

The ManuFuture Road

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Towards Competitive and Sustainable
High-Adding-Value Manufacturing



Springer

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Europe's Manufacturers: Bringing Together New Ideas with Market Needs

The work of ManuFuture could not come at a better time. Your Strategic Research Agenda, with its ambitious plan to invite European organisations to invest in a set of targeted research, innovation and educational activities, should make a big contribution to our goals. If followed through, it will improve both the competitiveness of, and employment levels in, Europe's manufacturing industries.

It is encouraging to see that ManuFuture has considered all three sides of the knowledge triangle – education, research and innovation. The same thinking went into the Commission proposal for a European Institute of Technology, which will help to close the gaps between our universities, research centres and industry. This is vital if we are going to unleash the full potential of Europe's knowledge economy.

An extract from: "Bringing Together New Ideas with Market Needs".

Porto, 24 July 2006

José Manuel Barroso
President of the European Commission
ManuFuture Industrial Advisory Group

Preface

Manufacturing, covering from products and services, to processes, companies and related business models, is the backbone of European economy. More than 34 million people are employed in more than 2.230.000 enterprises in 23 industrial sectors [1.1]. In the related service areas for manufacturing 60 additional million people are engaged. Nearly 500.000 people are engaged in research, technological development and innovation, related to education, within universities, research institutes and industry. Manufacturing turnover accounts for more than 6.300 BEURO, 55% of the European GDP with an added value of 1630 BEURO [1.2]. Europe is still leading the global trade market.

Key issues, from globalization to climate change, are challenging manufacturing in advanced as well as emerging countries. Hence, manufacturing is getting back to the political agendas and the awareness of stakeholders is rising. In Europe key issues may lead to disruptive changes in the socio-economic system.

The ManuFuture initiative has been promoted to provide: a 2020 Vision, a Strategic Research Agenda (SRA), Roadmaps, awareness of the resources required, basic activities and pilot actions, to help devise and support the European *response* to the key issues challenging manufacturing. These come from the economical, social, environmental and technological (ESET) context changes and call for a move towards sustainable development.

High-Adding-Value (HAV), Knowledge-based (K-based) Competitive Sustainable Manufacturing (CSM), has been proposed by ManuFuture as the European *response*. It would involve all stakeholders, from policy makers, to public authorities and financial institutions, to industry, universities and research institutes and centres. HAV CSM may be seen as the *European Technological and Industrial Revolution for competitiveness and sustainability*.

Pursuing HAV CSM is feasible, as European industry still leads in many domains at global level and the European Education, Research and Technological Development; Innovation (E&RTD&I) System is capable of enabling and supporting a shift to HAV CSM. But human and financial resources should be dedicated. The existing education RTD&I community could be enlarged, as highly educated people are available.

The main problem may be on the side of financial resources and quickness in action. Assuming that the shift to HAV may require 10% of the current investments for continuously upgrading education, the related investment would be in the range of 15

BEURO per year. It would concern from K-based industrial Innovation, though to RTD and education. Following Lisbon strategy, 5 BEURO should be invested by European, national and regional programmes and initiatives. The rest should come from industry.

As time constants, concerning the research-innovation-market value chain, are high, decisions must be taken by the stakeholders and in particular, by politicians, public authorities and industry very soon. It must be acknowledged that Europe is ahead of other global regions and countries. The High-Adding-Value (HAV), Knowledge-based (K-based) Competitive Sustainable Manufacturing (CSM), as proposed by ManuFuture, is being pursued by ongoing European programmes and initiatives. These should be fostered, supported, coordinated and, finally, integrated.

This book addresses the stakeholders and is intended to contribute to their awareness and support their fundamental proactive role and action. The book presents the contribution already given by the ManuFuture initiative, the role this is playing and its further proactive action as well as the European and global evolving economical social environmental technological reference context. Beside ManuFuture activities and results, reference is made to official documents, reported here as closely as possible.

HAV, K-based Competitive Sustainable Manufacturing (CSM) is a revolutionary model of future manufacturing. It refers to studies carried out by the International Academy for Production Engineering (CIRP). CSM covers a wide field from traditional to emerging sectors of industry. It fosters proactive initiatives and concrete fields of actions, to innovate products, processes and enterprises. Pursuing CSM implies transformation of industry, towards HAV, and its supporting knowledge-generating infrastructure: the education, Research and Technological Development and Innovation System, (E&RTD&I).

ManuFuture is an industry-led initiative [1.3] whose mission is to pursue CSM. It aspires to promote investment in innovation that will ensure the future of European manufacturing in a knowledge-based economy. ManuFuture represents a planning and implementation initiative that defines, prioritises and coordinates the necessary scientific technical and economic actions to achieve the objectives set out above. Acting as a new kind of infrastructure, the ManuFuture platform is generating Strategic Intelligence (SI), i.e. the Competitive Sustainable Manufacturing (CSM) Vision, Strategic Research Agendas (SRA) and Roadmaps. It is developing and managing the ManuFuture Framework (FW), where SI is being implemented, to pursue CSM.

This book covers from the anticipated European promoting and supporting activities for sustainable development, to CSM, to the ManuFuture platform activities to generate SI and the framework for SI implementation, to ongoing basic activities and pilot actions pursuing CSM, to future perspectives.

In the first chapter, the move towards Competitive Sustainable Development (CSD) is presented, considering the role of the EU. Then, Competitive Sustainable Manufacturing (CSM), as a fundamental enabler for achieving CSD, is described, with particular reference to its competitiveness and sustainability. The need for a new HAV, K-based manufacturing paradigm and the enabling role of education, research and technological development, innovation – the K-Triangle – is introduced. Then the proactive strategic role of ManuFuture is outlined.

In the second chapter, the role of products and services, processes and companies, in view of pursuing CSM, is analysed. Manufacturing industry situation and perspectives are presented, considering the changes of the global market, the migration of production and consumption, the economic potential of manufacturing as well as the industrial structure, including strengths and weaknesses. Then the European leadership in manufacturing is analysed, referring to customisation, global production and technologies.

In the third chapter, the European ManuFuture initiative is described, covering from the ManuFuture Platform, to Vision 2020 and SRA features: i.e. K-based manufacturing and roadmap for industrial as well as E&RTD&I system transformation, drivers of change, pillars and domains of actions, multi-level action. Further, this chapter reports on the current situation of the E&RTD&I system in Europe and perspective transformation required as emerging from the SRA. Issues concerning investments in RTD are raised here.

In the fourth chapter, following the European way to Competitive Sustainable Development (CSD) manufacturing strategies, in terms of visions, concepts and actions to reach long-term, as well as medium-term, goals and targets, are analysed, referring to products and services, new business models, lean efficient enterprises processes, new ways of working. Innovating manufacturing engineering, from adaptive to reconfigurable manufacturing, to knowledge-based factories as products, to new Taylorism, to networking in manufacturing, is analysed, as well as digital manufacturing engineering. The challenge of advanced industrial engineering, emerging manufacturing technologies and technologies beyond borders is described. The enabler role of manufacturing industries is underlined. This ManuFuture road is a contribution to support industrial strategic planning and work programmes for public trans-sectorial collaborative research. The visions, goals and targets follow the needs of competition and sustainability.

In the fifth chapter, the Roadmaps for manufacturing research, based on the ManuFuture SRA and developed in 2006 and 2007 by the Leadership Consortium (Annex), are reported.

The Roadmaps are driven by industrial and economic requirements and the need for transformation of manufacturing towards CSD. More than 80% of the proposed activities follow visions, strategic objectives and tasks of the ManuFuture pillars and are of common interest for all industrial sectors. The authors summarised them to several trans-sectorial Roadmaps, unified under a comprehensive approach representing the ManuFuture vision towards the European industrial transformation, further on called the ManuFuture work programme.

In the sixth chapter, the ManuFuture road to High-Adding-Value Competitive Sustainable Manufacturing, as emerging from the results achieved and the foreseeable perspectives, is outlined.

ManuFuture, acting as a strategic infrastructure to pursue CSM, has generated SI and the related implementation framework (FW). This encompasses from reference models for action and global cooperation, to EMIRA, to the 25 national ManuFuture platforms and the Knowledge Innovation Community (KIC). Stakeholders, from public authorities and financial institutions, from industry, university, research institutes and centres are cooperating in SI implementation, through basic activities. To speed up and lead the implementation process, pilot initiatives are being explored,

developed and launched. A Manufacturing Joint Technology Initiative (JTI) is currently being considered. Its objective is the implementation of manufacturing enabling technologies of the future, on the basis of the ManuFuture SI.

Finally, the Eureka cluster ManuFuture industry, has been conceived. Its definition phase has been launched. It will implement the ManuFuture SI concerning European production systems: products for the world market and processes to retain production in Europe. More than 40 companies, supported by ten research institutes, making up a Knowledge Innovation Community (KIC), will be investing in the cluster. Expected overall value of the projects is 400 MEURO.

The *European Technological and Industrial Revolution for competitiveness and sustainability* can rely on ManuFuture: a contribution to a leading role of Europe.

The ManuFuture road to HAV CSM is the result of four years of activities to find out the way to competition and sustainability. More than 350 actions have been defined and structured in sectorial and trans-sectorial Roadmaps. Nearly 80% of the actions are relevant for all industrial sectors. They are precisely defined and a source of innovations with high economic impact. Proposals for innovating the structure of research and education, the so-called Knowledge Triangle, show the way to the European Manufacturing Innovation and Research Area (EMIRA). Hence, this book may be seen as a ‘master’ for all experts and people, who are in charge of research and development in enterprises, research organisations and institutes, research foundations, governmental institutions and politics, and those who feel responsible for the development of competitiveness and sustainability in European, national and regional industries.

The authors and co-authors are members of the strategic group which elaborated vision, strategies and Roadmaps. They all spent much of their time for the ambitious goal to formulate the way towards the future of manufacturing in Europe.

The European Commission and some national governments supported the process of roadmapping by a co-ordinated action and by national or regional projects. Without high personal engagement this book could not have reached its high level of detail and concrete actions. The authors, co-authors and the ManuFuture community thank the European Commission and all their colleagues involved for their active support. We thank many experts for their active participation and we hope the book will help to transform manufacturing in Europe to the needs of the future by High-Adding-Value (HAV) and sustainability.

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The development of the European Technology Platform (ETP) ManuFuture was only possible by the support of the Industrial Technologies Directorate of the European Commission's Research DG over several years. The Vision and the Strategic Research Agenda (SRA) have been discussed with stakeholders and experts from research and industries. Several additional co-ordinated actions with initiatives of the ManuFuture Consortium represented a substantial contribution to this book. Especially the co-ordinated action Leadership (NMP2-CT-2006-033416) carried out a considerable amount of work for defining the fields and the road to implementation. Leadership was funded in the Commission's 6th Framework Programme (2002-2006).

During the phases from the Strategic Research Agenda to the Roadmap, many contributions have been integrated: EU-MECHA-PRO, MINAM, which gave special impulses to high-potential fields of research and industrial priorities. Technology Platforms such as Textile, Agriculture, Steel, Aluminum, Rapid Manufacturing, Photonics, Tools, Aerospace, Marine, Chemistry, Forest and others supported the ManuFuture implementation plan and made ManuFuture an umbrella platform for the area of manufacturing in Europe. Not all aspects could be integrated because this book focuses on the core of manufacturing and trans-sectorial activities. Sector specifics can be integrated under this umbrella later. Consultations by ManuFuture with other ETPs in common workshops and bilateral discussions allowed joint initiatives which should be continued under the guidance of the Commission.

Many actions described in this book follow industrial priorities and are proposals for future activities in the government funded research programmes at European, national and regional level. It is the beginning of a trans-European way of networking and co-operation in manufacturing research for competition and sustainability. The high dynamic of innovation in technologies and methodologies make it necessary to rework plans of action on a rolling basis.

Greetings



Professor Heinrich Flegel

President of the ManuFuture High Level Group

Europe has a long and successful tradition in industrial production. In fact industrialisation started from Europe. Manufacturing is the base of the European economy and welfare. Many sectors of manufacturing have leading positions in the world. But the European manufacturing industries are vulnerable and under attack in the global market by competitors which operate in regions with lower cost levels.

The European Technology Platform (ETP) ManuFuture is an industrial-driven initiative which follows the Lisbon Agenda for growth and sustainability in the knowledge community. A generic model has been defined to change the paradigm from cost-oriented manufacturing to High-Adding-Value (HAV) CSM. Guiding the route and technology in the global market is the strategic objective of more than 23 sectors of industries. Experts from industrial organisations and enterprises, research institutes and universities formulated the route to future development and the Vision of manufacturing in 2020. ManuFuture is an umbrella platform with many relations to other ETPs and sectorial platforms as well as themes of European research. Research into manufacturing is an investment in the competitiveness of European industries and the employment of more than 34 million people. ManuFuture started as a European initiative for research. In the meantime, national and regional platforms followed the strategic orientation of ManuFuture in all EU countries. Thus, the forces of research join to a European army of competence and knowledge to accelerate innovation and transform the structure of European industries.

The authors of this book did an excellent job in formulating a comprehensive view of research and development for all manufacturing sectors. They elaborated the way and perspectives of future development with strong relations to industrial needs and technological potentials. This book will be the new paradigm for manufacturers and gives industrial management and politicians clear answers for their research investment in the heart of the European economy. Let's now turn vision into business. Let's make it happen!



Carlos Costa

Vice-President of the ManuFuture High Level Group
Presently Vice-President of the European Investment Bank
Former Member of the Board and Executive Director of Caixa Geral dos Depósitos

Manufacturing in Europe is under high pressure in the global market due to a ‘pincer effect’: on the one side, the need to compete with low-wage competitors that are absorbing very fast the technologies available, and on the other side, the need to keep pace with science-based innovation processes and products that are creating new markets and new business opportunities.

It is therefore crucial to increase Europe’s manufacturing productivity and sustainability through new technological developments and, in parallel, to take advantage of the new market opportunities for which demand is growing very fast, creating employment and output opportunities that will compensate for the slow or even declining pace of the more mature markets. If manufacturing is not able to meet this twofold challenge – the key enabling factor for that being science-based innovation – it may lose its central role as Europe’s economic base.

The challenge is certainly a company one, but it is very dependent on the contextual environment at regional, national and European levels. Companies are known to be strongly dependent on the nature, efficiency and quality of the regional, national and European innovation systems that encompass three critical sub-systems: education, research and technological transfer and absorption.

All European countries, regions and sectors need a push from innovation focused on High-Added-Value Manufacturing. Investment in research and development in manufacturing has to ensure leadership and competitiveness and is thus mandatory for both industries and communities. The survival of European manufacturing is critical for preserving jobs as well as for giving them high qualification content. This means that the European manufacturing revival is at the heart of the Lisbon strategy inasmuch as it is a pillar of strategic orientation for economic growth, more and better jobs, sustainability and structural change towards the knowledge-based community of this century.

The ManuFuture platform represents the European stakeholders’ awareness of the critical role and the urgent need for science, technology and know-how supporting leadership in HAV products, manufacturing processes and business organization.

Over the last four years a Vision and a Strategic Research Agenda (SRA) and Roadmaps have been elaborated, discussed and endorsed by the stakeholders. Industry's high level of engagement throughout Europe and the contributions made by leading European research institutions represent a sound step towards successful development and structural change in Europe.

The way for industry to go now is to make effective the strategic lines which have been defined within ManuFuture. New business models, innovative products and emergent technologies are the expected outcome of the stakeholders' enforcement of the need for a strategy that is built on the Vision and the SRA. Furthermore, ManuFuture does not overlook the need for an efficient use of natural resources, such as energy and raw materials, and encourages building the future of manufacturing on the culture of human work and know-how with their centuries-long European tradition.

I am sure that the road of ManuFuture is of the utmost importance in adding value and making products with European management standards and culture in the world.

The authors and all the contributors to this book should be thanked for their commitment in this endeavour and for being both the brain and the muscle of a Technology Platform that is a cause of general interest. In fact, ManuFuture does not contribute for the benefit of a single group of companies or a specific sector, but rather creates a new positive and winning state of mind and conceptual framework that needs to be spread and shared by all actors that contribute and are decisive for meeting the challenge facing European industry.

This document is a working paper of the services accompanying the green paper on the European Research Area (ERA). It brings together a number of elements supporting the issues raised in the green paper and highlights various facts therein.

Despite the widespread popularity of the ERA concept, there is clearly a need to further deepen the analysis of the performance of the national and European research systems and to assess the implications of the issues and challenges that emerge for ERA. The distribution of, and access to, strategic intelligence among the key policy actors within ERA will be an important tool to satisfy this need, along with a stronger involvement of the academic community in the conceptualisation of ERA.

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Abbreviations

ANN:	Artificial Neural Network
BTO:	Build-to-Order
CAD/CAM:	Computer-aided Design/Manufacturing
CIM:	Computer Integrated Manufacturing
CIP:	Competitiveness and Innovation Framework Programme
CIRP:	The International Academy for Production Engineering
CRM:	Customer Relationship Management
CS:	Competitive/Sustainable
CSD:	Competitive Sustainable Development
CSM:	Competitive Sustainable Manufacturing
DfS:	Design for Sustainability
DG:	Directorate-General
E&RTD&I:	Education, Research and Technological Development and Innovation
E&RTD&I&M:	Education, Research and Technological Development, Innovation and Market
ED:	Economic Development
EMIRA:	European Manufacturing Innovation and Research Area
EMRI	European ManuFuture Research Institute
ERA:	European Research Area
ERP:	Enterprise Resource Planning
ESET:	Economy, Society, Environment and Technology
ET:	Enabling Technologies
ETIR:	European Technological and Industrial Revolution for global competitiveness and sustainability

ETP:	European Technology Platform
FW:	ManuFuture framework
FPs:	EC Framework Programmes
FuTMaN:	The Future of Manufacturing in Europe
GDP:	Gross Domestic Product
GPS:	Global Positioning System
GSM:	Global System for Mobile Communication
HAV:	High-Adding-Value
HCI:	Human-Computer-Interaction
HMM:	Hidden Markov Model
HRST:	Human Resources in Science and Technology
ICT:	Information and Communication Technologies
IEA:	International Energy Agency
I-KTs:	Intelligent Knowledge Triangles
IMD:	International Institute for Management Development
IPP:	Integrated Product Policy
IPR:	Intellectual Property and Rights
ITFSP:	International Task Force for Sustainable Products
KIC:	Knowledge Innovation Community
KIS	Knowledge-intensive Services
KNN:	K-Nearest Neighbour Algorithm
K-Triangle:	Knowledge Triangle
LCA:	Life Cycle Assessment
LKIS :	Less Knowledge-intensive Services
M2M:	Machine-to-Machine
ManVis:	Manufacturing Visions. The specific support action – Integrating Diverse Perspectives into Pan – European Foresight
MATAP:	Action Plan on Manufacturing Technologies
MD:	Molecular Dynamics
MDP:	Markov Decision Process
MEM:	Micro Electro Mechanical System

MES:	Manufacturing Execution System
MF.IND :	ManuFuture Industry Cluster
MOEM:	Micro-opto-electromechanical System
MPR:	Manufacturing Resource Planning
NACFAM:	National Council for Advanced Manufacturing
NOE:	Network of Excellence
NMP:	Nanoscience, Materials and Production Technologies
OEM:	Original Equipment Manufacturer
OSA:	Open Systems Architecture
PA:	Public Authorities
PLC:	Power Line Communication
PLC:	Product Life Cycle
PMPP:	Post Mass Production Paradigm
PPC:	Products, Processes and Companies
PS&PR&BM:	Products and Services, Processes and Business Models
QTD:	Quantity-Time Diagrams
RFP:	Research Framework Programme
RFID:	Radio Frequency Identification
RTD:	Research and Technological Development
RTD&I&M:	Research and Technological Development, Innovation and Market
RSE:	Researchers
SD:	Sustainable Development
SI:	Strategic Intelligence
SME:	Small and Medium-sized Enterprises
SMP:	Sustainable Manufacturing Paradigm
SQ:	Sustainable Quality
SRA:	Strategic Research Agenda
TEMS:	Total Energy Management System
TP:	Technological Platform
TPS:	Toyota Production System
VR:	Virtual Reality