14 E-transfer of materials surface engineering e-foresight results

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Abstract

Purpose: *The purpose of the chapter is to present an innovative concept of e-transfer of technology e-foresight results concerning materials surface technology, allowing for the practical industrial implementation of the results of materials science-heuristic research using a state-of-art IT technology.*

Design/methodology/approach: *Technology e-transfer is an innovating concept popularised in industry, especially in SMEs, developed in the course of the previously pursued e-foresight research of modern knowledge concerning the priority innovative materials surface technologies and the forecast directions of their development.*

Findings: *Technology e-transfer embracing e-information, e-advisory and e-learning, is an efficient method of disseminating the results of technology e-foresight of materials surface engineering within industry.*

Research limitations/implications: *If technology e-transfer is used in the Open Access mode, anyone, for free and at the same terms, has access to a database on the priority innovative technologies of materials surface engineering and the anticipated directions of their development, which has a positive effect on the development of a knowledge- and innovation-based economy.*

Practical implications: *The idea of disseminating the results of e-foresight of materials surface engineering by way of technology e-transfer is especially attractive for small- and medium-sized companies lacking the funds required to perform their own research in this scope.*

Originality/value: *The concept of technology e-transfer represents the Authors' original contribution into the development of Computer Aided Knowledge Management.*

Keywords: *Technology e-transfer; Technology e-foresight; Surface engineering; E-Delphix method; The Critical Technologies Book*

1. Introduction

Foresight research, conducted intensively abroad [1-3] and in Poland [4-7] in the recent decade and still continued, is aimed at seeking the innovative areas deserving financial support. The research is pursued with the participation of distinguished, internationally recognised experts. The research is an important source of diagnosing the key scientific, technological, economic and environmental issues and is an instrument of prediction and decision-making for the domestic authorities responsible for science, for business environments and for public administration. Foresight research, when referred to material engineering, enables, in particular, to identify the priority, innovative technologies of materials surface engineering and to define their strategic development directions. The dissemination of such research and the related public debate and the broadening awareness of entrepreneurs within the scope considered is tangibly translating into statistic growth in the quality of the technologies implemented industrially, into sustainable development and into the strengthening of a knowledge- and innovation-based economy. It is a common expectation these days that materials be manufactured possessing the properties ordered by product users [1, 2]. This expectation is significantly influencing the development of the products material design methodology as it is expected that materials are delivered having the required structure and physiochemical properties, meeting functional requirements, matching customer demands and usable functions of a product, i.e. so-called *materials on demand*. The functional properties of products can often be enhanced through the formation of the structure and properties of engineering materials surface layers [8, 9]. A full overview of the contemporary treatment technologies decisive for the formation of the structure and properties of engineering materials surface layers, including those exhibiting a nanometric structure, together with a general view on the current state of the art on the basis of analyses into the basic literature data and prior own research [10-20] is presented in an own book publication [9]. The publication [21] presents, on the other hand, the expert evaluation of the relevant material surface treatment technologies. The selected critical technologies of materials surface engineering, understood as priority technologies with the best development prospects and/or of key significance in industry over the assumed time horizon, were subjected to own research [10, 21, 22] in order to evaluate their value, according to objectivised criteria, against the micro- and macroenvironment and to identify their development prospects over the nearest 20 years. The development directions of the most advantageous technological solutions of surface layers structure and properties formation of products and their elements produced using engineering materials considered as critical were indicated as part of own materials science-heuristic and foresight research [10, 21, 22, 23], pursued together with top-notch, internationally recognised experts. The culmination of all such efforts is an own methodological monograph [22] pertaining to the computer integrated development prediction methodology in the area of materials surface engineering. Diagnosing the underlying scientific, technological, economic and environmental aspects of materials surface engineering and defining the directions of their strategic development and decision-making boils down to creating few alternative, feasible scenarios of their development. The aim of the scenarios is to improve the functional properties, durability and reliability of products and to select the most effective technologies that must be popularised in industry which – in terms of their modernity and a price to quality ratio – are most suitable for effective implementation in industry, grouped by the most avant-garde thematic areas. One of the final outcomes of the technology foresight of materials surface engineering is the Critical Technologies Book with technology roadmaps and technology information sheets. The Book is characterising, in a harmonised fashion, the critical materials surface engineering technologies, offering a convenient tool of comparative analysis, especially for SMEs lacking the funds sufficient to pursue their own research in this field. An important aspect here it to popularise this state-of-the-art knowledge in the broadest possible group of managers and engineers working in industry, especially in small- and medium-sized companies. The issue of technology transfer and knowledge transfer becomes pivotal, therefore, as the gathered results of detailed research may bring the desired economic effects only if put into life in industry and economy.

The purpose of this chapter is to describe the concept of e-foresight as a proven method constituting the key element of the computer integrated development prediction methodology in materials surface engineering area and to describe the method, deriving from this concept, of technology e-transfer, enabling the practical industrial implementation of the materials science-heuristic research performed.

2. Technology e-foresight of materials surface engineering

The development directions of the most advantageous technological solutions of surface layers structure and properties formation of products and their elements produced using engineering materials and biomaterials, considered as the critical technologies of materials surface engineering, were formulated as part of own efforts together with indicating their current strategic position and with identifying their development prospects [10, 22]. The critical materials surface engineering technologies are the priority technologies in this field having the best development prospects and/or being of key significance in industry over the assumed time horizon. They are grouped into two thematic areas, i.e. Manufacturing (M) and Product (P), with each of them grouped into seven specific thematic groups. The area of Manufacturing (M) reflects a manufacturer's point of view and encompasses technological processes determined by the state of the art and by the manufacturing capacity of the machine park. The following thematic groups are distinguished between for the M area: laser technologies in surface engineering, PVD technologies, CVD technologies, thermochemical technologies, polymer surface layers technologies, nanostructural surface layers technologies, other surface engineering technologies. The area of Product (P) is conditioned by the expected functional and usable properties stemming from customer needs and is focussed on the product and on the material it is made of. The following specific thematic groups are distinguished between for the (P) area, i.e. surface engineering of, respectively: biomaterials, structural metallic materials, structural non-metallic materials, tool materials, steels used in automotive industry, glass, micro- and optoelectronic and photovoltaic elements, polymers. The results of own pursuits [10, 22] are useful for a wide group of beneficiaries – the representatives of science, economy, public administration and students.

The adopted e-foresight research methodology and tools [24-27] (Fig. 1) are innovative, novel and experimental and consist in using the Internet and information technologies, including a virtual organisation, web platform and neural networks used in an innovative manner, for analysing the cross impacts existing between the analysed trends and the events likely to occur in the future within the considered timeframe [20]. Other research methods usually applied in such type of efforts were also applied in the research pursued [28-35].

The following methods of work, organisation and management were used at the different stages of the research [10]: review of literature, reference data analysis, defining the key technologies, environment scanning, technology mapping, beneficiary mapping, trends extrapolation,

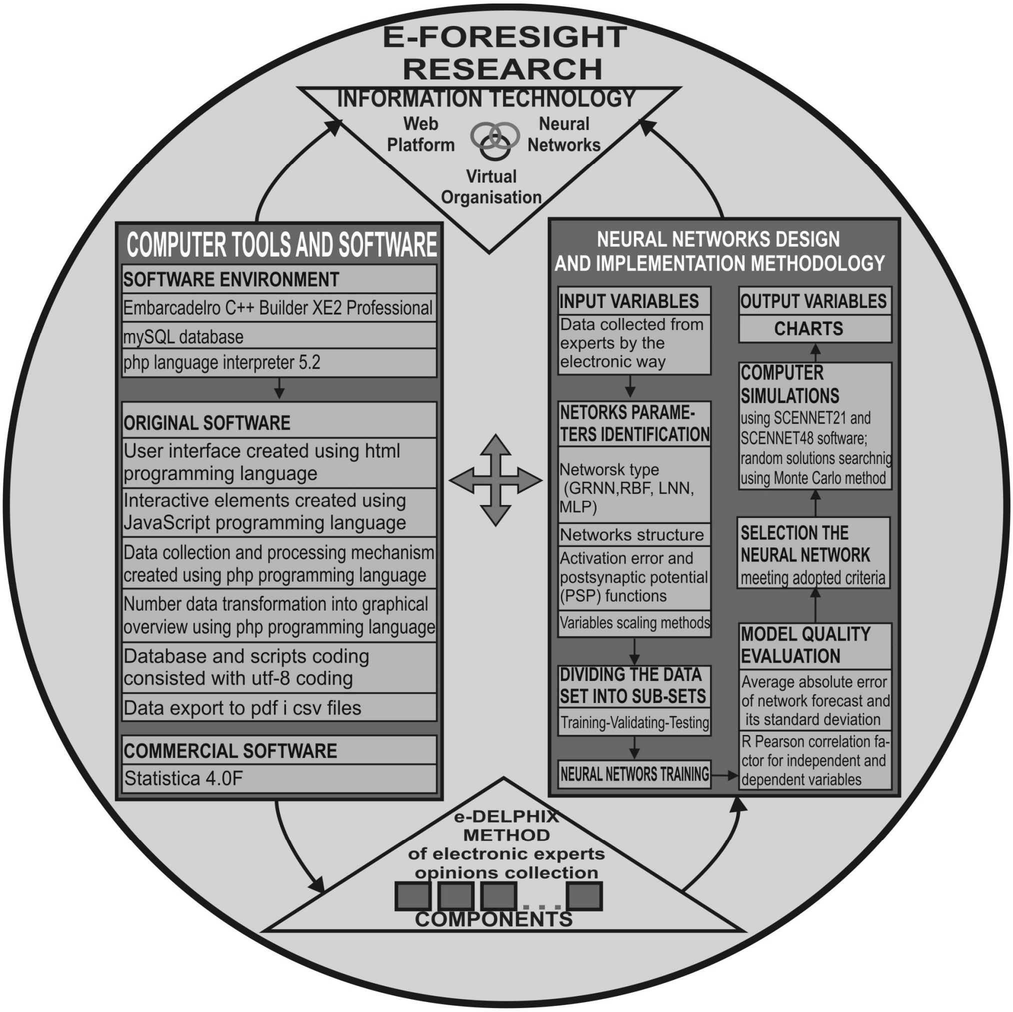


Figure 1. *The e-foresight research scheme [22]*

SWOT analysis, expert panels, brainstorming, workshops, sketches, benchmarking, multi-criteria analysis, computer simulations and modelling, econometric analyses and statistical methods. The scheme of correlations between used research methods and indirect results of the e-foresight process is presented in Fig. 2. An analysis of development prospects was made in the initial phase of research for approx. 500 groups of detailed technologies including an issue state assessment, technological review and a strategic analysis using integrated methods [36-38]. 10 critical technologies were selected in 14 thematic areas as a result of the works performed, representing the priority technologies of materials surface engineering with the best development prospects and/or a crucial role for industry over the nearest 20 years. A set of 140 critical technologies was thoroughly analysed for three iterations of the e-Delphix method [38] according to the e-foresight methodology [24-27] the scope of which is depicted in a chart in Fig. 3.

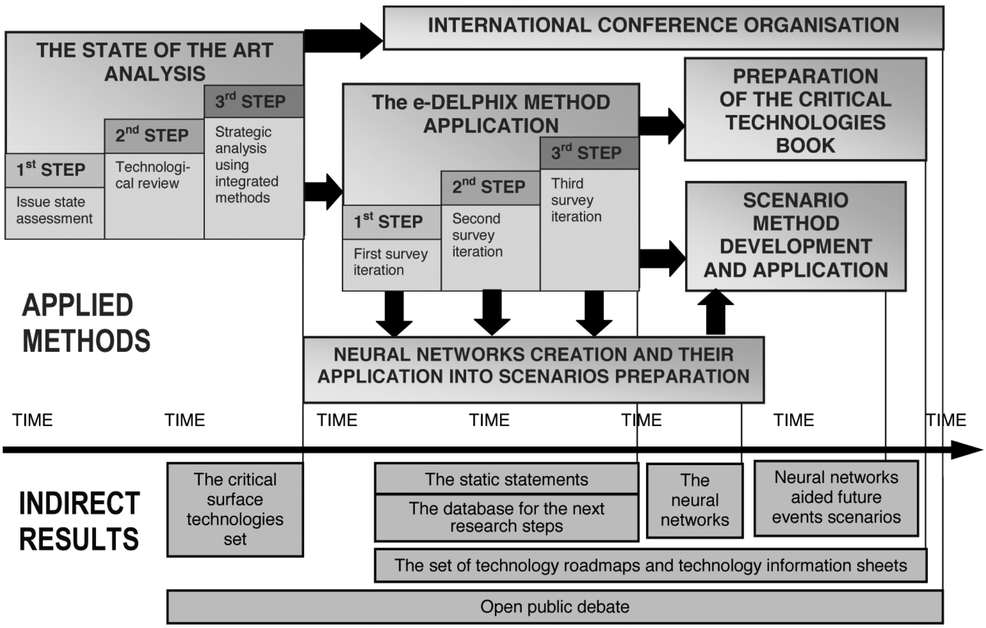


Figure 2. *The scheme of correlations between used research methods and indirect results of e-foresight process[9, 38]*

The e-Delphix method is a modified version of the classical Delphi method [28-34], differing from the original method mainly in that experts are surveyed electronically and in that the level of generality for the questions asked to the experts is growing along with the subsequent iterations of the research. Distinguished, internationally recognised experts participated in the expert studies relating to the future of materials surface engineering. They completed around 650 multi-question, complex surveys at different stages of the works. Alternative macro- and mezo-scenarios of future events for materials surface engineering were established using neural networks and the opinions of the experts surveyed were used as reference data. The scenarios can be and should be used for steering appropriately a process of channelling the development of the areas studied and also to accommodate R&D institutions and enterprises effectively to the swiftly changing demands of the global environment.

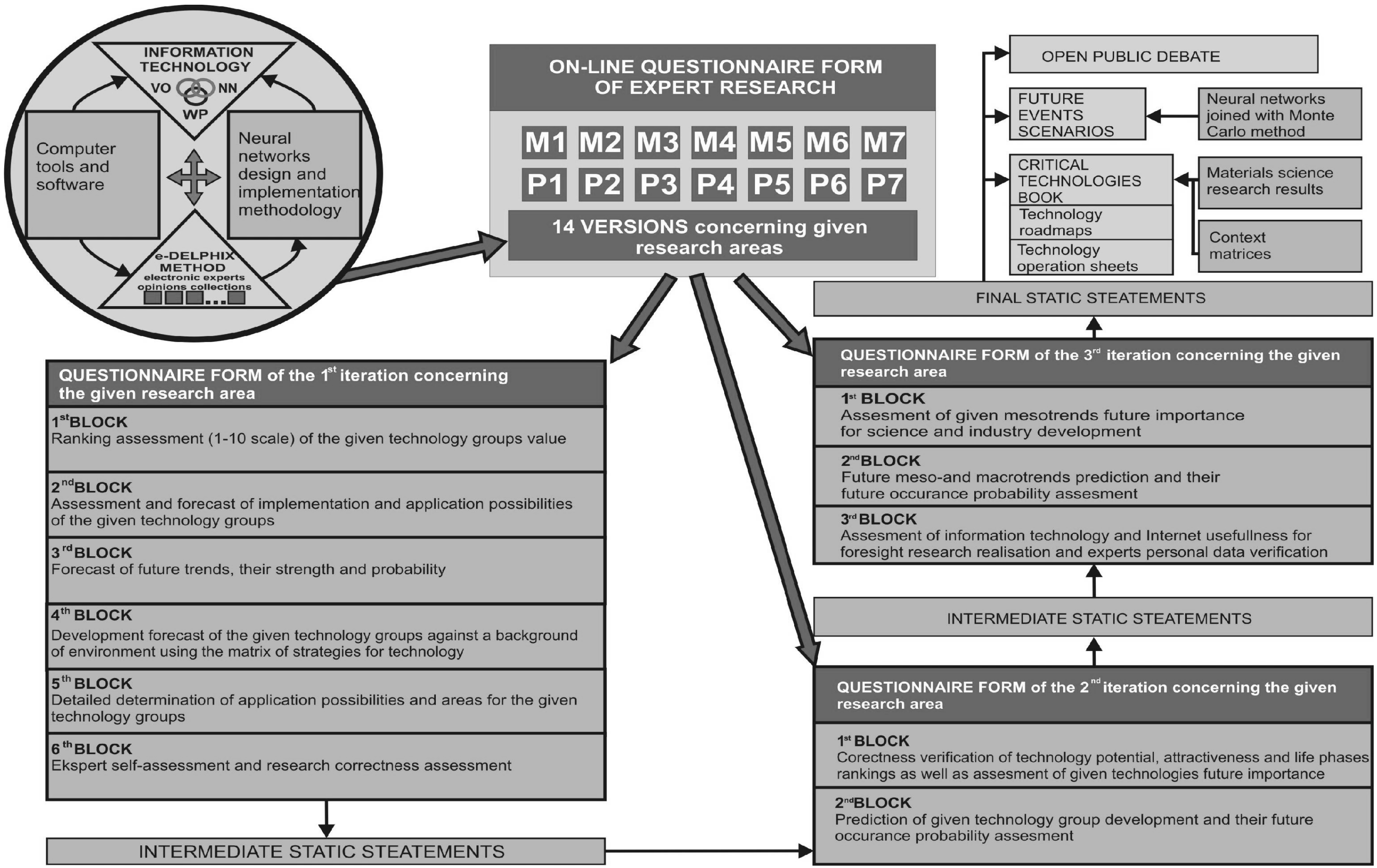


Figure 3. *The e-Delphix method scheme presentation; where: (VO) Virtual Organisation, (NN) Neural Networks, (WP) Web Platform [22]*

The relevant specific technologies were assessed according to the opinions of the key experts using the e-foresight research methodology provided in the references [24-27]. A universal scale of relative states being a single-pole scale without zero was used in the research undertaken, where 1 is a minimum rate and 10 an extraordinarily high rate. Homogenous groups were differentiated between for the technologies analysed in the first place. The groups were evaluated for their potential representing a realistic objective value of the specific group of technologies and for their attractiveness reflecting the subjective perception of a specific technology by its potential users. The objectivised values of the potential and attractiveness for the relevant, selected technology groups are visualised by means of the dendrological matrix of technology value [11, 25] consisting of quarters into which the results of the evaluation made are entered. According to the assumptions adopted, the most promising quarter guaranteeing a future success is a wide-stretching oak, with a soaring cypress and a rooted dwarf mountain pine also likely to ensure a success, provided an adequate procedure is applied, which is unlikely or impossible for a quaking aspen. The metrological matrix of environment influence [11, 25] presents graphically the results of evaluation for the influence of external positive factors (opportunities) and negative factors (difficulties) on the technologies analysed. Each of the technologies groups assessed by the experts was entered into one of the matrix quarters. Sunny spring illustrates the most favourable external situation ensuring the future success. A technology's success is also possible in rainy autumn providing a chance for steady progress in a neutral environment and it is risky but feasible in the quarters corresponding to hot summer in a stormy environment. Frosty winter informs that technology development is difficult or impossible.

A matrix of strategies for technologies [11, 25], presenting graphically a position of each technology according to its value and environment influence intensity and identifying a recommended action strategy, is prepared according to the results of expert studies provided in prior in the dendrological and meteorological matrix. The strategic development prospects of a given group of technologies are expressed in encircled numbers. An example of a matrix of strategies for technologies made for the most promising groups of PVD technology is shown in Fig. 4. Strategic development tracks, reflecting the predicted situation of a given technology if positive, neutral or negative external factors occur, are entered into the matrix of strategies for technologies investigated or their groups based on the outcomes of materials science-heuristic research. The examples of strategic development tracks prepared for the texturisation of polycrystalline silicon and for classical, selected methods of thermochemical treatment are shown in

Fig. 5. The forecast established describes a vision of future events consisting of several variants and concerns the time intervals of 2015, 2020, 2025 and 2030.

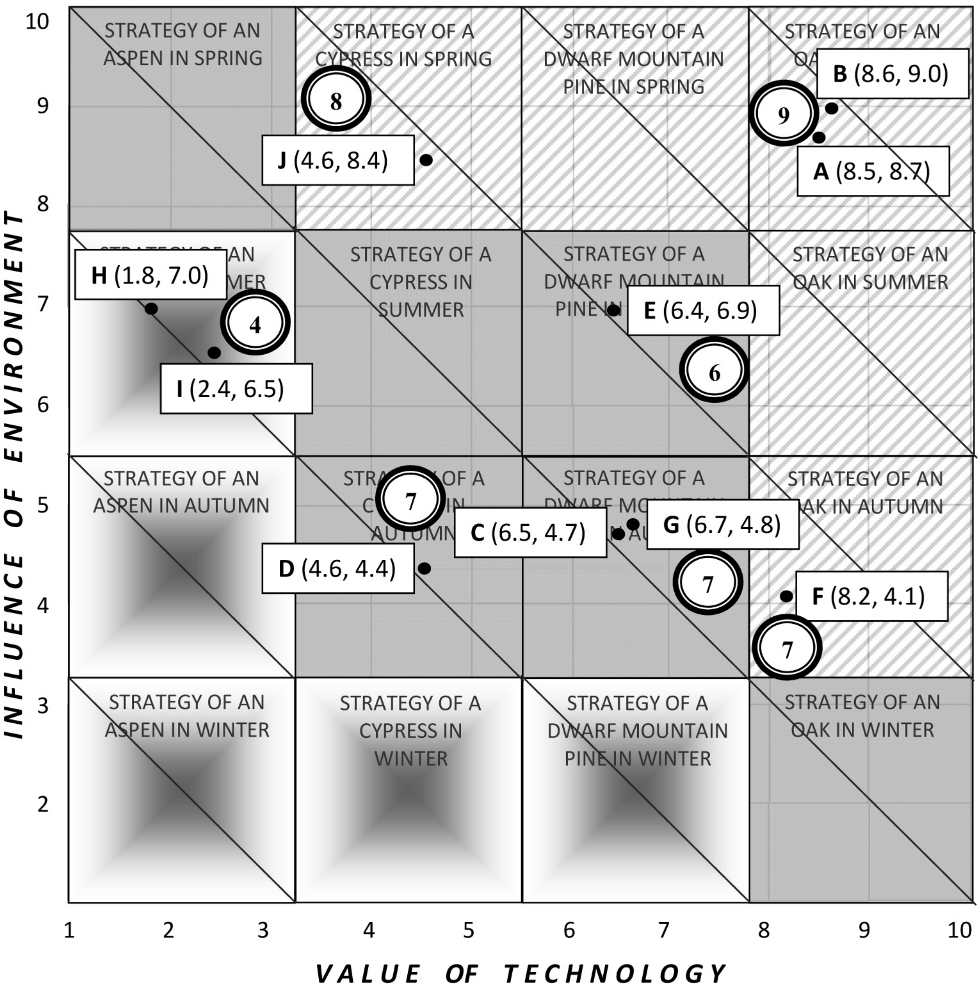
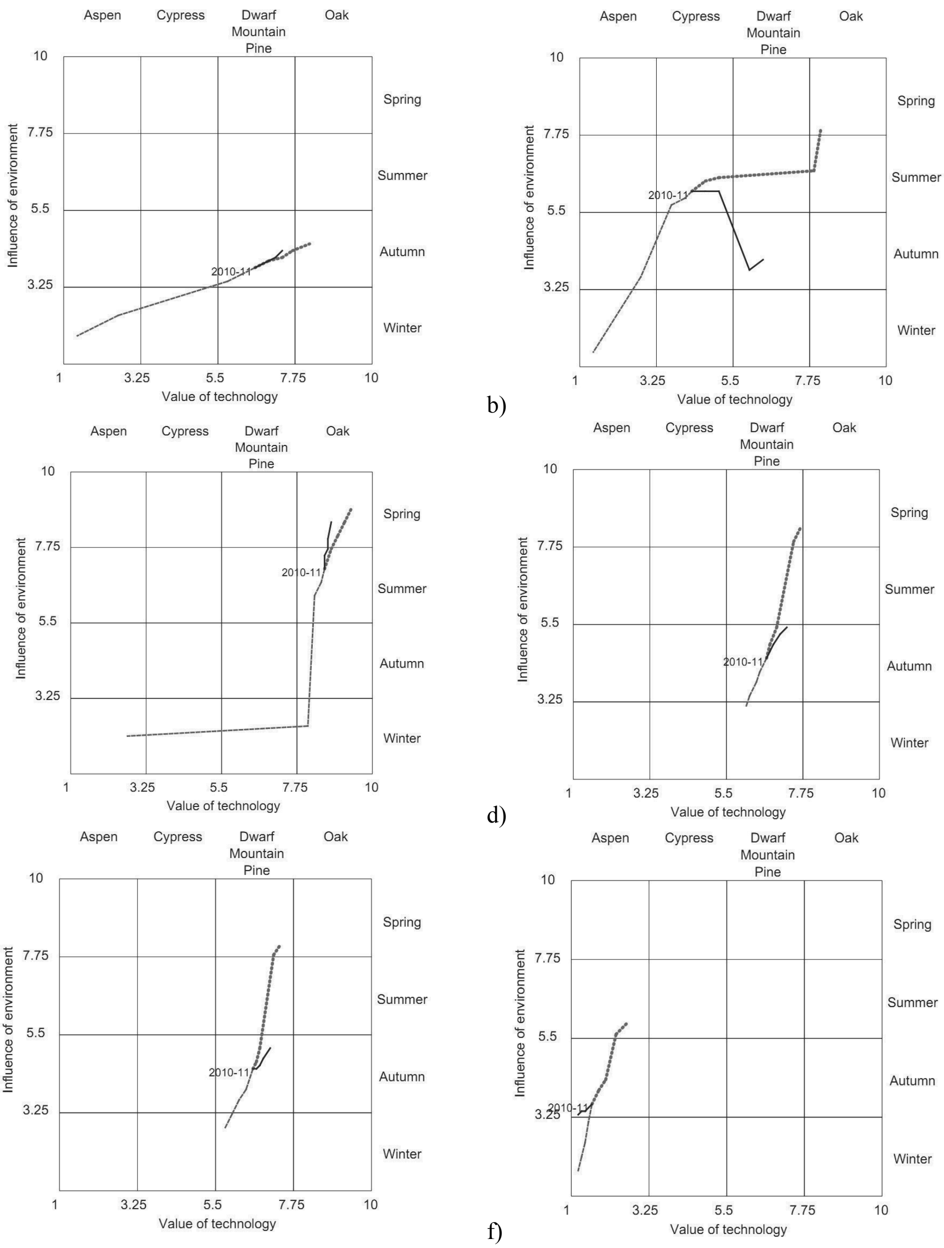


Figure 4. *The matrix of strategies for technologies prepared for "PVD technologies" thematic area, where: (A) CAD, (B) RMS, (C) PPM, (D) IBAD, (E) HHCD, (F) EB-PVD, (G) BARE, (H) ICB, (I) TAE, (J) PLD [9, 39]*

A lot of the evaluations and conclusions under the project [10] were formulated on the basis of materials science-heuristic research, as a customs approach in many works followed in connection with this foresight [12-20, 39-44]. The relevance and adequacy of the assessments performed according to the methodology developed [11, 22, 25] is ensured by the synergic



a) b) c) d) e) f)

Types of strategic development tracks:

•••••• Optimistic ▬▬ Neutral ▬ ▬ Pessimistic

***Figure 5.** Strategic development tracks prepared for polycrystalline silicon: (a) alkaline texturisation, (b) laser texturisation, (c) laser texturisation with chemical etching as well as for thermochemical treatment, i.e. (d) nitriding and its variants, (e) carburising and carbonitriding, (f) diffusion boriding; Co-authors: A.D. Dobrzańska-Danikiewicz, A. Drygała, E. Hajduczek*

influence of the materials science research and foresight methods of an interdisciplinary character conducted with the research methodology concerning primarily technology foresight [33, 34] being part of the field of knowledge known as organisation and management and of surface engineering forming part of the widely understood material engineering. Methods deriving from artificial intelligence, statistics, information technology, machine construction and operation and strategic and operational management were also used at some stages of the research. The overall methodology of the integrated computer-aided prediction of development trends in materials surface engineering embraces also the methodology of interdisciplinary materials science-foresight-IT research including a group of originally matched, but commonly known analytical methods and tools as well as an original methodological concept, allowing to pursue further research, that encompasses context matrices, the Critical Technologies Book of materials surface engineering and the neural networks-aided creation of alternative scenarios of future events. The underlying methodological assumptions of the research are shown in Fig. 6.

3. The Critical Technologies Book and its industrial usefulness

Of the approx. 500 technologies / groups of technologies of materials surface engineering analysed initially, 140 technologies (10 for each of 14 thematic areas) were classified for detailed expert studies with the e-Delphix method. The results of the studies, supplemented by the results of own materials science research, have represented reference data underlying the preparation of the Critical Technologies Book. The Book is comprised of a pool of roadmaps and information sheets being a compendium of concise knowledge on the priority materials surface engineering technologies with their best development prospects and/or of vital significance in industry over the nearest 20 years (Fig. 7).

The technology roadmaps, developed according to a customs concept, presented in particular in [12-20, 25, 40-44] – considering their coherent, harmonised formula – are a very convenient tool of comparative analysis, and allow to choose the best technology in terms of the materials science, technological or economic criterion selected. The set-up of the roadmaps corresponds to the first quarter of the Cartesian system of coordinates. Three time intervals, respectively, 2010-11, 2020 and 2030, are provided on the axis of abscissa. Seven main layers ordered by their

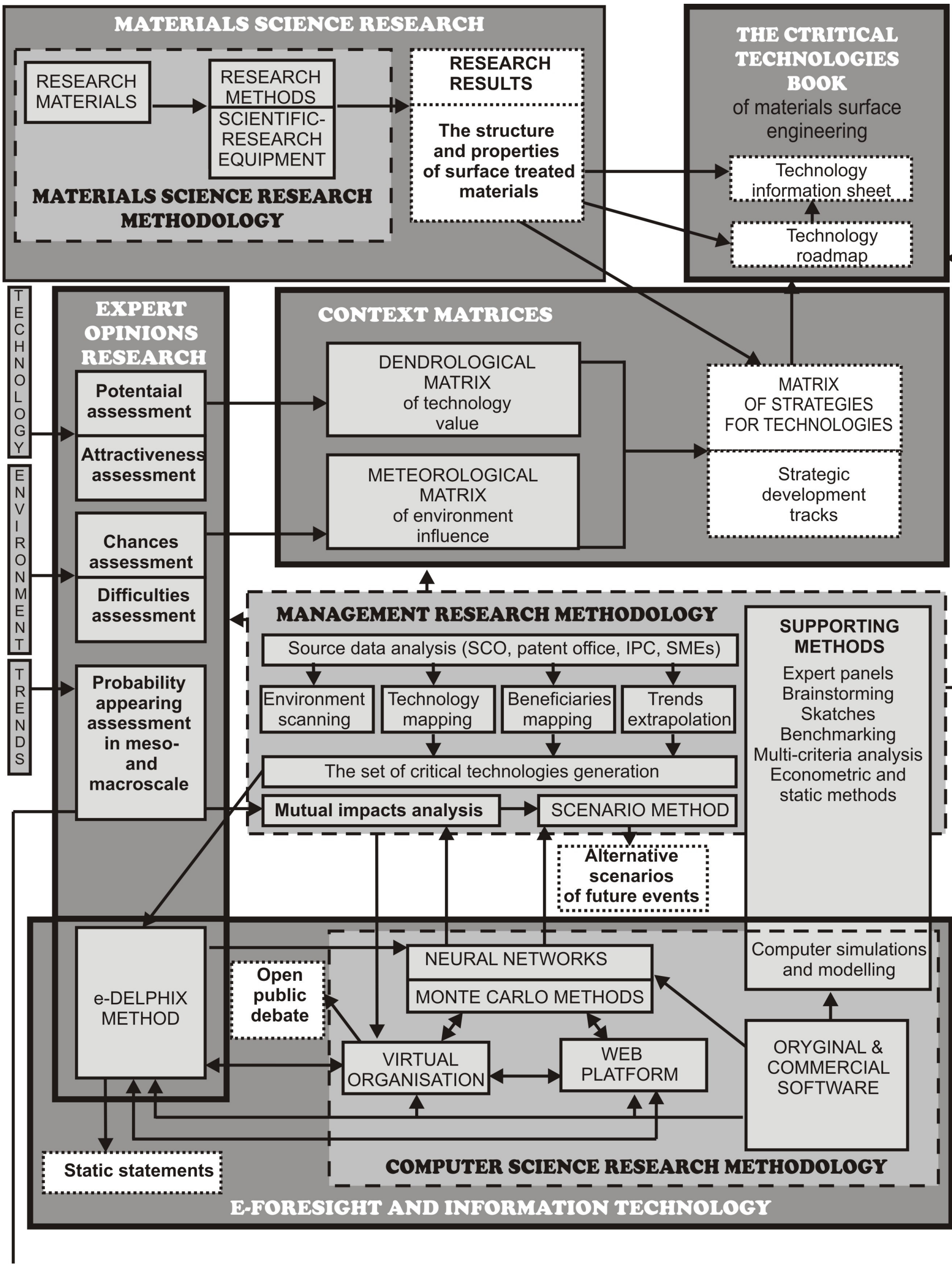


Figure 6. *The computer integrated development prediction methodology in materials surface engineering area [22]*

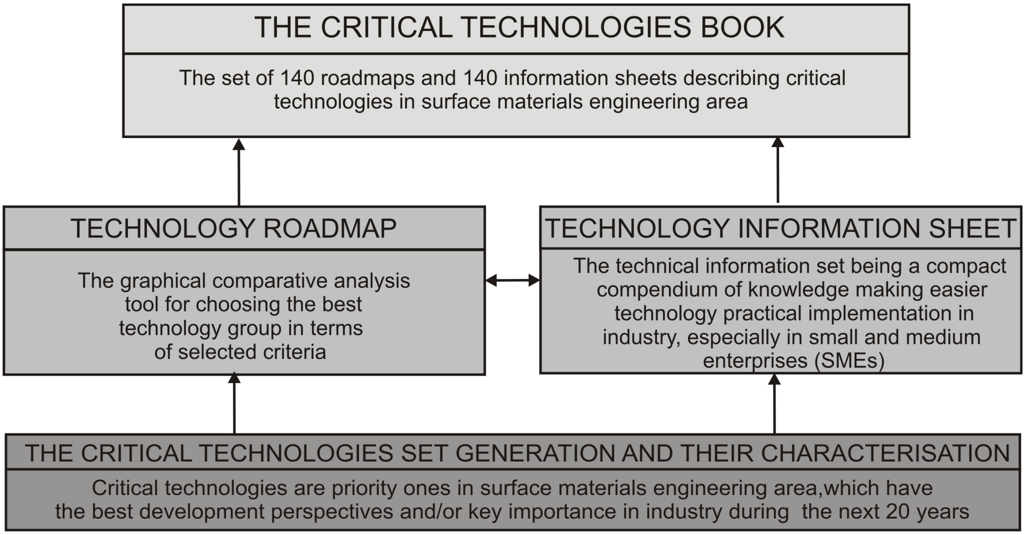


Figure 7. *The Critical Technologies Book as the set of technology roadmaps and technology information sheets*

growing hierarchy are provided on the axis of coordinates with the rising level of specificity characterising the technologies analysed, respectively for: sequence, relevance, subject, method, place, contractor and costs. Different arrows present different types of relationships between the relevant layers and sublayers of technology roadmaps. Flexibility is their undisputed advantage. If needed, they can be continuously accommodated to the particularity of the sector, size of an enterprise or an entrepreneur's expectations by adding the relevant content [11]. An example of a technology roadmap prepared for the PVD deposition of several (in the amount15) layers of coating onto the brass substrate is shown in Fig. 8.

Technology roadmaps are supplemented by technology information sheets, containing technical details helpful in implementing a specific technology in the industrial practice, especially in small- and medium-sized enterprises that must use the commonly available information as they are unable to carry out usually costly own research in this field. The technology information sheets provide, in particular, a description of a technological process, an overview of physiochemical phenomenon related to the technological processes, the advantages and disadvantages of the relevant technology, the most prospective detailed technologies and substitute / alternative technologies. The following details are also given in the other fields of the sheets: the types of a coating / surface layer that may be deposited or the processes occurring at the substrate surface; the specific properties of coatings / surface layers / substrate surfaces achieved as a result of technological processes; general physiochemical conditions of technological process implementation; substrate material preparation methods; types of research instruments; specific accessories. Each of the technology information sheets also contains information, expressed with a universal scale of relative states consisting of ten degrees, on: impact of technology implementation on the properties of the material and mechanisms of their wear, the industry with the broadest application prospects, computer modelling and steering methods and technology development prospects. A graphical chart and an index of the recommended references complete all the aspects presented in technology information sheets the example of which is made for ions implantation in the thematic area of non-metallic construction materials presented in Fig. 9.

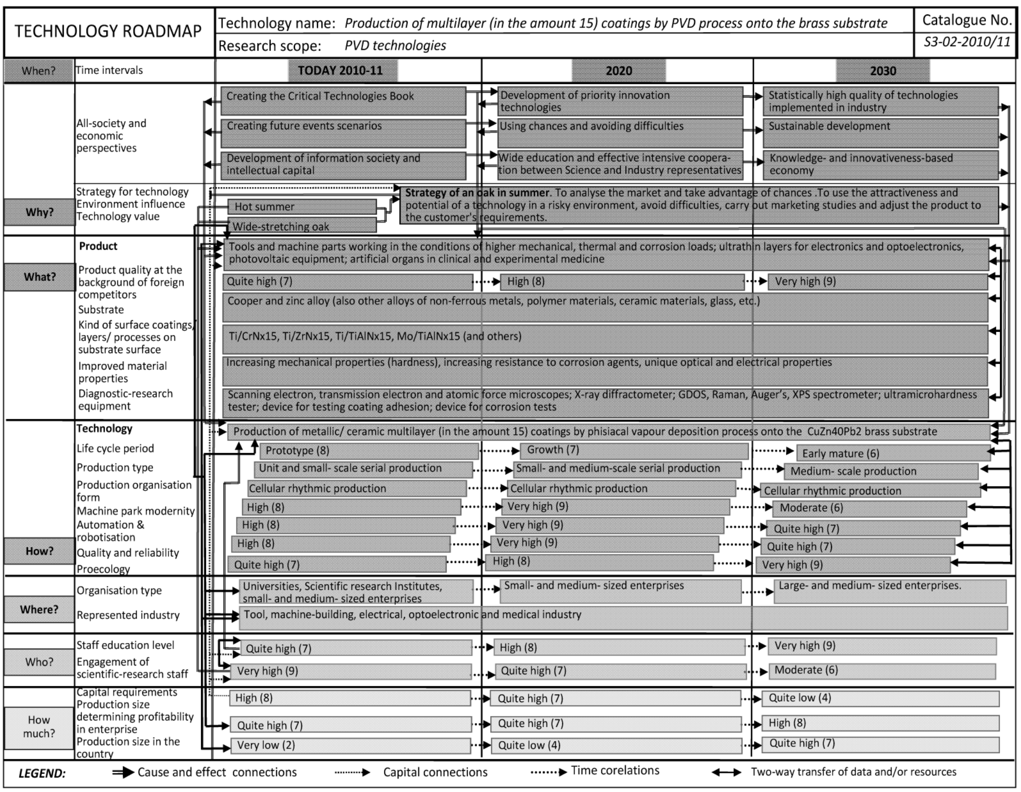


Figure 8. *An exemplary technology roadmap prepared for production of metallic/ceramic multilayer (number of layers 15) coatings by physical vapour deposition process onto the CuZn40Pb2 brass substrate; Co-authors: A.D. Dobrzańska-Danikiewicz, K. Lukaszkowicz*

a)

TECHNOLOGY INFORMATION SHEET	Technology	*Ion implantation*	Catalogue No.
	Thematic area	*Non-metallic structural materials surface engineering*	P3-05-2010/11

The essence of the physiochemical phenomenon
Ion implantation is a process of introducing ionised atoms of any element into a foreign body, with a high energy (of more than ten keVs to several dozens of MeVs) they gain in a vacuum in an electrical field accelerating and forming ions into a beam. Ion implantation is a treatment process aimed at modifying the properties of non-metallic construction materials, most of all ceramics and plastics. A 0.1÷1 µm thick layer is formed as a result of implantation joined integrally with the substrate with its properties being different, better than the substrate. Ions can be implanted into a solid in a continuous and pulse manner.

Type of possible coating / surface layer or of the process occurring on the substrate surface					
	monolayer		multi-phase		amorphous
	multilayer		graded		nanocrystalline
	multilayer (>100 layers)		composite		hybrid
	phase transformations of substrate surface	×	change of chemical composition on substrate surface	×	physical processes on substrate surface

Special properties of coatings / surface layers / substrate surface due to processes							
×	mechanical		magnetic		optic	×	tribological
×	chemical		diffusion		thermal	×	anticorrosive
	electrical		hydromechanical		acoustic		Others

Advantages	Disadvantages
Any element can be implanted and the concentrations of the implanted elements are achievable exceeding their solubility in the treated material.	A high apparatus cost; process directivity; items with complicated shapes cannot be treated.

The most prospective specific technologies and/or areas of applications
Ion implantation based on ceramic elements of mechanical devices and ceramic elements of electronic circuits (including microelectronic circuits) and based on polymers to improve tribological, electrical and magnetic properties.
Substitute / alternative technologies
Electron techniques.

Recommended references	
1	E. Knystautas (ed.), Engineering Thin Films and Nanostructures with Ion Beams, Taylors & Francis Group, Boca Rato – London - New York – Singapore, 2005.
2	Llc Books (ed.), Thin Film Deposition: Evaporation, Chemical Vapor Deposition, Sol-Gel, Focused Ion Beam, Thermal Spraying, Diamond-Like Carbon, Books LLC, Tennessee, 2010.
3	R. Hellborg, H.J. Whitlow, Y. Hang (eds.), Ion beams in nanoscience and technology, Springer Verlag, Berlin-Heidelberg, 2009.

Influence of technology application on the predicted and expected material properties	Level
Biocompatibility	Quite high (7)
Resistance to high temperature	Quite high (7)
Wear resistance	Moderate (6)
Hardness	Moderate (6)
Erosion resistance	Moderate (6)
Fatigue strength	Moderate (6)
Corrosion resistance	Moderate (6)
No brittleness	Moderate (6)
Efficiency of technology's counteracting the results of wear	**Level**
Abrasive wear	High (8)
Pitting	High (8)
Scuffing	Quite high (7)
Fretting	Quite high (7)
Erosion	Quite high (7)
Diffusive wear	Quite high (7)
Plastic wear	Quite high (7)
Industry sector with the highest applicability of technology acc. to the PKD classification	**Level**
Scientific research and development works	Average (5)
Manufacture of products with other mineral non-metallic raw materials	Low (3)
Production of computers, electronic and optic products	Very low (2)
Architecture and engineering activity; technical testing and analysis	Very low (2)
Manufacture of rubber and plastic products	Very low (2)
Manufacture of automotive vehicles, trailers and semi-trailers	Very low (2)
Manufacture of other transport equipment	Very low (2)
Other manufacture of products	Minimum (1)
Applicability of computer modelling and steering methods for the technology	**Level**
Large-scale modelling	High (8)
Artificial neural networks	Quite high (7)
Fuzzy logic	Quite high (7)
Genetic algorithms	Moderate (6)
Monte Carlo methods	Moderate (6)
Current life cycle of technology	Mature (5)
Development prospects	Quite high (7)

b)

TECHNOLOGY INFORMATION SHEET	Technology	*Ion implantation*	Catalogue No.
	Thematic area	*Non-metallic structural materials surface engineering*	P3-05-2010/11

Description of the manufacturing process progress

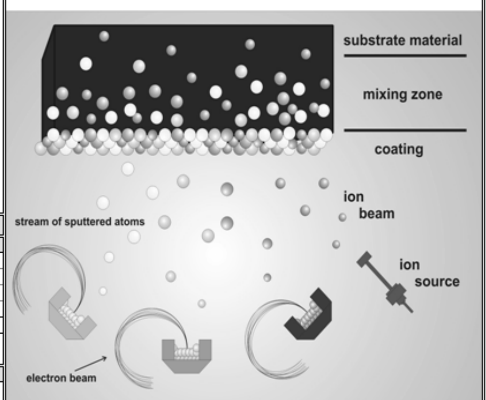
- The charge surface is initially prepared before implantation;
- A thin layer is deposited onto the surface of the implanted material (optionally);
- The charge is placed into the implantator working chamber;
- The implantator working chamber is pumped off;
- Ion implantation;
- Charge cooling;
- The charge is taken out from the implantator working chamber.

Ion implantation is a process of doping materials based on the use of a high kinetic energy. The dope atoms are ionised in the ion source and then accelerated in an electrical field. Any material can be doped with almost any element due to the kinematic character of the process. The concentrations of alloying additives exceeding their solubility in the material used can be achieved by means of the ion implantation technology (usually 20%, maximum to over 50%) and independence from the adhesion effect can be attained.

General physiochemical conditions of technological process performance

Standard range of process temperature	Unit		from		to	
Temperature	°C		20		600	
Pressure	Pa		10^{-5}		10^{-6}	
Current and voltage conditions	kV	mA	20	1	200	25
Time	min.		30		90	
Environment / atmosphere	vacuum					
Specific conditions of process performance	high vacuum					

Method(-s) of initial substrate material preparation
Initial cleaning: mechanical, chemical, physical, physiochemical cleaning; ultrasound cleaning.
Device type / kind
Ion implantators (ion accelerators)
Specific accessories
Ion source; focusing and accelerating system.



Example scheme of ion implantation process progress with the IBAD (Ion Beam Assisted Deposition) method

Figure 9. *Example of a technology information sheet prepared for ion implantation in the thematic area of non-metallic construction materials: a) Page 1, b) Page 2; Co-authors: A.D. Dobrzańska-Danikiewicz, K. Lukaszkowicz*

4. Technology e-transfer as a tool of e-foresight research results dissemination

There is a substantive justification for the outcomes of own works [10, 22] to be implemented and used practically in the economic reality. One of the general purposes of the research undertaken is to kindle a public debate with the participation of domestic and foreign representatives of the world of science, economy and public administration, in order to disseminate the project results in the environments interested in the area discussed. A public debate allows to further intensify liaison between the sphere of research and development and economy and to intensify the flow of human resources between such groups, which is also a utilitarian consequence of the actions taken under the own research conducted [10] resulting in the improved competitive position of the Polish economy and science against other European and global countries. The aspect of cooperation between Science and Industry was found by the experts attending the foresight research to be the most important factor determining the future development of materials surface engineering. 80% out of the 227 experts surveyed expressed such an opinion [10].

A web platform established under the project allows the general public, especially industry, scientific institutions and social organisations to acquire, anytime, detailed information on the project's objectives, assumptions and contractors, to track the results of the actions taken and to express their own opinion though social on-line consultation, ensuring the relevant feedback. By promoting the project results and by using widely electronic tools such as a website, databases on the technologies of biomedical and engineering materials surface properties formation and on the products they can be applied for, as well as by conferences, workshops and seminars, access can be ensured to the project results to a very wide group of users.

A concept of a **technology e-transfer** centre and the related tasks has been formulated in order to extend the objectives of e-foresight to include the domain of application and implementation of knowledge on selected engineering materials surface properties and structure formation technologies and, in general, material processes technologies and engineering materials processing, mainly in the machine and electrotechnical industry. The relationships between the e-foresight process, and technology e-transfer are shown in a chart in Fig. 10. The measures are aimed at the practical deployment of state-of-the-art technologies in this area

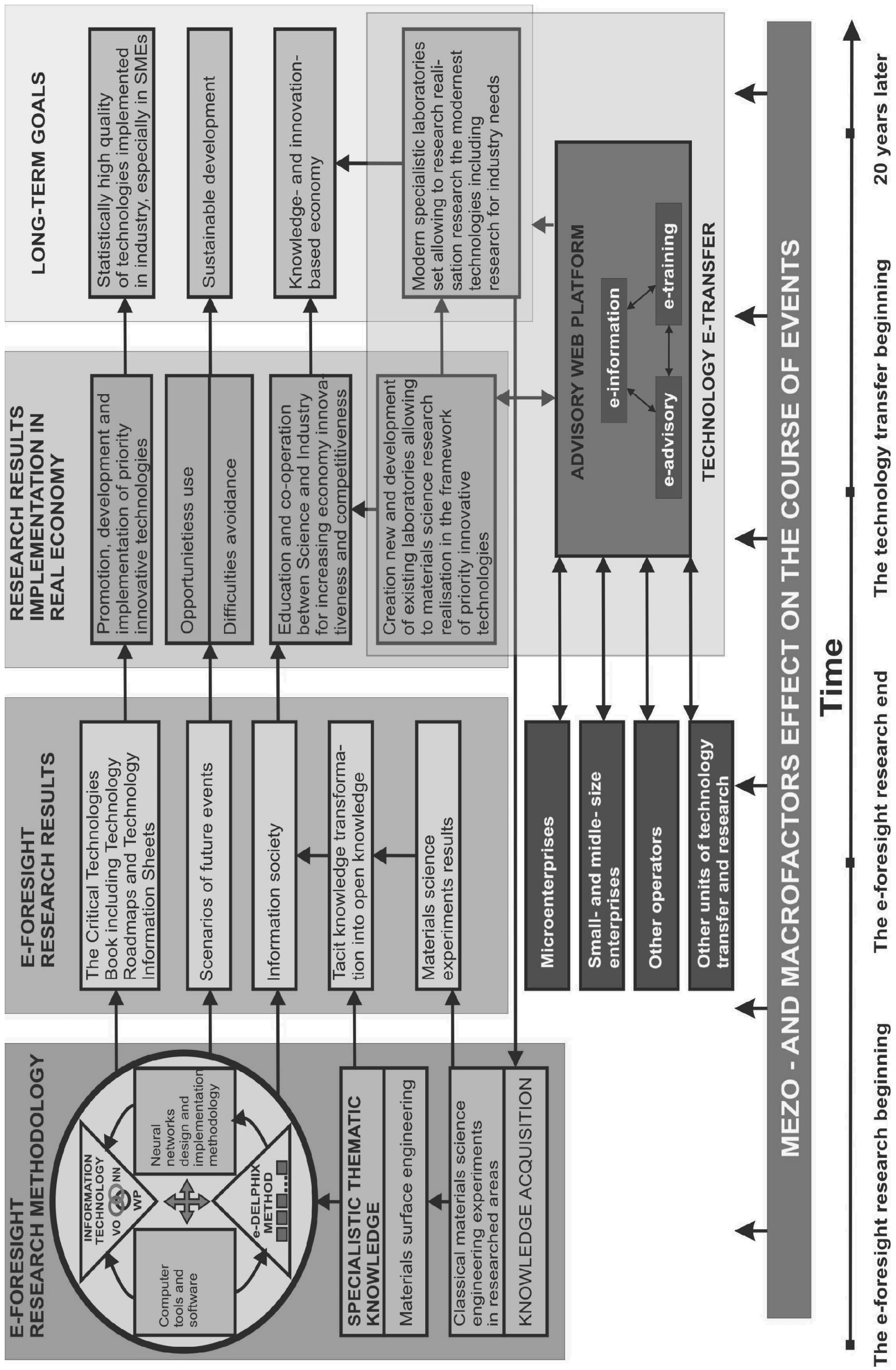


Figure 10. *E-foresight process versus technology e-transfer [22]*

by SMEs to strengthen their innovation and competitiveness. The new technology transfer centre is formed by a group of Thematic Workshops and Teams. The relevant Teams fulfil tasks of technology transfer, without providing services. By means of an the appropriately prepared web platform, they provide – in the Open access mode – information and knowledge on engineering materials and surface treatment and material processes technologies resulting from the e-foresight research performed and on the on-going monitoring of materials science issues without dedicating the offer to concrete users. Such tasks are considered to be technology e-transfer (electronic transfer of technology) to be conducted on a continuous basis without any limitations and for free using an openly available (Open Access) web platform. The role of the first Team is e-advisory, i.e. the stakeholders use freely and without limits, on the relevant pages of the platform, the roadmaps and information sheets concerning the priority innovative materials surface engineering technologies. The activity of another Team performing an e-training function according to the Open Access formula consists of publishing self-control cards at the web platform pages along with knowledge on quality control and on the technical selection of engineering materials and on the technology of material processes and surface treatment, and then to again verify the level of own knowledge after studying the recommended sources available from the web platform. The information team is focussed on conveying e-information, on an Open Access basis, on the development of the web platform's resources and the technology e-transfer initiatives taken and on the possibilities of adapting modern technologies by SMEs. A basis of the advisory, training and information functions, as the essence of technology e-transfer, is represented by specialised materials science research performed at the Thematic workshops that are conducting scientific research according to the development trends and directions formulated through e-foresight research and also problem monitoring. Specialist apparatuses are required for that. The tree of issues presented in Fig. 11 indicates the reasons determining the key problems and details out the predicted consequences of the events occurring at the domestic scale. Most probably one can presume, however, that the similar aspects are considered at the scale of Europe or even World. An innovative technology e-transfer concept discussed in this chapter, connected with e-advisory, e-training and e-information, supported with own scientific research in the areas resulting from the previously conducted e-foresight research and from the monitoring of current issues being a basis of technology e-transfer, will be continued to be developed and represents the Authors' vital contribution into the development of computer aided knowledge management science.

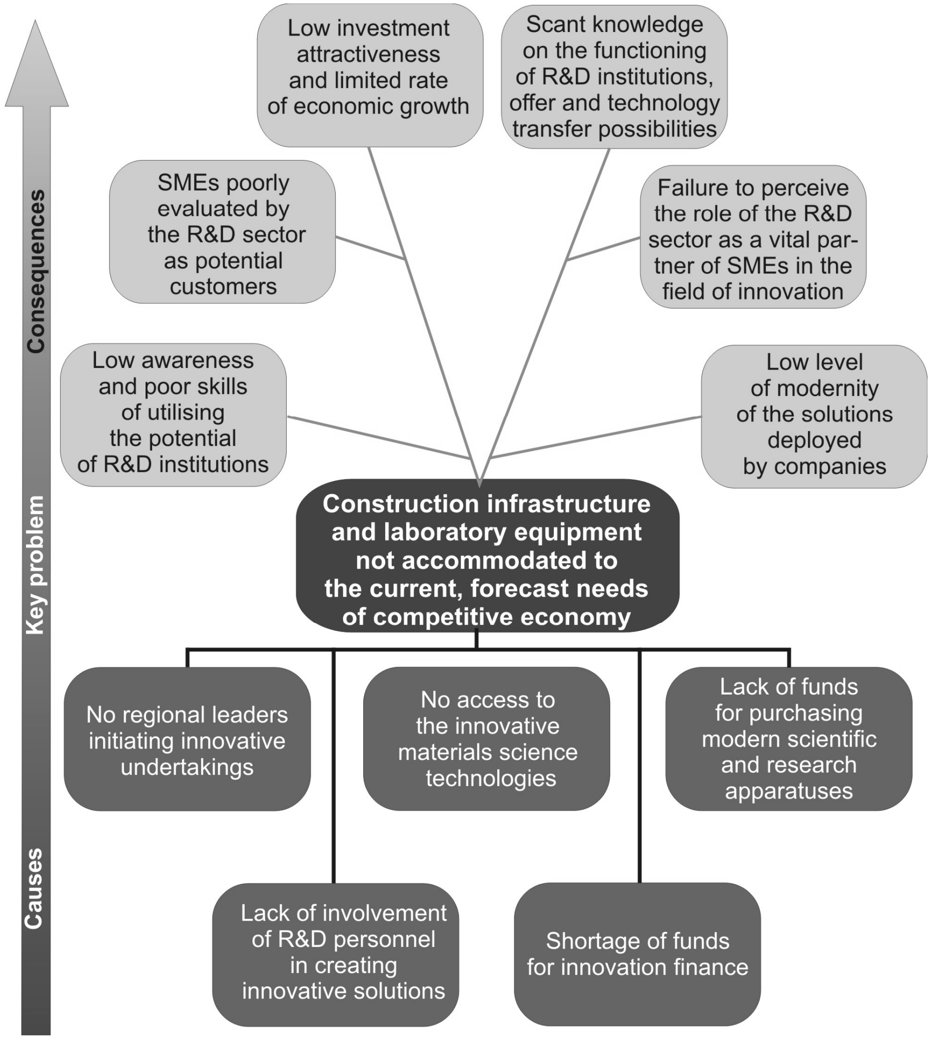


Figure 11. *Problem tree*

5. Conclusions

The purpose of this chapter is to describe the concept of e-foresight as a proven method constituting the key element of the computer integrated development prediction methodology in materials surface engineering area and to describe the method, deriving from this concept, of technology e-transfer, enabling the practical industrial implementation of the materials science-heuristic research performed. The synergic influence of the concepts of e-foresight and technology e-transfer creates a full and integrated system of predicting the development of surface properties and structure formation technologies and of implementing the results of such research in a wide environment of managers and engineers working at industrial entities. In consistency with the primary objective, the technology e-transfer method is related to e-advisory, e-training and e-information and is buttressed with own scientific research in the areas resulting from the previously conducted e-foresight research and from the monitoring of current issues. Specialist research using specialist equipment is essential for the advisory, training and information functions as the essence of technology e-transfer and, regardless the source of finance, work must not be performed at individual order of specific enterprises. Expectedly, the interested enterprises will be using the results of the research available on-line via an interactive web platform established. The Open Access mode enables anyone to use such a platform for free and at equal terms, while preventing the selective solving of any scientific and technical problems. All entrepreneurs can propose the topic of research in the Open Access mode and everyone can then use the results of such research for free. The approach proposed provides that anyone anytime and without any restrictions can be provided with all the information. Besides, the monitoring of issues, being merely an indirect way of interaction with enterprises, should enable to focus research works on satisfying the real needs of a knowledge- and innovation-based economy.

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