colleagues, expanding their knowledge, and improving their cooperation globally. Conferences in this series have previously been held at the Middle East Technical University, Ankara, Turkey in October 2012, at the St. Petersburg State Polytechnical University and St. Petersburg State University of Economics and Finance, Russia in September 2011, at the Masdar Institute of Science and Technology, Abu Dhabi University, United Arab Emirates in November 2010, at the Indian Institute of Technology Madras, India in December 2009, at the Pusan National University, Korea in October 2008, at the Rochester Institute of Technology, Rochester, USA in September 2007, at the University of Sao Paulo, Brazil in October 2006, at the Jiao Tong University, Shanghai, China in October 2005, at the Technische Universität Berlin, Germany in September 2004, and in the format of a workshop on Environmentally Benign Manufacturing in Birmingham, Alabama, USA, in January 2003.

From 23rd to 25th September 2013, the 11th Global Conference on Sustainable Manufacturing (www.gcsm.eu) is expected to attract representatives of science and industry from more than 35 countries all over the world to the conference chair's scientific home town Berlin, Germany, TU Berlin, Institut für Werkzeugmaschinen und Fabrikbetrieb (IWF) and Fraunhofer Institut für Produktionsanlagen und Konstruktionstechnik (IPK). Introductory keynote contributions will specify the challenges of sustainable manufacturing from U.S. and Latin American, Chinese and European perspectives.

An insight into the Collaborative Research Centre “Sustainable Manufacturing – Shaping Global Value Creation” (CRC 1026, www.sustainable-manufacturing.net) is given during a special session on the 24th of September. The German National Science Foundation (DFG) supports this CRC for an initial funding period from 2012 to 2015 in a perspective of two further funding periods until 2023. The CRC intends to demonstrate how sustainable manufacturing embedded in global value creation proves to be superior to traditional paradigms of management and technology. The dynamics of global competition and cooperation shall be utilized by the CRC for lending wings to processes of innovation and mediation towards the rationally required sustainability on our globe. A special focus lies on

condensing engineering to sustainable manufacturing, thus specifically addressing so called learnstruments generation for shaping human living. Learnstruments are artefacts which automatically demonstrate their functionality to users easing help for self-help and thus inspiring creativity and initiative for wealth generation in emerging regions. Products, processes, equipment, organization and humans together as configurable factors make value creating modules. Modules to be shaped by innovative technology are valuated according to economic, environmental and social criteria of sustainability. Vertical and horizontal integration driven by cooperation and competition leads to value creating modules connected in dynamic networking. Manufacturing and logistics in their fundamental roles for wealth generation considerably shape these networks. Research within the CRC 1026 is directed towards identifying exemplary solutions in sustainable manufacturing technology to cope with the challenges of economic competitiveness, environmental and social stability.

The third conference day 25th of September will start with the opening of a new learning center within the IWF and IPK laboratory. Short presentations on solar and wind learnstruments, simulation supported manufacturing scheduling and modern engineering education approaches applied in the international Masters of Science Program Global Production Engineering (GPE, www.gpe.tu-berlin.de) will be given. A Europe-Middle East partnership for teaching and learning will continue their project work (www.me-eng.eu). So will Brazilian German partners in their collaboration on business planning for remanufacturing as well as projects on knowledge gains about information and communication technology (ICT) enabling for sustainable manufacturing funded and related to the European Union (EU) research.

Contributors and participants from all over the world come together for presenting and discussing their research results in sustainable engineering.

Welcome to Berlin

Berlin the 2nd of August 2013

Günther Seliger

Conference Chairman

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Session 1: Entrepreneurship

1.1. Sustainability incubators: a coordinated collaborative approach towards sustainable manufacturing amongst small and medium-sized enterprises.

H. Kohl[1], R. Orth[1], M. Galeitzke[1]
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Abstract
Small and medium-sized enterprises constitute a major share of the manufacturing sector in many countries and are known for their dynamic structure and innovative strength. Despite the potential for sustainability performance the economic impact of environmental regulations may impede many business ventures. Business incubators foster entrepreneurship by offering infrastructural facilities and legal support. The central management of environmental impact reduction and cross-application technologies can in some cases be profitable. The entrepreneurial framework may initiate progress towards the application of sustainability principles. Benchmarking as a powerful management tool can induce best practice transfer and the conceivable collaborations may generate eco-innovations, social and creatively beneficial environments as well as economic advantages. The induced performance measurement, comparison and exchange of experiences is directed towards collective sustainability performance.

Keywords:
Business incubators, sustainability, sustainable manufacturing, ecologic innovations, manufacturing networks, benchmarking

1.2. Case study of ILVA, Italy: the impact of failing to consider sustainability as a driver of business model evolution

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Abstract
The case of ILVA steel works in Taranto, Italy demonstrates the potential impacts associated with failing to adequately consider environmental and social sustainability issues within the business model of the firm. This paper provides a review of the situation at ILVA today; the decisions and actions that contributed to the current situation since privatisation of the firm in 1995; and the choices now facing government, the local community, and the firm's owners going forward including a review of Best Available Techniques (BATs). The review is supported with relevant sustainability literature and explores how a more comprehensive assessment of sustainability considerations might be better integrated into business model evolution. The paper demonstrates that an inappropriate technology investment strategy that fails to consider broader concepts of value for the society and environment does not pay in the long-term, and that expectations of government support to mitigate negative impacts of business are becoming increasingly untenable.

Keywords:
Best available techniques; business model innovation; steel industry; sustainable manufacturing

1.3. Interdisciplinary planning of sustainable value creation modules with low income communities in developing countries

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Abstract
Value creation activities are normally considered to take place in relatively well developed areas of most countries. This is especially true when referring to developing countries where income generation possibilities are normally reserved to urban centers with adequate infrastructure, access to supply chain networks and trained human resources. In order to level quality of life and social conditions of low income rural and urban communities to the regional prosperous areas, opportunities to create local economic development have to be generated. A way to contribute towards the achievement of this end is the generation of sustainable local value creation modules. To achieve this, the integration of several knowledge areas is most of the times necessary in order to secure a smooth implementation in the field increasing thus its success chances. This contribution proposes a method to construct interdisciplinary teams capable of define, develop and conduct projects intending the implementation of value creation modules in economically disadvantaged communities in developing countries.

Keywords:
Value creation modules, interdisciplinary teams, developing countries, capacity building

1.4. Strategic innovation priorities for sustainable manufacturing in Australia

K. S. King [1]
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Abstract
This paper presents a strategic perspective and 3 sustainable manufacturing innovation priorities for the Australian manufacturing sector. They are, improving resource efficiency, developing new business models and adopting new technology. These are not the only strategies by which to achieve sustainable manufacturing or improved competitiveness. However, they are a prioritised response to current global trends, government signals and challenges and opportunities for Australian manufacturers. Manufacturing in Australia has reached a crossroad. Tough economic conditions mean in order to survive manufacturers must adapt and respond to competitive pressures by innovating to remain productive and prosperous. This paper provides an overview of the drivers, enablers and an example for each innovation response. This clearly demonstrates the link between innovation and sustainable manufacturing and how innovation can provide a competitive advantage.

Keywords:
Australia, innovation, R&D, resource efficiency, sustainable manufacturing

1.5. Modeling of enterprise investment activity, taking into account an environmental factor

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Abstract
The modern economy is becoming more dependent of environmental standards and orientation on international concept of sustainable development.
The most important condition on the way of economy transition to an innovative way of development is preservation of human vital activity-environment system equilibrium. Significant role in achievement of the country's economy strategic objectives performs investment activities, which affects not only the conditions of human vital activity, but also on the ecologo-economic system state.
At the paper, necessity to taking into account an environmental factor in the process of investment projects estimation is defined.
The projects efficiency criteria are suggested to calculate using the elements of the fuzzy sets theory, by mean of which many uncertainties factors may be formalized and correctly considered in the estimation process. The approach promotes objective justification of the investment decision.

Keywords
Fuzzy set, ecologo-economic estimation, investment project, sustainable development.

1.6. Investigating short term strategies in product sustainability index implementation, a case study at IKEA

E.Komassi[1], R. Pal [1]
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Abstract
Companies are aware of long term benefits of sustainability, and that in the future the competitive landscape will change. However, financial concerns slow down the sustainability development process.
This article aims to explore how companies move toward long term benefits of sustainability without compromise in their financial objectives in short term. This study focuses on investigating how companies use sustainability index tool as a component of short term strategy.
Findings indicate that companies try to simplify the sustainability assessment and combine it with other decision making tools. This simplification is toward finding potential improvements in the product level. Results are summarized in a model which corresponds to the short term strategy development process toward sustainability. This model describes how company identifies critical products based on financial, strategic and sustainability aspects. The investigation has been performed at children's IKEA in Sweden.

Keywords:
Critical products; product sustainability index; strategy; sustainability implementation; model

Session 2: Value Creation

2.1. A conceptual sustainable domain value stream mapping framework for manufacturing

Noordin Mohd Yusof [1], Muhamad Zameri Mat Saman[1], Nithia Kumar Kasava[1]
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Abstract
Adoption of lean manufacturing generally involves waste reduction and its adoption has been successful in improving companies. With increasing awareness on the need for sustainable development, works have been done on sustainability assessment of product design and manufacturing processes. The sustainable manufacturing, 6R method can be adopted to improve the existing design and manufacturing sustainability scores. A conceptual hybrid framework integrating lean manufacturing with sustainable manufacturing theories has been developed thus enabling the benefits from both techniques to be gained. Specifically, the lean manufacturing, value stream mapping tool is integrated with the sustainable manufacturing, 6R method to assist in solving manufacturing problems at process and or plant level sustainably. An indicator, providing the sustainability scores on value adding and non value adding elements at present and future state, has been proposed as part of the framework.

Keywords:
Lean manufacturing, value stream mapping and sustainable manufacturing.

2.2. Sustainable value creation through innovative product design

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Abstract
In the field of product development, many organizations struggle to create a value proposition that can overcome the headwinds of technology change, regulatory requirements, and intense competition, in an effort to satisfy the long-term goals of sustainability. Today, organizations are realizing that they have lost portfolio value due to poor reliability, early product retirement, and abandoned design platforms. Beyond Lean and Green Manufacturing, shareholder value can be enhanced and optimized by taking on a broader perspective, and integrating sustainability innovation elements into product designs.
This paper presents a framework for achieving the goal of mutual value creation, and identifies the drivers of product design that are used to ultimately create what is termed - The Sustainable Products Value Proposition. Focus is placed on a balanced approach towards the integration of total cost of ownership, social and environmental improvements, and an expanded definition of product life drivers.

Keywords:
Sustainability, sustainable value proposition, product design, product half life

2.3. Ecological analysis of manufacturing systems focusing on the identification of variety-induced non value adding emission

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Abstract
Today manufacturing companies need to raise their awareness about emissions (e.g. CO2 equivalents) and their origins within a manufacturing system. The identification of origins of emissions becomes progressively difficult because of the customer and competition driven increase in product and process variants and the corresponding high level of complexity. Therefore, it is necessary to enhance the ecological transparency in manufacturing systems. This paper introduces an assessment methodology which increases the ecological transparency through the identification of variety-induced ecological effects. Furthermore, the developed methodology enables the user to detect starting points for an ecological optimization of a manufacturing system by the use of organizational measures. The effects of influencing variables are presented on the basis of a case study. The obtained results allow manufacturing companies to reveal and reduce variety-induced non value adding emissions.

Keywords:
Ecological analysis, manufacturing systems, CO2 emissions, variety

2.4. Sustainable factory profile: a concept to support the design of future sustainable industries

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Abstract
The German industry caused more than a quarter (27.8%) of the total energy consumption. Factories have a high influence in resource saving during the realization of a factory and the production process. First “CO2 neutral factories” and “zero-emission factories” were realized in the last years. But they are just point solutions and these concepts are rarely used by enterprises in Germany. As part of an energy efficient optimization of factories, it is necessary to extend the focus of planning and to consider the location, the design, the integration into the environment and the potential of modern energy efficiency. Particularly the factories provides additional high saving potentials for the company. Low emission production methods or resource-efficient building practices offer opportunities for integrated environmental factory design. These approaches are integrated into the comprehensive concept “Sustainable
Factory Profile (SFP)” which is described in this paper.

Keywords:
Factory planning; green factory; sustainability; sustainable production

2.5. TUT-microfactory – a small-size, modular and sustainable production system

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Abstract
Micro and desktop factories are small size production systems suitable for fabricating and assembling small parts and products. The development originates in the early 1990's Japan, where small machines were designed in order to save resources when producing small products. This paper introduces the modular TUT-Microfactory concept, developed at Tampere University of Technology during the past 15 years, and its applications. The sustainability of miniaturized production systems is discussed from three perspectives – environmental, economic and social. The main conclusion is that micro and desktop factories can remarkably enhance the sustainability of manufacturing from all these three perspectives.

Keywords:
Desktop factory, microfactory, modular production system, sustainable manufacturing, TUT-Microfactory concept

2.6. Environmental indicators applied to reality of Eco-Industrial Park (EIP)

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Abstract
The Eco-Industrial Parks (EIP - Eco-Industrial Park) emerged as a new model of spatial organization for industrial arrangements. An important feature for an EIP is the adoption of the concept of industrial symbiosis (IS), in which companies reuse waste to reach a closed system, reducing environmental impact. The article describes an analysis of the environmental indicators used in EIPs through a systematic literature review (RBS). Results indicated that there are proposals to evaluate the waste stream and the symbiosis of an EIP through detailed indicators, which capture the need in a particular moment of time. The paper describes, compares and analyzes these proposals. As a result, it was shown that they have limitations described and exemplified in the text.

Keywords:
Eco-industrial park (EIP), indicators, industrial symbiosis (SI), systematic literature review (RBS).

Session 3: Resource Utilization

3.1. The role of resource efficiency in engineering education

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Abstract
The purpose of this paper is to address various issues of resource efficiency in the perspective of engineering education in the Middle East and North Africa (MENA) region, with particular focus on Occupied Palestinian Territory (Palestine). First, the paper reviews the concept of resource efficiency from several perspectives including energy, electricity and water related challenges, material management and solid waste management. Then the current state of the education and training is discussed along with some details regarding the developed resource accounting perspective for engineering education. Open knowledge platform is foreseen to aid the transition from problem to solution, bringing engineering education up front to tackle the resource efficiency challenges in the MENA region. Finally, capacity building through university graduates is considered as an important mechanism for raising awareness in resource efficiency.

Keywords:
Resource efficiency, renewable energy, water treatment, waste treatment, engineering education.

3.2. Upgradable system opportunities in order to rationalize materials

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Abstract
Design of more sustainable products is a fundamental priority in our society. New opportunities for facilitating the dissemination of the remanufacturing approach or the Product-Service Systems, or for increasing the lifetime of product (three ways for rationalizing of materials) are proposed by the integration of upgrades, functional enrichments brought to the product. This paper aims to show the need of product upgradability through a concrete study focused on four hypotheses:
• H1- Upgradability concept requires a potential of disposed devices which still works.
• H2- Upgradability concept requires a need for adaptability of product towards user needs.
• H3- Upgradability concept requires a need for adaptability of product versus the competition.
• H4- Upgradability concept is consistent with an accumulation of problems.
The first results show the necessity to consider a new sort of "evolutionary" products for sustainability: Innovations with multiples upgrade cycles.

Keywords:
Sustainable innovation, upgrades, PSS, remanufacturing

3.3. Material efficiency in companies of the manufacturing industry: classification of measures

S. Fischer[1]
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Abstract
Improving material efficiency in the manufacturing industry is a sustainability imperative for companies due to economic and environmental advantages such as the reduction of material costs and resource use. Innovative solutions in terms of material efficiency measures are diverse and widespread. As a systematic assessment of efficiency approaches and their effects are likely to support dissemination and deployment, this paper aims to develop an approach that helps to classify material efficiency measures. The classification approach presents different dimensions and properties of material efficiency measures based on a literature analysis regarding existing classification approaches as well as on work that has been conducted for the Eco-Innovation Observatory. The classification has been designed as basis for an empirical impact assessment of material efficiency measures based on a data sample that stems from the German Material Efficiency Agency.

Keywords:
Classification; material efficiency measure; sustainable manufacturing

3.4. Process optimization of resources for packaged water factories in Nigeria

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Abstract
Inaccessibility to drinking water is an intractable growing problem in developing countries such as Nigeria. This paper, presents the energy and manpower input resources needed to increase water accessibility and guarantee sustainable profitable operations. The work relied on detailed questionnaire administration for data collection from water packaging factories within Nsukka and Enugu Cities. The data were collated and Project Evaluation Review Technique (PERT) was used to determine the amount of energy needed. A profit profile was determined for both sachet and bottle water products. The gross energy sequestered by the packaging process is 87.8J for sachet water and 0.52 MJ for bottle water with average of 10 workforces. Also, optimal production rates of 1658 and 1551 were determined for sachet and bottle water, respectively at a profit of N 291,428.29 per day. The results have significant implications for Nigeria's millennium development goals target for water in 2015.

Keywords:
Energy, optimization, packaged water, process resources

3.5. Water management in sustainable manufacturing

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Abstract
Sustainable manufacturing and conservation of resources are more than just energy management. A broader perspective is necessary as stewardship of resources goes to further extents. Water management is expected to take a more pronounced role amongst the metrics for sustainability. This is backed by the reality that freshwater resources are facing extensive stresses which are leading to events of potential scarcity. Opportunities for water management exist in all areas of its demand, especially in the manufacturing sector being a key economic activity, dependent on natural resources. In a local scenario, the effects of water scarcity are on the rise. This paper discusses the relevance of water management for achieving sustainable manufacturing. An evaluation of the water footprint assessment tool is included, as applied in case studies in the manufacturing sector. The assessment method is evaluated against criteria relevant for assessing water sustainability in the local context.

Keywords:
Corporate water use; sustainable manufacturing; water footprint; water management; water scarcity.

3.6. Sustainable uses and method for water treatment plant sludges

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[2] Civil Engineering Department, Universidade Federal de São Carlos, Brazil

Abstract
Once Water Treatment Plant (WTP) for public supply is considered as an industry, it uses water as a source, chemicals and physics and biologic steps to treat the water and, obviously, generate waste, which is called as sludge. Most of these WTPs in Brazil use surface water as a source and a conventional complete cycle treatment type. The WTPs sludges are found mainly in clarifiers and backwash water filter. Unfortunately, most of Brazilian WTPs launches its sludge directly into water resources, without previous treatment, violating management practices and the Brazilian legislation. A solution for this sludge is to remove its water and after that, recycle the water removed and use the dried sludge in other activities, for example in ceramic production, in non-structural buildings and even to generate energy. This paper presents a natural and sustainable technology to dewater clarifiers WTPs' sludge and discusses possible uses for this processed waste.

Keywords:
Water treatment plant (WTP); industry; sludges; dewatering; systems; drainage bed (BD)

Session 4: Equipment

4.1. Improving energy efficiency of machine tools

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Czech Republic

Abstract
Manufacturing is responsible for about one half of global consumption of primary energy, a great deal of which is consumed by machine tools producing discrete parts. The topic of energy efficiency is driven forward by machine tool users who demand low operational costs, as well as social and legislative forces requiring environmentally friendlier manufacturing. This paper aims to provide examples and good practices for improving machine tool energy efficiency with a focus on metal cutting machine tools. During the design stage, there are various opportunities to minimize inherent energy losses by selecting and dimensioning drives and peripherals. On the other hand, users have a large impact on productivity by using the machine effectively and knowledgeably. The paper also presents techniques for measurement and analysis of the energy profile of machines which help to better target energy saving measures on already existing machines.

Keywords:
Design modification, electrical power, energy efficiency, machine tool

4.2. Energy consumption analysis of robot based SPIF

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Abstract
Production processes, as used for discrete part manufacturing, are responsible for a substantial part of the environmental impact of products, but are still poorly documented in terms of environmental impact. A thorough analysis of the causes affecting the environmental impact in metal forming processes is mandatory. The present study presents an energy consumption analysis, including a power study of Single Point Incremental Forming (SPIF) processes using a 6-axes robot platform. The present paper aims to investigate whether the fixed energy consumption is predominant or negligible in comparison to the actual forming operation. Power studies are performed in order to understand the contribution of each sub-unit towards the total energy demand. The influence of the most relevant process parameters, as well as the material being processed and the sheet positioning, with respect to the power demand are analysed.

Keywords:
SPIF, 6-axes robot, energy consumption, sustainable manufacturing

4.3. Interdependencies between energy productivity and target figures of lean production systems

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Abstract
Energy productivity will be a significant competitive advantage for manufacturing companies in future. Therefore, a methodical approach is necessary to identify potential in manufacturing and reduce energy waste. In order to develop this approach, it is obligatory to consider interdependencies to established production systems. Starting with Toyota, car manufacturers were pioneers for the implementation of Lean Production Systems (LPS). Their production processes are measured by LPS target figures like quality or through-put time. Efforts to raise energy productivity can cause impacts on existing production processes and therefore result in interdependencies with LPS target figures. The methodology presented in this paper helps to increase energy productivity under consideration of these interdependencies. The so called House of Energy Productivity is introduced as one important part of the methodology.

Keywords:
Lean production, energy productivity

4.4. Measurement strategy for a production-related multi-scale inspection of formed work pieces

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Abstract
The technology of sheet-bulk metal forming provides numerous advantages in the field of manufacturing. Work pieces with filigree and complex structures can be formed by only a few forming steps. To ensure a sustainable and effective production, the forming process has to be controlled by a production-related measurement system. A measurement system, which meets the high requirements of a forming process like a short measuring time, a high measuring point density and the ability to measure different features at the same time, is a multi-scale fringe projection system with multiple sensors of different resolutions. However, an adapted definition of a measurement strategy is necessary in order to enable a rapid conformity decision of the manufactured work piece based on the evaluated measurement data and thus to be able to inspect as many work pieces as possible. It allows to correct the manufacturing during a primary forming process and to assure a sustainable forming process.

Keywords:
Fringe projection; multi-scale measurement; sheet-bulk metal forming

4.5. Optimization of cutting parameters using robust design for minimizing energy consumption in turning of AISI 1018 steel with constant material removal rate

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[1] Instituto Tecnológico y de Estudios Superiores de Monterrey Campus Estado de México, México

Abstract
The strategies to reduce energy consumption are obtaining emphasis due to the constant increase in electricity prices, and concern of manufacturing companies and clients about the environmental impact that results from activities related to the production of goods. CNC machine tools, including those that perform turning operations, contribute significantly to the energy consumption in the manufacturing sector.
The present work outlines an experimental study to optimize cutting parameters during turning of AISI 1018 steel under roughing conditions and constant material removal rate, in order to get the minimum energy consumption of the machine tool. Robust design is employed to analyze the effects of depth of cut, feed rate and cutting speed on the response variable.

Keywords:
Energy consumption reduction, robust design, turning.

4.6. Energy consideration in machining operations – towards explanatory models for optimisation results

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Abstract
This paper reports the application of a systematic research methodology for uncovering the reasons behind results obtained when energy is considered in machining optimisation. A direct search optimisation method was used as a numerical experimentation rig to investigate the reasoning behind the results obtained in applying Taguchi methods and Genetic algorithm (GA). Representative data was extracted from validated machining science equations and studied using graphical multivariate data analysis. The results showed that over 80% of reduction in energy consumption could be achieved over the recommendations from machining handbooks. It was shown that energy was non-conflicting with the cost and time, but conflicting with quality factors such as surface roughness and technical factors such as power requirement and cutting force. These characteristics of the solutions can provide an explanative motif required for practitioners to trust and use the optimisation results.

Keywords:
Direct search method, energy minimisation, machining optimisation, sustainable machining operation

Session 5: Knowledge

5.1. Regional investment attractiveness in an unstable and risky environment

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Abstract
Investment process effectiveness, which along with investment risk and investment potential defines the investment attractiveness of a region, and, therefore, the investment climate, is also characterized by the growth of regional gross product through investments in physical and human capital. The investment attractiveness of a region is determined by comparison of two parameters reflecting the conditions in which investors' activities take place: investment potential and investment risk. The amount of risks associated with investment activities is large, while uncertainty of their occurrence compels investors to evaluate the investment potential of a region as uncertain, too. Eliminating uncertainty in investment risk evaluation and increasing investment attractiveness of regions may be possible through application of logical and stochastic methods of evaluation, to the author's mind.

Keywords:
Investment attractiveness, risk factor, geographical region, logical stochastic methods.

5.2. Requirements on the engineering of advanced standby strategies in automobile production

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Abstract
A key challenge in manufacturing industry within the next years is to reduce and optimize energy consumption of production systems without affecting productivity. To adress this problem, different approaches are discussed, such as smart grids, or utilization of more energy-efficient machine components. A new approach on shop floor level is to optimize production control strategies, to power down inactive machine components during non productive phases. To fully exploit this potential, it is necessary to integrate the planning of the required control systems into all phases of the engineering process. This paper presents a concept for the integrated engineering of these new applications by evaluating planning tools, methods and data models regarding their suitability to implement the concept of advanced power down and restart concepts. In conclusion, requirements on these tools, methods and data models are defined, to empower them for optimal support of the future engineering process.

Keywords:
Engineering process, standby control, energy efficiency, engineering data models

5.3. Drivers and barriers to implement sustainable manufacturing concepts in Sri Lankan manufacturing sector

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Abstract
Sri Lanka promotes manufacturing sector without much concern on environmental and social problems as one of the driving forces for the economic prosperity. This has aggravated number of issues and this has lead to adapting of some sustainability related initiatives in local manufacturing sector. However, majority of them function independently with fix boundaries. Conversely, there are some hindrances to implement the sustainable manufacturing concepts as a one comprehensive solution. This research intends to investigate the motivators and barriers to adapt sustainable manufacturing concept to overcome current issues faced by the manufacturing industry. An evaluation criterion was developed based on some of the popularly used guidelines and sustainability options available in number of sub domains. Results highlights the main motivators plus common and cluster specific barriers to implement sustainable manufacturing in local industry. These outcomes can be easily considered for the policy development purposes in developing countries in future.

Keywords:
Drivers and barriers for sustainable manufacturing, policy making, awareness of sustainability, manufacturing plant sustainability, triple bottom line in sustainability

5.4. Assessment of perspectives and challenges on sustainability in Palestine

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Abstract
Sustainability has rapidly become imperative at a global level. Collaborative work is required to address the global challenges. However, the effort towards sustainability varies between developing and developed countries. Assessing sustainability in Palestine with its unique context can exemplify the awareness and understanding of sustainability in developing countries. The objective of this paper is to assess the awareness of sustainability from different perspectives of government, industry, and academia. The significant of this study is how to promote sustainability in a country with limited resources and special conditions. The primary data was collected through conducting semi-structured and in-depth interviews with CEOs and decision makers of the major stakeholders in government, industry, and academia. In addition, secondary data were used, which included literature review of current practices documented in government and NGOs reports.

Keywords:
Assessment, awareness, Palestine, sustainability

5.5. Energy efficiency in production processes – the influence of consumption visualization and staff training

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Abstract
This paper examines the influence of the visualization of consumed compressed air and staff training on the consumption behavior of employees in a real production process. To measure potential changes in consumption behavior a real-effort experiment at the Training Factory for Energy Productivity, a real production setting at *iwb* of TUM, had been designed. Therefore, four groups were defined, each group in a different experimental setting. This experiment is the first one ever conducted in a real-life setting and thus adds valuable results to academia and practitioners. Compared to the group without any information about the amount of consumed compressed air the participants provided with a display showing this information saved on average 7-8%. The group provided with a movie about general measures to save compressed air in production consumed around 24% less compressed air than all other groups of participants. Generally, no significant differences between male and female participants had been found.

Keywords:
Empirical study, employee behavior, energy efficiency, production, sustainable manufacturing

5.6. Proposed framework for end-of-life vehicle recycling system implementation in Malaysia

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Abstract
Normally in Malaysia, vehicles are being used extensively regardless of its age or condition. This situation is not only in rural areas but exists in major cities. Vehicle manufacturers expected their vehicles to last in 15 years, hence vehicles exceeding this limit are considered as End-of-Life Vehicle (ELV). The extensive usage of ELV may lead to vehicle failure which threatens the safety of its user as well as other road users. ELV usage also contributes to environmental pollution. In order to overcome this, a framework for ELV management needs to be developed. Prior to that, a survey was done to study the current practice being applied in Malaysia. This paper also study the existing framework applied by other countries as adaptation for Malaysian ELV recycling implementation framework. This framework is expected to assist the government in drafting new ELV related policies.
Keywords:
ELV; framework; vehicle recycling; vehicle recovery

Session 6: Lifecycle

6.1. On improving the product sustainability of metallic automotive components by using the total life-cycle approach and the 6R methodology

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Abstract

This paper presents a novel methodology involving the use of total life-cycle approach, including the Life-cycle Assessment (LCA) method, for improving the product sustainability performance of metallic automotive components. This involves consideration of all four life-cycle stages (pre-manufacturing - PM, manufacturing - M, use - U and post-use - PU), and integration of the 6R activities (Reduce, Reuse, Recycle, Recover, Redesign and Remanufacture). Various end-of-life (EOL) product scenarios - reuse, remanufacturing, and recycling - are modeled and analyzed within the chosen SimaPro LCA software environment. By using the recently established metrics-based Product Sustainability Index (*ProdSI*) methodology, final aggregated product sustainability scores for different product EOL options are generated. The validated *ProdSI* results provide options for improving the overall product sustainability by using the new evaluation methodology. This work also shows that a closed-loop material flow, and multiple life-cycles can be achieved through the use of this new methodology.

Keywords:

Automotive products, product sustainability index (*ProdSI*), 6R methodology, total life-cycle approach, life-cycle assessment (LCA)

6.2. Life Cycle Inventory (LCI) analysis of the sicilian artistic and traditional ceramics as a tool for sustainable manufacturing

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Abstract

In the last few decades, greater attention is being paid by the Italian industrial ceramics sector to the environmental impacts related to ceramics production cycle and many companies have acquired voluntary environmental certifications (ISO 14001 or EMAS) or labeling (Ecolabel or EPD). This is not the case with the artistic ceramics sector in which few companies are certified. One of the most common and used tool for evaluating the environmental impact of products is the Life Cycle Assessment (LCA) methodology. This paper presents the preliminary results from a Life Cycle Inventory (LCI) analysis of the artistic ceramics sector in Caltagirone (Italy). Representative life cycle inventories are essential for any good quality LCA. They represent the fundamental blocks for compiling the full LCA of the ceramics production process, hence promoting environmental sustainability.

Keywords:

Ceramics, environmental hotspots, inventory, sicily

6.3. Life cycle assessment of structural system in Brazilian buildings

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Abstract
This paper will address the LCA of Steel Structural System of a commercial building in Brazil. In this context, this method analyzes the weight of each stage and process within an overall system impact. To this end, the analysis is made from steel production in the Brazilian metallurgical process, including the manufacturing of steel beams and steel deck by dismantling and disposing the elements of this building. As a result, there is the component of steel production which was the most impact, the hard coal and its transoceanic transport. This result is mitigated by the potential for recycling of steel at the end of the life cycle. From the standpoint of construction, the contribution is an indication of the lorry transport process which has the most impact. More importantly, there are few inventory life cycles of products and processes in Brazil. This contributes to the formation of a Brazilian database.

Keywords:
steel structural system, civil construction, life cycle assesment, Brazilian database

6.4. Structured identification of business improvement opportunities using life cycle assessment: a case study in the gas turbine industry

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Abstract
In the last two decades the power sector has been adopting environmental conscious practices in several business areas and processes. Bridging the identification of environmental “hot-spots” in the product life cycle and the implementation and execution of an environmental management system requires an integrated approach starting with a Life Cycle Assessment to identify the improvement potentials; then analyzing the current management and product development systematics in use, and finally mapping the environmental practices against the improvement potential. The improvement tracking will be embedded in the management system as an Environmental Improvement Roadmap, mapping the efforts required to realize the goals. The methodology has been implemented in pilot studies, focusing on the processes performed in-house to enable further decisions on process alternatives and providing reliable information for strategic decisions within the Siemens Environmental Product Portfolio.

Keywords:
Life cycle assessment; eco design, environmental portfolio

6.5. Integrating life cycle assessment tools and information with product life cycle management / product data management

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Abstract
Integrating Product Data Management (PDM) solutions with Life Cycle Assessment (LCA) software offers the opportunity to obtain LCA results fast, based on high-quality, product-specific information and integrated into the design workflow, enabling thereby, inter alia, efficient Design for Environment (DfE).
In a recent project, Dassault Systèmes and GreenDelta have investigated different options for combining LCA tools and information with the ENOVIA platform, a broadly used PDM and Product Life Cycle Management (PLM) platform by Dassault Systèmes. In the course of the project, solutions have been developed for main LCA software systems, including SimaPro, GaBi, EIME, and openLCA. A demonstration implementation has been performed for the openLCA software. A specific connector interface, called 'eLCA', was developed in the project; it provides an interface which makes it easy for LCA software to "dock" to eLCA that in turn links to the ENOVIA platform.
The paper will describe the technical solution that has been developed and show its benefit and further potential.

Keywords:
Bill of material, computer aided design, life cycle assessment, design for environment, product data management, product lifecycle management

6.6. Ecological holistic assessment for production technologies

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Abstract
Treating the natural environment in a responsible manner is becoming a key challenge for manufacturing companies. This challenge also regards the planning, implementation and modernization of production technologies. In this case, a new technology should not only have economic advantages, such as higher productivity or flexibility, but should address ecological aspects as well. Many existing approaches only focus on air pollution, measured in CO_2, and therefore consider only one ecological dimension. So these approaches disregard other effects on the natural environment, such as water and soil pollution. Only through a holistic approach, the influences of a production technology on the environment can be considered completely and comprehensively. The following article describes a holistic ecological assessment approach and illustrates this with an example. This approach enables manufacturing companies to ecologically assess production technologies in a holistic way.

Keywords:
Ecological evaluation, manufacturing, production technology

Session 7: Maintenance

7.1. What makes cleaning a costly operation in remanufacturing?

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Abstract
Product remanufacturing is a widely accepted product reuse strategy in most industries due to its unique advantage of retaining a greater portion of added value in the initial manufacturing stage. Remanufacturing involves a sequence of operations including disassembly, cleaning, inspection, parts replacement, re-assembly and testing. Previous research has shown that the cost of cleaning is only second to the cost of parts replacement. The objective of this study is to illustrate the significance of the cleaning operation in automotive remanufacturing and to identify the factors influencing the cost of the cleaning process. Case studies on four UK remanufacturers, three automotive and one copier, were carried out. Seven key factors causing high cleaning costs were identified and categorised under two dimensions. These are the technical nature of the products and processes of cleaning and the business nature of the remanufacturer.

Keywords:
Automotive industry; cleaning; remanufacturing

7.2. Manufacturing strategy using new and reconditioned rotable spare parts

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Abstract
The process of remanufacturing is attractive economically and environmentally for both manufacturers and consumers. It is important to properly use reconditioned parts in a production plan based on their availability and production costs. A mathematical model is derived to find the cost-optimal production strategy that incorporates reconditioned components in the manufacturing effort. New and reconditioned parts are used to carry out replacements upon failure under an unlimited free replacement warranty policy. Key production decisions, such as when remanufacturing should commence, how long the warranty period should be, and how many returned parts should be reconditioned are answered. The availability of reconditioned parts and their discounted costs are incorporated in the model. Interactions between these decisions and their impacts on the manufacturing system and the consumer are investigated. A case study on aircraft rotable spare parts will be presented.

Keywords:
Remanufacturing; end of life; reconditioning; spare parts; unlimited free replacement warranty

7.3. Adaptive location of repaired blade for NC machining

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Abstract
Free-form blades are widely used in different industries, such as aero-engine and steam turbine. Blades that are damaged during service or have production deficiencies are usually replaced with new ones. This leads to the waste of expensive material and is not sustainable. However, material and costs savings can be made by repair of locally damaged blades or blades with localized production deficiencies. The blade needs to be further machined after repair to reach the aerodynamic performance requirements. This paper outlines an adaptive location approach of repaired blade for NC machining. Firstly, a mathematical model is established to describe the localization problem under constraints. Secondly, by solving the mathematical model, localization of repaired blade for NC machining can be obtained. Finally, an example is given to validate the proposed approach.

Keywords:
NC machining; repaired blade; adaptive localization;

7.4. Tool life prediction for sustainable manufacturing

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Abstract
Prediction of tool wear is essential to maintaining the quality and integrity of machined parts and minimizing material waste, for sustainable manufacturing. Past research has investigated deterministic models such as the Taylor tool life model and its variations for tool wear prediction. Due to the inherent stochastic nature of tool wear and varying operating conditions, the accuracy of such deterministic methods has shown to be limited. This paper presents a stochastic approach to tool wear prediction, based on the particle filter. The technique integrates physics-based tool wear model with measured data to establish a framework, by iteratively updating the tool wear model with force and vibration data measured during the machining process, following the Bayesian updating scheme. Effectiveness of the developed method is demonstrated through tool wear experiments using a ball nose tungsten carbide cutter in a CNC milling machine.

Keywords:
Tool wear prediction, particle filter, bayesian updating

7.5. Part agent that proposes maintenance actions for a part considering its life cycle

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Abstract
The transition from a consumption-oriented society to a reuse-based society is needed for the effective use of resources and environmental protection. However, it is difficult for a user to make appropriate decisions for maintenance of his/her parts because of the wide range of choices of action and the huge amount of information required. To support the user's decision and to promote the reuse of parts, we have developed a part agent system that manages information about individual parts throughout their life cycle. A part agent is a network agent that contains the information of its corresponding part and follows the movement of the part via the network throughout its life cycle. This paper describes a new mechanism of a part agent that proposes appropriate maintenance actions for the corresponding part by estimating its expected value, cost, and environmental load based on the predicted information about its life cycle.

Keywords:
Part agent; life cycle of parts; reuse; life cycle simulation; proposal of maintenance actions

7.6. Machining allowance optimization of complex parts with integrated structure

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Abstract
At present composite manufacturing process, such as linear friction welding plus NC machining, is the main method for the manufacturing and repairing of complex parts with integrated structure. Due to different datum position and inevitable distortion from different processes, it is important to ensure sufficient machining allowance for complex parts during the NC machining process. In this paper, a workpiece localization approach for machining allowance optimization of complex parts repairing based on CMM inspection is developed. This technique concerns an alignment process to ensure sufficient stock allowance for the single parts as well as the whole integrated parts. The mathematical model of the constrained alignment is firstly established, and then the symmetric block solution strategy is proposed to solve the optimization model. Experiment result shows that the approach is appropriate and feasible to distribute the machining allowance for the single and whole parts for complex parts repairing.

Keywords:
Adaptive repairing; CMM inspection; complex parts; machining allowance optimization; workpiece localization

Session 8: Process

8.1. HPC for improved efficiency on standard machine tools by using new fluid-driven spindles

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Abstract
The use of fluid-driven spindles is well known for machining various components, but not in real metal cutting. Machining of larger precision components as prototypes, tools and dies requires the use of relatively large machine tools and high-performance spindles. Usually these are mechanical spindles with relatively high power, displaying a rather low maximum speed of approximately 15,000 rpm. However, in semi-finishing and finishing with HPC conditions and in micro machining, the required rotation speeds are higher and the required power is lower.
This paper presents sustainability and efficiency using fluid-driven spindles for HPC on standard machine tools with small tool diameters and rotation speeds of up to 90,000 rpm using air and 30,000 rpm using the coolant flow. The fluid-driven spindle leads to a significant widening of the application range of larger machine tools and to an improvement of productivity by higher efficiency and faster tool- and spindle change, respectively.

Keywords:
HPC; cutting; tools; spindle

8.2. Finite element modeling of laser assisted friction stir welding of carbon steels for enhanced sustainability of welded joints

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Abstract
In Friction stir welding (FSW) of carbon steels, process parameters must be set to avoid defects such as warm holes. Proper selection of process parameters also affects the final grain microstructure and phase transformations and, ultimately, the weld's mechanical properties. Process parameters, including laser-assisted heating, of AISI 1045 carbon steel were investigated via a 3D finite element method (FEM) model. The laser action was modeled as heat source with constant flux. The simulation findings favorably agree with experiments reported in the literature and suggesting that with laser-assisted-FSW welding can be performed at higher traverse speeds (400 vs. 100 mm/min) while maintaining defect free weld. Also, evolved phase transformations are predicted across the weld geometry as time progresses. Such findings will help in the prediction of sound welding parameters and in estimating the mechanical properties of the various regions of the weld leading to more sustainable joints.

Keywords:
FEM; simulations, friction stir welding; laser.

8.3. Cutting tool manufacturing: a sustainability perspective

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Abstract
Over the last few years, sustainability has become a major challenge for manufacturing systems, due to the rising awareness of energy consumption and to the associated environmental impact of processes. In order to measure the sustainability of a specific process, metrics for sustainable manufacturing were developed and proposed in the scientific literature. The research activities presented in this paper aim to apply a structured sustainable approach to a tool manufacturing process. More in detail, the production of a tap, starting from the raw material up to the finished product, is investigated. The process, divided into the various stages of the manufacturing route, is evaluated from a technological and sustainable point of view. Results provides a basis for decision-making, and are expected to be incorporated into the business strategy development processes.

Keywords:
Machining, process consumption, sustainable manufacturing, tap production

8.4. Sustainability of energy and material consumption within manufacturing processes

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Abstract
A model for the evaluation of machining processes with all direct in- and outgoing energy and material flows as well as the plant infrastructure installations is presented within this paper. The flows were captured, connected to functional units and evaluated in combination with a life cycle inventory data base regarding typical ecological indicators.
Former studies identified that the peripheries of manufacturing processes are responsible for the major part of the energy and resource consumption and that the process effectiveness is only dependent on the used machine tool and peripheral components. Within this paper it will be shown, that this assumption is not totally correct and that the generated efficiency values for the different processes are influenced in huge amount by process parameter variation.

Keywords:
Machining processes, sustainability, life cycle assessment

8.5. A Thermal analysis framework for cryogenic machining and its contribution to product and process sustainability

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Abstract
Cryogenic processing methods are environmentally-clean, toxic-free, and safe sustainable manufacturing processes, which also provide improved surface integrity, superior functional performance and greater product life in manufacturing processes. This paper presents a summary of findings from a preliminary study of the cryogenic cooling effects in a machining process. Various heat transfer scenarios need to be built into the model to consider the boiling phenomena. Cryogenic turning process includes a large radial thermal gradient in a thin layer of machined surface and changes the dynamic recrystallization process. A high speed, wide range temperature measurement system was developed, and preliminary experiments are carried out, investigating the contributing factors and the proper boundary conditions for modeling of cryogenic machining processes. The transition from slow cooling to a rapid cooling is observed.

Keywords:
Product/process sustainability, cryogenic machining, cooling, boiling, boundary conditions

8.6. Experimental study of micro-holes position accuracy on drilling flexible printed circuit board

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Abstract
Drilling through holes is an important procedure in the manufacturing process of flexible printed circuit board (FPCB). The main influencing factor of micro holes quality is holes position accuracy. Holes position accuracy directly influences the FPCB electrical performance, reliability and the realization of the installation requirements. Therefore, it is very necessary to analysis the influencing factors of holes position accuracy. In this paper, single factor experiment method is used to study the relation of holes position accuracy and those influencing factors, obtaining the influence law of each factor on the holes location accuracy. The accuracy will get better with the increasing of spindle speed, retraction speed and drill diameter , however the accuracy will get worse with the increasing of thickness of entry board and number of FCCL stack. Choosing appropriate entry board use-pattern will greatly improve the holes position accuracy.

Keywords:
micro-holes, position accuracy, high speed, micro-drill, FPCB

Session 9: Implementations

9.1. The slow factory: a new paradigm for manufacturing

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Abstract
The current industrial system is generally based on highly automated manufacturing plants, which allow fast production and serial manufacturing. However, some Italian entrepreneurs, using their expertise and know-how, have decided to recover the value of tradition and craftwork and are finding that slow working processes can produce positive results and add distinctive value to a product. Similar cases are recognizable all around the world and in different industrial fields; in particular slowness in the food industry is of great significance.
Slow Manufacturing can increase the quality of the product, giving the uniqueness and excellence that attracts the most demanding of customers. Traditional machines can be fitted in order to assist modern automatic equipment and skilled workers can thus perform semi-automatic processes in order to obtain appealing high-caliber goods. Technology returns to being predominantly mechanical. The reduction of electronics and computerization, the elements largely responsible for standardization, allows the skills of the craftsman to once again become relevant.

Keywords:
Craftsmanship, made in Italy, manufacturing, slowness, sustainability

9.2. An optimization model for a sustainable agro-livestock industry

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Abstract
This paper deals with an optimization model for a sustainable agro-livestock industry. In this case, the agro industry established a subsidy program for the farmers in terms of utilizing pineapple skin waste generated from its production activities as the main cattle feed as a grass substitute. The policy is desired to increase welfare of farmers as well as minimize welfare deviation among farmers. The problem faced by the agro industry is to determine the cattle which will be fattened using the subsidized feed with regards to waste availability. The result of the study shows that the subsidy policy could improve welfare of the farmers and minimize welfare deviation among farmers. This indicates that such kind of subsidy policy can be use to promote sustainable development.

Keywords:
Agro-livestock industry, optimization, subsidy policy, sustainable development

9.3. Study of the possibility to reuse waste plastic bags as a modifier for asphalt mixture properties (binder course layer)

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Abstract
Thin plastic bags are mainly composed of low density Polyethylene (LDPE) and it's commonly used for packaging, protecting and many other applications. However disposal of waste plastic bags (WPB) in large quantities constitutes an environmental problem, as they considered non-biodegradable materials. Hence, there is a real need to find useful applications for these growing quantities of wastes. In this research, WPB as one sort of polymers is used to investigate the potential prospects to enhance asphalt mixture properties. Research aims studying the effect of adding different percentages of WPB on the properties of asphalt mix comparing it with conventional mix properties. WPB content of 9.0 % by weight of OBC is recommended as the optimum WPB content for the improvement of performance of asphalt mix. Asphalt mix modified with 9.0 % WPB by OBC weight has approximately 24 % higher stability value compared to the conventional asphalt mix.

Keywords:
Waste plastic bags, hot asphalt mixtures, polyethylene,

9.4. Product carbon footprint in polymer processing – a practical application

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Abstract
Light weight and synthetic polymer materials form the physical basis of many products across various applications worldwide. Given their reliance on fossil fuel inputs, this increases the importance of environmental assessment in the polymer industry. The energy intensity of plastics manufacturing and processing and the associated high embodied energy of polymer products warrants further investigation. The Carbon Footprint (CFP) methodology enables the estimation of the GHG emissions associated with polymer production. It quantifies the greenhouse gases released from polymer processing. An existing mid-sized polymer processing factory is utilised as a case study in this analysis. In addition, this study provides the data necessary for reviewing energy efficiency measures by estimating their value within CFP analysis. It also identifies the different strengths and weaknesses of the CFP approach. The analysis could then be used in plastics industry 'green' decision making.

Keywords:
Life cycle assessment; energy efficiency; plastics industry; sustainable manufacturing

9.5. Implementing energy efficiency in manufacturing – overcoming risk perception barriers and reducing cost impacts

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Abstract
The increased complexity of manufacturing has resulted in process chains and equipment which demand more energy and resource categories. Energy management standards are being adopted by industries in order to focus on improving this capability; however there is recognition that a more detailed approach is required. This paper proposes a novel application of risk methods to energy efficiency projects by investigating the application of two structured problem solving techniques to energy efficiency improvements within complex manufacturing chains. The techniques evaluated were the 6-sigma and analytical hierarchy (AHP) processes. Industrial investigations and results to date indicate the benefit of utilizing such approaches. The approaches enable a structured method to engage the worker in assessing risk and highlight the value of minimizing risk to core Overall Equipment Effectiveness (OEE) metrics in order to ensure energy optimization opportunities can be implemented.

Keywords
Energy efficiency, risk, structured problem solving

9.6. Performance adaptive manufacturing processes in an energy efficient car production

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Abstract
Energy efficiency is of increasing importance towards sustainable manufacturing in the automotive industry, in particular due to growing environment regulations and rising electricity costs. Approaches within the manufacturing planning phase are insufficient to address dynamic influences during run-time (e.g., electricity tariffs or workload). Additionally, conventional production monitoring and control systems consider the 'Overall Equipment Effectiveness' of manufacturing systems, but do not include related energy efficiency. This paper introduces a novel approach that combines these both aspects and provides more effectiveness based on so-called production variants. The latter are designed during the planning phase and used to adapt manufacturing behavior when facing dynamically changes during run-time. A simulation shows how dynamic adjustments of cycle times lead to a high reduction of energy costs while maintaining high throughputs.

Keywords:
Energy efficiency; performance adaptive production; production planning and control

Session 10: Remanufacturing

10.1. Closed and open loop recycling of aluminium: a life cycle assessment perspective

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Abstract
Compared to other base metals, the refining options for aluminium during the final metallurgical recycling stage are very limited. These limited melt purification options, along with the relatively large number of alloys and the accumulation of alloying and foreign elements during the different life cycle stages, force the aluminium industry to operate in a cascade recycling chain. A Life Cycle Assessment (LCA) based, resource oriented approach, is presented in order to: i) assess the environmental impact calculation during aluminium recycling, ii) examine the scrap recycling loops and iii) express and quantify dilution and quality losses during recycling. Finally, this paper discusses, from an environmental point of view, strategies and opportunities for improved recycling as well as opportunities for more sustainable scrap management. Case studies focusing on major post-consumer scrap streams are examined based on their environmental performance in two different recycling scenarios.

Keywords:
Life cycle assessment, cascade, aluminium recycling, resource efficiency

10.2. Attractiveness criteria for remanufacturing in Brazilian enterprises

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Abstract
Brazilian industry has the challenge to maintain sustainable growth, considering economic, environmental and social dimensions. Remanufacturing, a strategy that aims to recover used products to “as new” quality and maintain its original product identity, can contribute to face this challenge. This paper’s aim is to describe remanufacturing attractiveness criteria that could improve or contribute to the development of remanufacturing oriented business models. The attractiveness criteria cover laws, challenges and motivations influencing remanufacturing. They are defined based on literature research and on an analysis of industrial companies remanufacturing in Brazil. Results comprise the description of the main attractiveness criteria for a sample of 12 Brazilian industrial companies involved in remanufacturing as well as discussion about the influence of the Brazilian Law for Solid Waste on remanufacturing activities.

Keywords:
Attractiveness criteria, Brazilian industry, business models, remanufacturing

10.3. Considering real end-of-life scenarios in a design for disassembly methodology

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Abstract
Disposal of products is one of the main causes of pollution and resource depletion. Therefore, handling products at the end of their lifecycle is a matter of great importance since it aims to encourage different End-of-Life (EoL) strategies as recycling, remanufacturing and reuse. This research attempts to propose a methodology that integrates real EoL scenarios throughout the design process, focusing on the Design for Disassembly approach. The methodology consists of two major steps: first, an evaluation of assemblies and disassemblies is made; and second, three different recovery rates are established. It allows designers to explore different assembly alternatives in order to find the one that leads the highest percentage of components that can have a closed-loop lifecycle. A case study was carried out with a leading manufacturer of air conditioning systems to illustrate the proposed methodology.

Keywords:
Design for disassembly; ecodesign; end-of-life; recyclability rate.

10.4. Sustainable water reuse resulting from oily wastewater of the manufacturing industry

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Abstract
A key element of sustainability is the prudent use of natural resources. This means using non-renewable resources efficiently and developing alternatives to replace them in the future, while using renewable resources in ways that do not endanger the resource or cause pollution. It is known that oil-based cooling is one of the most unsustainable elements of machining processes. The effect of cutting fluids on the environment is widely recognized by users of machine tools, particularly with regard to their degradation and ultimate disposal as a major problem. Faced with this problem this article seeks to define the requirements and restrictions of water resulting from the effluent treatment of cutting fluids, so that this can be reused in the machine tools.

Keywords:
Cutting fluids, microbiological monitoring, treatment of oily industrial effluents, water reuse.

10.5. Market driven emissions associated with supplying recovered carbon dioxide to sustainable manufacturing applications

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Abstract
This paper presents a life cycle assessment (LCA) framework for quantifying marginal emissions associated with the use of recovered carbon dioxide (CO_2) in sustainable manufacturing applications. A consequential LCA approach is applied to estimate marginal emissions from various steps in the recovered CO_2 supply chain such as capture, separation, and transport. These emissions are allocated to the CO_2 producer or the end user considering market forces, technology application, and product substitution. Additionally, a GHG accounting method is proposed that distinguishes between CO_2 generation and CO_2 emission to account for direct emissions from the recovered CO_2 supply chain. The approach is demonstrated in the context of a case study that considers using recovered CO_2 from an ammonia plant as an input to a machining process using supercritical CO_2-based metalworking fluid.

Keywords
Carbon dioxide reuse, consequential life cycle assessment, green house gas accounting, pollution prevention, technology diffusion

10.6. Sustainable increase of overhead productivity due to Cyber-Physical-Systems

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Abstract
The amount of information is increasing constantly because of a growing automation in manufacturing processes and an increasing application of sensors. To handle this information in order to ensure sustainable decisions is the challenge in the future. Concurrently, the amount of decisions made by the management are increasing, which demands for an improvement of overhead productivity. This requires both the existing practical knowledge new technologies, which must be linked by matching software systems. The growing complexity of business processes will be configurable and controllable by the use of new assistance systems. Cyber-physical systems having characteristics such as ad-hoc networking, self-configuration and intelligent data processing will play a decisive role. This paper presents how current innovations can make an essential contribution to a further increase of overhead productivity by the support of collaboration and communication through cyber-physical systems.

Keywords:
Cyber-physical-systems, optimization, productivity, sustainability

Session 11: Energy Efficiency

11.1. Fostering energy efficiency by way of a techno-economic framework

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Abstract
Aiming for a more benign approach to manufacturing, new technological and logistical approaches to energy sensitive production control have been developed. However, practical experience shows that these are or will usually not be implemented due to unclear or conflicting objectives from the technical and the economic side. A prominent example for this is buffers within production systems. While these should be avoided or at least minimised in order to decrease costs and investments, they may allow for the temporary transfer of production equipment into less energy consuming operation states. This paper reports on joint efforts to reduce interface issues by integrating technical and economic decision making into a consistent procedural framework. Exemplary for its potential application, a specific approach to energy sensitive production control, as well as fundamentals for both a technical and an economical evaluation thereof are presented.

Keywords:
Energy efficiency; economics; production control

11.2. Energy usage and efficiency in non-conventional micromachining

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Abstract
Energy efficiency is one of the main strategies adopted by companies to reduce their environmental impact. This paper presents some case studies on the energy consumption, both electrical power and compressed air, of abrasive jet and laser drill machines used in the production of printer inkjet cartridges. The study also examines the practical challenges involved in the implementation of energy reduction strategies in an industrial environment, and in particular the technical, economic and practical viability of energy saving solutions for in situ toolsets. The objective of the paper is therefore twofold: 1. To contribute to the understanding of energy use in non-conventional micro-machining, an important element of Life Cycle Inventory analysis and 2. To help researchers understand the difficulties in implementing energy efficiency measures, and in particular the role of risk as a barrier to energy savings.

Keywords:
Energy efficiency, laser, abrasive jet, micromachining, risk

11.3. Energy saving by using a redundantly actuated parallel mechanism

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Abstract
In this work, energy saving by using a redundantly actuated parallel mechanism is presented. The redundantly actuated parallel mechanisms have more actuators than the degrees of freedom of the mechanisms. We show that the excessive actuators can be used to save operating energy of the mechanism by distributing the operating torques against the gravitational force. The energy saving is verified by experiments for a 2-DOF parallel mechanism with three actuators, which is operated against the gravity. The results show that the redundant actuation scheme can save about 25% of average energy in various pathways with respect to the non-redundant analogue.

Keywords:
Parallel kinematics, energy efficiency, redundant actuation

11.4. Extending the boundaries of energy management for assessing manufacturing business strategies

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Abstract
Manufacturers are responsible for about one third of global energy demand, and thus have a responsibility for reducing their reliance on rapidly depleting non-renewable energy sources. Consequently, a plethora of research has arisen to develop novel ways of improving energy efficiency in factories by focusing on changes to energy intensive production processes and other energy using systems that support manufacturing activities. However, the ultimate goal of manufacturing companies is to maximise profit by refining their business strategy, highlighting the importance of assessing the impact of different business strategies on energy demand. Therefore, one of the key research challenges is to assign anticipated energy demand to various decisions within a business. This paper presents a hierarchical approach to attribute the potential energy demand of manufacturing activities to alternative business decisions, thus informing selection of the most energy efficient business strategies.

Keywords:
Energy management, business strategy, manufacturing, life cycle analysis, sustainable manufacturing

11.5. Energy equivalent of compressed air consumption in a machine tool environment

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Abstract
Compressed air has many applications in machine tools. Compared to the potential energy stored in the fluid tank its production requires a large amount of energy. In addition to the potential energy, heat loss does occur as by-products. Dependent on the amount of heat loss, energy consuming cooling is required. For life-cycle investigations of machine tools, the gray energy and environmental impacts of compressed air consumptions have to be known. This work presents a theoretical approach to quantify the energy equivalent of compressed air and its by-products. A model based approach is set up to describe the required physical relationships for the compressor and its peripheral components. Measurements obtained from a shop floor compressed air supply have been used to validate the results of the theoretical approach. Concluding from the analysis, a general approach for the theoretical energy equivalent calculation, including the compressor and treatment of heat loss, is possible.

Keywords:
Compressed air equivalent, machine tool modeling, energy monitoring

11.6. Optimization design of tandem blade rotor of new savonius hydrokinetics turbine model

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Abstract
The Fossil energy crisis prompted many studies to design energy conversion machines from renewable natural sources. One of them is the development of a model turbine savonius with tandem blades for hydropower. For the preliminary research, three model options of tandem blade savonius (TBS) were designed, i.e.: Overlap TBS, Symmetrical TBS, and Convergent TBS. This study aims to determine the best model and the optimal size of the tandem radius (Rt) and clearance blade (e) to produce a maximum pressure drop (ΔP). The method used is to apply CFD simulation and optimization using Response Surface Method (RSM). The best selection model and the result of the optimization design is convergent TBS model with Rt = 27 [mm] and e = 2.75 [mm] capable to generate maximum pressure drop ΔP = 9415.91 [Pa].

Keywords:
Tandem blade; savonius; hydro-kinetic; RSM optimization; CFD simulation

11.7. Worldwide development of efficient energy production in the G20 countries

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Abstract
The Kyoto Protocol, the EU climate protection strategy 20-20-20 set for states to limit the energy consumption. The energy revolution is the way into a new age of power. Aims are to achieve greater energy efficiency and the balance between renewable and fossil energies. The energy revolution is a great opportunity for the world. Renewable energy from wind, solar and water wins central importance. In the contribution the development of energy efficiency in the G20 countries, the macro level and the determination of the specific potential of states are examined. The central point is the concrete risk quantification of global energy. Results of the investigation are the development of energy efficiency. Unlimited resources of renewable energies are available worldwide. Should it not be possible, regardless of political, economic, and ecological interests of every State to ensure global energy independence of all States, regions, infrastructures, companies and peoples?

Keywords
Global, fossil, renewable, energy, risks, quantification, efficiency, production, ecology, economy, technology, G20-counries, future

Session 12: Material

12.1. Evaluating the performance of selected constitutive laws in the modeling of friction stir processing of Mg Alloy AZ31b – toward a more sustainable process

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Abstract
In modeling friction stir processes (FSP), the choice of material constitutive law directly influences the state variables output which, in turn, is critical in producing uniform metal sheets. This is especially true in AZ31b due to the temperature sensitivity of magnesium. Different constitutive laws tend to produce wide variations in the values of predicted flow stress as well as in temperature profiles especially in the stir zone. Capturing accurate state variables would improve the controllability of friction stir processes by providing suitable control models and, thus, contributing to enhanced sustainability of this process. Two constitutive laws widely used in FSP modeling of AZ31b are assessed in this work. We utilize a robust finite element model with fine-tuned boundary conditions. Comparing the output state variables with those from experiments provided for an objective assessment of the capabilities and limitations both constitutive laws over variable ranges of interest.

Keywords:
AZ31b, material constitutive laws, FEM, friction stir processing, sustainability

12.2. Mechanical properties and surface integrity of direct recycling aluminium chips (AA6061) by hot press forging process

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Abstract
This study discusses on the effect of different chip sizes and operating temperature in recycling the AA6061 aluminum chip. It introduces a new approach of direct recycling using the hot press forging process that eliminates the two intermediate processes of cold-compact and pre-heating. The recycled specimens exhibited a remarkable potential in the strength properties where it increased with increment of total surface area of chips. On the other hand, recycled specimens with medium surface area of chips posed highest elongation to failure. Grain size and oxide amount of billet have an effect on the elongation of recycled materials. Analysis for different operating temperatures showed that the higher temperatures gave better result on mechanical properties and finer microstructure.

Keywords:
Aluminium, hot press forging, mechanical property, solid-state recycling, surface integrity

12.3. Ecological evaluation of PVD and CVD coating systems in metal cutting processes

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Abstract
Due to the ongoing demand for sustainability assessments regarding manufacturing processes, this paper concentrates on the factor of coated cemented carbide tools. Previous publications have shown the potential ecological benefit of coated vs. uncoated tools. In this paper data which has been gathered from the KOMET group providing PVD- and CVD-coatings as well as sound assumptions for the assessment of coatings for cemented carbide tools, especially for indexable inserts, will be presented. Furthermore, the performed ecological assessment and its respective results will be shown. These results can be used for further and broader studies regarding the impact of cutting tools within manufacturing. Finally, the use of coatings for cemented carbide tools and their advantageousness will be discussed.

Keywords:
Ecological evaluation, sustainability, manufacturing

12.4. Resource-saving manufacturing of more dimensional stiffened sheet metals with high surface quality and innovative lightweight products

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Abstract
Vault-structured sheet metals are produced in a unique material and surface preserving way. Hexagonal structures evolve instantly and energy-minimized with lowest strain hardening when a curved material is partially supported and loaded with very low external pressure. Synergetic properties are a reduced weight by increased rigidity, reduced droning of vibrating components, increased thermal stability by avoiding wrinkling (e.g. by welding heat), enhanced crash-energy absorption, large reserves for secondary forming, and preserving of initial surface qualities. Structure conform secondary forming techniques are invented and realized such as a bending technique with additional enhanced rigidity and fine structures for joining with quasi planar edges.
Exemplary vault-structured light weight products are an automotive catalyst cylinder made of stainless steel (Emitec), aluminium back-panel (Daimler SLK), demonstrator of a vault-structured perforated sheet metal which is deep drawn to a 3D-shape (Graepel), coiler plate “CLEANcoil” for spinnery machines (Rieter), Miele washing drum and a vault-structured façade (Manhattan, USA) made of perforated stainless sheet metal.

Keywords:
Energy-minimization; hexagonal structures; lightweight products; self-organization; vault-structuring

12.5. Improving powder injection moulding by modifying binder viscosity through different molecular weight variations

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Abstract
Powder injection moulding (PIM) is a versatile technology for manufacturing small metal or ceramic parts with complex geometry. Invariably, PIM consists of 4 stages: feedstock preparation, injection moulding, debinding and sintering. Debinding is the most time consuming step and in an effort to reduce debinding times, catalytic debinding was introduced, which rely on the sublimation ability of Polyoxymethylene (POM). Besides fast debinding, POM provides excellent mechanical strength to the moulded part. One major problem of POM-based binders is their high viscosity that can complicate the injection moulding process. This paper examines the possibility of lowering the viscosity of POM without affecting its mechanical strength by changing its average molecular weight (M_w). It was observed that POM's viscosity increases with M_W at a faster rate than impact toughness and it is suggested that a M_w of around 24000 g/mol provides the most appropriate combination of strength and fluidity.

Keywords:
Impact toughness, molecular weight, polyoxymethylene, powder injection moulding, viscosity

12.6. Sustainable manufacturing of near net shaped engineering flexible fibrous structures for high value applications

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Abstract
This paper discusses various manufacturing and production technologies in the field of textiles and engineered fibrous structures. Processes have been listed which help in the development of high value added products with a feature of sustainability. The work talks about case studies which have been implemented as best practices for the fields of self-optimized machinery, processing of recycled fibrous structures from high modulus fibres and energy efficiency in textile production processes.

Keywords:
Self-optimized, cognition, textile, high modulus fibre, yarn, energy

Session 13: Design

13.1. CDMF-RELSUS concept: reliable products are sustainable products – automotive case study "clutch"

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Abstract
Based on the customer's product recognition sustainability and environmental protection become key sales arguments within the automotive industry. Thereby customer expects reduced resource consumptions, environmental friendly manufacturing and optimised long usage phase. Especially product reliability saves resources in many ways. One main influence regarding to sustainable life span area of products is the design of a component during the design phase and the placing of upgrades during the use phase regarding to the balance of sustainability and reliability.
This paper outlines the "Collaborative development, manufacturing and field verification for higher product reliability towards sustainability (CDMF-RELSUS) concept", substantiated by the automotive case study "clutch". Based on a typical failure symptom of a clutch disk, the linkage of former field damage causes and prospective design stages is shown. With the aid of standardised innovation cycles inside the automotive industry an assignment between long-term sustainable manufacturing and reliability of mechanical components is demonstrated.

Keywords:
Life cycle Engineering, product reliability, sustainable design, manufacturing processes, field data analysis

13.2. New approach to integrate customers in early phases of product development processes by using virtual reality

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Abstract
Increasing product complexity, reducing time of product design phases and a rising number of customer requirements impede the product design, especially for small and medium-sized enterprises. In order to solve these problems a new approach for an effective, efficient and sustainable product design by integrating customer demands to reduce time to market and increase resource efficiency has to be developed. Customers and product designers have to get involved in an early stage of the product design process, using a virtual reality environment, to realize an interactive experience of applications, focusing customer demands to generate "tailor-made" solutions. Therefore this paper points out, how virtual reality can be already used in early design phases to communicate with customers. It will be described how product designers and customers can interact. Concerning surveys of determining factors for the different design phases, a general product design process via VR will be illustrated.

Keywords:
Product development process, resource efficiency, sustainable product design, Virtual Customer integration (VCI), Virtual Reality (VR)

13.3. How to solve the new product design model considered life cycle cost and product architectures

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Abstract
A novel product design model is proposed in order to develop a new product in terms of global performance by using a Boolean quadratic model, where the relationships among functions and interfaces are illustrated by using life cycle approach. Considering integrity, for example, can be presented as a good design in which the disassembly and recycle of the product will be performed easily. This concept can be used to illustrate and modify the proposed model. However because solving the proposed quadratic model is hard, we transfer it to a simple linear programming form without changing its identical feature. Then a branch and bound algorithm is proposed to solve the linear programming transformation model. Numerical experiments are provided to show the effectiveness and efficiency of the algorithm. As a result, optimal solution of a 16-devices case (nearby real world) can be obtained in a reasonable computation loads.

Keywords:
Product architecture; product development; integrality; modularity; life cycle approach; combinatorial model; linear programming transformation, branch and bound algorithm

13.4. Enhancing End-of-Life vehicle recovery through modularity optimisation

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Abstract
Appropriate handling of end-of-life vehicles is necessary in addressing environmental sustainability. To date, a number of methods and measures for designing and developing modular products have been generated, aimed at facilitating the separation of parts/components into independent modules for reuse, remanufacturing and recycling enhancement. This paper provides a review and analysis on existing methods and measures for product modularization that deal with product complexity in terms of product architecture, functionality and design. An effective method must be able to verify and validate the proposed modularization process and their results. Therefore, this paper presents an on-going research for a practical and integrated approach for modularity optimisation based on qualitative and quantitative measures capable of validating the developed modules. Findings from the study which was conducted on a national car door assembly can be used to further enhance the design for ease of reuse and remanufacture.

Keywords:
Automotive component; modular design; recovery; remanufacture; reuse.

13.5. Energy saving innovative design of green machine tools by case-based reasoning

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Abstract
This paper presents a methodology for eco-innovation that integrates examples of effective energy-efficient practices in the machine tool industry, case-based reasoning (CBR) and TRIZ in energy saving design of green machine tools. An index system that combines the eco-design and function performances of green machine tool and energy saving technology is proposed. Designers can easily utilize prior cases to redesign a new product and satisfy the both performances. the knowledge for solving energy-saving problem can be supported by examples of effective energy-efficient practices in the industry. Then, TRIZ tools are introduced to modify the knowledge to obtain new designs. A case study is used to explain the capabilities of the proposed methodology.

Keywords:
Green machine tools, energy saving, case-based reasoning, TRIZ, eco-innovation

13.6. The innovative waste container for sustainable cities

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Abstract
Nowadays, the municipalities needed to solve problems about waste collecting and transporting process for a sustainable urban development; humidity, foul odor, load factor of vehicle increases, collecting period and fluid leakage. For a sustainable waste management these problems can be eliminated. The innovative waste container decreased waste's amount, collecting and transporting costs, exhaust emissions and stench. The traffic problems, exhaust emissions, fuel and labor costs decreased with low waste collecting process. Additionally, waste monitoring system supported waste management collaterally waste's storage, collecting and transporting route optimization. Solid waste storage area capacity increased due to wastes transported to waste storage area decreased. This system will contribute the successful examples of climate-friendly cities all over the World.

Keywords:
municipal wastes, waste collecting and transporting, innovative waste container

Session 14: Supply Chain

14.1. Environmental management practices within the supply chain: a case study of textile industry

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Abstract
This study analysed the environmental management practices of a textile supply chain responsible for yarn manufacturing, located in Brazil. Using literature as the start point, a questionnaire was developed and applied with key individuals of the company. The results indicated the implementation of environmental tools, such as an environmental management system and the control of environmental aspects of the company, capable of contributing to the improvement of the company's environmental performance. It was also apparent that the environmental practices in the company studied were required for its suppliers, indicating a continuation of the environmental dimension along the supply chain. The relationship between the company and its partners indicates the existence of collaboration based on the joint development of technical and technological innovations and contribution to the improvement of training of employees.

Keywords:
Environmental management practices, green supply chain management, textile industry

14.2. Gas cylinder distribution planning for saving the LP gas distributors

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Abstract
There are two measures of distributing LP gas to residences in Japan. One is LP gas cylinder distribution method. Two gas cylinders are located in each residence. The other is municipal gas supply through underground pipelines. Recently latter took major market share due to the convenience of pipeline. Therefore LP gas distributers made their managerial situation worse and many companies disappeared from the gas distributer's market. However the Tohoku-earthquake showed the decisive shortcoming of underground pipeline. LP gas distribution measure needs to be re-examined for dealing with the emerging LP gas demand. Also it is necessary for LP gas distributers to decrease operating cost in order to survive. This study addresses minimizing inventory cost by decreasing the number of gas cylinders located in residences and minimizing transportation cost by ACO-based VRP. Gas cylinders requires natural resource and transportation of gas cylinders consumes much energy, too. Saving transportation operation may contribute to sustainable manufacturing.

Keywords:
Gas cylinder transportation, Ant Colony Optimization (ACO), Vehicle Routing Program (VRP), LP gas distributer (liquefied petroleum gas)

14.3. Analysis a stochastic inventory control system under variability of semiconductor supply chain in automotive industry

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Abstract
As an innovation in the semiconductor industry grows speedy, supply chain processes have not followed up. The variability in semiconductor supply chain have increased and been more complicated. These results in accurately forecast demand and set inventory target. Demand and supply are more and more stochastic and non-stationary. Inventory is one of the methods that companies are able to buffer themselves from complex and variable environment, while still being able to satisfy customer needs. We explore the variability of semiconductor industry in automotive industry. On the supply side, we evaluate variability in complexities of manufacturing process and also products are composed with multiple parts efforts to stochastic production lead-time. However in this paper, we disregard the variability arising from supply side so we assumed lead-time is fixed at 16 weeks. For demand side, the phenomenon is known as the bullwhip effect, the demand variability increases as one move up a supply chain, severely effects to semiconductor supply chain. This results the stochastic demand process is not well understood. Thus we evaluate the stochastic in demand as two aspects: 1) the dispersion of historical demand data from its mean which denoted as standard deviation of demand) 2) the difference between the actual demand and forecast data which denoted as standard deviation of forecast error. We use them as a proxy for demand variability. Then we apply the data to the base stock model. We then determine what each variability parameter contributes to inventory. The inventory model represents the semiconductor manufactory's inventory with actual data which provided from semiconductor company to calculate inventory target required to meet the desired customer service level.

Keywords:
inventory targets level, bullwhip effect, forecast error, demand fluctuation, base stock model

14.4. The level of organizational integration framework

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Abstract
In today's global economy, it is critical for companies to improve their competitive advantages. Supply chain integration, if applied effectively, is known to bring about a significant improvement to all companies. The target of supply chain integration is to enhance the material and information flows within a company and also connect it with other supply chain members. With the technology available today, very intimate, beneficial and profitable supply chain integrations can be structured. Many researches have been conducted which approve a much higher operational and business performance of firms while the level of integration raises. The purpose of this study is to provide an overview of the level of supply chain integration frameworks in the manufacturing sector of the supply chain management and to derive a proposed framework from this overview. As a result, a proposed framework for supply chain members has been elaborated.

Keywords:
Supply chain integration (SCI); supply chain management (SCM); level of supply chain integration; framework; manufacturing sector

Session 15: Energy Assessment

15.1. Visual analysis of performance indicators and processes in modern manufacturing

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Abstract
The amount of business information in different levels and areas of manufacturing grows constantly, so does also the need for quick analysis of it. Despite of existing methods of data analytics, at the end the humans have to analyze the results and make decisions. This may overstrain the users, which have to access heterogeneous data sources and evaluate a plenty of data views in different dashboards and reports to get all the information they need together. The project PLANTCockpit explores the new ways of integration of information from diverse levels of manufacturing as well as for comprehensible visualization of it. This will improve the decision making process and help make the manufacturing more effective and sustainable. The paper demonstrates the developed approach on two use case studies of analyzing the performance indicators and processes, showing the two perspectives of the analysis. The paper also concerns the simplifying of the configuration processes for the end user.

Keywords:
Key performance indicators; process analysis; configuration; visual analysis

15.2. Lean and green framework for energy efficiency improvements in manufacturing

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Abstract
With energy efficiency being one of the major development lines in production planning and control today, recent R&D activities have created a large amount of possible measures for improvements. However, in the daily business situation of existing factories, the implementation of available measures often still is limited to most obvious improvements, commonly known as “low hanging fruits”. Further implementations are often neglected due to time, cost or information restrictions. For overcoming this shortage, the Lean and Green Framework introduced in this paper has been developed, providing a standard process of identifying and implementing energy efficiency improvements. The framework provides structured processes for the acquisition of production as well as energetic information on the considered factory, for deriving specific areas where, according to this information, improvements are needed and for the identification of appropriate measures to achieve the identified improvements.

Keywords:
Energy efficient production, sustainable production, lean production

15.3. Smart Manufacturing Execution System (SMES): the possibilities of evaluating the sustainability of a production process

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Abstract
Sustainability in production processes is mandatory in the manufacturing environment due to restrictions such as legislation. Conventional Manufacturing Execution Systems (MES) don't really support environmental sustainable goals but are actually the most suitable background for an extension towards sustainability monitoring, control and assessment. This paper introduces a new MES generation which is enhanced with interoperable data acquisition, analysis and optimization in line with sustainability goals.
A harmonization work on metrics and indicators, aligned with the Triple Bottom Line, is presented based on an analysis of industrial users' requirements within machining process context. Also, a framework for sustainability evaluation through a specific architecture is introduced.
Based on an industrial use case, the given approach is set in the context of the FoFdation project which also addresses the integration among manufacturing IT systems towards overall lifecycle management.

Keywords:
Data acquisition, green manufacturing, manufacturing execution system (MES), sustainability evaluation, triple bottom line

15.4. Increasing energy efficiency through simulation-driven process evaluation

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Abstract
Continuous improvement of the production efficiency is one of many goals a company has for attaining a sustainable market position. When considering traditional objectives, benchmarks are used to compare numerous improvements concerning required inputs and created outputs. Adopting this approach for increasing the energy efficiency of individual manufacturing steps is difficult as their comparability is usually low. However, motivated by the need for competitiveness, regulatory mandates, and a desire for proactive green behaviour, companies seek for sustainable measures to make their manufacturing operations environmentally benign and thus require means for the ecologic assessment of their production processes. This paper presents a novel approach to benchmarking and process evolution, which minds both traditional economic and energy related key performance indicators (KPI). For this purpose, a procedure model making use of an enhanced material flow simulation system has been developed to evaluate and scrutinize the energy efficiency in production processes.

Keywords:
Benchmarking; energy efficiency; process evolution; simulation

15.5. Life cycle evaluation of factories: approach, tool and case study

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Abstract
During the planning phase of the build up or overhaul of factories a large share of the life-cycle-spanning impact of such production facilities is determined. This fact creates a big challenge as a factory is a very complex system and there are various uncertainties regarding the mode of operation and unexpected events that can affect the costs and ecological as well as social impact of a factory during its entire life cycle. Furthermore the life cycle of a factory often even exceeds the time horizon of strategic management decisions. So do also the ecological burdens that are created by the factory. Against this background this paper presents an integrated life cycle evaluation approach for a streamlined economical, ecological and social life cycle assessment of factory systems. The approach also gets transformed into a tool which is used in order to evaluate case studies on machine and factory level

Keywords:
Factory planning; life cycle evaluation; strategic decision support; total cost of ownership

15.6. Sustainability evaluation using a metrics-based Product Sustainability Index (*ProdSI*) methodology – a case study of a consumer electronics product

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Abstract
As the demand for sustainable products increases, developing a capability to evaluate the sustainability content in manufactured products becomes significant and timely. This paper presents the application of recently established metrics-based Product Sustainability Index (*ProdSI*) methodology for evaluation of product sustainability by presenting a case study of a consumer electronics product. Two generations of the product manufactured by an international consumer electronics company are evaluated and compared for the sustainability content, by applying a comprehensive set of metrics across the total product life-cycle. The older generation is set as a benchmark for normalizing the selected relevant metrics. These product sustainability metrics are weighted and aggregated to calculate the *ProdSI* and to compare the sustainability performance of the two product generations.

Keywords:
Sustainable manufacturing, product metrics, life-cycle, case study, consumer electronic

Session 16: Sustainability Assessment

16.1. Towards a factory eco-efficiency improvement methodology

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Abstract
The industrial system consumes a considerable amount of resources in the manufacture of products impacting on the environment generally and the production of CO2 specifically. Manufacturers have recognised the need for efficiency since their inception and placed emphasis on particular resource efficiency according to prevailing pressures. Energy and other resource efficiency are receiving particular attention in the current era and there are numerous examples of companies making significant improvements. Despite the successes there is a scarcity of published procedures and methodologies to guide a company through eco-efficiency improvements. This paper reviews available methods for energy and other resource reduction and presents generalised methodology that contains process steps and guidance for identifying improvement opportunities.

Keywords:
Eco-efficient improvement methodology, energy reduction, factory modeling, resource efficiency

16.2. Monetary assessment of an integrated lean-/green-concept

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Abstract
Energy and natural resource prices are subject to a rising tendency with increasing volatility worldwide. On account of growing demand and limited resources, companies are obliged to aim at minimum waste production. However, the forecast of effects of combined lean and green practices presents a major challenge. So far, they have predominantly been calculated, optimized, and assessed independently of one another. This paper introduces a methodology for a successive further development of lean and green production based on the proactive monetary assessment of combined effects of both lean and green strategies. The outlined approach covers data collection and evaluation of the current production system, calculation of relevant key figures of selected combinations of lean and green practices by use of a queuing theory based analytical material flow model, proactive monetary assessment of the analyzed combination, and deduction of a company-specific plan of measures.

Keywords:
Lean and green; monetary assessment; production system;

16.3. A study on a sustainability indicator of manufacturing processes

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Abstract
Since one of the most important goals of sustainable manufacturing is to obtain high quality manufacturing by low environmental impact, eco-efficiency of manufacturing processes can be the key indicator. In order to evaluate eco-efficiency, an evaluation method of manufacturing quality is indispensable. The author's former research group has proposed a new evaluation index for sustainability of products. The eco-efficiency type indicator was named Total Performance Indicator (TPI). This paper tries to apply TPI in evaluating energy efficiency of manufacturing processes, considering manufacturing quality. After showing a general procedure of calculation, the paper tries to calculate TPI in some case studies. Through the case studies, the paper shows the effectiveness of TPI in comparing a conventional process with an improved process. Finally, the paper concludes that the proposed index; TPI can be a powerful indicator in evaluating sustainability of manufacturing processes.

Keywords:
Sustainable manufacturing; manufacturing processes, eco-efficiency, manufacturing quality, material characteristics

16.4. Sustainable development of socio-economic systems: a new approach to assess

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Abstract
The existing methods to assess sustainability have already revealed their major shortcomings: difficulties in obtaining information, aggregate estimates with different dimensions, and the choice of indicators weights. Here we suggest a new approach to measure sustainable development of socio-economic systems.
Our approach offers a comprehensive analysis of five blocks of equilibrium indicators (economic, social, environmental, institutional, innovation) by integrating average levels of stability Index. The mean resistance level is defined as an average of the normalized indicators for sustainable socio-economic systems and has a value between 0 and 1. This allows distinguishing three equal intervals, each corresponding to a particular type of sustainable socio-economic system: low, medium and high. The method was efficiently tested on data from Russian regions and may be also applied to monitor the sustainability of other socio-economic system.

Keywords:
Sustainable development, stability level, typological classification, type of stability

16.5. Developing a new assessment framework of sustainability in manufacturing enterprises

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Abstract
Sustainability means the rearrangement of technological, scientific, economical, social and environmental resources. There are two levels of sustainability: Macro-Level (Global) such as Country and cities; and Micro-Level (Manufacturing enterprises) such as town and regional areas. In this paper, Micro-Level of sustainability will be targeted. The main objectives addressed in this paper are how to model the required issues/aspects, how to assess a new framework for measuring sustainability from indicators, aspects, dimensions, and integrating levels up to general sustainability. New concepts such as "economic-social, social-environmental, and environmental-economic sustainability" are also suggested and presented. The proposed framework is used in a hypothetical numerical example for investigate which dimensions are more significant in the sustainability. The results show that the estimation of sustainability performance is not simple task.

Keywords:
Manufacturing enterprises; sustainability; sustainable development

16.6. Achieving resource- and energy-efficient system optima for production chains using cognitive self-optimization

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Abstract
Production systems no longer have to pursue one, but a set of goals. Classic optimization regarding lead time or capacity utilization is still sought after, but was extended by factors such as energy consumption or use of cooling lubricants. Thus the models of dependencies and system behavior become more complex, hampering optimization by classic algorithmic approaches.
One subdomain of the Cluster of Excellence "Integrative Production Technology for High-Wage Countries" examines the potential of cognitive self-optimization as a way of handling technical complexity. This paper analyses the constraints and dependencies that have to be considered to find overall optima for process chains and gives an assumption of the associated complexity. This builds the base for future implementations of self-optimization to boost overall resource- and energy-efficiency in process chains. Furthermore, examples are presented on how optimization can be realized by using cognition and self-optimization.

Keywords:
Self-optimization of process chains, complexity of job shop scheduling problems, production system optima

Session 17: Strategies

17.1. What do we assess for a sustainable society from a manufacturing perspective?

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Abstract
Global recognition of sustainability appeared in the early 1970s as the rapid growth of the human population and the environmental degradation associated with increased consumption of resources raised concerns. Since 1987 a definition of sustainability is given by the Brundtland Commission. For a decade, sustainability has become a main challenge for manufacture because this could imply more competitiveness for manufacturer and because countries may use this issue as a trade barrier. While sustainability becomes an indispensable element, there are currently no scientifically convincing and widely accepted indicators for assessing sustainability. This paper presents the scope and boundaries of sustainability assessment and the aspects to be considered for selecting a proper set of indicators related to pressures, such as e.g. Methane emissions, and impacts, such as e.g. Climate change. Furthermore this paper also present a draft set of indicators within a novel approach for areas of protection.

Keywords:
Method, evaluation, indicator, sustainability

17.2. System dynamic optimization in the sustainability assessment of a world-model

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Abstract:
The System Dynamics (SD) methodology is a framework for modeling and simulating the dynamic behavior of socioeconomic systems. Characteristic for the description of such systems is the occurrence of feedback loops together with stocks and flows. The equations that describe the system are usually nonlinear. Therefore seemingly simple systems can show a nonintuitive, nonpredictable behavior over time. Controlling a dynamical system means to define a desired final state in which the system should be, and to specify potential interventions from outside that should keep the system on the right track. The central question is how to compute a globally optimal control? We propose a branch-and-bound approach that is based on a bound propagation method, primal heuristics, and spatial branching. We apply our new SD-control method to a model that describes the evolution of a social-economic system over time. We examine the problem of steering this system on a sustainable consumption path.

Keywords:
System dynamics; mixed-integer nonlinear optimization

17.3. Production planning for non-cooperating companies with nonlinear optimization

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Abstract:
We consider a production planning problem where two competing companies are selling their items on a common market. Moreover, the raw material used in the production is a limited non-renewable resource. The revenue per item sold depends on the total amount of items produced by both players. If they collaborate they could apply a production strategy that leads to the highest combined revenue. Usually the formation of such syndicates is prohibited by law; hence we assume that one company does not know how much the other company will produce. We formulate the problem for company A to find an optimal production plan without information on the strategy of company B as a nonlinear mathematical optimization problem. In its naive formulation the model is too large, making its solution practically impossible. After a reformulation we find a much smaller model, which we solve by spatial branch-and-cut methods and linear programming. We discuss the practical implications of our solutions.

Keywords:
Non-cooperative two-person games; mixed-integer nonlinear optimization

17.4. Value creation in open source hardware models

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Abstract
Open Source Hardware is an emergent bundle of technologies, practices, business opportunities, and regulatory approaches for collaborative manufacturing. Open Source Hardware has raised high expectations in regards to its potential in value creation networks and in regards to sustainability. To allow a clear understanding of the phenomenon, the underlying concepts like open source, online platforms, and collaborative practices are outlined in this article. We describe the state of the art in Open Source Hardware, potentials, opportunities, and challenges. Open Source Hardware based value creation is depicted by showing complementary business models and organizations. The potential contributions of Open Source Hardware to sustainability are shown. The article concludes by stating directions for future research to better understand the prerequisites and conditions of value creation for collaborative manufacturing.

Keywords:
Innovation; open source hardware; sustainable manufacturing; value creation

17.5. Life cycle sustainability assessment & sustainable product development: a case study on Pedal Electric Cycles (Pedelec)

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Abstract
Sustainability is one of the important topics in nowadays societies since it was brought up in 1987 from the Brundtland Commission. The comprehensive sustainability assessment investigates products and value chains in the environmental, economic and social dimension. However, a large share of worldwide industries so far only focus on particular issues, e.g. energy efficiency or greenhouse gas emissions, and thereby ignoring the significance of integrity to achieve an overall sustainability in product development and value chains. This paper focuses on adopting a Life Cycle Sustainability Assessment, covering all three dimensions via Life Cycle Assessment, Life Cycle Costing and social Life Cycle Assessment within a case study for Pedelecs. Through this case study, significant hotspots and key parameters in the life cycle of Pedelecs are identified and discussed. The findings serve for the further development of existing methodologies to complete the Sustainable Product Development.

Keywords:
Life cycle sustainability assessment, sustainable product development, sustainability, pedelec, manufacturing

17.6. Openness as a supportive paradigm for eco-efficient product-service systems

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Abstract
Product-Service System (PSS) is a concept which can be exploited to increase the eco-efficiency of value creation. It does not focus only on physical products but also on common access to their functionality, thus allowing mutualizing of products between manufacturers and users. However, reaching PSS eco-efficiency requires facing the challenge of an intensive information exchange between them. Especially in the case of business-to-consumer offers, stakeholders are an anonymous crowd of users, of which product usage information is hard to be obtained. This paper explores the potential of the Open Design concept - the opening of the development process and its documents - in order to address this problem. By promoting user involvement, Open Design might bridge the gap between use-related information and the design process – thus supporting eco-efficient PSS design. This general idea will be illustrated by the examples of PSS taken from both business-to-business and business-to-consumer domains.

Keywords:
Open design; product-service systems (PSS); eco-efficiency.

17.7. A system dynamic enhancement for the scenario technique

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Abstract:
The Scenario Technique is a strategic planning method that aims to describe and analyze potential developments of a considered system in the future. Its application consists of several steps, from an initial problem analysis over an influence analysis to projections of key factors and a definition of the scenarios to a final interpretation of the results. The technique itself combines qualitative and quantitative methods and is an enhancement of the standard Scenario Technique. We use the numerical values gathered during the influence analysis, and embed them in a System Dynamics framework. This yields a mathematically rigorous way to achieve predictions of the system‘s future behavior from an initial impulse and the feedback structure of the factors. The outcome of our new method is a further way of projecting the present into the future, which enables the user of the Scenario Technique to obtain a validation of the results achieved by the standard method.

Keywords:
Scenario technique; system dynamics

17.8. Sustainability analysis for indicator-based benchmarking solutions

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Abstract
In times of scarce resources, the concept of sustainability management has become tremendously important within today's business environment. The integration of a sustainable perspective into corporate management structures does not only satisfy the involved stakeholders, but rather prepares a company to cope with the continuously increasing challenges on the markets. The Fraunhofer Institute for Production Systems and Design Technology (IPK) offers the BenchmarkIndex-Analysis that allows especially small and medium-sized enterprises (SME) to measure their business performance based on selected indicators of the Balanced Scorecard (BSC). Since the methodology and the broad dissemination of the BenchmarkIndex represent a promising opportunity for a wide application of sustainability management solutions, an analysis of existing and potential sustainability indicators was carried out to identify how an adaption of the BenchmarkIndex can consider the long-term economic, but in particular the environmental and social aspects of sustainability.

Keywords:
Benchmarking; sustainability management; triple bottom line

Session 18: Tools and Technologies

18.1. Investigation of the upgrading potentials of out-of-date cutting machine tools to promote sustainable and global value creation

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Abstract
Cutting machine tools play a major role in global value creation. During last decades machine tools have been developed regarding production efficiency, working accuracy and flexibility. Nevertheless there exist a large number of conventional milling machines particularly in developing countries, which cannot be applied effectively in global creation networks due to the low processing efficiency and low flexibility. Upgrading existing machines can save raw material and energy resources and supports sustainability. In this paper the improvement potentials of out-of-date machine tools without exchanging system relevant components have been investigated and necessary tests and measurements have been implemented. Two machine tools, a newer and an older milling machine as representative example were compared and some possible improvement solutions of the older machine have been proposed concerning working accuracy and flexibility.

Keywords:
Machine tool, optimization, working accuracy, performance comparison, sustainability

18.2. Microsystem enhanced machine tool structures to support sustainable production in value creation networks

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Abstract
The modularization of machine tool frames is a promising approach to support sustainable manufacturing in global value creation networks. The idea of designing single versatile lightweight and accuracy optimized (LEG²O) modules allows for innovative concepts with respect to mobility, configurability and adaptability. This contribution focuses on possible use-case scenarios that involve modular machine tool frames equipped with microsystems providing enabling functionalities, e.g. self-identification and provision of additional sensor data. The study provides a profound overview of potential capabilities and limitations of the proposed concept. As replacement, reuse and upgrade of single parts become critical issues when considering the complete product lifecycle, the question on how electronics integration can successfully contribute to a sustainable usage is investigated.

Keywords:
Microsystem, modular machine tool, sustainable manufacturing, system life cycle

18.3. Human centric automation: using marker-less motion capturing for ergonomics analysis and work assistance in manufacturing processes

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Abstract:
Manual labour is still an essential factor for industry. However, work can be physically demanding causing absence through musculoskeletal issues. Moreover, production processes appear to be highly complex causing stress and production errors due to mental fatigue. Methods of human centric automation tackle these problems using automation technology to assist workers. In this paper, we propose marker-less motion capturing to automatically analyse the worker's motion and ergonomics during manufacturing processes. With the information acquired, robots can assist workers to not only meet health demands, but also reduce labour costs and increase the worker's social welfare. Production errors can be reduced by giving situational feedback and guidance based on the worker's motion. We present a first implementation using the Microsoft Kinect® system and propose hypotheses concerning possible social, environmental and economic impacts on semi-automated production, which shall be proven.

Keywords:
Human centric automation (hca); lifecycle sustainability assessment; sustainability indicator; manufacturing process

18.4. The potential of reducing the energy consumption for machining TiAl6V4 by using innovative metal cutting processes

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Abstract
Small and medium-sized production companies are alarmed at the increasing costs for energy. There are two possibilities presented to decrease the energy consumption per produced part. The first approach of energy saving refers to turning TiAl6V4. For this, the energy demand of machine tool, cooling system and tool wear of an internally cooled turning tool with closed cooling circuit at dry and wet machining and at combined cooling were compared. It becomes obvious that the turning tool allows for an enormous energy saving potential as well as for lifetime advantages or productivity increases respectively. The second energy saving approach investigates the milling of TiAl6V4 workpieces. In this case, a machine tool's energy consumption during conventional milling was compared to the energy consumption during a trochoidal milling process. It is described that a trochoidal milling strategy offers considerable potential for improvement as regards energy consumption and process time.

Keywords:
TiAl6V4; energy consumption; energy efficiency; internally cooled tool; trochoidal milling

18.5. Rapid Sustainable Plant Assessment (RSPA) – experiences of practical application and its impact on the further development

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Abstract
Sustainability may have the means to ensure that manufacturing can prevail at the forerun of modern societies, ensuring a profitable productivity without harming the environment and societal values. Without establishing means to evaluate how well the sustainability is carried out in the manufacturing industries, this cause is lost. The Rapid Sustainable Plant Assessment (RSPA) tool was developed in 2012, to assess how well manufacturing enterprises are doing in the different dimensions of sustainability.
This paper discusses the development that the RSPA tool has undertaken in order to increase the general applicability of the tool and the industry direction created in order to assess specific industry's characteristics. Also, primary results of industrial application are presented. The paper also provides an outlook on further development of the tool and proposes mechanisms to seamlessly integrate the RSPA results to more detailed analysis methods such as the multi-perspective modelling.

Keywords:
Plant assessment; rapid sustainable plant assessment; sustainable manufacturing, multi-perspective modelling

18.6. Evaluation of energy and resource efficiency supported by enterprise modeling – experiences from application cases and their significance for the multi-perspective modeling approach

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Abstract
The multi-perspective modeling method is an enhancement of enterprise modeling and will enable understandable, operational views ("perspectives") on sustainable value creation. The goal is to allow all stakeholders to make decisions towards the sustainability in their context, ranging from individual enterprise decisions up to cooperation strategies. As known, the sustainability is based on the environmental, economic and social dimensions. The energy and resource efficiency is an essential subset within the sustainability context that affects mainly the first two dimensions. This paper presents an enterprise modeling driven and supported analysis of energy and resource efficiency, which was performed at several small and medium sized enterprises. The experiences gained from this application case are described and their consequences for the multi-perspective modeling method are argued.

Keywords:
Multi-perspective modeling, enterprise modeling, business process modeling, sustainable manufacturing

18.7. Using ontology to support scientific interdisciplinary collaboration within joint sustainability research projects

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Abstract
A multitude of different perspectives and scientific disciplines have to be regarded considering research in sustainable development. Each discipline usually has its own understanding of sustainability and uses different vocabulary. Nonetheless, they have to work together to make a progress. To get a complete picture within the field of production, for example to evaluate the sustainability of a product or a process, different disciplines such as environmental engineering, mechanical engineering, mathematics or social sciences must be combined.
In the Collaborative Research Center 1026 – Sustainable Manufacturing an ontology is developed in order to link the different disciplines considering sustainable value creation networks. The ontology assists in exchanging information and data and thus fosters collaboration. The paper presents and discusses an extract of identified requirements and the approach on developing the ontology for collaborative research.

Keywords:
Ontology, IT-based collaboration, sustainability research projects

18.8. Sourcing automation to the crowds – by means of low cost technical solutions

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Abstract
Increasing the level of automation in manufacturing organizations through low costing means should be a very lucrative option for those involved. Increased level of automation would mean higher productivity and could also mean higher quality, thus less lost opportunity cost, higher customer satisfaction, furthermore, less use of engineering materials that make up every tangible product. It is through crowdsourcing where every member of a certain community can contribute with their specific knowledge about a topic, towards innovative new ways of problem solving. The backbone of this specific crowdsourcing methodology is how it is structured by means of value creation module mapping, to a network. Contributions are designed and configured in a sequence of modules, offering the possibilities of comparison on a singular level or even a network level. This approach can be very useful for small and medium enterprises to remain competitive on the volatile global markets.

Keywords:
Crowdsourcing; innovation; low cost intelligent automation; value creation networks

18.9. Learnstruments in value creation and learning centered work place design

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Abstract

Increasing awareness of sustainability across the broad span of stakeholders involved in the value creation process is one challenge in manufacturing. The value creation participants will emanate from a multitude of globally divided regions, cultures and educational backgrounds if wealth and value creation is to be more evenly distributed throughout the world population. This in turn results in a significant increase in the required teaching and learning efforts. This paper will focus on achieving this increase through the development and application of so called learnstruments in combined learning and working environments. Learnstruments are artifacts and systems which automatically mediate their functioning to their user. The authors present a method for determining and assessing such systems as well as exemplary cases from the area of manual assembly and repair work places.

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Keywords:

Knowledge engineering, learning factory, sustainable manufacturing, usability, work place design

Session 19: Energy Awareness

19.1. A framework for a multiagent-based virtual enterprise with a microgrid energy market model

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Abstract
Within the scope of the promising Smart Grid (SG) vision, the concept of microgrids is a key facilitator, especially in order to incorporate the distributed and renewable energy resources. In manufacturing, a Virtual Enterprise (VE) is a Web-based, virtual, and temporary consortium of companies with different core competencies to fulfill product orders during a specified period of time. In this paper, we are proposing a framework and an architecture of a Microgrid-based VE to diligently and intelligently manage energy consumption in the manufacturing process and to incorporate Distributed Energy Resources. We develop a conceptual framework for computing the energy requirement of a VE and come up with an energy pricing formulation in conjunction with a process and energy scheduling methodologies to reduce the Peak-to-Average ratio of energy usage. We utilize a Multi Agent System (MAS) in VE's clusters that is in full compliance with FIPA specifications.

Keywords:
Smart grid, virtual enterprise, renewable energy, multiagent system

19.2. Stochastic optimization method to schedule production steps according to volatile energy price

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Abstract
Manufacturing systems are one of the main consumers of electrical energy worldwide. Inaccurate demand side prediction and time dependent renewable power generation can cause volatile energy prices in short term energy trading. Future manufacturing systems can benefit from volatile energy prices by managing their demand. This affects the profitability and also has a positive effect on CO_2-emissions. Leveraging this potential requires scheduling of production steps based on order situation, electrical energy demand of each machine, and day-ahead electricity market prices. A stochastic optimization method for the scheduling of production machines with specific processing times and energy consumption has been developed and implemented as a software prototype. The optimization method is validated for eight production machines as a part of a production line to shift load to off-peak hours when electricity prices are lower.

Keywords:
Manufacturing systems, energy markets, demand-side management, optimization, product-service systems

19.3. MEDA: Manufacturing Energy Demand Assessment method for future production planning and product development

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Abstract
Sustainability drivers such as competitive advantages through sustainable products, environmental regulations and social awareness motivate manufacturing companies to implement measures such as energy management systems, which require energy balancing of manufacturing processes. Unfortunately, current methods for energy demand assessment do not sufficiently meet industrial requirements. As a consequence, practical application of these methods in production planning and product development remains incomplete. This paper proposes a method focused on energy demand analysis of manufacturing processes. It is based on a combination of existing and self-developed assessment methods. Going beyond energy balancing, due to suitable KPIs, the method application provides feedback information not only to production planning but also to the development of future product generations. The method has been validated by the analysis of a gearwheel manufacturing process in a crane manufacturing company.

Keywords:
Energy efficiency, energy demand assessment, product lifecycle, manufacturing, product development

19.4. Monitoring production systems for energy-aware planning and design of process chains

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Abstract
Various energy-relevant data can be acquired from monitoring equipment and processes in production systems. Systematic analysis of these data is the basis for predicting the energy consumption of the production system and its energy-consuming elements. In order to continuously reduce the energy consumption in manufacturing, a new approach for the acquisition, aggregation and evaluation of these energy-relevant data throughout the production systems lifecycle is needed. This paper describes how energy-relevant data can be used for both the energy-efficient production planning and control and the energy-aware planning and design of the production system. Therefore, the comparability of equipment and processes in the data acquisition phase and the planning phase will be considered.

Keywords:
Energy consumption, predictive planning, methodology

19.5. A theoretical energy consumption prediction model for prismatic parts using STEP AP224 features

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Abstract
The rate of global warming increases sharply, thus energy and resource efficiency in manufacturing gain vital importance. In order to increase energy and resource efficiency, first consumed energy amount must be quantified accurately for each manufacturing process. Furthermore, CO_2 is one of the top green house gases that contributes to global warming and its emission can be derived from the quantified energy consumption data. In this study, a prediction model for determining theoretical energy consumption during the manufacturing processes of prismatic parts is presented. The prediction model relies on the STEP Application Protocol 224 features for volumetric information and material properties of prismatic parts.

Keywords:
Process energy prediction; energy efficient manufacturing; carbon footprint

19.6. Cloud SME – sustainable computer aided engineering for SME's

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Abstract
The authors describes a manufacturing support process, Computer Assisted Engineering (CAE) concept, with a Cloud Computing approach, mainly oriented to SME´s that takes account of manufacturing sustainability in several perspectives such as economic, environmental, innovation and social. This case is a result of the CloudPyme Project (CPP), where the main objective is providing this CAD/CAE tools to SME´s, which in normal cases can´t access to this tools, related to acquisitions issues (e.g. high costs in software, hardware and training).
The concept has been running for providing a structure and services (SaaS), using Cloud Computing, based on Open Source Software (OSS) and support services, given the opportunity to SME´s to improve their products using advanced engineering tools at low price. With this service, small manufacturing companies can design new products in a more efficient way. SME´s using this support service can spend less energy, time, materials and more durable.

Keywords:
Sustainable manufacturing; product design, cloud computing; SaaS; OSS, CAE;

19.7. Reducing the cumulative energy demand of technical product-service systems

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Abstract
Technical Product-Service Systems (PSS) are made up of a technical product enhanced along its lifecycle by different services. PSS have a high potential to increase the energy efficiency within the capital goods industry. In order exploit these potential systematically, a method to analyze and reduce the cumulative energy demand (CED) of PSS is required. However, the existing guideline for calculating the CED is mainly intended to physical products. It neglects the services shares of a PSS as well as the interdependencies between products and services. Against this background, this paper provides a research approach that aims at calculating, analyzing, and reducing the CED of PSS.

Keywords:
Product-service system, cumulative energy demand, lifecycle engineering

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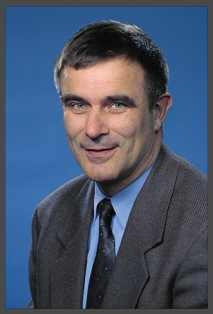

Prof. Dr.-Ing. Günther Seliger holds the Chair for Assembly Technology and Factory Management in the Production Technology Centre of the Technische Universität Berlin (TU Berlin) and Fraunhofer Society, Germany. He is the Dean of the international study program for Master of Science in Global Production Engineering at the TU Berlin. He has led more than 100 students to Ph.D. degree in manufacturing technology and published more than 300 refereed journal papers. He is the chairman of the annual Global Conference on Sustainable Manufacturing (GCSM). He is leading interdisciplinary Collaborative Research Center (CRC 1026) funded by German National Foundation (DFG). He is a fellow in the International Academy for Production Engineering (CIRP), member of the German National Academy of Science and Engineering (acatech), and German Academic Society for Production Engineering (WGP). Prof. Seliger received a doctor engineer degree (Dr.- Ing.) in manufacturing technology in 1983 under the supervision of Prof. Dr.-Ing. Günter Spur at the TU Berlin.

The constitution of the cooperative research centre (CRC 1026) “Sustainable Manufacturing – Shaping Global Value Creation" at the TU Berlin has been granted by the German Research Foundation (DFG) with a total funding of approximately 30 million Euro and for a duration of 12 years. Prof. Dr.-Ing. Günther Seliger of the Institute for machine Tools and Factory Management (IWF) at the TU Berlin is speaker and co-ordinator for the CRC 1026. CRC 1026 intends to demonstrate how sustainable manufacturing embedded in global value creation proves to be superior to traditional paradigms of management and technology. CRC 1026 utilizes dynamics of global competition and cooperation for lending wings to processes of innovation and mediation towards the reasonably demanded sustainability on our globe. A special focus lies on condensing engineering to sustainable manufacturing, thus specifically addressing artifact generation for shaping human living.