"Cleaner Production in the Forming, Machining and Surface Treatment Industries - a Contribution to Advancing Sustainable Manufacturing in Europe"

Imprint

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The booklet is only available in electronic form. It can be downloaded from the *European Observatory for Eco-Manufacturing* at www.ecomanufacturing.eu.

Compiled and edited by i.con. innovation GmbH, Stuttgart

*) Full project title: "Observing, linking, coordinating and consolidating RTD actions in Europe by 2010 in order to support effective and efficient innovation on sustainable production processes"

Preface

Issues of long term importance become more and more relevant to the SME dominated industry in Europe.

One central point is related to the availability of resources. The improvement of an efficient use of materials has already led to an increase in the long term availability of raw materials. For instance, the accessibility of platinum metals has been increased from 83 years in 1975 up to 400 years in 2001, even though the usage of platinum has doubled within this period of time. This ongoing development towards sustainability is based on intense endeavours on advanced production technologies in combination with the processing of new and sophisticated materials, carried out in particular also by the many small and medium sized manufacturing companies. As a result, the efficiency of resources has already increased significantly, and the product and process properties realised are indeed comparable or even better in functionality than with conventional technologies. Thus, the specific technical functions required by the end users can indeed be achieved with decreasing amounts of material.

This success is based on several factors which fit together like key and keyhole. Undoubtedly, sustainable process technology is one such key factor. For the required further advancement of sustainable production processes, a deeper understanding 'at molecular level' of the physical and chemical phenomena occurring throughout the overall process chain will be as important as the knowledge of the interfaces between the various stages of production and the development of adjusted and advanced materials.

A sustainable technological development is definitely one of the most important issues to ensure long term competitiveness of the European industry. European SME dominated industries like the manufacturing and in particular the surface technology sector are currently on a very promising path to find successful answers to the global challenges. But they need the support from policy and other stakeholders to further advance and implement the visions and strategies developed.

Dr. Uwe König

Zentralverband Oberflächentechnik

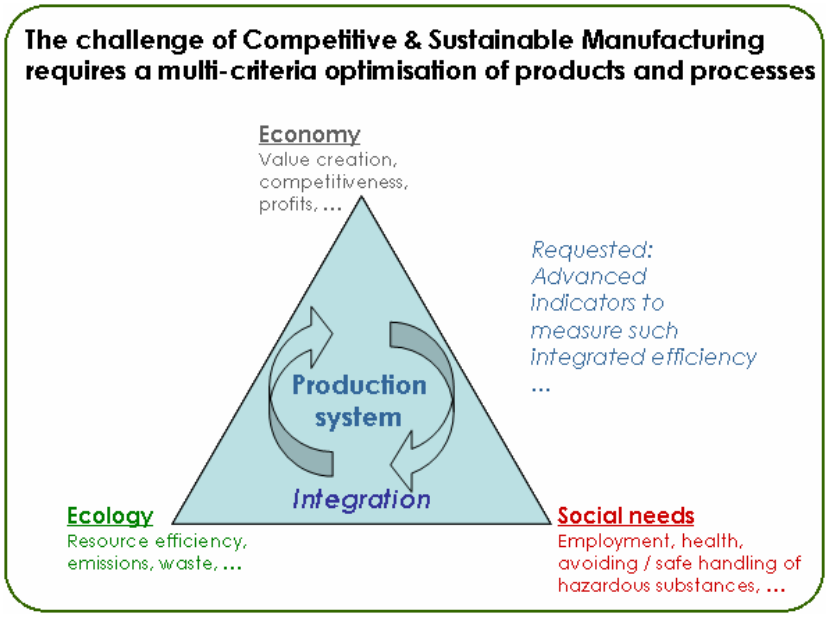
Hilden, 5 September 2008

Content page

The Needs and Issues for More Sustainable European Production Systems

Over the past decade the globalised economy has led to a tremendous increase in the pressures to change today's productions systems and to make them both economically and ecologically sustainable under a long-term perspective. While in the beginning of globalisation these pressures concerned mainly economical competitiveness, the dramatic development in climate change and the steep price increases for energy resources as well as for other basic materials (steel, coppper, zinc etc.) have made it clear that ecological sustainability is indeed of equal importance and will further grow rapidly, in line with the growth of world population and the related fast growing resource consumption.

And along with the ecological concerns go more and more also concerns for an overall social sustainability (jobs, health, safe handling of substances etc.) of modern production systems. This has been summarised in the graphic beneath*).



The European Union has reacted to these threads through various measures making sustainable development a core objective of its policies. Current EU policies are based in particular on the renewed Sustainable Development Strategy (SDS) of June 2006 which at its core the statement that „*the needs of the present generation should be met without compromising the ability of future generations to meet their own needs*". The Sustainable Development Strategy thus forms the overall framework within which the Lisbon Strategy, with its renewed focus on growth and jobs, provides the motor of a more dynamic economy. Its implementation finally requires a substantial change towards more sustainability not only for single production processes but for the entire production system in Europe.

The renewed Sustainable Development Strategy especially recognises the need for more research and development which plays an important role in order to promote

- a forward-looking and integrated approach on sustainability, with a view in particular on sustainable consumption and production **to break the link between economic growth and environmental degradation**, and
- a prosperous, innovative, knowledge-rich, competitive and eco-efficient economy.

*) according to Westkaemper, Manufuture Conference 2007

The ***CleanProd Initiative***[*)] which is described in this paper, aims in particular at the decoupling of economic and ecological impact for three major steps in manufacturing process chains, and namely the forming, machining and surface treatment processes which constitute a major part of the production system.

The envisaged shift of European manufacturing systems towards full long-term sustainability requires a multifaceted innovation approach including the following core components:

- eco-design of new resource-efficient ('dematerialised') and high value-added products with minimised negative environmental impact over the life-cycle,
- breakthrough advances in manufacturing pocesses and materials technologies including the new emerging technologies field,
- new sustainable business models and performance indicators, as well as the
- integration of education, research and innovation support activities

and their application in all relevant industry and market sectors.

The complexity of this overall innovation process is further increased by the fact that the single components are interlinked through multiple feedback loops, leading to complex non-linearity of the overall process. The European Commission is addressing this major challenge in a joint approach with industry and research institutions through the various Technology Platforms, and in particular the Manufuture, SusChem and EuMat initiatives.

Complementary to these high-level initiatives and in a deliberately chosen *bottom-up* approach, the ***CleanProd project*** has been focused on developing sustainable technology ***roadmaps*** and corresponding ***implementation scenarios*** for the forming, machining, surface preaparation and surface treatment of metal and plastic products. These processes are at the core of the value creation chain of a multitude of industrial and consumer products. Implementation of the CleanProd roadmaps thus may substantially contribute towards cleaner, more resource-efficient as well as economically and socially more sustainable manufacturing systems in Europe. The required links and interfaces towards the other three components of the above overall innovation process – eco-design, sustainable business models and integrated innovation support – have been accordingly integrated in the CleanProd implementation scenarios.

What ***CleanProd is offering*** is therefore a coherently developed ***Starting Point*** for the development of the emerging new sustainable production processes in core fields of the European manufacturing system. The suggested approach is open to and needs to be integrated in the whole innovation chain as well as with further technology and application sectors, in order to fully exploit the results so far.

Notwithstanding this issue for integration, the CleanProd initiative has also developed self-standing implementation and exploitation routes such as the European Observatory for Eco-Manufacturing, a platform which provides netwoking and innovation support as well as a substantial knowledge base, linked also to major national as well as sector specific initiatives.

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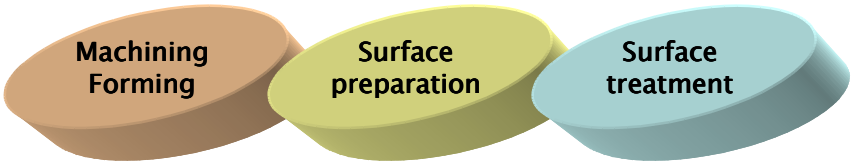
*) ***CleanProd*** is a Coordination Action performed under the NMP Theme of the EU's RTD Framework Programme, and is oriented at the EU's Environmental Technologies Action Plan (ETAP) – a joint initiative of DG Research and Environment to support the implementation of the SDS.

CleanProd - a Short Profile

The project

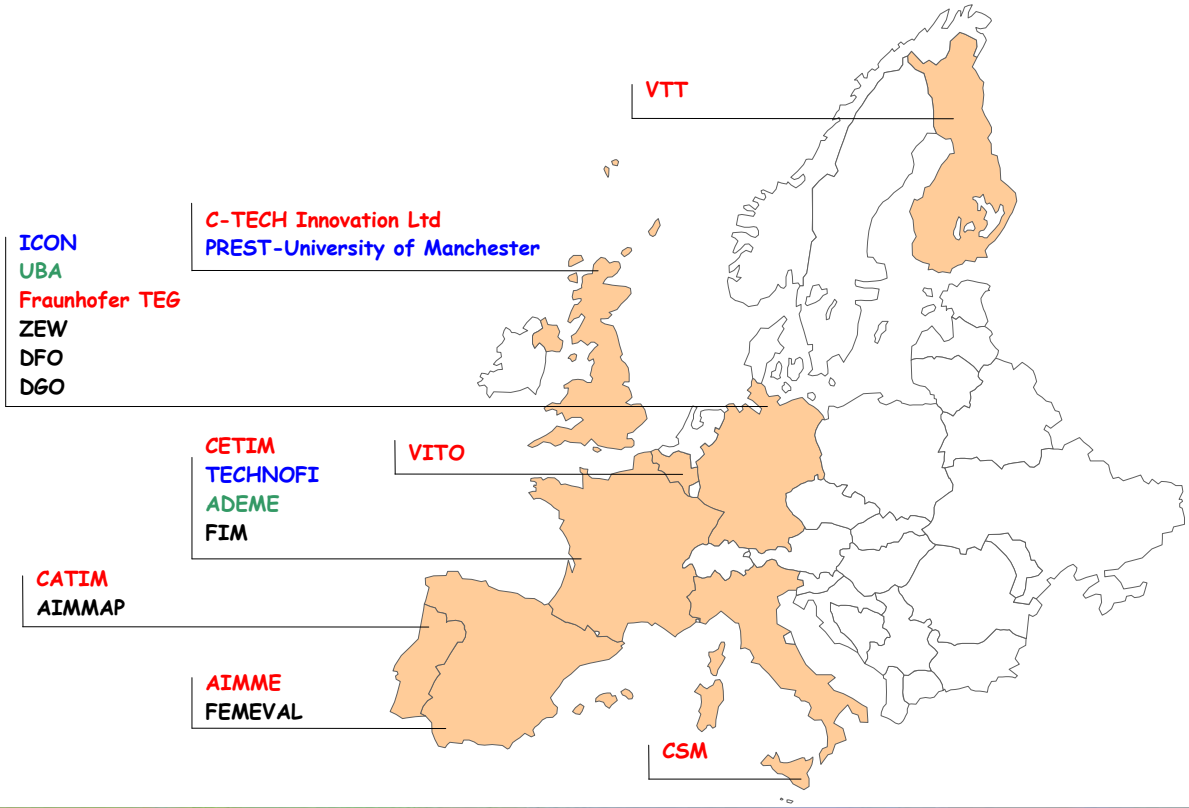
The CleanProd project, supported by the EC, is a Coordination Action to consolidate the R&D initiatives across Europe towards **more innovation in sustainable production processes**. CleanProd aims at changing the paradigm that cleaner processes are implemented on regulatory constraints and infringe enterprises' competitiveness. It will pave the routes for cleaner processes as real competitive opportunities. CleanProd focuses on three classes of processes, impacting many industrial sectors (aerospace, automotive, energy, agro-food, etc.), and which will require more and more innovations to improve their sustainability.



The team

19 partners from 8 Member States: Belgium, Finland, France, Germany, Italy, Portugal, Spain and UK.

The consortium brings together the complementary competences of **Research Centres**, **Innovation experts**, **Industrial associations**, and **Environment agencies**, as depicred in the graphic below.



Ambitions of CleanProd

- Design 2020 European visions for the development of sustainable manufacturing processes in the forming, machining, surface preparation and surface treatment sectors;
- Propose research roadmaps pinpointing R&D topics that need to be coordinated at EU level, Member State level or even regional level;
- Launch a European Observatory on sustainable manufacturing that will become the permanent European knowledge repository for industrial users;
- Implement a first set of R&D coordinated activities, based on priority needs identified, and involving professional associations and national environmental agencies;
- Enrich the European manufacturing Technology Platform with a sustainability dimension, through a permanent working group able to deal with comparable issues in other sectors of clean/sustainable manufacturing.

Background analysis (Results from WP 1/2)

The constraints driving Innovation in sustainable manufacturing processes

Over the last decade, the observation of European R&D and innovation activities in the plastics and metal working industries show that **evolving regulations and increasing competition are driving the industries' moves** towards cleaner processes.

Regulations

European regulations on chemicals, energy consumption of critical devices, the wise use of electrical and electronic equipment, waste management, and also the working environment, are constraining manufacturing processes with impacts on:

- products
- their energy needs
- worker protection

Regulations on substances and products reveal to be the most critical. Let us mention the REACH regulatory framework for the Registration, Evaluation and Authorisation of Chemicals, and the EUP Directive on eco-design of Energy-using Products.

This has been confirmed by an in-depth analysis of 55 R&D projects supported by these EU-based programs. It revealed that the latest R&D activities emphasized air/water pollutant emissions and hazardous substances, whereas the product contents were addressed when forming, machining and surface treatment processes were used.

55 projects reviewed				
Regulatory constraints on...	***Constraint addressed by projects***	***Number of projects in ...***		
		Forming, Machining	***Surface Preparation***	***Surface Treatment***
Substances	Hazardous substance use	9	4	6
	Volatile organic compound use	1	2	5
	Waste treatment	18	5	6
	Air & water pollutant emissions	15	6	13
Products	Dangerous substances content in final products	2	2	7
Energy	Energy consumption	2	1	4
Worker protection	Physical protection of worker	6	3	5
	Explosive atmosphere	1	1	1

Competition

Even though evolving regulations push process manufacturers to innovate towards more sustainability, increasing competition appears to be the primary reason for

innovation in the studied sectors. A series of interviews performed with EC supported R&D project leaders showed that cost competitiveness is perceived as one of the most critical innovation drivers that lead to sustainable processes. By cost competitiveness is meant:

- Higher process productivity
- Lower manufacturing costs
- Higher end product quality

As a matter of fact, **energy costs** should be pointed out as one of the future main sources for sustainability improvement: the increases in energy costs will require major innovations dealing with energy use efficiency to help process manufacturers remain competitive.

Major innovation gaps in various areas

The main results of the analysis of the individual processes education, research, innovation, stakeholder convergence and technology integration as well as other support measures are summarised hereafter.

Mainly important seems to be the stakeholder convergence of all relevant actors from research and industry between different sectors and disciplines. The major problems encountered that prevent from a successful collaboration within the value chain actors are the discrepancy of economic and technological interests and targets between the partners and the difference in systems (design etc.), and traditions between companies of different parts of the value chain.

Improved stakeholder convergence is a key to improve the education, research and innovation processes as well as technology integration.

Educational process

SMEs in particular face important barriers in gaining and retaining knowledge and know-how: Training is one main important option to bring specialist knowledge into the company.

Training activities at different levels regarding sustainable manufacturing are numerous, but the efforts are scattered. From the information obtained it is however hard to say how well innovative technological solutions and approaches penetrate to industry through these channels.

Barriers for participation in training are above all a lack of time and resources. Many employees are therefore still reluctant to be trained and companies do not see the added advantage of learning from the experience from other participants. On the other hand, specific training required is often too theoretical or is even unavailable, particularly in relation to newer technologies.

Moreover a significant lack of collaboration between the scientific community and the industrial players can be stated, leading to inadequate education (and research) programmes with regards to real industrial needs. At present industrials are poorly involved in the education process.

Research process

A significant lack of collaboration between the scientific community and the industrial players leads to inadequate research programmes with regards to real industrial needs. The limited understanding of the real industry challenges and innovation requirements by the academic community limits the possibilities of success for future development and integration of the results and explains the existing gap between the laboratory scale experiments and the pilot or industrial scale development.

Conversely, industry has difficulties to access scientific knowledge, resulting in a lack of qualified workers (and of time) to integrate new scientific knowledge, and to adapt them to their own production. Moreover process suppliers are poorly involved in collaborative R&D, which can be related to the difficulty of adoption and implementation of new processes by the process users.

Innovation process

Beneath the problems with regulatory constraints SMEs experience some barriers to clean innovation specifically due to the lack of skilled people available to innovate and limited resources. Moreover SMEs also suffer from insufficient collaboration within the industry branch (collaboration with larger companies, suppliers, customers) or within the research community (poor access to European funding, and thus to collaborative research).

In general the sector's culture plays thereby a key role: The forming, machining, surface preparation and surface treatment sectors are not fast growing markets and are characterised by conservative attitudes.

To exploit undeveloped research, more multi-disciplinary exchange platforms, via internet or via innovation congress, it may be helpful to improve partnering of all relevant stakeholders like university researchers, industrialists, technical centres and engineering companies.

Technology integration

Technology integration is the process of involving multi-disciplinary and multi-sector knowledge generation in the concrete technology development for sustainable manufacturing. User acceptance will be one key success factor for technology integration. The hiding of complexity, increased levels of hard- and software integration, increased intelligence in tools and devices will be - beneath networks - the key to unlock future success. Interoperability and open standards in such a context become main issues for value creation and solution provisioning across technologies, services, tools and devices. These objectives can only be achieved through co-operation and communication of research and industry between different sectors and disciplines.

Funding and support measures

A final detected barrier for innovation for SMEs is the lack of access to exhaustive and clear information on public (and private) national or ### European support

Methodological approach for Roadmap development

R&D and innovation roadmaps combine the use of existing clean technologies and new technologies to comply with the expected end user needs and future selection criteria.

The road mapping tasks focused on the sectors under scrutiny in the framework of CLEANPROD: forming, machining, surface preparation and surface treatment. They include four steps:

1. A long term vision building, relying on a background analysis, which was broken down into Orientations by 2020, and Targets by 2015;
2. A 1st road mapping workshop to list the key technologies to be developed in order to reach the 2015 Targets, which took the form of project sheets;
3. A 2nd road mapping workshop to appraise the projects according to ranking criteria detailed hereafter;
4. A 3rd road mapping workshop to adjust, rank and consolidate the selected projects against potential scenarios (the possible futures);

Since the 1st road mapping workshop, it became critical to implement a tailored cross process approach to enable the appraisal and optimization of the whole process chain involved to reach a pre set level of eco performances. It is based on an integrated vision of the interacting processes that are necessary to yield mechanical parts having pre-specified surface properties.

Three technological components have been scanned:

- Materials;
- Processes, processing and plants;
- IT (e.g. simulations, automation and control, trajectory optimization in machining, etc).

For each of those components, candidate innovative solutions have been analysed combining technology push and market pull approaches.

Each elementary project has its own level of importance to help reach the long term vision. This is why an appraisal methodology has been implemented to distinguish between top priority projects for breakthrough sustainability, and those having a less importance.

Six ranking criteria have been defined, two for Technology assessment, two for Market assessment, and two for Sustainability assessment;

The Technology portfolio approach compares the degree of controllability and the attractiveness of the technology. The consortium experts at technology development have assessed the individual technologies identified qualitatively with respect to their present and future potential based on the following criteria.

1. Controllability:

- Technological potential
- Raw materials and resources
- Education and know-how
- Complexity
- Feasibility
- Integration in the environment
- Interrelation with society

2. Technology attractiveness:

- Scope of technology
- Relevance of the technology for the solution
- Technology limitations
- User acceptance
- Patent situation

Then, the consortium's market experts assess the individual technologies qualitatively based on the following criteria:

3. Prospects for successful implementation:

- Technological controllability
- Technology attractiveness
- Market position
- Scope of technological potential
- Acceptance by society

4. Market attractiveness

- Market potential, market size
- Market development
- Range of different markets/cross-branch potential
- Structure of user companies
- Production in Europe
- Cost structure (branch/firm)
- Succession markets
- Competition

Finally, the sustainability is assessed with a view to economic and ecological aspects:

Economic sustainability (including social sustainability)

- Stability of employment
- Stability of prices
- (International) competitiveness
- Economic development
- Ability to innovate
- Economic structure
- Working conditions
- Safe handling of substances etc.

Ecological sustainability

- Advantages and disadvantage of the technologies (e.g. climate, human and eco-toxicology, etc.)
- Raw materials and material production
- Production (dangerous processes, energy use, emissions, wastes etc.)
- Advantages and disadvantages of technology use and operation
- Recovery and disposal/recycling

Each of the proposed technology developments is evaluated against these 6 criteria on a scale ranging from 1 to 4:

1 low

2 below average

3 above average

4 high

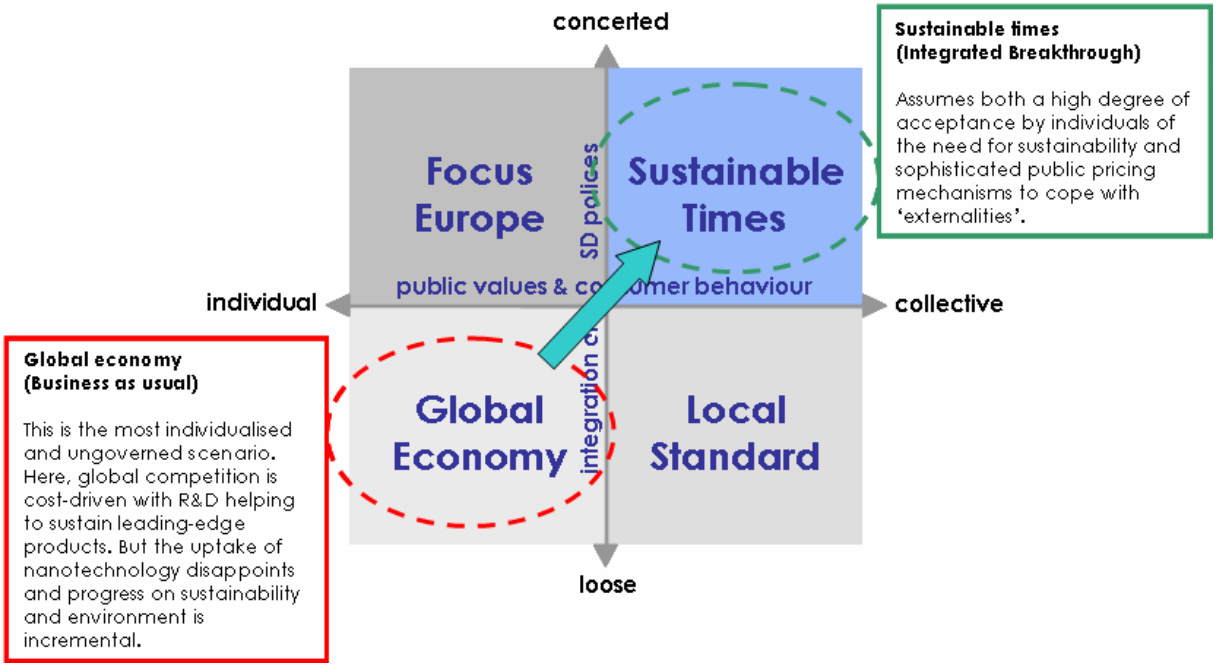
Roadmaps for the 3 sectors

Deploying scenario analysis

To focus discussion in uncharted territory, the technique of scenario analysis is used. Scenario analysis is a widely used foresight exercise. Scenarios are plausible stories about the future, given past events and current circumstances. They are a set of consistent story lines that carry the present into the future.

These Scenarios are not hard-and-fast predictions, but identify common, robust traits European manufacturing must show in the event of a variety of possible futures coming to pass. The aim here is to focus on alternative futures and thereby overcome problems of anchoring to current events and group bias in judgements.

Figure: Futman Scenarios and their implications for Cleanprod



"Global Economy" or "Sustainable Times"

These two individual scenarios "*Global Economy – Business as Usual*" and "*Sustainable Times – Integrated Breakthrough*" were chosen as a focus for discussion. They are based on the extent to which socio-economic attitudes and governance became either more individual or more collective. The scenarios build around two contrasting sets of future events: *Global Economy – Business as Usual* is the most individualised, ungoverned scenario.

Under this scenario, global competition is cost-driven, with R&D helping to sustain leading-edge products. But progress on sustainability and the environment is incremental. In contrast, the *Sustainable Times – Integrated Breakthrough* scenario contains both a high degree of acceptance by individuals of the need for sustainability and sophisticated public pricing mechanisms to cope with "externalities".

Building a European vision on R&D for sustainable production processes by 2020

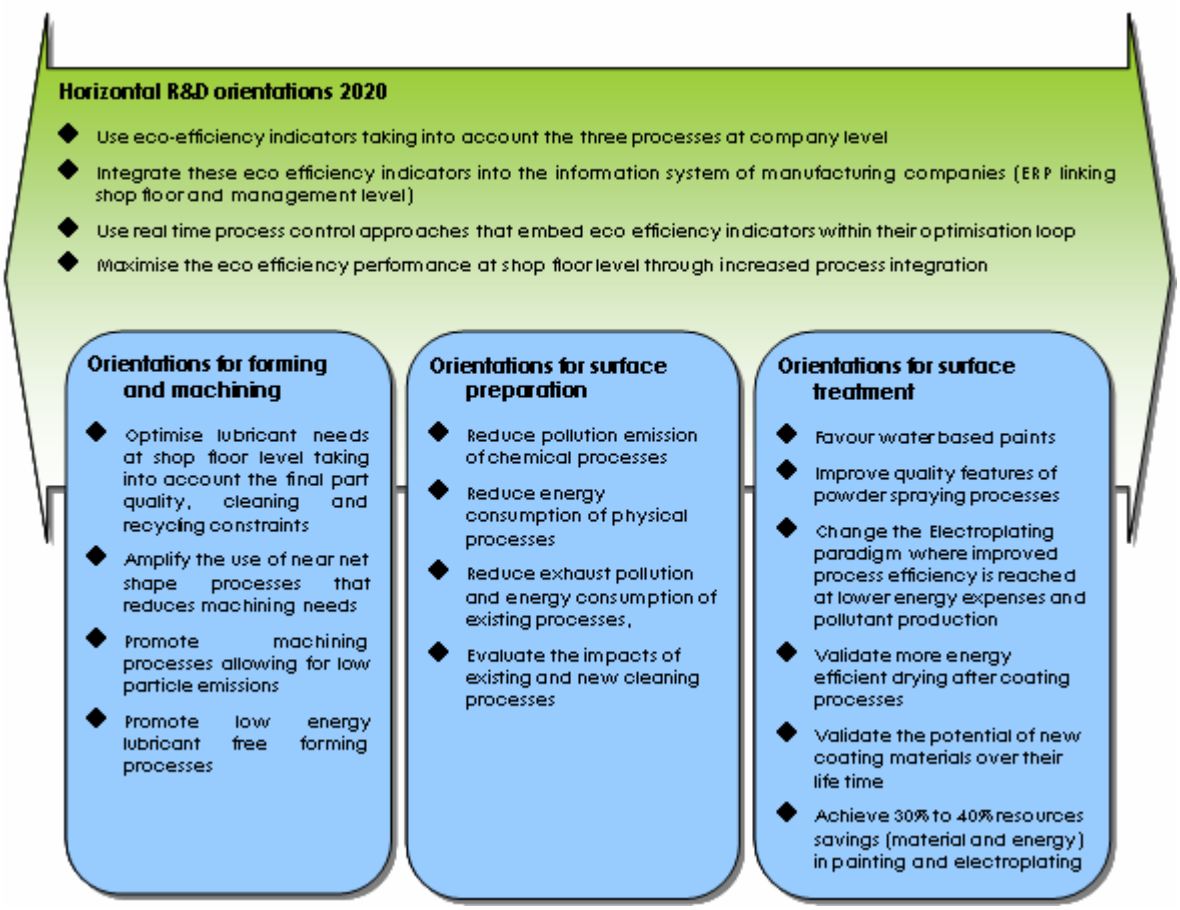
One of the project's ambitions is to build up a coherent vision of sustainable production processes by 2020, i.e. a set of sustainability orientations by 2020, with a focus on the research and development activities required to reach the vision.

A set of roadmaps was therefore developed to organize the R&D efforts for the time horizons 2015 and 2020, combining two complementary approaches:

An approach per process (forming; machining; surface preparation and surface treatment) addressing the features of each individual process, in order to identify specific margins of improvements in sustainability and competitiveness at the same time;

An integrated approach considering the three processes combined: some common issues addressed by multidisciplinary, "horizontal" R&D efforts may positively impact all processes at once.

The scheme below gives an overview of the orientations by 2020 defined for each of the four R&D components considered.



The CleanProd Roadmaps

The following pages show three example roadmaps, each one forming a part of the roadmaps for

- the forming and machining industries
- the surface preparation sector, and
- the surface coating sector

The full roadmaps include the description of a set of possible projects to be conducted in order to properly reach the 2020 visions, through the 2015 targets (intermediate step). These R&D initiatives will be proposed in the frame of future 7th FP calls.

In addition, the project team highlights horizontal activities which precise 2020 visions for the integration of the three processes:

- To use eco-efficiency indicators taking into account the three processes at company level
- To integrate these eco efficiency indicators into the information system of manufacturing companies (ERP linking shop floor and management)
- To use real time process control approaches that embed eco efficiency indicators within their optimisation loop
- To maximise the eco efficiency performance at shop floor level through increased process integration

The complete roadmaps are available for download on www.ecomanufacturing.eu

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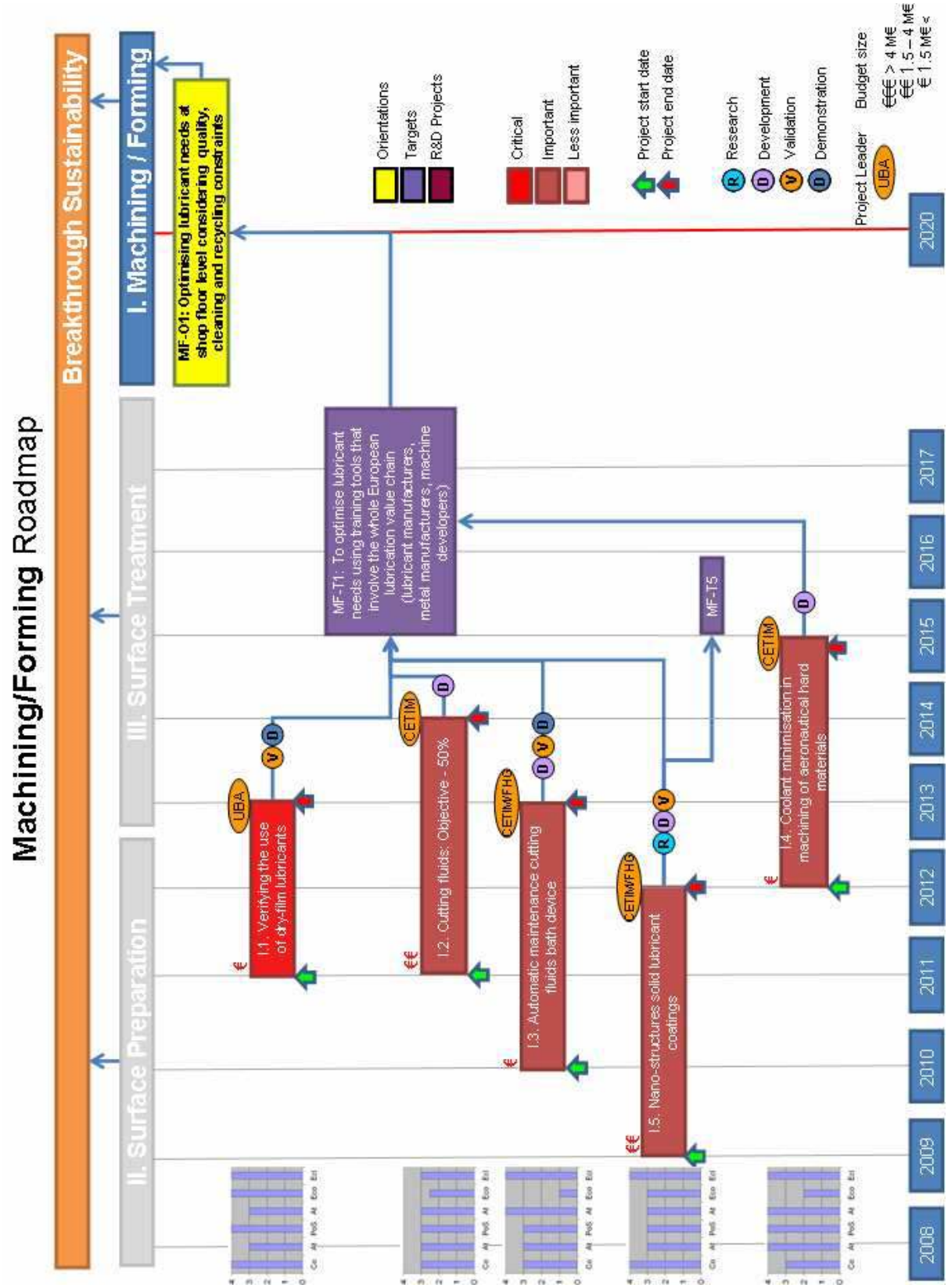
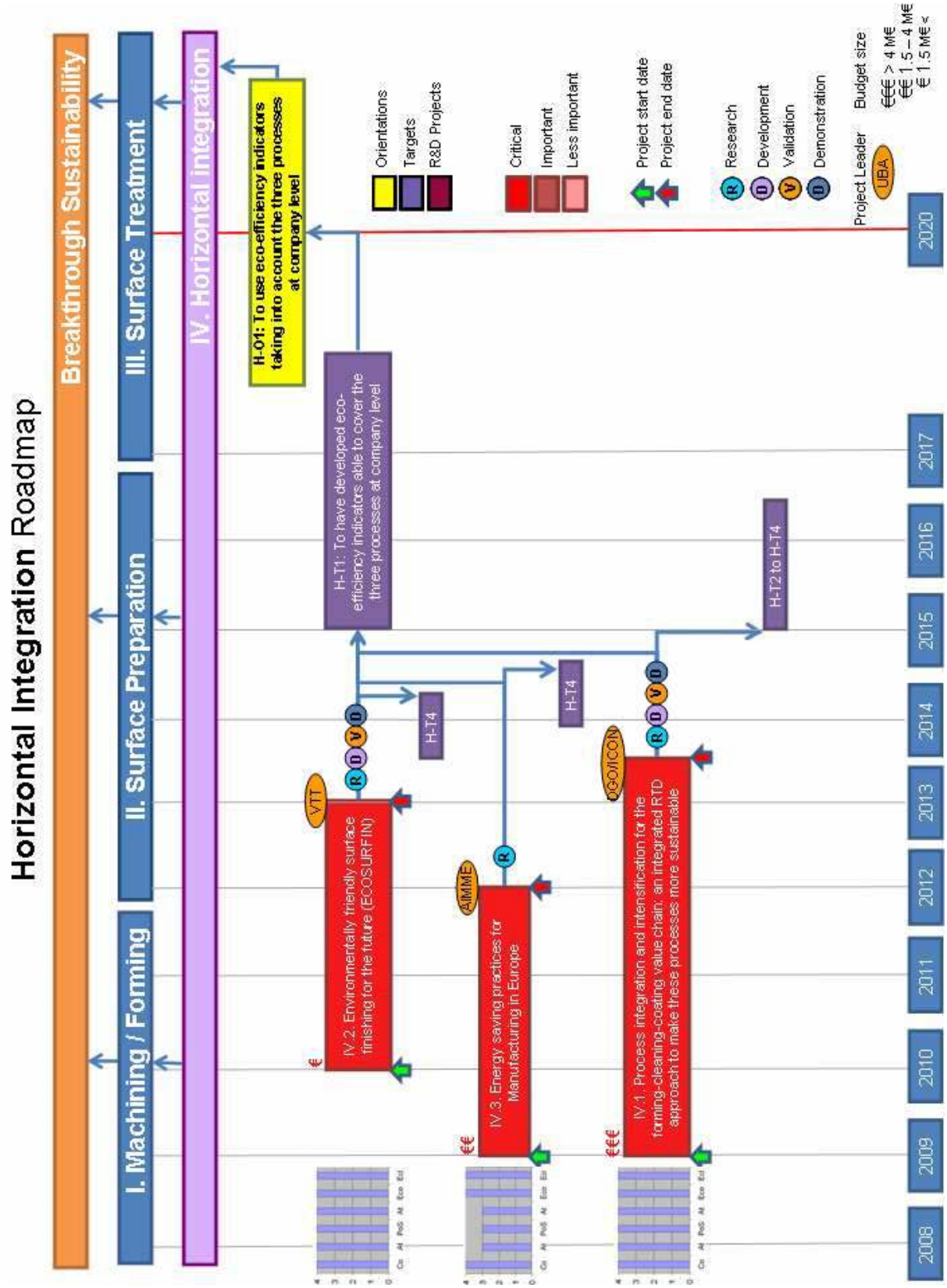
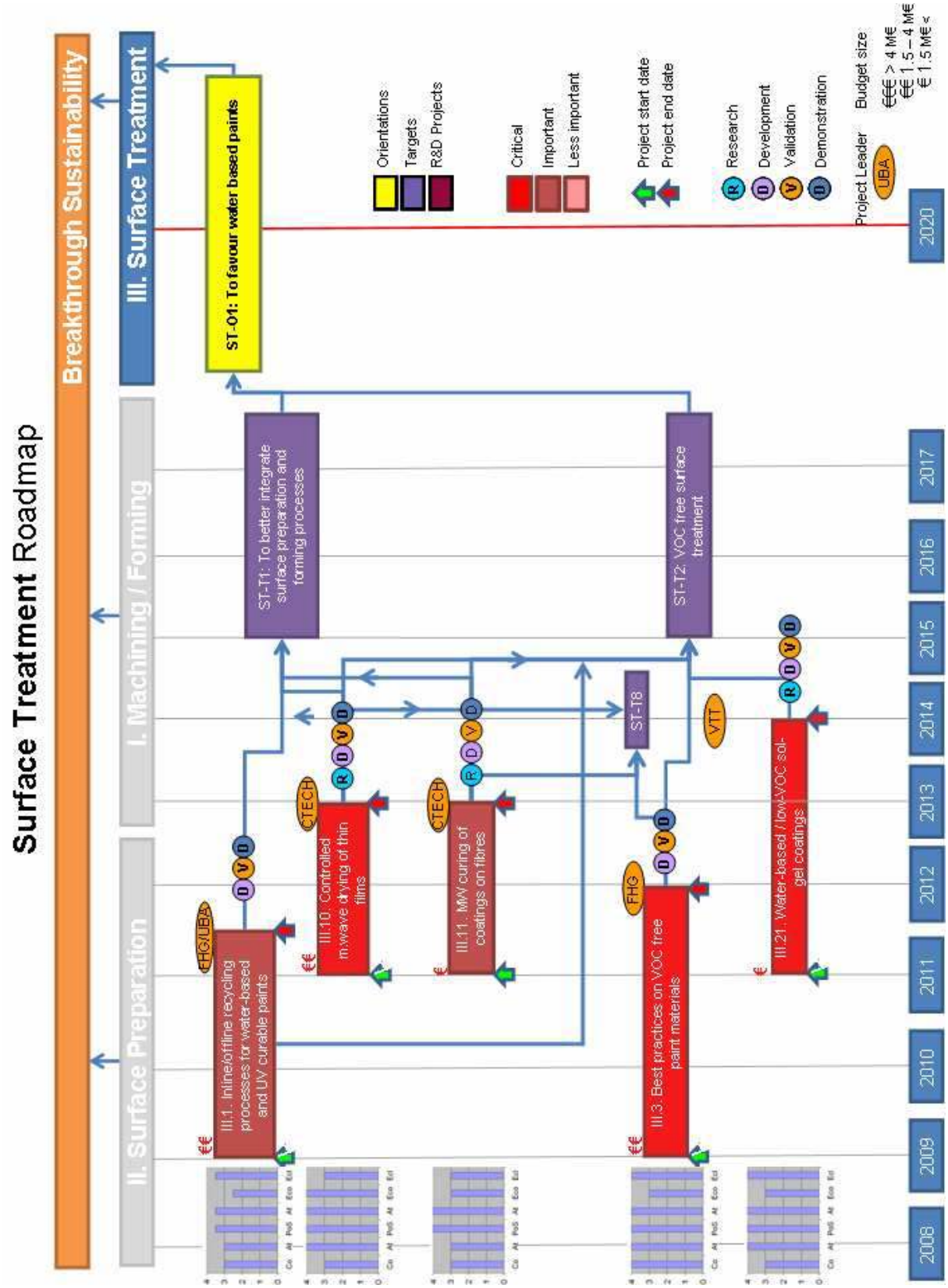

Machining/Forming Roadmap
Breakthrough Sustainability
I. Machining / Forming
II. Surface Preparation
III. Surface Treatment
MF-01: Optimising lubricant needs at shop floor level considering quality, cleaning and recycling constraints
Orientations
Targets
R&D Projects
Critical
Important
Less important
Project start date
Project end date
Research
Development
Validation
Demonstration
Project Leader
Budget size
UBA
€€€€ > 4 M€
€€€ 1.5 – 4 M€
€€ 1.5 M€ <
2020
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
MF-T1: To optimise lubricant needs using training tools that involve the whole European lubrication value chain (lubricant manufacturers, metal manufacturers, machine developers)
MF-T5
I.1. Verifying the use of dry-film lubricants
I.2. Cutting fluids: Objective - 50%
I.3. Automatic maintenance cutting fluids bath device
I.4. Coolant minimisation in machining of aeronautical hard materials
I.5. Nano-structures solid lubricant coatings
CETIM
CETIM/FHG


Horizontal Integration Roadmap
Breakthrough Sustainability
I. Machining / Forming
II. Surface Preparation
III. Surface Treatment
IV. Horizontal integration
H-01: To use eco-efficiency indicators taking into account the three processes at company level
Orientations
Targets
R&D Projects
Critical
Important
Less important
Project start date
Project end date
Research
Development
Validation
Demonstration
Budget size
€€€ > 4 M€
€€ 1.5 – 4 M€
€ 1.5 M€ <
Project Leader
UBA
H-T1: To have developed eco-efficiency indicators able to cover the three processes at company level
H-T2 to H-T4
H-T4
H-T4
VTT
IV.2. Environmentally friendly surface finishing for the future (ECOSURFIN)
AIMME
IV.3. Energy saving practices for Manufacturing in Europe
CIDAUT
IGOVICON
IV.1. Process integration and intensification for the forming-cleaning-coating value chain: an integrated RTD approach to make these processes more sustainable
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2020

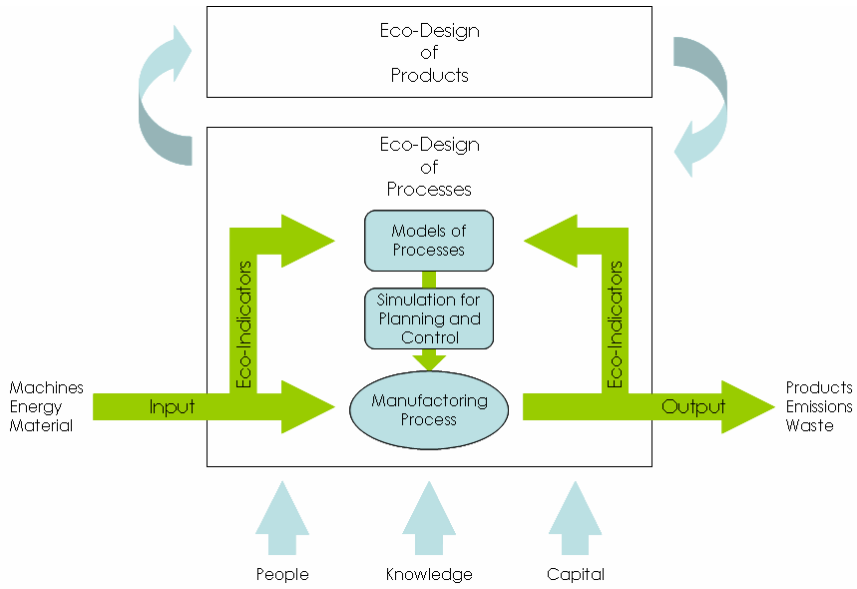

Surface Treatment Roadmap
Breakthrough Sustainability
III. Surface Treatment
II. Surface Preparation
I. Machining / Forming
ST-01: To favour water based paints
Orientations
Targets
R&D Projects
Critical
Important
Less important
Project start date
Project end date
Research
Development
Validation
Demonstration
Project Leader
Budget size
€€€ > 4 M€
€€ 1.5 – 4 M€
€ 1.5 M€ <
UBA
ST-T1: To better integrate surface preparation and forming processes
ST-T2: VOC free surface treatment
ST-T8
III.1: Inline/offline recycling processes for water-based and UV curable paints
III.10: Controlled m-wave drying of thin films
III.11: MW curing of coatings on fibres
III.3: Best practices on VOC free paint materials
III.21: Water-based / low-VOC sol-gel coatings
FHG
CTECH
VTT
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2020

An Integrated Approach for a Breakthrough in Cleaner Production

Forming, machining, surface preparation and surface treatment processes are at the core of the manufacturing chain to create high value added products for many sectors, such as transport, construction, energy or domestic appliances.

In order to contribute to an increase of both competitiveness and sustainability of manufacturing processes that changes today's manufacturing paradigms, CleanProd has elaborated a dedicated holistic and integrated RTD approach focussed on the production of metal and plastic products and components over the above chain of manufacturing processes.

In the past decade much work has been undertaken on the optimisation of single processes within the process chain. Yet the manufacturing optimization under a life-cycle perspective to produce high value added products in a competitive and sustainable way, is a multi-objective optimization problem. Thus without addressing the overall process chain in an integrated way, these individual optimisations necessarily have led to sub-optimal results for the overall process efficiency and sustainability, leaving substantial room for further improvement.



This integrated approach requires for each module of the process chain, an in-depth understanding of physical / chemical process models allowing for process simulation, and the definition of process interfaces allowing for an integration of the simulation over the manufacturing chain as well as with the product eco-design.

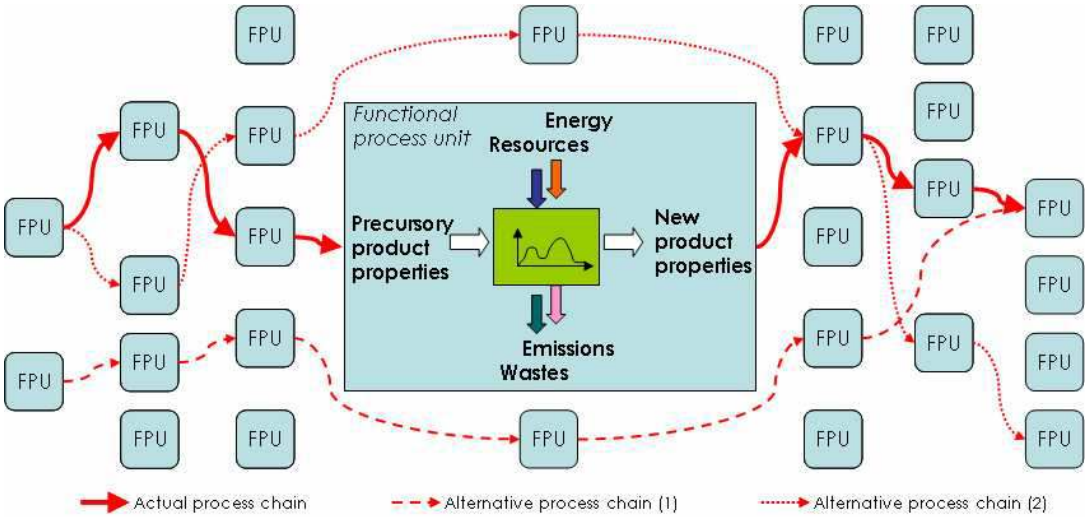
This requires new common scientific grounds to support a knowledge-based sustainable design and production, and the use of this new knowledge to innovate on process engineering.

This integrated approach will be based on 7 key contributions:

- Interdisciplinary research to deepen the scientific understanding of existing manufacturing processes and a common nomenclature throughout different technical disciplines
- Development of comparable process simulation and modelling approaches throughout the forming / machining - surface preparation - surface coating process chain

- Advanced modularisation of the manufacturing process chain into well defined "Functional process units (FPU)" in order to create new flexibility and possibilities, integrating parameters for life cycle analysis regarding competitiveness, sustainability and innovation
- Process interface and life cycle analysis for each FPU over the whole value chain to ensure proper combinations of basic forming, machining and coating processes to meet product design specifications
- Science based process engineering with a focus on the process optimisation of critical real-life cases, addressing in particular the complex interlinks of forming / machining - surface preparation - surface coating options

Graphic: Modularisation, interface definition and process eco-engineering



- Development of advanced product eco-design options and guidelines for the manufacturing of new high added value product with tailored properties
- Eco-innovation management methodologies addressing integration issues of the developed technological solutions

This will result in four major contributions to substantially increase the competitiveness and sustainability of manufacturing processes:

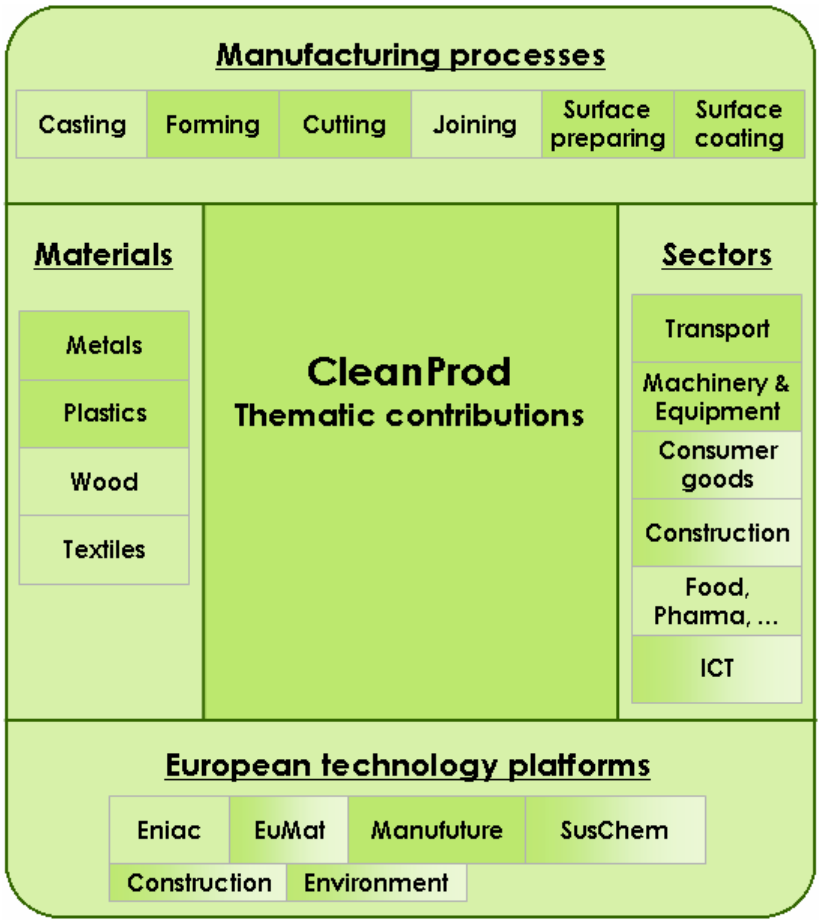
Expected impact

- Process models enabling the continuous simulation of the process chain, with interfaces to the eco-design of products
- "From eco-indicators to CSM indicators": Comparison and ranking techniques of manufacturing processes with regard to their competitiveness and sustainability performance, innovation potential and social impact, and to establish such CSM ranking options as decision support criteria for the optimal choice of critical manufacturing processes
- Advanced CSM indicator-based life-cycle optimisation by better integrating the eco-design of products and processes
- Reduced time-to-market of manufacturing process innovations through improved capabilities to integrate new processes into the process chain

The CleanProd Contribution to the Vision of the Sustainable European Manufacturing System — Results of the Joint Workshop with Manufuture

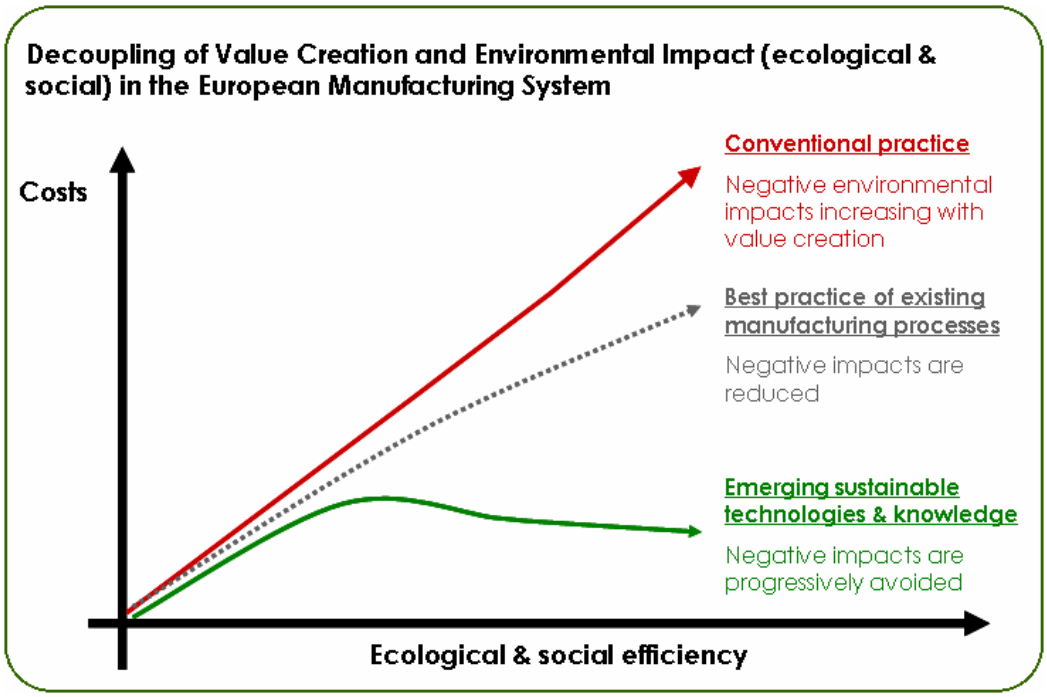
The CleanProd Roadmap is addressing major manufacturing processes, materials technologies, product/market sectors, and related European Technology Platforms (as depicted in the figure below).

Since CleanProd is aiming to contribute to core fields European manufacturing, it offers a potential starting point to the formation of a Sustainable Manufacturing working group within Manufuture, which could be combined with complementary initiatives to cover the whole field.



(To be completed based on the workshop results)

The overarching objective of such complementary approaches will be the decoupling of of the economic and ecological impact of European manufacturing processes which is qualitatively depicted by the "Innovative Sustainable Manufacturing" pathway in the figure below.



(To be completed based on the workshop results)

Steps towards Implementation

The European Observatory for Eco-Manufacturing (see www.ecomanufacturing.eu) aims at delivering state-of-the-art knowledge to all the stakeholders willing to innovate in manufacturing technologies that optimize their environmental footprint. It must be seen as a one-stop shop to access leading eco manufacturing techniques and technologies and to find appropriate partners for sustainable business development.

The Observatory delivers the following services:

- A **knowledge** area fed by expert stakeholders in eco-manufacturing activities;
- A **technology transfer** area where the most promising research results will me posted seeking an uptake by industry for further development and marketing;
- A **partnering** area linking users with a pool of European experts in eco-innovation management, including a competence database in the near future.

Besides these core services, the Observatory

- relays the most important events related to eco-manufacturing at European and international levels,
- provides links to other important web sites serving eco-manufacturing issues,
- relays news from relevant sources

Figure 1 : Home page

The developed roadmaps have been presented using graphical techniques, which are downloadable from the "Founders" page.

To be inserted after uploading

The **knowledge** page is entitled EncyCleanPedia. It enables knowledge search in a way similar to the famous WikiPedia web site. The **EncyCleanPedia** is fed using contributions from a community of experts, who upload new articles or complement existing ones. **EncyCleanPedia** is not a blog: it aims at being a reliable knowledge area involving

- eco-technologies (state-of-the-art equipment diagrams, scientific papers, etc…)
- background information (regulations, standards, directives, green papers, etc…)
- and methodologies (life cycle assessment, energy management, etc…)

which are in support of cleaner manufacturing processes.

The articles are signed and classified by industrial sectors and by technology type.

Any expert in a field related to eco-manufacturing willing to enrich the knowledge database can become a contributing Member free-of-charge, either on a sponsorship basis relying on the existing contributors' community, or through the filling of an application form involving an expertise verification procedure.

A user manual can be downloaded from the "Founders" page.

Uploading a user manual

Figure 2 : EncyCleanPedia page showing search tool and contributing members' login area

The technology transfer area is entitled "Cleaner Production Europe". On this web site, research results seeking uptake by industry are posted in a searchable way.

To be inserted after clarifying

Anyone desiring to post research results has to register for free. The access to the results database is public.

A partnering area has been created which links the visitor with the Greenovate! Europe pool of eco-innovation management experts. Their members provide a whole range of services that ease partnership building, internationalization and financial services, offering a European perspective to respond to the requests.