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INTEREST

Integrating Research and Standardisation

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Executive Summary

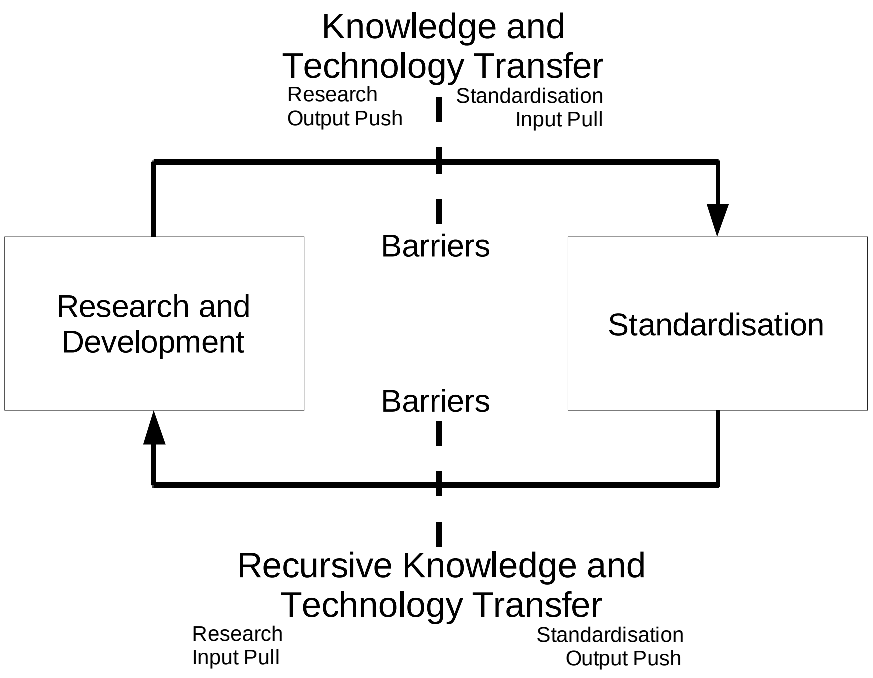
Integration of research results are the basis for successful standards. Still, a constant flow of information from research to standardisation is not a natural phenomenon. The link between research and standardisation is influenced by a number of aspects including barriers, incentives, the practice of research work, the role of standards in the work of researchers, etc. This report sums up the results of the INTEREST project funded under the 6th Framework programme to shed a deeper insight on the phenomenon of the link between research and standardisation. In the course of the project a multitude of quantitative and qualitative methods have been applied to identify relevant dimensions that have to be considered to successfully integrate research and standardisation. These dimensions where used to develop a generic taxonomy of the research and standardisation link. Moreover, a taxonomy to link research output to Technical Committees in CEN, ETSI and CENELEC has been developed. In addition, two manuals have been developed that can help to foster the integration of research and standardisation. One of the manuals is aimed at R&D organisations and researchers and provides information on benefits, barriers and how to shape incentives for researchers to participate in standardisation. The other manual provides standards setting bodies with guidelines how to better incorporate findings from R&D activities into ongoing or future standards projects. Further and more detailed information can be obtained from the other deliverables of the INTEREST project that can be downloaded free of charge from the INTEREST website.

1. Introduction

Standards play a vital role in the European market by promoting competitiveness and interoperability of products and services. They also serve to protect consumers and the health, safety and environment of citizens. The development of new and improved European standards requires high quality technical information. It is therefore important to ensure that standards are developed in an objective and timely manner and that their usage is free from obstacles. Otherwise, there is a risk that interests at national, industrial or technical level will bias standards in their favour, or delay their implementation. The potential delay in implementation of standards is additionally influenced by the inclusion of relevant stakeholders in the decision process. In case of systematic absence of interests and perspectives of relevant groups of stakeholders, e.g. researchers or research organisations, the technical consensus embedded in standards might not reflect the interests of these groups. In such a scenario standards might be perceived as a nuisance and a burden by researchers leading them to not implement those standards and rather stick to other paths of knowledge production or use them as source of information in their research and development work. The feedback loop from standardisation to research can best be established by the integration of the knowledge generated by researchers, thereby raising the potential impact of the standards on future technology development and research activities. This problem is similar to the constant struggle to integrate the knowledge of SMEs into the standardisation process. This creates one fundamental interdependency between the standardisation and research communities. Standards are the bridge between the technical domain and the economic, social and regulatory framework. This bridge function can best be represented by the notion of knowledge and technology transfer. Figure 1.1 represents this fundamental notion by rendering the link between research and standardisation as a process of knowledge and technology transfer. Besides the perspective from the standardisation bodies – as the demand side – and their need for updated or new technical information, one can also analyse the interface between research and standardisation from the perspective of the supply side, the researchers and the research organisations. Although in publicly supported research programmes it is emphasised that the outcome of research projects should be implemented in new production processes or new products, the concepts of technology transfer do often not appropriately take into account the capacities of standardisation bodies and standards as organisations or instruments to foster the diffusion of technological know-how and new technologies. Whereas in some specific areas in the former Framework programmes, like measurement and testing, we have both close interfaces between standardisation and research and first studies about obstacles for the transfer of research results into standards, a comprehensive and systematic approach covering all major fields of science and technology is missing.

As already mentioned above the feedback from standardisation to research also can be a basis for analysis. From this perspective research and standardisation switch roles. Research is now the demand side, i.e. researchers perceive the need for standards of a certain type, which are potentially relevant in their research work. Analogously standardisation now is in the role of the demand side pushing certain standards into the technical domain. While in some fields like ICT standards are deeply embedded in the practice of research work and structures of formal and informal standardisation have evolved over time some other fields only have weak linkages to standardisation. In some cases this is due to the age of a field and the emergence and consolidation of the networks of involved actors. In nanotechnology for instance specific standards are still rare and limited to issues of terminology or measurement and testing.

Figure 1.1: The research and standardisation linkage as mutual process of Knowledge and Technology Transfer



Source: INTEREST project, Fraunhofer ISI

To establish the link between research and standardisation both perspectives are necessarily interrelated. The constant processing of knowledge that is produced, transferred, selected and stabilized in standards plays a major role. The link between research and standardisation is therefore reflexive in nature. Research can support the development of new and improved standards through the provision of objective technical information on the other hand standards can provide an element of coordination of activities dislocated from specific actor interests. Some research is already aimed at standardisation. RTD which is aimed at producing objective technical information for standards is known as "normative RTD" and there are two types:

- *Co-normative RTD, which is carried out in support of current standardisation programmes*
- *Pre-normative RTD, which generates new information or knowledge for future standards*

Normative RTD has always featured in the former Framework programmes and the Standards Measurement and Testing programme (until FP 4) has been a natural platform for both pre-normative and co-normative research proposals. However, normative research activity can also be identified in all of the other RTD programmes. This was highlighted in a 1998 Commission Working Document on Research and Standardisation [COM98(31)] which concluded that more monitoring and coordination is needed between the RTD and standardisation programmes. From the perspective of the standardisation bodies, it has to be noted that CEN established the CEN-STAR ad-hoc group in recognition of the inter-dependency between the standardisation and research communities. This has led to a number of actions designed to strengthen the link between normative research and standards activities within CEN. The most significant one was the introduction of a mechanism for the identification and the development of a method for prioritisation of co-normative research requirements to support the standardisation programmes. Still, the focus of the INTEREST project extends this notion to a more general perspective of research. This also includes research that is not directly aimed at integration into standards. This perspective is necessary as pre- and co-normative RTD is not the rule in research.

It is therefore necessary to develop analytical frameworks, methods and indicators to understand and quantify a number of aspects and key links between research and standardisation in relation to the pursuit of sustainable growth and development, competitiveness and social cohesion. In order to promote the European Research Area and also the competitiveness of the European Union, it is also necessary to integrate better the research system, responsible for progress in science and technology, with the activities of standards development bodies, which contribute by their work to the diffusion of new technologies accepted by the involved stakeholders. The overall objective of INTEREST to contribute to the improvement of the interface between research and standardisation by providing an analytical instrument approach to identify the current relationship between research and standardisation based on taxonomies of standards and research outputs, respectively, science and technology indicators and on the evidence of single cases, models and data to identify the prospects and barriers to the achievement of the Lisbon and Goteborg objectives and assess the relevant policy options and tools.

The mechanics of the interdependency between research and standardisation is not without frictions. Barriers as well as issues of awareness, incentives and institutional frames on both sides influence the bridge function of the link between research and standardisation. One way of levelling the gap between research and standardisation is to provide tools that provide researchers as well as standard setting bodies (SSBs) with useful recommendations and tools to integrate the realms of research and standardisation. Such tools can be guidelines that help actors in research and standardisation to better understand the inner workings of the other realm and provide mechanisms to reduce the frictions in this transfer, overcome barriers to transfer and provide incentives to all involved parties. Another useful approach is to use available information to build taxonomies of the link between research and standardisation to help channel the knowledge produced in research to suitable SSBs.

The remainder of the report is structured in the following way. In chapter two a general overview of the objectives of the INTEREST project is provided. Chapter three lays out the theoretical framework of the INTEREST project. Special respect here is paid to three basic aspects of the research standardisation link; technical closure implicated by standards, social closure of the standardisation process and the link between research and standardisation as a knowledge and technology transfer process. Chapter four summarizes the most relevant results aiming at the primary objective of the INTEREST project to develop a taxonomy of the research standardisation link. Contrasting the quantitative results from chapter four a synopsis of the qualitative case studies is presented in chapter five. Chapter six then integrates the collected knowledge and elaborates which dimensions are relevant for the taxonomy of standards. Chapter seven and eight then describe two taxonomies developed. Both taxonomies differ in the underlying perspective. The first taxonomy developed in chapter seven is based on the knowledge from the survey, the case studies and the literature review and represents a theoretical approach to the link between research and standardisation. The second taxonomy is based on the knowledge from the indicator based approach and links research outputs that can be classified according to fields in the International Classification for Standards (ICS) to Technical Committees in CEN, ETSI and CENELEC considering the specialisation of these Committees for every ICS field. Finally, the knowledge collected in the project are condensed into policy recommendations for policy makers, standard setting bodies and research organisations.

2. Description of the INTEREST Project

The overall objective of INTEREST was to develop taxonomies of standards, of research outputs and of research-standards relationships and to contribute to the improvement of the interface between research and standardisation, and thus contribute to the effective diffusion and utilisation of research which is being performed in Europe. Moreover, the specifics of the link between research and standardisation is elaborated using a multitude of methods ranging from qualitative case studies to quantitative analyses using indicator based approaches and survey analysis.

In order to achieve the goal of developing said taxonomy the following set of specific objectives had to be met:

- A thorough description of the state-of-the-art of the interface between research and standardisation.
- The identification of rationales and incentives schemes within the research communities and to contact standardisation bodies.
- The identification of the barriers that hamper the transfer of research results to the standards setting process.
- The development of a taxonomy of standardisation products, covering both formal and informal standardisation bodies, and of a taxonomy of research outputs.
- The elaboration of a taxonomy of current research-standardisation-relationships.
- The definition of policies for the optimisation of the interface between research and standardisation possibly differentiated for relevant clusters of technologies including the development of an approach to enable the identification of the most appropriate types of standards products for different research sectors.

3. Theoretical Basis of the INTEREST project

To assess the link between research and standardisation a number of theoretical key concepts are necessary to understand the frictions between research and standardisation. These key concepts include perspectives like

- Social Constructivism, Social and Technical Closure regarding the relationship between involved actors, technology and standards,
- rationality, incentives and resources regarding the issue of propensity to participate in standardisation,
- mediating factors like institutional settings, frames and technical fields affecting the relevance for certain types of standards and the role standards play for researchers and research organisations in general and
- Knowledge and Technology Transfer to formalize the link between research and standardisation in a bi-directional way.

3.1 The perspective of Social Constructivism and Social Closure of Technology

Standards are the product of a consensus among participants in standardisation. They also constitute important phases in the generation and diffusion of new technologies and are the product of a process of social construction. Much thought has been given in this respect to groups that are participating in generation of knowledge but not in the coordination of this social process of standards construction. Be it small medium enterprises, users of the standardised technology or customers. each of the mentioned groups have, at least at European level, institutional representations of their interests in standardisation like NORMAPME representing SMEs or ANEC representing consumers. Still, one group lacks such an institutional representation - researchers and experimental developers. Even though their role is of high importance for standardisation and SSBs struggle to integrate their knowledge, comparably little research has been done that address their role and necessity in standardisation. European projects like COPRAS, MAXIQUEST and INTEREST, on the latter this research has been conducted in, try to pinpoint how the relationship of research and standardisation can be described. COPRAS for instance highlights the notion of a "standardisation gap", the gap between the successful end of a research project and standardisation activities. INTEREST highlights a more systemic view of the relationship between research and standardisation by generally assessing three broad aspects of standards and standardisation:

1) standards as "institutional mechanism" with similar effects like technological trajectories,

2) standardisation as a form of social closure and

3) the integration of research into standardisation as a special type of technology transfer.

While the first provides a good starting point for the assessment of a relationship from standards towards research activities, focusing on standards as symbolic artefacts, the second provides a perspective of the relationship from research to standardisation, the process of generation of this artefact. The third then sums up both perspectives and integrates them into a heuristic framework to assess this linkage in terms of the effect standards have on research, how the institutional setting researchers are embedded in, their research context and the resulting relevance for certain types of standards mediates their propensity to standardise and affects their incentive structure to participate in standardisation.

Generally standards are believed to be relevant as a catalyst of diffusion of technology at later stages in the innovation process (Rammert 1993). This view, based on a view of standards as purely institutional means to technology coordination, is neglecting that standards a) can have different functions apart from the typical effects of compatibility and interface standards and b) can coordinate other aspects that are not necessarily market related but have an effect on other aspects like terminology or measurement and testing standards. Those standards, especially the latter two have effects beyond their market relevance by coordinating relevant communities in their work. They can therefore also be part of the technological knowledge base of research, e.g. in engineering or computer sciences. Bauer (1980) points out that technical standards, respectively their drafts, contain information about the state-of-the-art of technology and in addition the state of science, and provide – if publicly accessible as formal standards – a good basis, like patent documents, for researchers to generate new ideas. Other authors like Tassey argue that standards are part of the science base by organising scientific knowledge (Tassey 2000). A standard in this sense has an effect similar to technological trajectory (Dosi 1982). Technological trajectories can be assumed to have an inherent element of momentum, meaning that after a path of technical progress has in some way been selected, innovation tends to be oriented along the path of a trajectory (Nelson, Winter 1977). This implies that a technological trajectory has within it a way of coordinating actors to invent along the lines of a more or less predefined path. Standards have similar impacts to technological trajectories as they are mechanisms which are genuinely situated in the realm of technology. Standards can be believed to organise technology by constituting rules of permanence in a similar way that technological trajectories do (Schmidt 1998). A standard set in the past thereby influences future options and research possibilities which are, as long as they are not mandatory or integrated in a regulatory framework, voluntary in their application by the community which they address. This path dependency (Teece 1998) has been discussed in the literature about market standardisation but is also demonstrated in a multiple case study approach by Funk and Menthe (2001) about the evolvement of mobile communication standards. They show at the example of the development of the 2nd and 3rd generation of mobile communication, that companies had a record of research and their own vested interests in favour of a particular strand of technology being chosen, while governments and SSBs influenced expectations about an evolving standard, not least by the announcement when to select a single standard. At any given point in time a standard therefore represents an agreement between social groups on what to be agreed upon for a certain amount of time. The result is "pruning the tree" of product differentiation leading to an allocation of resources towards activities related to products or services that are complying to a given standard (Swann 2000) ; also (Swann 2004). This "pruning the tree" can be believed to be the technological aspect of the effect standards have on research. This might be interpreted as one aspect of closure (Schmidt 1998). Standards therefore act as formalized mechanisms of closure of technical variety. In case a technology is established, or closed, the number of alternative solutions for a given problem decreases over time. In the constructivist view, the reason for this is not based in the realm of technology but in the social component of technology. We might refer to this type of closure as closure through standards as symbolic artefact addressing problem solution complexes and having a cognitive component similar to technological paradigms.

The second aspect of closure, social closure, shifts the focus from its effects towards the process of creation of standards. This aspect of closure we will refer to as closure through the institutional setting of the social processes of standardisation and the incentive and barriers of participation. Social closure becomes relevant for the relationship between research and standardisation as "[…] standardisation is a professional activity, guided by specific rules for access and operation, and with a specific legitimation attached to its output" (Schmidt 1998). The fact that standardisation can be interpreted as an activity that is reserved for professionals raises two questions that are crucial to be answered to assess and to improve the link between research and standardisation. This question relates to the problem of social closure and choice. Understanding social closure as an effect of barriers keeping actors and actor groups from a given activity draws attention to institutional aspects of standardisation. This should not imply that SSBs are inherently keeping researchers and developers from participating, as a matter of fact they linger for their participation, but factors in their institutional setting that are not fitting the institutional structure researchers and developers are embedded in. Other aspects might lie in the degrees of freedom of actions researchers from different institutional settings are subjected to. These barriers might also incur barriers facilitated in the institutional setting of the researcher. Drawing on Whitley (1984) researchers have different levels of control over their research including how their research results are used. Especially researchers from industry might be subjected to stronger control mechanisms which might also lead to a barrier even if the researcher would wish to participate in standardisation. It is therefore a misfit on institutional level. The other option is closely related to this view but argues from another angle. Are researchers voluntary not participating in standardisation because they chose not to do so? One might either argue that researchers may not experience their expertise as crucial in standardisation processes or simply refuse to spend time in standardisation activities. Even though this view is also prone to an institutional misfit between research and standardisation it draws more attention to the incentive structures of researchers and developers rather than to the barriers researchers face in the standardisation process. Still both of these aspects are inherently part of the construction process of standards: the process of standardisation. It is therefore necessary to ask questions regarding constellations of interest of actors and their influence on technology and how technology is "constructed" by actors in processes of negotiation. In other words, technology and also their symbolic representation as standards are political products (Cockburn 1985). The shift towards the construction process of technology can argumentatively be achieved by the notion that policy and power distribution in the form of hierarchies are implicitly included in such processes. Standards as results of a social processes are thereby the product of a process in which multiple interests meet and eventually collide. In the eighties the concept of the Empirical Programme of Relativism (EPOR), a theory that originates in the sociology of science, was taken up by researchers in the sociology of technology like Bijker et al. (1987). The concept of EPOR highlights the aspect of *interpretative flexibility* of scientific results. The term interpretative flexibility describes the notion that facts constructed in research processes are based on the interests of researchers and that such facts are open to more than one interpretation. This includes that different social groups, which might also include researchers and standardisers, have different interpretations and highlight different aspects of technology and technological artefacts (also including standards as symbolic artefacts) but also perceive different barriers and have different incentives regarding these artefacts. This view holds an important implication for the role of standardisation in the innovation process and, furthermore, the role research has in this constellation. With regard to the paradigm of social construction of technology and the role standards play in the social dynamics of technology three distinct phases can be distinguished. These three phases are development, stabilisation (or closure) and implementation (Weyer et al. 1997); in a comparable way also: (Glatzer 1998). In this view technological development ends with the successful release and diffusion of an innovation in the market. Each phase is described by certain key features that dominate the phase and results that promote further development. The phase of development is characterized by creativity, deviant from established and generation of new concepts. The most important goal to be achieved in such a process is the creation of a paradigm (leitbild), meaning technical and social principles of construction that are stable beyond the innovation as such. In the next phase, stabilisation occurs by linking strategies of heterogeneous actors (e.g. producers, suppliers etc.). Economically this phase is characterized mostly by an increase in efficiency by a concentration on key issues. This is achieved by a reduction of openness, in the literature also termed closure. Closure is "[…] the outcome of the interaction among the different participating, or relevant social groups, and of a process narrowing down the features and the form of available technical artefacts." (Schmidt 1998). This closure processes lead to a reduction of uncertainty among the actors and also limits the degrees of freedom for subsequent technical development. In simple terms this concludes that in light of a specific problem one solution, like a certain type of engine, transfer protocol or measurement apparatus, is favoured while all the other solutions are disfavoured. This is especially important when a certain technology is very complex and consists of many partial technologies that have to interact seamlessly. In consequence this however also leads to a disfavouring of (at least parts and aspects of) the underlying technical knowledge in the next phase. The achievements of the development phase thereby are twofold: network generation and closure in technical discourse. The final phase of implementation and diffusion now aims at the commodification of this favoured technical knowledge in form of artefacts in the market. The invention is thereby transformed into an innovation, i.e. an invention that is successfully put to market. In this phase the networks generated in the prior phase and networks of users, especially the early adopter of a technology, play a dominant role. Different types of standards can play an important role in all those phases. Regarding the interaction of technical and scientific development a standard as a closure mechanism comes with a number of implications for research. Especially for researchers oriented towards basic research a standard partly symbolizes that the scientific and technical knowledge on which it is based has reached a state that finalizes basic research activities, or at least symbolizes that some entity decided, that the research results generated up to now are condensed into a trajectory.

This has been highlighted by Knie (1998), who postulates that for a successful innovation the aspect of opening in the development process has to be counter-pointed by an early phase of closure to reduce uncertainty and provide for a structured and fixed environment for further development. This leads to a de-contextualisation of the knowledge in question; meaning that the knowledge is decoupled from its origin and further research work is oriented "in-wards" and aimed towards optimisation. This leads to an inflexibilisation to add new aspects to the knowledge since the cognitive structure of the further development is set (Knie 1998). Simply put, the closure of scientific and technical knowledge through standards is marking a switch of the knowledge use from basic research towards applied research and experimental development. Still, this switch can also affect the basic researchers. In some cases basic researchers will not accept a standard as it does not fit their research work or is considered to be unsuitable regarding the state of the art or as "burden" or limit to their creative potential. Basic researchers should in this logic have a lower propensity towards the inclusion of their knowledge in a closure mechanism such as standards and hence should be less inclined to join standardisation activities apart from standards that relate to their work and the coordination aspect of standards (e.g. terminology, measurement and testing). Apart from the effect such closure mechanisms have on knowledge or artefacts; there are also effects on the macro level. Closure thereby can facilitate effects in terms of networks of actors as discussed above. A concept that links the state of networks to stabilization has been developed by Callon (1997). By the differentiation of emerging fields and stable configurations of actor networks in research it is possible to assess the effect of closure mechanisms such as standards. "The analytical framework [...] takes on board the main concepts of [...] codification/embodiment, rivalry, exclusivity, generality etc. However, instead of associating these properties with the notion of information, it relates them to the state of the networks whose construction and interaction are defined by the participating actors who produce, diffuse and use scientific knowledge" (Callon 1997). Emergent and stable configurations are in Callons interpretation the polarized extreme states of networks, with a number of states between both states. The typical members of emergent configurations are members of research laboratories, that can be both from academic and industry.

Both aspects of closure find their representation in the link between research and standardisation, i.e. the process of knowledge and technology transfer between both realms. The component of social closure influences the link from research to standardisation, or, more precisely, access to standardisation can be influenced by certain factors that exist both in the realm of standardisation by partly unintended barriers due to the institutional setting of standardisation organisations but also in the environment of standardisation. From this perspective standardisation is on the demand end and research on the supply end of the spectrum.

Analogously the second aspect of closure relating to closure of technical aspects by means of standards can formalise a feedback loop from standardisation to research. This opens a perspective regarding the relevance of standards in the practice of research work. In this case it is important to differentiate between different types of standards, different types of research frames and the role standards have as source of information for researchers. From this perspective research represents the demand side and standardisation represents the supply side.

Both perspectives are constantly interrelated and reflexive regarding the link between research and standardisation. While barriers and motives moderate the choice to participate the feedback loop represents the awareness and the role of standards in research work. This perspective is further enriched by aspects of free riding and specificities of the research field analyzed.

3.2 The research standardisation link as process of Technology Transfer

The third aspect of the theoretical framework is the perspective to understand the link between research and standardisation as process of knowledge and technology transfer. Scholars of knowledge and technology transfer highlight the link between research and industry, and produced try to describe the process, mechanisms and factors of transferring relevant knowledge between the research system and the market system. The process of standardisation can be regarded as a special form of a transfer of knowledge from one institutional setting into another. It is thereby valuable to define relevant research output by different types of knowledge and technology transfer mechanisms. Therefore a taxonomy of relevant research output is congruent with mechanisms of technology transfer from research to other institutional contexts. A collection of the most common forms of knowledge and technology transfer along with a classification regarding implicit and explicit knowledge as well as formal and informal characteristics of the knowledge and technology transfer mechanisms has been assembled by Bongers et al. (2003). Moreover, information regarding the phases of the innovation process is provided. The different types of knowledge and technology transfer mechanisms are presented in table 3.1. For our analysis, only such outputs are relevant that can be part of such a knowledge and technology transfer mechanism from research settings to other settings, as these can be part of a link between research and standardisation.

The transfer of knowledge from research to industry has been researched in the past, leading to several concepts of technology transfer. Even though these models are all aimed at describing the transfer of knowledge from research to industry, some of them can be adapted to also assess the link between research and standardisation. The relevance of standards in the context of knowledge transfer can best be described by regarding them as a result of interaction of different aspects in the innovation process. "Standards result from the intricate interaction of company business strategies, standards committee activities, government interventions, and processes of market diffusion, and they are rooted in the perceived technical requirements for developing, manufacturing, operating or using devices that are meant to inter-work with others" (Schmidt/Werle 1998). It is thereby a complex combination of interests rooted in commercial and regulatory interests, but also in academic interests regarding the aspect of technical requirements for development. Assessing the link between research and standardisation via models of knowledge and technology transfer requires discussing the different concepts of innovation processes, the implications of these concepts regarding knowledge and technology transfer and special aspects of standards and standardisation in such a context.

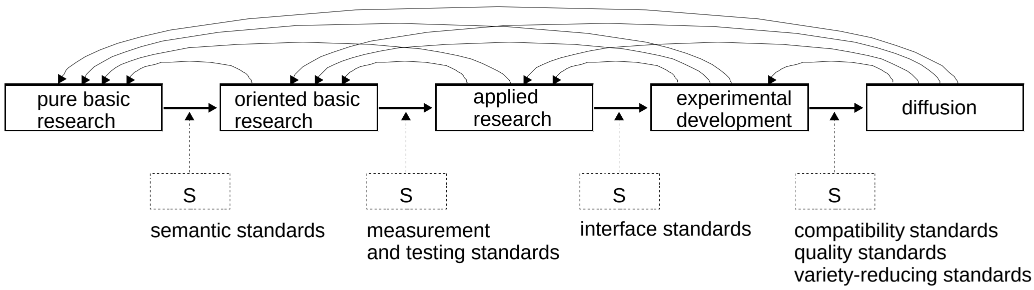
Table 3.1: Types of knowledge transfers

	Transfer mechanism	Formal/ Informal	Explicit/ Implicit	Phase of innovation
A	**People mobility**			
	graduates	Formal		(3)
	Institute ➔ company/organisation	Both		(1-2)
	company/organization ➔ Institute	Both	All	(1-2)
	Traineeships	Both	Implicit	(1-2)
	Dual positions	Formal		(3)
	Exchanges , detachments	Formal		(2)
B	**R&D cooperation**			
	Joint R&D projects	Formal	Both	(1)
	Presentation of research	Both	Explicit	(2-3)
	Supervision of students and PhD. candidates	Formal	Both	(3)
	Financing PhD. research	Formal	Both	(3)
	Research grants by firms and organisations	Formal	Both	(1-2)
	Research sponsoring			
	[co-patenting, see E]	Formal	Both	(1)
	[co-publications, see H]			
C	**Contract research and consulting**			
	Contract research	Formal	Explicit	(2)
	Consulting	Formal	Explicit	(3)
D	**Cooperation w.r.t. Educations and training**			
	Contract teaching or training	Formal	Explicit	
	Post-graduate courses or continuous learning for employees	Formal	Explicit	
	dual learning	Both	Explicit	
	Guest lecture	Both	Implicit	All
	Student information events, demonstrations	Both	Implicit	(3)
	(Contribution to) developing curricula	Formal	Explicit	
	Student grants	Formal	Both	
	Sponsoring of education	Formal	Both	
E	**Intellectual property**			
	Applying for patent			
	Use patent information			
	Co-patenting	All	All	All
	Granting licenses	Formal	explicit	(1)
	Acquiring licenses			
	Copyrights or others forms of IPR			
F	**Spin-offs and entrepreneurship**			
	Spin-offs	Formal	Explicit	
	Start-ups	Formal	Explicit	
	Incubators at knowledge institutes	Formal	Explicit	All
	Stimulating entrepreneurship	Both	Both	(1)
G	**Sharing facilities**			
	Joint laboratories	Both		
	Joint use of equipment and facilities (vice versa)	Both		
	Co-location (including, science parks)	Both	All	All
	Purchase of prototypes (vice versa)	Formal	Implicit	(1)
H	**Publications**			
	Scientific publications of firms	Formal	All	All
	Co-publications	Formal	Explicit	(3)
	Consulting publications	Informal		
I	**Participation in conferences, professional networks and management**			
	Participation in conferences	Informal		
	Participation in exhibitions	Informal		
	Exchange in professional association / body	Informal	All	All
	Management/board of knowledge institutes	Formal	Implicit	(2) en (3)
	Governmental advisory committees	Formal		
J	**Other Informal contacts and networks**			
	Networks of personal relations			
	Alumni associations	All	All	All
	Other sorts of organizations, managements, boards	Informal	Implicit	(2) en (3)

Source: Bongers et al., 2003

Generally speaking, research and development activities produce knowledge, which can be partly codified in form of publications, patents and other forms of codified (explicit) content, e.g. databases. Besides the codified knowledge, research activities generate tacit (implicit) knowledge within the researchers. This is especially true for emergent fields and the actor networks in such configurations. In such configurations a large extent of the knowledge is tacit and linked to the members of the networks. Successful standardisation, in terms of an inclusion of relevant knowledge in a standard, is thereby necessarily based upon the inclusion of researchers in the standardisation process. This fact is consistent with the findings of Grant and Gregory, who found that in technology transfers tacit knowledge can be an important factor for effectiveness. (Grant, Gregory 1997). The transfer of codified knowledge from research to standardisation can be realised by taking into account scientific literature and patent documentation. The latter is even required in each standardisation process in order to settle relevant IPR issues (Blind et al. 2002). More important is the transfer of tacit knowledge from researchers to standardisation processes via their immediate participation (Blind 2006b). However, this channel of transfer is obviously more severe and deserves therefore a major focus in the analysis. In order to address the knowledge flow from standardisation to research explicitly, it has to be taken into account the role standards play as an information source for researchers and developers. Besides taking into account the technology transfer channels, both from research to standardisation and from standardisation to research, we introduce a further dimension in our general framework, which makes explicit that standards play a crucial role in the research and innovation process (see Figure 3.1). More specifically, we distinguish the various roles of different types of standards within and between the different phases of the research, or better, the innovation process. Terminology standards are already required in basic research investigating new technologies, e.g. nanotechnology, in order to allow or facilitate efficient communication, but play a crucial role for the transfer of knowledge from basic to oriented basic and applied researchers. The transfer of knowledge from basic to applied research requires in addition measurement and testing standards, which allow the progress towards first product-related developments. The gap between applied research and experimental development of new products and processes is facilitated by interface standards, which allow the interoperability of components integrated into product or process technology. Finally, the transmission of pilot products into mass markets require, besides compatibility standards to ensure the interoperability between products or whole systems, especially quality standards which guarantee that the products comply with some minimum safety requirements. The role of compatibility standards as a mediator between research contexts is additionally moderated by the scientific and technological field of the researchers. Fields that incorporate an underlying logic of networking of products, ICT being the prime example, or other fields that facilitate Large Technical Systems (Bijker et al. 1993) moderate the relative importance of compatibility and interface standards at early stages in the research process. Requirements such as quality and safety standards are either set by a regulator, who refers in his regulation to a set of specific standards, like in the New Approach, or are wanted by lead users and early adopters interested in the new products, but not willing to accept rather large risks by using these new unknown products. Finally, the diffusion of new products is fostered by variety-reducing standards allowing the exploitation of economies of scale and by compatibility standards generating positive network externalities among users.

Figure 3.1: Various Roles of Different Types of Standards in the Innovation Process (Source: Interest Project, Fraunhofer ISI)



Function of Standards	Reduction of information cost Reduction of transaction cost	Interoperability between components Savings in adaption cost	Increased quality Reduced health, safety, privacy risks Building critical mass Economies of scale Creation of network externalities Interoperability between products

Source: INTEREST project, Fraunhofer ISI

4. The INTEREST survey

The main objective of the INTEREST project is the "improvement of the interface between research and standardisation, and thus to contribute to the effective diffusion and utilisation of research which is being performed in Europe". In order to be able to find solutions which may foster the optimisation of research and standardisation, it is crucial to identify the problems especially researchers face when they try to participate in standardisation within their institutional background and their research activities. Moreover, the survey will shed a deeper insight on the interrelationship and will guide the selection of relevant dimensions for the development of the taxonomy linking research and standardisation.

To achieve these objectives, a survey among participants of research projects funded by the European Union is the key source for new insights on barriers to the transfer of research results to standardisation and standards, and proposal for solutions. Although there were previous attempts to address this issue by Hossain et al. (1999) in the field of measurement and testing and by Blind et al. (2002) focusing especially on the IPR-related issues, in our survey we follow a broader and more conceptual approach by addressing first all research areas covered in the 5th Framework Programme and all problems regarding the transfer from research to standardisation, including organisational and institutional contexts.

Based on conceptual models and hypotheses about the interface between research and standardisation developed in the literature survey, a questionnaire was designed for participants of the 5th Framework Programme. In October and November 2005, more than 3,000 project coordinators were contacted via email to fill out the questionnaire. In total, more than 500 participants responded to the survey. Based on this broad and solid database, an in-depth and differentiated analysis of the responses allowed a distinction between researchers active in basic or applied research, but also in different institutional settings.

4.1 The Sampling

Before the questionnaire was sent out to the target sample, a pre-test was conducted among participants of a workshop to try to identify future needs for standards in nanotechnology organised by the German Institute for Standardization DIN and the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE in June 2005. The background for the workshop was the discrepancy between the large German public investments in nanotechnology research leading to a strong growth in scientific publications and patent applications and rather delayed standardisation activities, in comparison to other countries like the U.S.A., but also the United Kingdom and recently China. Obviously, the German research and standardisation system is not very effective in transferring research results into standardisation processes in time.

Based on successfully identified e-mail addresses of 89 participants, 36 completed questionnaires were returned in July 2005. The answers to the questionnaire, but also the comments of the persons not responding to the questionnaire, were the basis for the revision of the questionnaire especially in order to better attract researchers from industry and researchers active in experimental development. In general, the item non-response to the pilot survey was rather low, which confirmed the general attractiveness and quality of the questionnaire.

Due to problems of receiving data about project coordinators in the 5th Framework Programme directly from the CORDIS team, the project team decided to use the publicly available contact data of project coordinators (www.cordis.lu). In the database all coordinators were included, except those responsible for exhibitions, conferences and individual grants and the coordinators from Norway (see below). The highest share of projects approached were cost-sharing contracts which make up about 70 percent of the base sample. In total, the target group consisted of 3,652 project coordinators (which translates into 5,374 projects due to coordinators leading multiple projects), which included also some project coordinators of projects under the 6th Framework Programme. These 3,652 individuals were approached via e-mail in the middle of October 2005, and reminded at the end of October to complete the questionnaire. Since 755 e-mails could not be sent successfully, these persons were approached via fax. In addition to the CORDIS data, we approached 513 Norwegian participants of the 5th Framework Programme.

The total response to the survey amounted to 485 answers based on the CORDIS database. Since we encouraged the project coordinators to forward the questionnaire also to their project partners, 96 of the 485 responses were submitted by project participants. To the survey among Norwegian project coordinators and participants, 58 persons responded. Since we assume no differences between project coordinators and participants and no special country effects, the following descriptive results of the survey are based on the answers of 543 respondents.

4.2 Results of the survey data analysis

In the following key results from the survey analysis relevant for the development of the taxonomy of the link between research and standardisation will be presented. The results focus on a number of different issues. These issues are

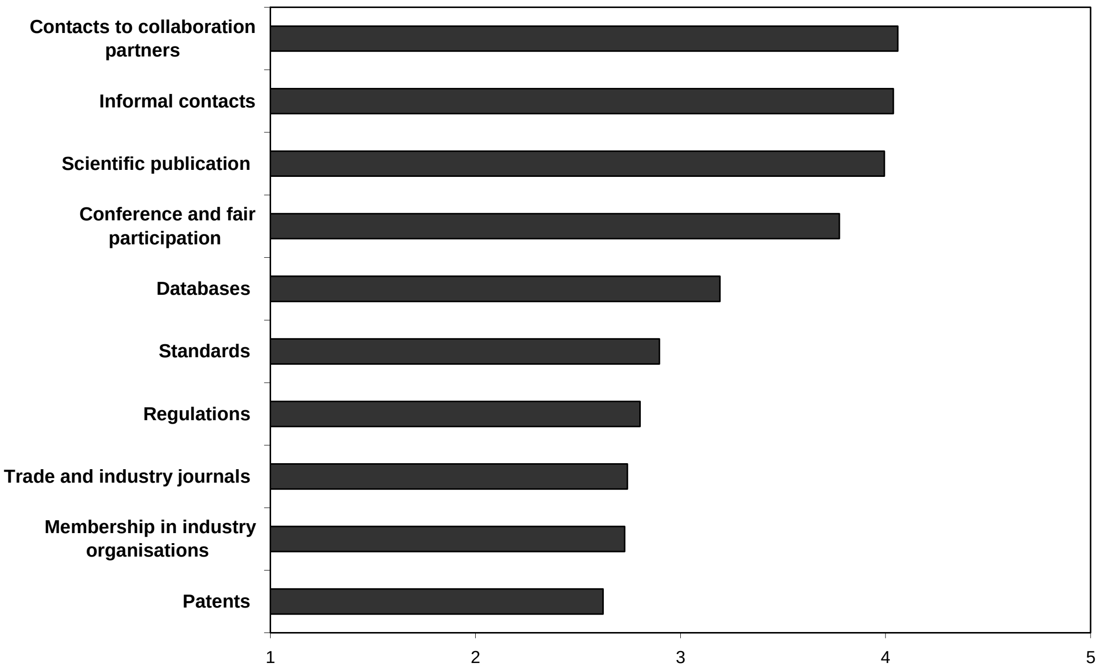
- The relevance of standards as source of information and the relative relevance of standards compared to other sources of knowledge used in research activities.
- The collaboration patterns of organisations active in standardisation comparing those organisations that do not participate in standardisation controlling for the institutional context.
- Barriers to the transfer of research results into standardisation.
- Potential incentives that can lead to stronger involvement of researchers in standardisation work
- The motives of respondents active in standardisation, and
- a integrated view of the relationship of barriers and incentives captured in a Problem-Solution-Matrix

4.2.1 Relevance of standards for R&D and standards as sources of knowledge

As argued above, relevance of standards plays a crucial role in the link between research an standardisation. So does the role of standards as source of information for researchers. Both dimensions represent a notion of demand in the research community regarding standards as part of their work. Understanding the structure of this demand is important, as it determines the baseline for participation in terms of awareness for standards, which can be considered a necessary condition for participation. Even though relevance and awareness are not sufficient to explain participation in standards, there can always be effects of free-riding, missing resources, field-specific frames or institutional frameworks involved, an analysis of relevance of standards as sources of information and for research work can provide clues for analysis of the distribution of relevance of standards in the innovation process. Also a specific analysis of relevance of standards compared to other sources of knowledge, i.e. patents, publications etc., can provide information how standards rank in the community of researchers or experimental developers.

In Figure 4.1, the various sources of information relevant for research and development are ranked according to the answers of the responding researchers. Most important is the observation that contacts to collaboration partners and more informal contacts to other researchers are the most important sources of information, even slightly more important than scientific publications. At number four of the ranking, we find conference and fair participations as a further informal channel of information. All the other codified sources of knowledge are more or less equally important with databases at the top. Standards are even slightly more important than both regulations and even patents. However, taking into account only the answers by those not participating in standardisation, they are still of equal importance.

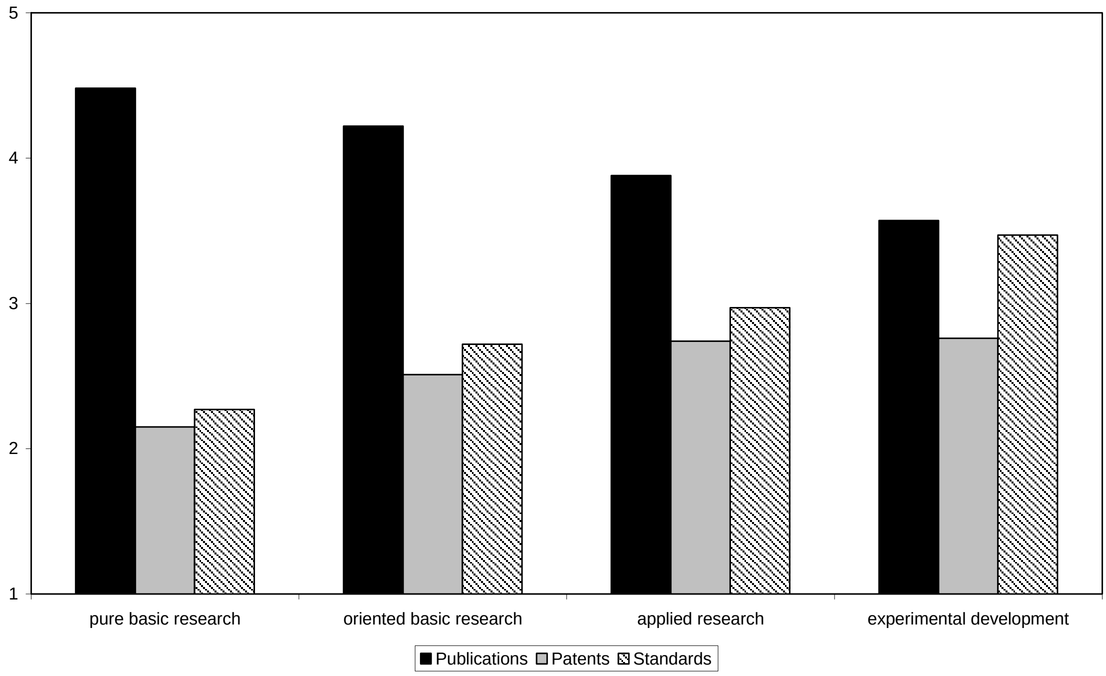
Figure 4.1: Importance of Information Sources for Research and Development (1 = very irrelevant to 5 = very relevant)



Source: INTEREST project, Fraunhofer ISI

Returning to our conceptual model, which postulates that more and more types of standards become relevant in the research and innovation process, the closer we come to the market introduction of new products or systems, the role of standards as sources of information should also increase in the same way over the research activities. Figure 4.2 confirms this hypothesis, since standards are almost as important for researchers active in experimental development as scientific publications, which relevance decreases in comparison to basic research. For comparison, the importance of patents increases also from basic to applied research, but does not reach the high scores of standards from experimental developers. In a comprehensive approach of integrating research and standardisation, this differentiated role of standards as a source of information has to be taken into account.

Figure 4.2: Importance of Selected Information Sources for R&D by Type of Research Activity (1 = very irrelevant to 5 = very relevant)

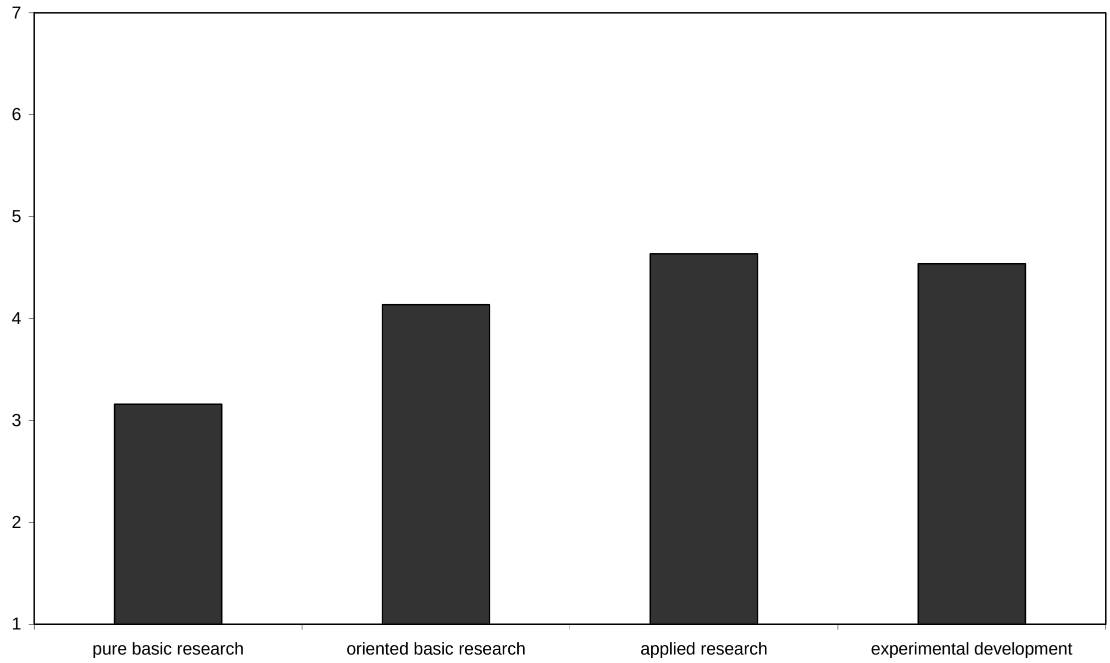


Source: INTEREST project, Fraunhofer ISI

Since there is a reciprocal relationship between the relevance of the source of information and the channels of recognition for the own research and development activities, at least in some dimensions, the researchers were asked to evaluate the contribution to standards among other channels of recognition for the own research and development related work. At first glance, the assessment is unambiguous, since the contributions to standards rank lowest among all channels of reputation, which are led by scientific publications and success in raising external funds. However, even patents are of rather low reputation for researchers. Nevertheless, this clear-cut picture of the low reputation of contributions to standards is a major reason for the missing motivation to transfer own knowledge via direct participation into standardisation and standardisation processes, which has to be addressed via an adequate reshaping of incentive schemes.

Coming back to the comprehensive approach on the interrelationship between research and standardisation, we have also to address the relevance standards have for research and development. Figure 4.3 demonstrates again that standards become the more relevant the closer the own activity is related to the development of specific products and applications.

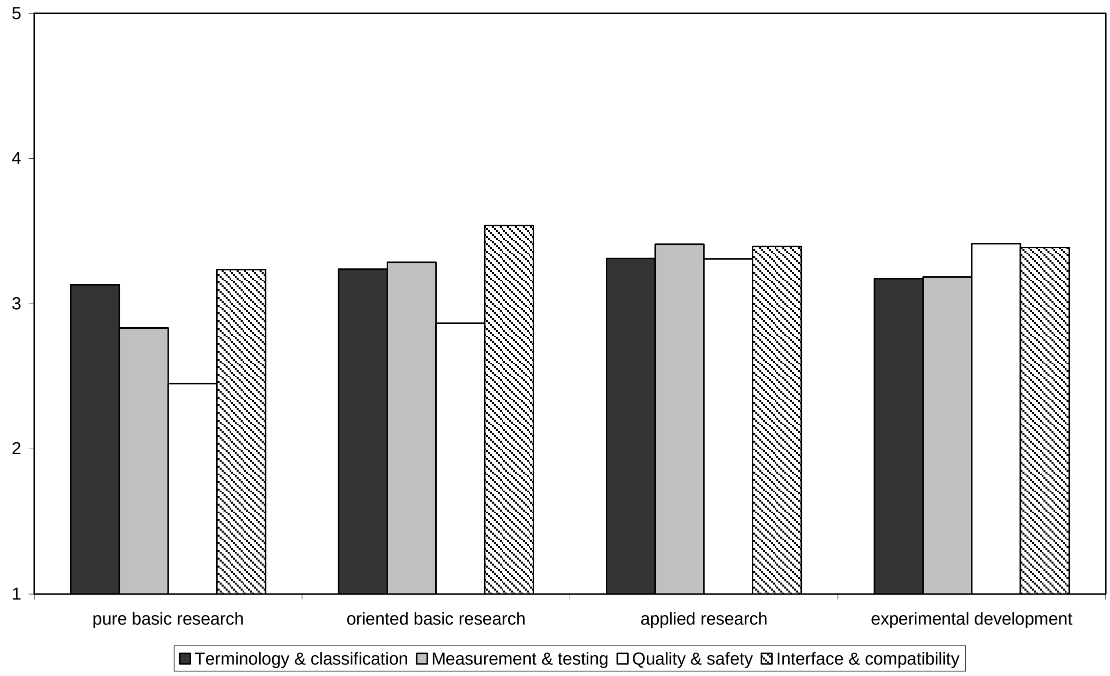
Figure 4.3: Relevance of Standards for Research and Development by Type of Research Activity (1 = irrelevant to 7 = very relevant)



Source: INTEREST project, Fraunhofer ISI

Besides the distinction of the relevance by research activity, it is also important to return to the conceptual framework of the various roles of different types of standards in the research and innovation process (see Figure 4.4). The responses of the sample to the question of the relevance of the different types of standards for their research, differentiated by the different types of research activity, reveal a general confirmation of the conceptual framework. First, terminology standards are more or less equally important in all phases of the research and innovation process. Second, measurement and testing standards become more important for applied research, whereas their relevance in basic research is still limited. Third, quality and safety standards experience a continuous increase in relevance from basic research to experimental development, since these aspects become more relevant the closer the activity comes to the development of products, which should not generate health and safety risks for potential lead users and consumers. Fourth, interface and compatibility standards are obviously almost equally important in all research phases, whereas we postulated in our conceptual framework a much higher relevance for applied research and experimental development, because of the requirement to secure compatibility both between the single components in new products and to existing products or systems.

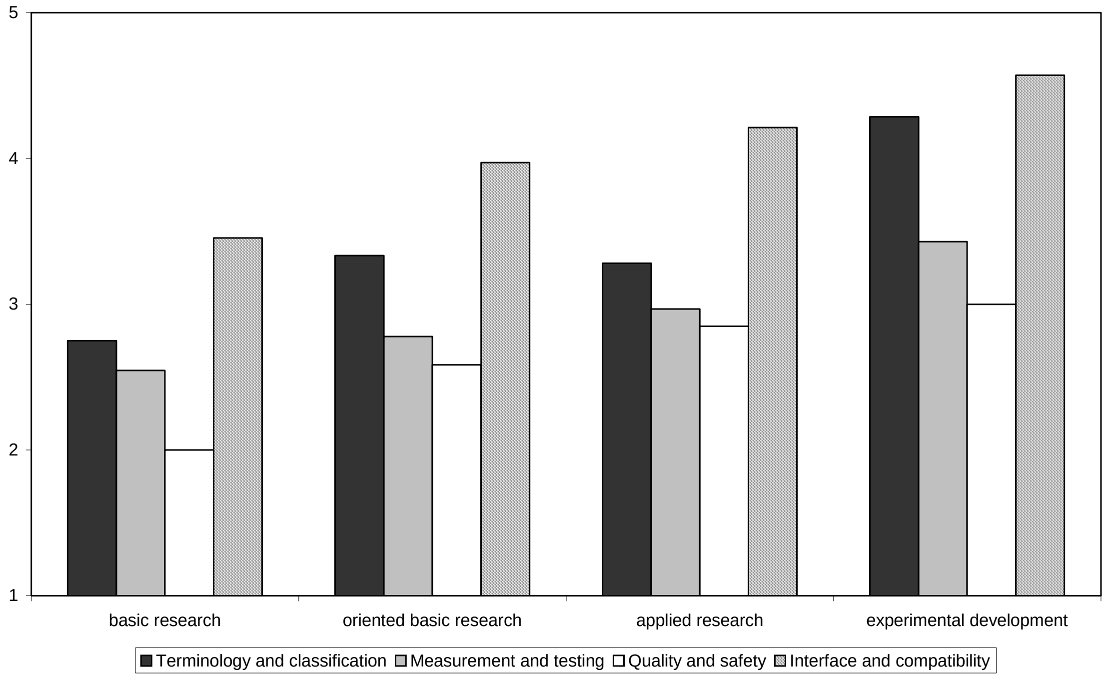
Figure 4.4: Relevance of Different Types of Standards by Type of Research Activity (1 = very irrelevant to 5 = very relevant)



Source: INTEREST project, Fraunhofer ISI

Since we assume that technology-specific aspects play an important role for the shifts of relevance of the four standard types in the four research and development phases, we have a special look at the answers of the more than 160 respondents active in the ICT area in order to focus on interface and compatibility standards. Figure 4.5 confirms our hypotheses on the increasingly important role of this type of standard the closer the activity is to the development of products and systems, although this tendency is also valid for almost all types of standards in the ICT area. The essential role of these standards for the ICT markets is reflected in the responses of the persons active in ICT research and development and leads to the postulated pattern of the increasing importance the closer their activity is related to the development of marketable products and systems.

Figure 4.5: Relevance of Different Types of Standards by Type of Research Activity only ICT (1 = very irrelevant to 5 = very relevant)

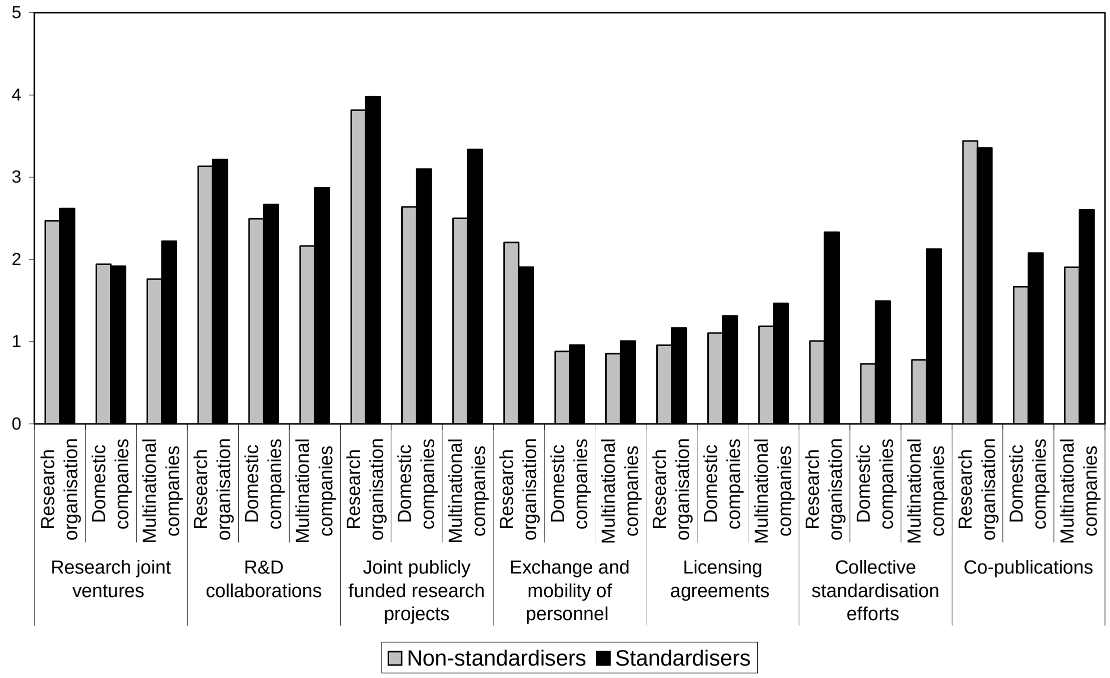


Source: INTEREST project, Fraunhofer ISI

4.2.2 Patterns of collaboration

Since standardisation is one form of collaboration with other stakeholders in the research and innovation process, we have to compare the involvement in standardisation with other forms of collaboration. Figure 4.6 presents the frequency of collaborations of the respondents' organisations with other research organisations, domestic companies and multinational companies in multiple dimensions. The frequency of collective standardisation efforts is significantly lower than the intensity of the performance of joint publicly funded research, which is a consequence of the sampling of approaching participants of the 5th Framework Programme, other research and development collaborations, research joint ventures and co-publications. Only the exchange of personnel and of licensing agreements are of similar frequency. However, the differentiation between the answers of those involved in standardisation and the rest of the sample reveals that the former have slightly higher cooperation frequencies in almost all collaboration types, especially with multinational companies. Those organisations not involved in standardisation have in general the highest frequency of collaboration with research organisations, followed by domestic and multinational companies, whereas the standardisers have a more intensive interaction with multinational companies compared to national companies.

Figure 4.6: Collaboration Frequencies by (Non-)Standardisation (0 = never to 5 = very frequent)



Source: INTEREST project, Fraunhofer ISI

Although we have already seen the higher propensity of standardisers to collaborate with universities, domestic and multinational companies in almost all types of collaboration, the approach to perform a network analysis requires us to analyse the collaborations by type of organisation. As "conventional" network data[1] is hard to obtain for the transfer of tacit knowledge and INTEREST also covers this form of transfer, the following analyses are based on the self-assessment of the survey respondents. To build a coherent composite indicator of networking, the items measured on a scale of 1 to 5 were recoded to binary variables where a score of 1

1 In terms of the transfer of codified knowledge, measures like co-patents and co-publications might be used as network data. Unfortunately, such data is very costly to collect from the commercially available data sources.

reflects a high self-reported cooperation on the item (i.e. a score of 4 or 5) and 0 reflects a score between 1 and 3. The cooperation level of 0 (never cooperated) and missing values were excluded from the calculation of the composite indicator. The binary variables were then summed up to build an additive index ranging from 0 (low cooperation on all items) to 6 (very high cooperation on all items) and calculated for each dimension (i.e. cooperation with research organisation, domestic companies and multinational companies). The single item values were not weighted in any form, so that all items are treated as having the same degree of importance in the impact of single items on the composite indicator. The item regarding standardisation was excluded from the calculation of the additive index to allow for comparisons between standardisers and non-standardisers.

The comparison of the collaboration intensity of universities involved and not involved in standardisation revealed that the respondents from universities involved in standardisation have stronger links to other research organisations, domestic companies, but especially to multinational companies. In summary, the collaboration intensity of universities correlates positively with the likelihood of the involvement in standardisation. However, it is rather difficult to argue that the collaboration in research triggers participation in standardisation or vice versa. Special regard should be paid to the fact that regarding the cooperation with multinational companies, non-standardising universities have the lowest score on the composite indicator compared to all other organisation types and standardising universities feature the highest score on this dimension.

The collaboration pattern of public research organisations is slightly different, because those involved in standardisation have more intensive contacts to domestic and multinational companies, but a somewhat lower collaboration intensity with other research organisations. There is obviously only a virtuous cycle between collaboration intensity and participation in standardisation regarding companies.

The pattern of the private research institutes is similar to that of the universities. Their collaboration intensity correlates positively with the likelihood of participation in standardisation bodies. Whereas in the universities the collaboration with multinational companies is much higher for standardisers, in private research institutes the collaboration with domestic companies is much more intensive for those involved in standardisation.

Finally, the companies reveal another pattern of collaboration by differentiating between those involved in standardisation and the remaining companies. The results show that companies involved in standardisation have slightly stronger collaborative relationships to research organisations, but are less involved in collaborations with other domestic companies. In contrast, those involved in standardisation collaborate more intensively with multinational companies. Obviously, there is some tension between common research and common standardisation activities among companies at the national level.

Analysing the four pictures together, we see that those organisations involved in standardisation open up their collaboration activities to other types of organisations. Standardisation is obviously a way to bridge the gap between industry and the various organisations, like universities, involved in science and research. Furthermore, the involvement in standardisation is related to globalisation, because the links to multinational companies are likely to be stronger. In summary, standardisation is complementary to research collaboration both within the national innovation system, but also to common research activities taking place at the international level.

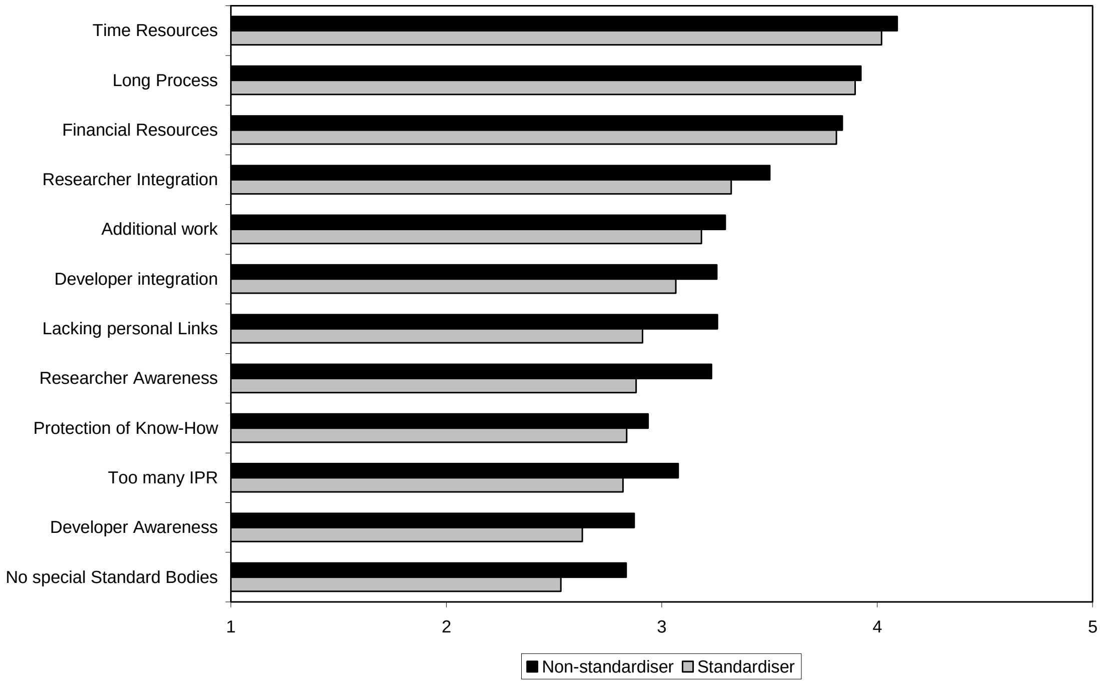
4.2.3 Perceived Barriers

Although the previous analysis has already revealed different kinds of barriers, the assessments of the various barriers to the transfer of research results into formal standards are central for obtaining further insights into the problems of transferring knowledge from research to formal standardisation.

Figure 4.7 presents the ranking of the various barriers differentiated in the answers from those involved in standardisation and the rest of the sample. The ranking of the barriers by both groups is almost identical, which indicates that there is no general misperception among those not involved in standardisation about possible barriers. However, those researchers not involved in standardisation put a slightly higher relevance to almost all barriers. This first result indicates that those not involved in standardisation have a rather good perception of the relative relevance of the various barriers, which confirms also their rather good understanding of problems in the standardisation process and does not allow us to identify a general awareness problem.

The barriers can be roughly divided into researcher- and standardisation-related problems. At the top of the ranking, we find that participation is too costly for the researcher in terms of time resources. This argument has to been assessed in the light of the low reputation of contributions to standards among other reputation-enhancing activities. Since the researchers gain only little additional reputation if they become involved in standardisation, their opportunity cost of spending time on standardisation if they could invest their time more efficiently in the sense of fostering their recognition by writing a scientific article or a project proposal for raising additional funds, by joining a scientific conference or even by drafting a patent application, is too high. Besides the high opportunity cost in terms of time, participation in standardisation requires additional financial resources, especially for travel costs. This obstacle also related to the situation of the researchers is third in the ranking of the barriers. The length of the standardisation is perceived as the second most important obstacle for the transfer of research results into standardisation. In a company survey conducted by Blind et al. (2002), this argument was ranked even highest. There is obviously a discrepancy between the timing and the speed in research processes and the procedures in standardisation processes, although the development of new standardisation processes, like workshops, and new products similar to standards, like workshop agreements, has reduced the length of standardisation processes significantly. The general critique that standardisation processes are not geared to integrating the contributions from researchers and developers follows in the ranking. Besides the inconsistency regarding timing, there is a general critique on the absorptive capacity of standardisation processes regarding inputs from research and development, which is equally supported by those involved in standardisation. Even the participants of the Standards Measurement and Testing (SMT) Programme within the 4th Framework Programme responding to a survey conducted by Hossain et al. (1999) ranked the lack of coordination at the top of the list of barriers. Consequently, the respondents also complain about the additional work required for adjusting research results in a way which fits into standardisation processes. In addition, those not involved in standardisation suffer from lacking links to standardisation bodies. However, the lack of specialised standardisation bodies is obviously no serious problem for the majority of the researchers. Furthermore, most researchers and developers are obviously aware of the benefits of standards, which was also confirmed by the other results of the survey presented above in chapter 4. Finally, neither too many IPRs nor insufficient protection of own technological know-how are very serious obstacles for the successful transfer of research results into standards. The limited importance of these two aspects was already detected by Blind et al. (2002) in their company survey.

Figure 4.7: Barriers to Transfer Research Results into Formal Standards by (Non-) Engagement in Standardisation (1 = very irrelevant to 5 = very relevant)



Source: INTEREST project, Fraunhofer ISI

In summary, high opportunity costs in terms of time and the financial expenditures caused by the participation in standardisation processes are the major obstacles on the part of the researchers, whereas standardisation processes themselves are not geared to integrate the contributions from researchers and developers, especially the time-consuming standardisation process, despite the various significant improvements, is still a major problem for the researchers and developers.

4.2.4 Incentives for Transfer

Since more participation of researchers and developers in standardisation processes is on the one hand the most efficient way to transfer knowledge from their research to standardisation processes, and this personal participation is hindered by high opportunity and financial cost, on the other hand, we asked the target group for additional incentives which would lead them to consider a participation in standardisation processes.[2]

The responses on the most attractive incentives to join standardisation processes reflect very well the pattern of the most relevant barriers. Almost 70% of the respondents would join standardisation processes, if their costs were covered by third parties. However, almost 50% indicate that more flexible and faster standardisation processes would lead to their participation. The problem of the high opportunity costs regarding time resources is confirmed by the 40% of the responses indicating that a higher reputation of their standardisation activities by taking it into account in the evaluation of their research would lead to their participation in standardisation processes. The recognition of the input of researchers in standardisation processes could also be promoted, if standardisation bodies pointed out the relevance of their input for the standard-setting process and of their expertise for the outcome of the process. However, researchers still need some support, since 30% of the responses indicate that support from experienced standardisers and more knowledge about the standardisation process would lead to their participation. Furthermore, standardisation processes would gain in attractiveness, if decisions would be based on scientific and technological superiority instead of on the preferences of dominant players or other strategic considerations (Weiss, Sirbu 1990). Finally, 30% of the responses suggest that the attractiveness of standardisation processes would increase for researchers, if other researchers from their field of activity would participate.

It is obviously not efficient to install another helpdesk for researchers in case of questions and problems. Furthermore, the proposed solution to award a personal authorship to a standard, as in other kinds of codified documents like scientific publications or patents, or in the development in Open Source Software, does not increase the attractiveness of standardisation processes. Only in the ICT area can a higher share of responses be observed. Finally, reducing the influence of IPR in standardisation processes does not increase their attractiveness, because as seen above, IPR do not seem to be a serious problem for researchers.

In summary, the coverage of expenses in connection with standardisation processes is the immediate solution for the restricted participation in standardisation. However, there are several other solution mechanisms, both within the standardisation system, but also in the research system, which have to be considered for the development of policy recommendations.

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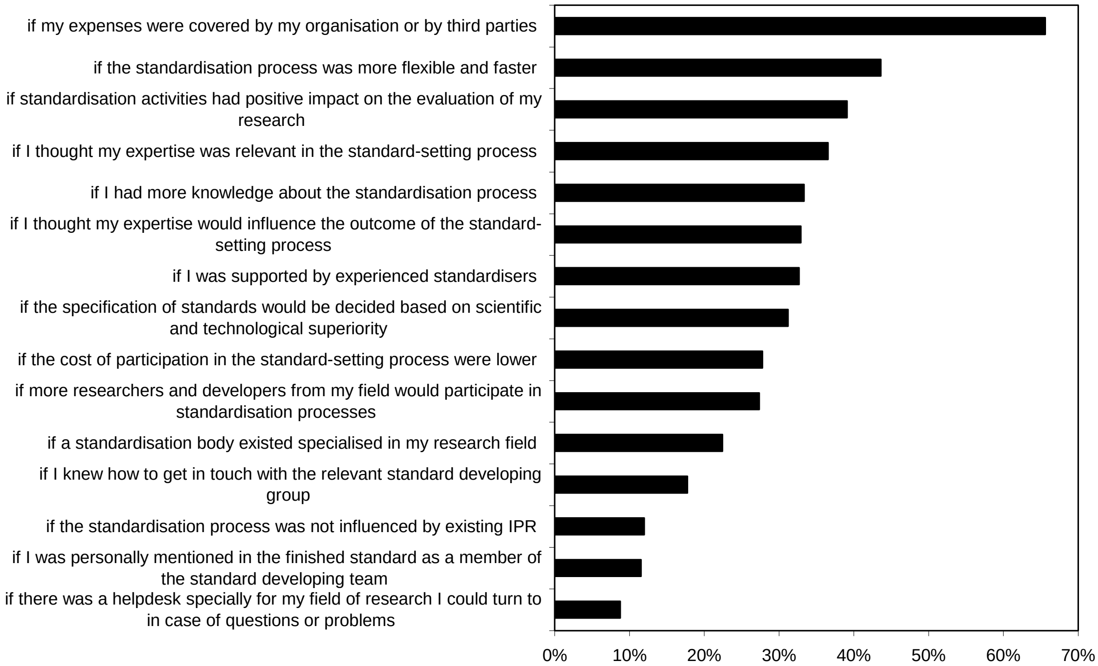
2 Hossain et al. (1999) present a list of solution mechanisms, which especially address the measurement and testing area, without prioritising them.

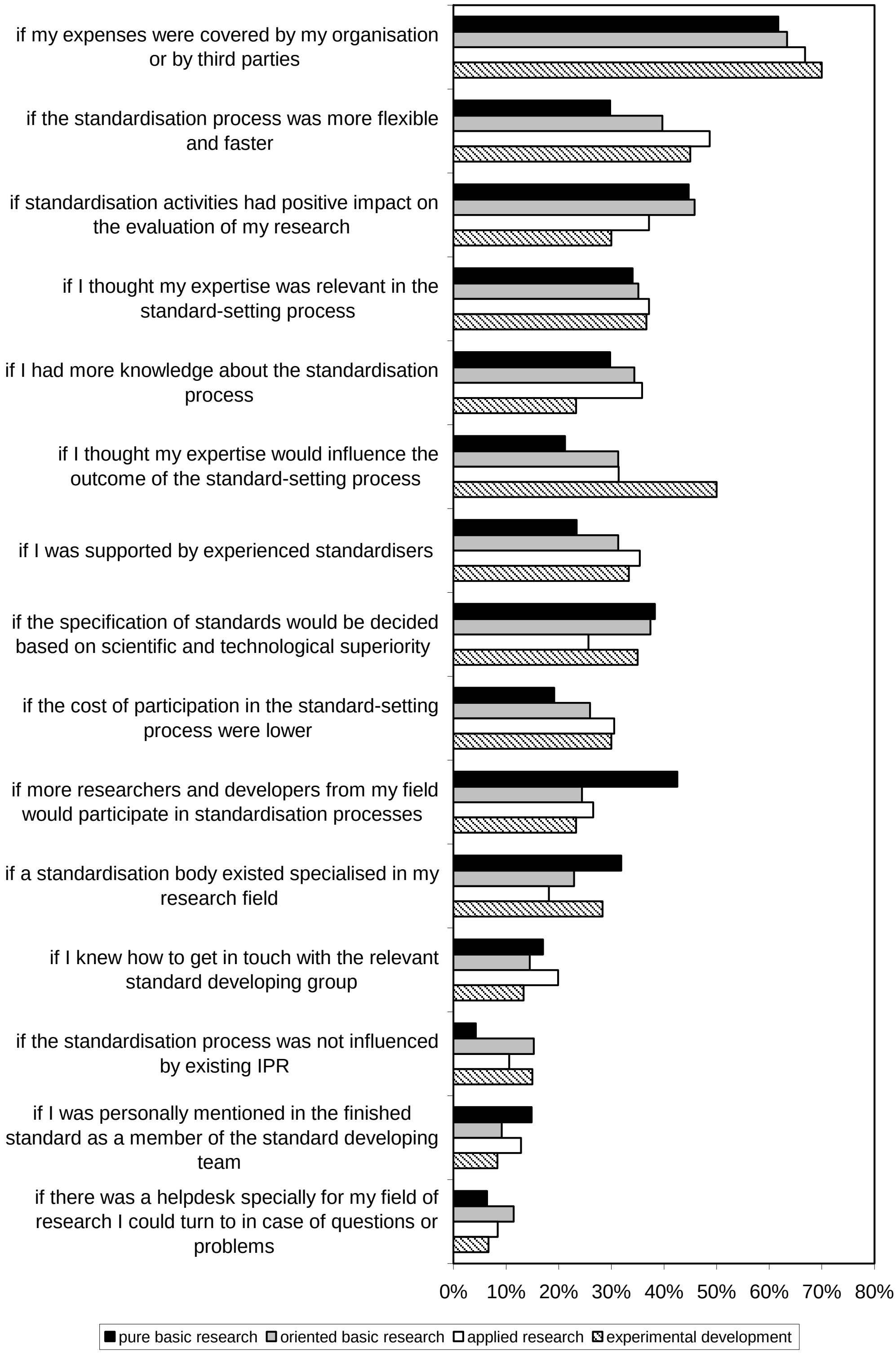
Figure 4.8: Share of Responses of the Most Efficient Incentives Leading to a Participation in Standardisation allowing for Five Responses



Source: INTEREST project, Fraunhofer ISI

As seen above, differences exist in the rationales and motives between different research contexts. It should thereby also be analysed if there are differences in the incentives that make the different groups consider participation in standardisation processes (see Figure 4.9). Obviously, different research contexts lead to different incentive structures. Even though the overall ranking seems to be stable, some incentives show interesting variations over the different research contexts. Regarding the subjectively assessed demand for their expertise, there seems to be no direct connection between research context and expected demand. Still, the related item regarding the subjective efficacy of the researchers varies greatly, with experimental developers scoring the highest. This might be interpreted as a problem of standardisation processes to integrate the experience of experimental developers. This is especially crucial in conjunction with the findings above, that experimental developers see the relevance of researchers and developers in the improvement of existing standards. Another striking difference between research contexts is in the incentive regarding the networking aspect of standardisation processes. Here basic researchers allot very high importance to this item. This means that in order to integrate pure basic researchers into standardisation, it is crucial to achieve a critical mass of other researchers with similar backgrounds. A similar point can be made for standardisation activities as part of research evaluations. The closer researchers are to the market, the less this element seems to be attractive for them. Regarding cost arguments, the opposite seems to be the case. The closer the researchers are to the market, the higher the incentives regarding lowering or covering of participation cost gain in importance.

Figure 4.9: Share of Responses of the Most Efficient Incentives Leading to a Participation in Standardisation allowing only Five Responses differentiated by research context



Source: INTEREST project, Fraunhofer ISI

4.2.5 Motives for participation

A further step towards gaining new insights on how to improve the transfer of research outcomes to standardisation is to analyse the motives of those researchers already participating in standardisation. Figure 4.10 ranks the motives of participation in standardisation activities. At the top of the ranking, we find that researchers try to address or solve a specific technical problem via their participation in standardisation. This motive is closely related with the second most important objective, to shape the specifications of a standard. This might be seen as a functional approach to standardisation activities with standards as a mechanism of solving specific problems. At position three the standardisation process itself is addressed, because researchers assess it as an option to improve their cooperation with other researchers, which is confirmed by the motive at position six, which stresses that standardisation strengthens the links with other researchers and developers in general. The fourth motive on the ranking list is the facilitation of jointly agreed rules leading to interoperability, compatibility, common terminology and other agreement via standards. The relevance of this reason increases, the more market-related the activity of the respondents.

The company survey by Blind et al. (2002) shows that this motivation is weaker for companies. At position five of the ranking, researchers put the incentive to improve the dissemination of their research results via standardisation. The dissemination of research results has also to be seen in connection with the two motives at position seven, the improvement of chances of future funding, and eight, fostering the commercialisation of research results. Especially the latter two incentives are based on the assumption that from the participation in standardisation processes and the influence on specific standards, positive feedbacks can be generated for the own research activities. This result confirms the integrated approach specified in our conceptual framework, which includes the recursive feedback from standardisation to research. The ninth most important motive points out that participation in standardisation generates not only additional codified knowledge in form of a new standard, but even further tacit knowledge among the participants, which is not easily available for those not participating in standardisation. Based on two other motives on monitoring the involved researchers and developers, standardisation is not necessarily an interdisciplinary business, but mainly concentrated within one scientific discipline or technology. The number ten on the ranking list makes explicit that standards are part of the regulatory framework, which can – at least indirectly – be influenced via standardisation, which is at position six in the ranking of the experimental developer. Number eleven in the ranking, the motive to prevent proprietary standards, is obviously not as important for researchers to get involved in standardisation processes, in contrast to the engagement of software developers in programming Open Source

Software. Approaching the bottom of the ranking, we find that delegation by the own organisation is not very relevant for the majority of the respondents, which in contrast is an indication for the strong intrinsic motivation to join standardisation processes, which is also not triggered by gaining personal reputation via participation in standardisation. In contrast, delegation by the own organisation is number eight in the ranking of the experimental developers. Although the involvement in standardisation generates a knowledge advantage for a significant share of respondents, it does obviously lead to a time advantage. Researchers do not intend to participate in standardisation in order to prevent certain specifications in standards, although this is a very relevant argument for some experimental developers, which confirms the findings by Blind et al. (2002), in whose company survey this incentive was among the top motives. Finally, standards are not assessed to be an efficient means to improve the legal security in new fields of science and technology. Here, formal legal regulations organising new forms of intellectual property or restricting ethically ambivalent research are required.[3] Since researchers are less involved in market transactions, the relevance of standards for reducing transaction costs between stakeholders in the market is limited for their activity and therefore the related motive to participate in standardisation is low. However, the survey by Blind et al. (2002) also presents this argument at the bottom of the company-based ranking.

In summary, the most important motives to join standardisation are related to generating technical solutions, although standardisation processes are also an opportunity to improve the collaboration and links with other researchers and developers, which means that the process itself is of value for the participants regarding their research activities.

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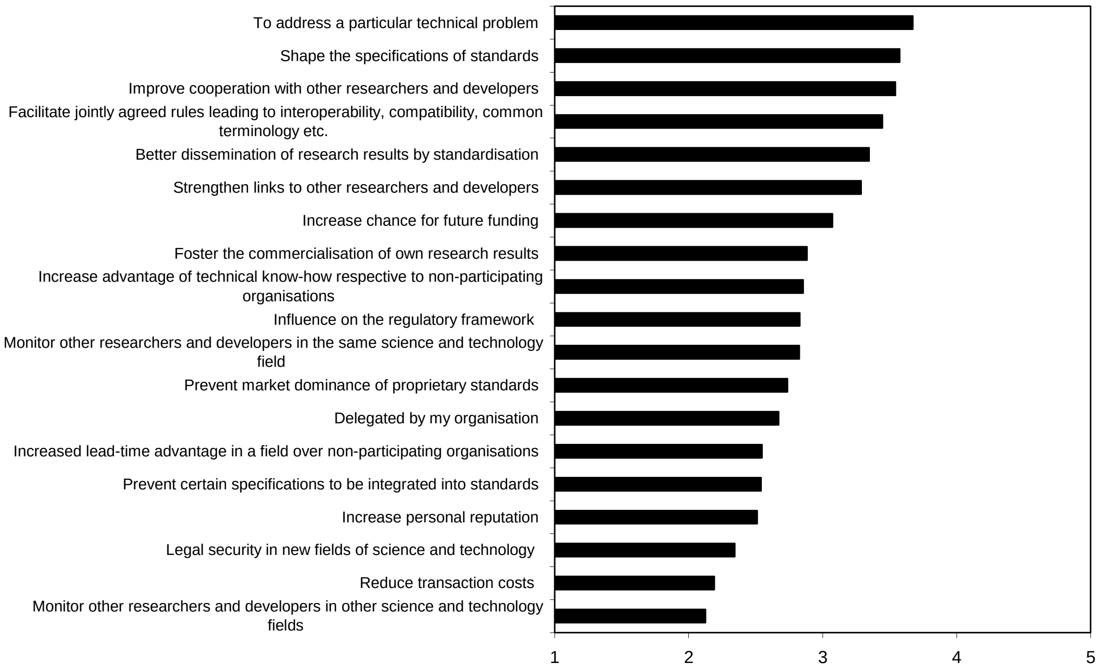
3 Blind et al. (2002) show that companies participate especially in formal standardisation processes in order increase legal security concerning the introduction of new products and services.

Figure 4.10: Motives for Participating in Standardisation (1 = very irrelevant to 5 = very relevant) (Source: Interest Survey, Fraunhofer ISI)



Source: INTEREST project, Fraunhofer ISI

4.3 The Problem-Solution-Matrix

Since we have observed a variety of problems regarding the transfer of knowledge from research to standardisation in chapter 4.2.3 and several solutions to the different problems in chapter 4.2.4 , we structure the relationships between the different kinds of problems with the various solutions based on the identification of significant statistical correlations computed using the phi-coefficient of correlation exceeding a correlation value of +.1 and a significance level below 0.1 (results from chi squared tests were used to calculate the significance levels.) The results thereby reflect interrelationships of barriers and solutions that have a substantial significance (reflected by the score of the coefficients) as well as statistical significance (reflected by the chi squared scores). The basis for this table is therefore a statistical one, derived directly from the survey results representing the accumulated judgment of more than 500 FP5 participants including standardisers and non-standardisers. The table thereby is not only based on subjective assumptions as already done in chapter 4.2.4.[4] We expect from this procedure further insights on how to solve the transfer problem efficiently. The Problem-Solution-Matrix can be found in table 4.1.

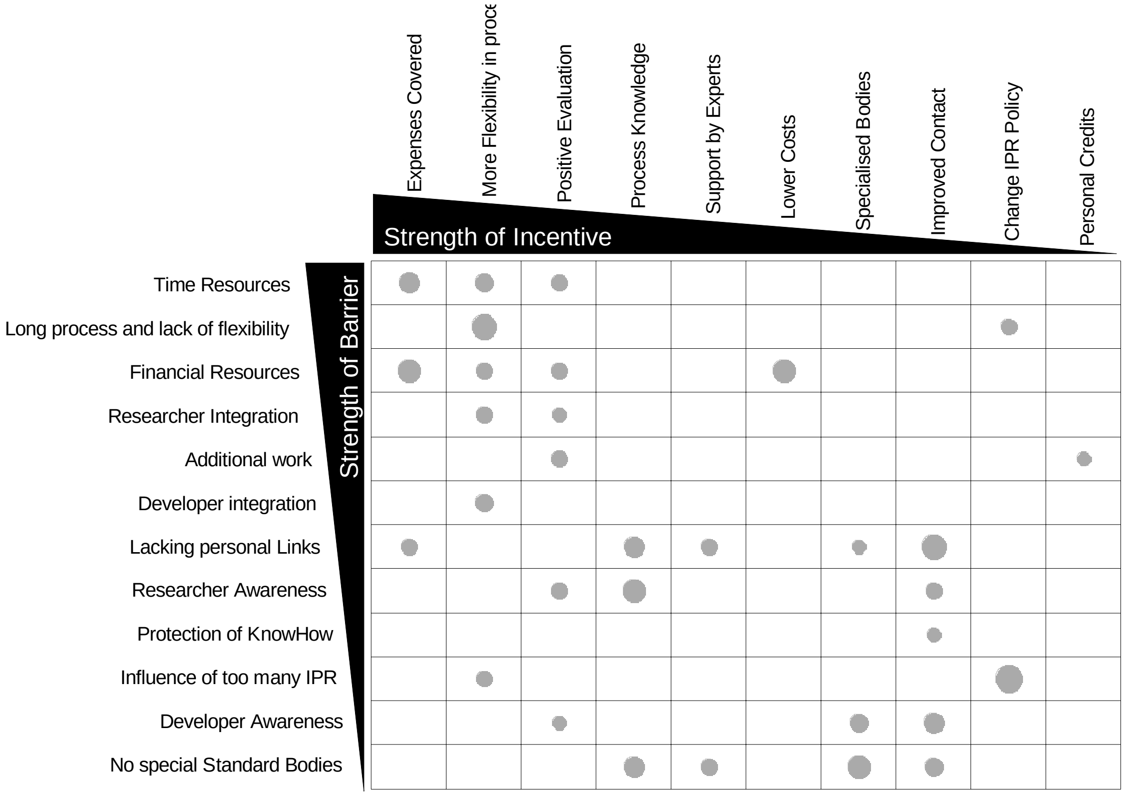
In the Problem-Solution-Matrix we only highlight the most significant relationships and have ranked both the barriers and the solutions according to their relevance. The coverage of the expenses certainly would help to relax the problem of insufficient time resources and of lacking financial resources.[5] However, this solution correlates also positively with the problem of lacking links to standardisation bodies. The reimbursement of costs obviously would compensate also for joining standardisation processes, which are per se not attractive because of the missing personal links. More flexible and faster standardisation processes would not only respond to the complaints of too long and inflexible processes, but relax also the problem of time and financial resources. Furthermore, the integration of the inputs from researchers and developers became easier and existing hindering IPR can be circumvented. After this standardisation-related solution, the positive evaluation of standardisation efforts in the research community has to be mentioned, since it would not only reduce the weight of the argument of too high opportunity costs regarding time resources, but would also justify the additional work required for adjusting research results for standardisation processes. Consequently, the higher recognition of standardisation work would solve some serious problems of the transfer in the researcher-related area. Improved expert support and more knowledge about the standardisation process would help to compensate for the missing personal links to standardisation bodies and for the missing specialised standardisation bodies. The creation of specialised bodies would solve not only the latter problem, but would also increase the awareness of the benefits of standards, especially among the developers. The knowledge about other researchers of my field joining standardisation processes would compensate both for the missing personal links to standardisation bodies and for the missing specialised standardisation bodies. The consequence of this relation is to increase the transparency of the membership in Technical Committees and other standardisation fora. However, the individual researcher involved in standardisation activities should promote this activity in his/her scientific community. Furthermore, the reduction of the influence on IPR in standardisation processes addresses consequently the rather

4 Hossain et al. (1999) have carried out a simple qualitative ad hoc assessment of the potential impact of various solutions on the barriers, which they have identified in the area of measurement and testing.

5 The latter problem would also be reduced, if the participation in standardisation bodies would be possible at lower costs.

limited problem of too many IPR in standardisation processes. Finally, the rather less attractive solution of attributing a personal authorship for the development of a standard is obviously a compensation for additional work required for reshaping research results for standardisation processes. However, it is obviously not very appropriate to compensate for the high time resources required for participating in standardisation processes.

Table 4.1: Problem-Solution-Matrix: Significant Relationships between Problems and Solutions



Source: INTEREST project, Fraunhofer ISI

The analysis of the significant relationships between the problems for and the solutions to transferring knowledge from research to standardisation processes confirmed, on the one hand, the plausible relations between specific problems and solutions, but revealed on the other hand further insights relevant for the preparation of a consistent set of policy recommendations addressing both the research and the standardisation area.

5. Case studies

In contrast to the survey analysis aimed at determining large scale patterns between research and standardisation it is also necessary to identify specifics on the micro-level in a qualitative way to answer questions regarding the actual role of standards and standardisation in the routines of organisations, or, more precisely, the way organisations deal with issues of standardisation and how the institutional setting of an organisation influences the mode of standardisation activities. To identify such modes of standardisation ten case studies where conducted to complement the knowledge gathered by quantitative analysis of the INTEREST survey data. The qualitative analysis is also used to derive best practice approaches to be included in the manuals for researchers and standardisers.

5.1 Characteristics of the case studies

An important dimension of the interaction between research and standardization is the question of how it takes place within organizations. The chapter first delves into how firms and research institutes, which have active interests in the research and the standardization worlds, organize their relevant activities internally and whether, and to what degree, they link to formal standardization activities. To study this, the project carried out a set of ten case studies which cover the interface between research and standardization activities in a range of organizations. Instead of trying to assess barriers of a general nature, i.e. if and why specific researchers are not engaging in standardisation, the case studies where selected to represent organisations both active in research and standardisation and throw light on how research and standardisation interact in different organisational frames. The case-based examples draw on interviews and other sources in order to provide empirical information about how the relevant activities are organized in different organisational settings, about the types of challenges that are faced, and, where relevant, about potential ways to improve the coordination of the research and of standardization activities.

Although the ten cases can in no way be seen as representative of the issues and challenges that arise in every context, they provide useful illustrations that complement the output from the survey as well as the project's work more generally.

Two general sets of organizations are looked at. Five cases were done on Research and Technology Organizations (RTOs) and five cases on companies. The companies were selected to cover a broad range of markets. These cases demonstrate different organizational types, and a range of different characteristics, including size, and technological and geographical markets. Against the background of the baseline characteristics of these organizations and their contexts, we present general information and viewpoints on the relative importance of R&D and standardization in the organization, on the organization of these respective activities, the perceived need for coordination between the two, etc. Further, the cases also provide observations about obstacles, challenges and opportunities that are seen as important in this area.

The project's original intention was to select a sample of ten of the set of European organizations surveyed (see chapter 5) to conduct case studies on the organization of the interface between research and standardisation activities. This approach proved to be impractical as the survey among researchers was postponed to the fall 2005 due to difficulties in getting addresses for FP 5 participants from the CORDIS database provider. In this situation we utilized the general breakdown of the types of organizations in the project lists and shifted more weight to criteria suggested by the literature survey.

The first include a set of large scale research and technology organizations (RTOs), (i.) because their design generally acknowledges a technology transfer role between research areas and industry often they are funded also because of the prominent role for technology transfer, (ii.) because they are involved in a range of different research areas, and (iii.) because RTO researchers are known to participate in different standardisation settings. The focus on RTOs was then linked to dissemination efforts at the European research and technology organization (EARTO) meeting in March 2006, where the project was presented and input collected.

The second type of cases the project focused on organizational structures involved a range of commercial organizations. Five of the ten cases look at enterprises in a range of industries and circumstances. The cases include research intensive fields such as ICT, consumer electronics, as well as life-sciences; they look at enterprises in mature as well as in service industries; and they consider larger and smaller firms.

Although the ten cases are not meant to be representative of the issues and challenges that arise in every context, they provide useful illustration that will complement the output from the survey as well as the project's work more generally.

5.2 Synthesis from the case studies

The way enterprises organize standardization and research activities involve central aspects of the way firms and, ultimately, the way industries develop. These activities involve an intersection of three general classes of 'routines' in a firm (Nelson, Winter 1982). These encompass the short-term operating characteristics of a firm, the investment activities, as well as the 'search' oriented activities. The pursuit of R&D

investment decisions fall especially under the third as well as second; they essentially involve ‘routine guided, routine-changing processes’. The choice to participate in standardization follows from this investment and might be closely associated with the more day-to-day routines of the product-development activities.

In this environment a goal of standards participation is to contend with uncertainty about where technology and the industry is going, either by trying to influence developments through active participation in key standards activities or by merely seeking to improve the firm’s information position by monitoring them. A standard that achieves industry-wide prevalence will serve to create costs for firms not readily compliant with it while potentially favouring frontrunners at home with the preferred technology (where there is contention between different technical solutions); a standard, if it is broadly wrought, might even significantly define market conditions in that industry (cf. the GSM standards in Europe).

Standards that become prevalent can influence, sometimes fundamentally, market conditions creating gradients in that industry in which some actors may be better positioned than others. So, whereas R&D is an expression of adaptive processes that may permeate the firm from the strategic level, standardization activities may be seen in one capacity or another as a bid to keep these adaptations in synch with the adaptations of the market more widely. Activities in the S and R frames involve to different degrees of adaptive behaviour by firms to match the position of the firm (‘firm-state’ factors) with the changing ‘industry state’ in the Nelson & Winter description.

The question then turns to how organizations coordinate these choices internally, and what inroads are made from these the firm level activities with activities in the standardization environment. The cases presented above provide novel empirical insight into how the S and R frames are organized and what sorts of concerns arise in different organizational settings. In looking at the ten different cases, the central division is between the Research Technology Organizations and the enterprises. One crucial aspect of the RTOs is that they do not have a set of commercial product lines around which their research and standardization activities may be organized. In this context, the arrangement of the interrelationship of the R and S frames at large RTO research activities tends to reflect the fact the underlying activities tend to grow out of research activities, mostly specific research projects, or the expertise of individual researchers or the problems they face in their work. Although fundamentally different objectives and framework conditions, the enterprises cases shared some organizational modes and concerns with these RTOs.

5.2.1 Organizing principles

Coordinated mode: Researchers can become involved in standardization activities in a variety of ways. In a minority of cases, the organizational links to standardization activities are coordinated by an internal department or layer of the organization. These cases all involved large enterprises, and two of the three cases were large ICT companies where standardization is an essential element of the competitive environment.

One of these cases emphasized the link to the management level, and the importance of having a good interface with overall company strategy. Here the standardisation department works internally to promote participation of the product lines in relevant standards activities and to avoid duplication of efforts. The questions that may be encountered include how to match its R&D roadmap to ongoing standards efforts, whether to modify that roadmap based on such efforts, or if and when to initiate such an effort based on internal developments. In the other ICT case, the decision on which projects to follow through with and how to utilise the research output is taken by the enterprise-wide technical steering group which consists of both executives who are coordinating the research and standardisation strategy, and the resource owners, i.e. research directors. The remaining case involved shipbuilding, a sector characterised by many standards and regulations. The case of the medical device company presented a foil to this. Here standards were seen to have large potential for emerging areas but the enterprise did not have a specific approach to standardization. To link practical standardisation and standardisation strategy, the standardisation department involves an internal marketing approach and the links to other relevant committees and standardisation organisations, thereby fostering the information flow.

Self-organizing mode: In most cases, especially those of all the RTOs, the researchers get involved in the standards activities on an essentially ad hoc basis. Participation is typically motivated by a specific project. In isolated cases researchers can be recruited into national activities based on reputation but mainly RTO researchers´ participation grows out of research for a client. In others, participation can be driven by the particular technical interest of the engineers "as part of their job" and requests from industry associations to have a "neutral expert" on the committee or the delegation of a national representative into an international committee.

Long-term R&D contracting with major actors that have stakes in standardization outcomes provide a good basis for involving researchers in relevant standards tasks. More ad hoc R&D contracts for individual private-sector companies may also provide a good funding basis. So can EU funding under the Framework Programmes of the EU, which was mentioned by several cases as engendering good practice since it encourages participation in standardization activities.

In general the self-organization of participation was seen to provide the necessary flexibility for researchers to link up with relevant standards activities over time. This is important when both the research fields and the standards activities are changing. But it leads to at least two concerns. The first is how to secure sufficient funding in this situation: the second is how to recruit new researchers to standardization activities.

5.2.2 Resources especially funding

The other question associated with organization is the universal concern about the availability of adequate funding and other resources. It was pointed out that insufficient funding for participation often leads to sub-standard participation in the committees. Participants that do not analyse the material between meetings will generally not be able to contribute to the elaboration phase, contributing to the perceived inefficiencies in the process: the duration of time was especially noted. On the other hand, one case reports on a telecoms enterprise where several people would be involved in standardisation providing input before and during the process and helping to prepare the standard. This includes the review of competitors' technologies.

Standardization costs money, and although the cost of travel is relatively low and although membership fees are geared to participation level, the direct costs related to standardization activities remain high. Finding reliable funding not only for the direct costs but the actual contribution between meetings to the standards is a universal problem. The exceptions were the two ICT company cases. The small firms as well as the RTOs noted that question of cost and of the fact that participation eats into time for other necessary work.

In some cases, researchers found their participation thwarted by national funding agencies that did not recognized the significance of standards-work as part of R&D output. A counter example was that of the EU Framework Program (which is also funding this work). The EU FP was specifically cited as a funding agency that recognized the interrelationship between research and standardization. Securing adequate funding while retaining the flexibility of self-organizing is thus a challenge. The interviews mentioned several ways to improve funding conditions:

- Earmarking national public funding to the participation of researchers in standards committees

- Getting industry organizations more involved in supporting (especially for some technological areas)

5.2.3 Awareness and Involvement

One deficit is on the interest of researchers in standardization activities. General awareness of the standardization process, and its merits vis-à-vis the research process, are required at different levels. A lack of awareness or interest in the standards activities either by the actor who commissions the R&D contract or by the researcher can otherwise get in the way of a good cross-pollination between the two frames.

Getting researchers interested in standardization is not easy, and the interviews among RTOs and Enterprises both noted this. Once interested researchers have the opportunity to participate, the key precondition for fruitful involvement depends on financing. One challenge is thus to change the tendency towards short-sightedness about standardization and to better integrate it further into overall operations. The most common concern is that standardization work is recognized as being important by those commissioning R&D. A lack of awareness and interest among funding agencies for standardization was emphasized in several cases.

Funding from EU framework programs is cited here as a vehicle for standards-participation and where standards work is explicitly built into project-design. Whereas the EU FP was specifically cited as a funding agency that was aware and interested, there were many complaints that research programmes are not open for standardisation. Branch organizations, were also suggested to be a type of organization that should become more aware and involved in this area.

5.2.4 Personal factors

A list of personal factors that shape the interface between research and standardization was mentioned. Even in cases where standardization efforts were centralized the importance of individuals with knowledge, understanding, drive, and social and diplomatic skills were noted to be central. In many cases the link to standardization will be different from case to case.

The importance of engaged and knowledge persons among the clients companies for R&D was also noted as moving along the process. Here the combination of technical knowledge, knowledge of the standardisation process and the wider (political and market) contexts, and some social characteristics (such as the ability to work together with others) was seen to promote fruitful participation. In the standardization process, the role of secretariats was also mentioned as crucial.

A related question about motivation is whether participation in standardization is seen as meritorious or not. In many cases, the reaction is ambivalent, but in some cases standardisation was seen as increasing the researcher’s reputation in his own research community. In these cases, the engineers are aware of the reputation building effect of active participation in standardisation bodies. Especially chairing a technical committee has very high reputation effects and high visibility.

The return of the investment in standardisation can be high in certain settings. The participation itself is an opportunity for the researcher to network with potential collaboration partners and clients. It may also have a positive marketing effect among customers and improves and stabilises the relationship to their customers (new standards generate new markets especially for certification services).

5.2.5 The standardization environment

The role of standards bodies was commented on by most cases. In a couple of cases the observation that, in addition to the cost of standardization, the process itself was not efficient was expressed by some interviewees. Many observed that while the development of standards move at a relatively slow speed, the funding of the R&D work covering participation might run out before the standard is developed. However, none made the case that the way standards bodies function prohibits the uptake of research very strongly.

Cases were a little bit split on the question of consensus. On the one hand some cases emphasized the importance of greater efficiency in the standards process. Others however underlined the need to continue to focus on consensus as a goal of the process, despite the difficulties this might pose. Matters are complicated by the fact that new technologies often encompass several interfaces which are in need of standardisation. Also, there is hardly enough time for a new idea to mature. This is where EU and other joint projects play a significant role as an incubator. Many observed about the changing standardization landscape, including on the proliferation of standards bodies and the shift between national and international levels were mentioned.

One effect that was noted by the RTOs was that the changing development of the standards ‘ecology’ was to make tactical participation more important.

5.2.6 IPRs

IPRs were acknowledged as something of a concern by most interviewees with increasing relevance in standards work. The RTOs generally did not see it as a problem but noted that IPRs are becoming more important for the way standardization works. One specific concern mentioned by an enterprise was that the system had not adjusted to dealing with patent holders that are not engaged in production activities and not interested in cross-licensing deals. The threat of ‘patent trolls’ was identified as one area which is not adequately addressed in the current environment. Actors interested only in extracting maximum returns on IPRs were seen as a problem. There were a couple of developments that were mentioned which were suggested to be important. One was The Department of Justice initiative to allow licensing terms to be discussed in standards bodies and the multilateral use of non-assertion covenants. This was seen as a promising initiative which could improve negotiations and ultimately aid the broader dissemination of standards. One aspect of this initiative is that it might promote multi-lateral instead of bilateral negotiations. This could among other things allow greater openness about what constitutes fair and non-discriminatory terms for essential IPRs since negotiations would take place more in the open. But it also raises concerns about the risk for cartelization behaviour.

6. Synopsis from the empirical background research and the case studies

In the following implications from both the case studies and the survey are discussed. Using both sources of knowledge an integrated view is presented in which quantitative and qualitative information is used to form a coherent picture of the link between research and standardisation. Moreover, the theoretical aspects elaborated in the theoretical framework as well as this synopsis is the basis to identify relevant dimensions that have to be included in the taxonomy of the link between research and standardisation.

Taking together the results from the case studies and the survey a number of issues are obvious regarding the link between research and standardisation. First of all, the relevance of standards is reciprocally connected to a notion of "scientificness" placing it closer to the realm of technology and experimental development than into the sphere of research. This is most obvious when analysing the importance of certain sources of information for different research communities. As the importance of scientific publications decreases from basic research to experimental development the importance of standards increases. Also, with growing importance of markets for researchers the importance of standards grows accordingly. This places standards, as we have expected in the literature review, into the realm of technology rather than science and research. This perspective is also plausible from a point of view that accentuates the standards as a market relevant institutional solution to coordination problems. Interestingly we also find clues for the link of market relevance and standardisation in collaboration patterns. For instance, universities active in standardisation have a higher collaboration intensity with multi-national and domestic companies. Even though the causal relationship can not be established it is plausible to believe that the interest in markets can influence the awareness of standards instead of the other way round. Still, the relevance of standards is not sufficient for explaining why researchers participate in standardisation activities. As found in the case studies standards might very well be important in a researchers work but the participation in standardisation is problematic.

This highlights two aspects that are central to the INTEREST project: barriers and incentives to the transfer of research to standardisation. Both the case studies and the survey analysis revealed that the strongest barriers are concentrated around issues of resources, be they resources regarding time, or, in some organisational contexts even more important, financial resources. This also slightly shifts the focus from considerations of awareness of researchers towards awareness of funding agencies and clients in contract research for issues of standardisation.

One organisation active in telecommunications even reported that the lack of resources is the single most important barrier to standardisation. This qualitative result can also be backed by the survey analysis where the incentive of covered cost is the strongest incentive to participate in standardisation activities. The lack of resources also has indirect long-term effects regarding pure basic researchers and standardisation participation. The incentive generated by participation of peers, i.e. participation of researchers from their field, is significantly higher than in applied research or experimental development. Apart from the fact that for those type of researchers this incentive is significantly more important than for other types of researchers it also ranks third in the overall importance of incentives for participation. The lack of critical mass that would render standardisation work as attractive is therefore indirectly inhibited by the lack of funds. Without funding a critical mass can thus almost not be reached as the lack of funding also is the most important barrier for those researchers. The perception of funding agencies on standardisation as an integral part of innovation policy and the provision of funding is therefore of prime importance in this matter. While patenting is an integral part of most funding programmes aiming at applied research, matters of standardisation are seldom addressed in an equally prominent fashion.[6] The effect of such policies has also been noted in the case studies, where funding from the EU framework programs was mentioned as a catalyst for standardisation activities.

The issue of funding is also linked to two distinct modes of standardisation strategies. Generally, these modes can be distinguished between an organisational approach and a self-organizing approach. The coordinated approach, i.e. the integration of standardisation into the organisational structure of an organisation is very rare and mostly limited to big enterprises, where standardisation is an explicit part of the organisations mission. Both the survey as well as the case studies found that the second type of mode based on self-organisation is more prominent in research organisations. The importance of funding is intensified as the self-organizing mode can again be separated into personalized approach and a project-based approach. While the former highlights an intrinsic motivation of a researcher to participate in standardisation the latter one seems to be the most dominant mode of the research

6 There are some exceptions to the rule. The European Framework program encourages standardisation work. As the COPRAS project found the issue here is more towards leveraging the "standardisation gap", i.e. the gap between the generation of research results at the end of a project and the potential start of standardisation activities. Also some national innovation policies are aware of the importance of standardisation. In Germany the Impulskreis Innovationsfaktor Staat released a detailed recommendation developed by DIN, the Technical University of Berlin and the Fraunhofer Institute for Systems and Innovation research that highlights the importance of adequate funding for standardisation activities in new and promising technology fields

standardisation link in research organisations. In this mode the standardisation strategy is largely reactive on the part of research organisations. Standardisation work is done, but is limited to the awareness and interest of clients and funding agencies willing to support these activities.

Even though the issue of resources was found to be very prominent in both the case studies and the survey other important barriers and incentives that do not directly address resources have been identified. Some of these incentives cover a different perspective on resources in the notion of "scientific capital", i.e. the attribution of others that refers to the achievements of an individual or a group in a research field. A comparable term for this is what anglo-saxon scholars refer to as visibility of a researcher. This visibility is an analogy to the appropriation of research results through patents. Still, the aim of this appropriation is not necessarily the accumulation of economic resources, but rather the accumulation of peer recognition. This peer recognition can be transferred to economic resources capturing the idea of the already discussed credibility cycle in the research system.

As the case studies found the participation in standardisation activities is not necessarily believed to help accumulate this kind of capital. The survey results imply that the increase in cooperation and networking with other researchers is one of the strongest drivers to participation apart from more problem based approaches to solve technical problems in a standardisation process. That this strategy can lead to a higher collaboration intensity has also been shown in the analysis of the cooperation indices computed based on the survey data. Still, the gain in reputation can vary. Again, the reflexive nature of the link between research and standardisation becomes obvious as well as the importance to account for the specificity of research fields. The closer the produced standards link to the actual work of researchers the more likely it is to gain reputation from standards related activities. As the survey results show the field of ICT is one of the fields where the relevance of standards, most notably standards that relate to terminology and compatibility, is significantly higher compared to the rest of the sample. In such fields a gain in reputation can potentially be achieved, especially, as the case study results show when the involvement leads to a formal leading position like the chairing of a Technical Committee. The incentive to be mentioned as a participant in standardisation activities, e.g. as member of the consortium that developed the standard, also has the potential to lower barriers that relate to additional work like bringing the research results in the form required for standardisation work. Also the inclusion of criteria that relate standardisation work to positive evaluation is a very strong incentive to participation.

Another important aspect relates to the nature of the standardisation bodies, i.e. characteristics of the process. Still, there is a fundamental dilemma relating to the necessity of consensus and flexibility of standardisation processes. The survey results and the case studies imply that a large number of researchers perceive the process of standardisation as too time consuming and not flexible enough. On the other hand, the case studies found that consensus was also regarded as important and essential to the development of successful standards.

The synopsis of the empirical research implicates that a number of topics are relevant to build a taxonomy on the link between research and standardisation. As the objective is to build a generic taxonomy boundary conditions that influence the link between research and standardisation have to be included. The rough structure of the taxonomy represents the analytical framework developed. Here a distinction is made into three broad dimensions:

- the dimension of research
- the dimension of standardisation
- the link between research and standardisation

These three dimensions then have to be enriched with the findings from the empirical research, most notably the case studies and the survey analysis.

7. The theoretical taxonomy of the research and standardisation link

The overall aim of the INTEREST project was to develop a draft taxonomy that captures the linkage of research and standardisation across disciplines. The intention is to enhance the ability of researchers and standardisers at the individual and institutional level to understand the generic types of friction that can emerge between research and standardisation processes. To address this important area, this chapter analyzes and categorizes the underlying mechanisms in both the standardization and the research systems or frames.

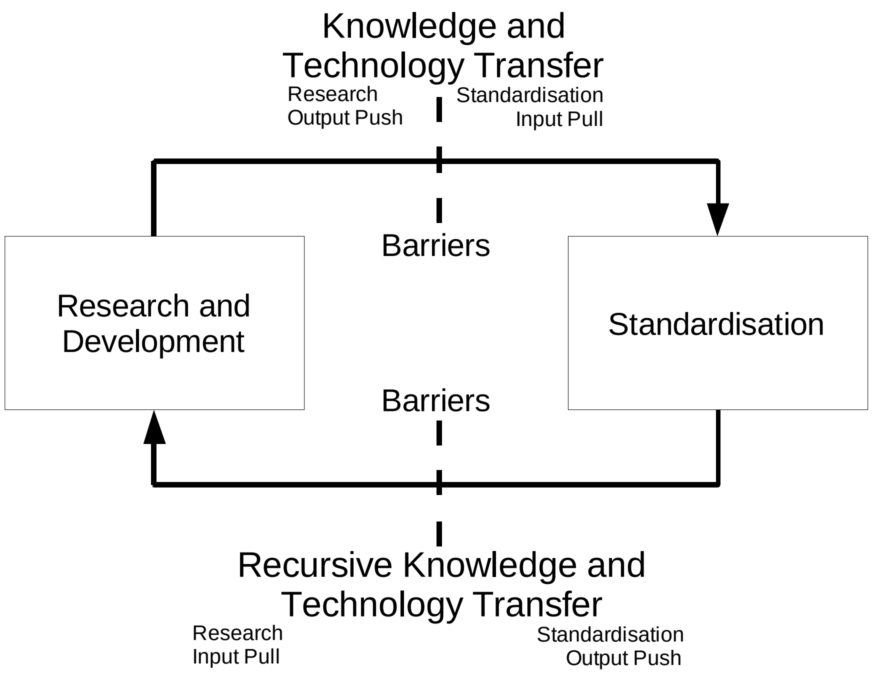
The results produced in the case studies and the survey analysis emphasizes the need for the taxonomy to go significantly beyond mapping generic research output and standardisation input dimensions. This approach neglects a set of crucial aspects that come into play, including the institutional setting of researchers, the maturity (emergence or stability) of the research field, the mode of the underlying research and the potential feedback effects that involve standards, and the researchers' incentive structure. We have integrated such key aspects into the draft taxonomy presented here in the interest of promoting greater realism and augmenting its explanatory power.

The resulting taxonomy emphasizes richness of detail even though it increases the complexity of the presentation. To develop a taxonomy of the research standardisation link three general aspects have to be considered. A taxonomy of research, a taxonomy of standardisation and a taxonomy of the link between the two realms. All three major dimensions are then integrated into a complete taxonomy of the research-standardisation link.

As argued above the development of such a taxonomy can be approached from many angles. There is here an initial tendency to blackbox the underlying processes. This leads to a base model (see figure 7.1) in which research and development (R&D) actvities lead to the generation of new knowledge which, by a process of transfer into standardisation, is selected as knowledge to be represented in a standard. This knowledge is then "transferred" into research and development activities and naturally becomes part of the knowledge base of researchers and developers. Where such an approach gains in simplicity it looses in accuracy and explanatory power.

In this chapter, we attempt to elaborate a taxonomy which is sufficiently realistic and useful. The aim is to build a taxonomy of knowledge and technology transfer mechanisms while at the same time take into account the specificity of the transfer object (knowledge), the transfer media (i.e. patents, publications in the case of codified and participation in the case of tacit transfer) and the specificity of both processes and organisations in both realms, or, to put it another way, the specificity of standardisation output and standardisation process and the specificity of research output and research process.

Figure 7.1: A simple representation of the research standardisation link



Even though the model is valuable fort he prior empirical analysis we found that in order to develop a taxonomy of the link between research and standardisation a more detailed model is required, as the base model

- does not account for the "framing" the knowledge is generated in (i.e. the organisational setting, the mode of research, the effect of necessity to raise funds etc.),
- abstracts from the role of actors (researchers, developers and as well standardisers),
- therefore ignores the distinct differences of tangibility of knowledge; the difference between tacit and codified knowledge.
- It also abstracts from the rationale of the researchers by overlooking aspects of the medium of transfer, i.e. patents to provide return on investment on research or as strategic tool, publications to accumulate scientific capital. (Bourdieu 1975)

- it also abstracts from types of standards (e.g. terminology, measurement & testing, quality & safety, compatibility, etc.)
- and finally it abstracts from scientific fields in their tendency for closure, as a system in the sociological sense, against external influence or their environment.

Moreover, our theoretical framework points to a perspective that is contrary to a monocausal relation of research and standardisation: it is in other words not a one-way and non-recursive directed relation from research towards standardisation, only fully understandable by investigating the "interrelation" of research and standardisation. Therefore the reduction of the relationship to "research output" vs. "standardisation input" provides an inadequate basis for a comprehensive taxonomy of the research standardisation linkage. In the following we will gradually add bricks and mortar to this basic model to end up with a comprehensive taxonomy reflecting reality as closely as possible without becoming over-complex, i.e. accounting for more factors than necessary to describe the research/standardisation link. The challenge is that the linkage between research in standardisation is characterized by a certain degree of contingency. This means for our purposes that the linkage is not subject to more or less, determinant rules which can be mechanically described in a model. The description of the four boxes above therefore is necessary to provide a guide (e.g. for self-assessment of researchers) to reduce this contingency.

7.1 The dimension of R&D

Research as an activity is fundamentally oriented towards the generation of knowledge. This knowledge can in some cases be transferred into different forms of capital, i.e. scientific capital in the form of journal articles that (hopefully) lead to positively connoted forms of peer recognition, but also into economic capital, in an indirect way via return on investment on R&D by the licensing of patents or directly by the commodification of this knowledge in goods and services. Such forms of capital can be circulated and, simply put, exchanged among one another (Bourdieu 1975). Examples include the exchange of scientific capital, i.e. the recognition of peers resulting in a relative position in a scientific field and thereby the legitimacy to represent "scientificness" or "excellence" and to impose which problems might be regarded as "scientific", into financial capital, i.e. funding form public or private sources both internal and external to the organisation context, that then is used to generate more scientific capital. This "credibility cycle" (Latour, Woolgar 2006) provides an important perspective on the research/standardisation link as it poses the question of the "relative value" of standardisation activities, i.e. the amount of capital that can be accumulated in this process in contrast to other activities, always keeping in mind the opportunity cost that are linked to these activities. In principle this reflects what economists adhere to as opportunity costs, i.e. the costs of engaging in some activity while other activities could be undergone at the same time. Participation in standard-setting therefore is an activity that can be valued in the light of the incentives that lead to participation.

An initial step of a taxonomy of the research standardisation link therefore has to at least integrate the following aspects:

- the degree of autonomy an individual researcher can exert regarding his activities in general.
- the relevance of standards as a proxy for the overall measure of probability to gain capitals (economic or social, i.e. scientific) that a researcher can accumulate in a standard-setting process.
- the mode of coordination the organisation has implemented in its institutional setting, i.e. the existence of layers, departments or other types of institutional solution vs. project based approaches.
- the mode of research production the researcher is engaged in, i.e. basic research, applied research or experimental development.
- the motives to participate in such a process, i.e. aspects of social factors, economic factors and factors regarding the legal framework. While the first group of motives is mostly centered around the motives of actors, the second and third is mostly mediated by the organisations the actors are embedded in.

Clearly some of these dimensions, or branches, are confounded due to the stochastic element of the interrelation of the given variables.

7.1.1 The framing of research work I –Types of Organisations

As we stated above we can assume that the type of organisation has an effect on the general mode of technology transfer mechanisms. As we found in the case studies RTOs in contrast to companies are different by their mode of knowledge outcome, i.e. the lack of a coherent set of commercial product lines, and mostly link their research results to standardisation on a project basis, while enterprises integrate standardisation in their organisational structure, especially in cases where standards play an important role in their technical field, e.g. information technology and telecommunication technology.

The impact of the organisational setting on the research/standardisation link can be found both in the structural aspect of this link, i.e. the existence of standardisation departments, the relevance that is ascribed to standards and, to some extent, also are reflected in collaboration patterns.[7]

In terms of the structural representation of the research and standardisation link in the form of departments, i.e. what we will later relate to as the "coordinated approach" to a research and standardisation, companies are very distinctively different from other types of research organisations. While the pattern of relevance of standards as source of information is not that clearly cut the general relevance of standards shows that respondents from private organisation, such as private research organisations and companies, cast slightly more relevance to standards in general compared to the respondents from public organisations, like universities and public research organisations.

All in all, the type of organisation in many ways affects the research standardisation link. First, it is the (physical) locus of the actual research work and is closely related to the way the research is both funded, i.e. by mostly public sources or private sources, as well as the way research results as such are produced. Second, the integration of the research standardisation link into the organisation is guided by the type of organisation, or more precisely, by the underlying missions and modalities of research production. Generally organisations which are relevant as providers of research input, that does logically include organisations that have the function of "representation" of certain stakeholders like NORMAPME or CEAPME, can be differentiated by public organisations, or, to put it another way, governmental organisations and private organisations, the latter including private research organisations and enterprises or companies.

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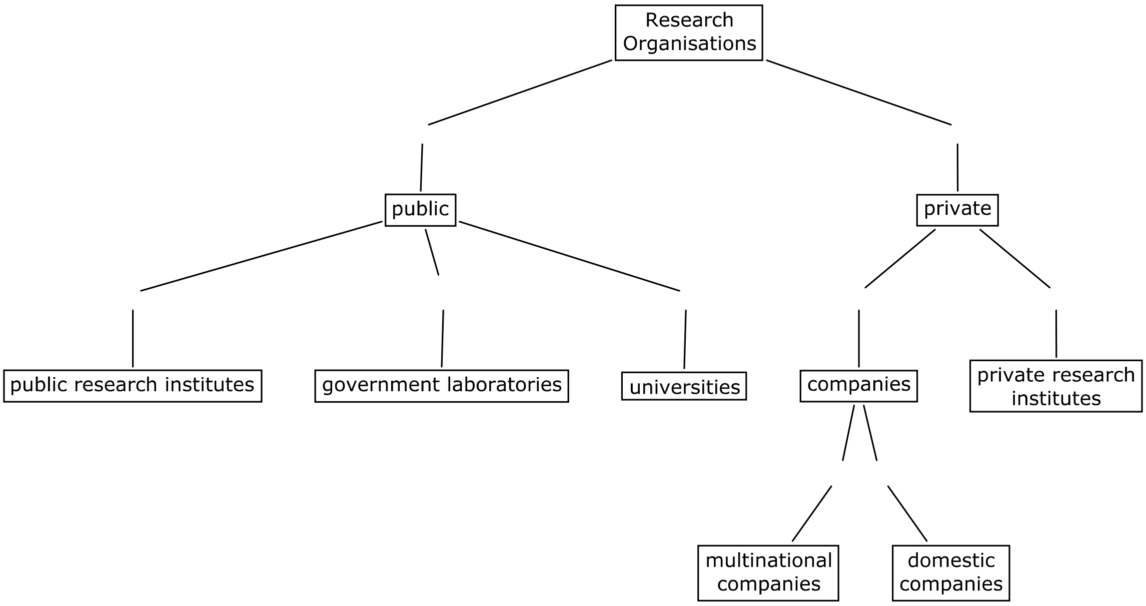
7 The results should be interpreted as a correlative relationship between standardisation activity and collaboration pattern and not as a strict cause and effect relationship.

Figure 7.2: *Taxonomy of Research Organisations*



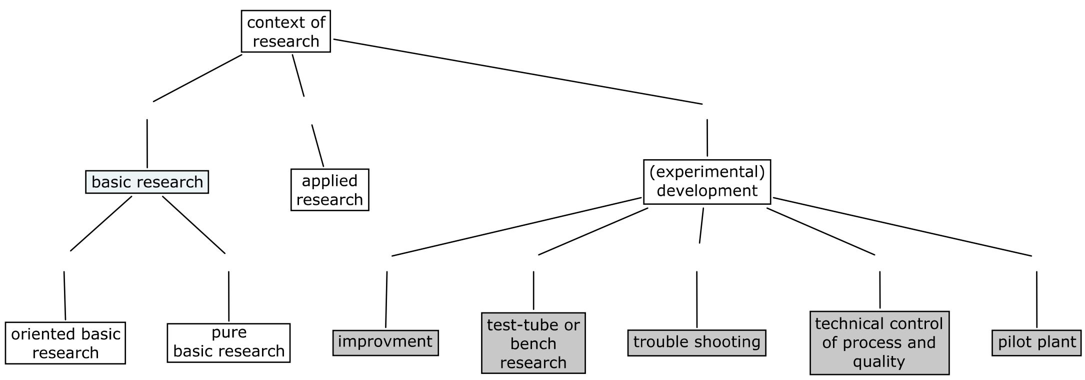
To interpret this dimension as perfectly congruent to the mode of research, that is the aim and way of knowledge production, is a too generalized view of research. Even though it can be assumed that most of basic research is undergone in universities, a view that is mostly reflected in classic theories regarding technology transfer, we have to assume that the two dimensions, type of organisation and context of research are not reducible to each other. We therefore have to include this dimension into the taxonomy to account for this fact.

7.1.2 The framing of research work II – The modes of scientific knowledge production

Apart from the frame of research activity that is determined by the type of organisation a researcher is embedded in the context of research, i.e. the overall aims of the research work. In a recent work focused on the issue of the development aspect in R&D taxonomies by Godin (2006) a comprehensive discussion of taxonomies of research and development was provided. Still, most of these taxonomies are more or less congruent in nature. The Frascati Manual 2002 (OECD 2003) developed by the OECD defines research and development as "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". This general activity can, according to the Frascati Manual, be classified into basic research as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view", applied research as " original investigation under-taken in order to acquire new knowledge […] directed primarily towards a specific practical aim or objective" and finally experimental development as "systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices, or installing new processes, systems or devices, or to improving substantially those already produced or installed". Basic research can furthermore be classified into "pure basic research" and "oriented basic research", while the first is not oriented towards "long-term economic or social benefits and with no positive efforts being made to apply the results to practical problems or to transfer the results to sectors responsible for its application" the second produces knowledge that "is likely" to be used to solve future problems. The classification of research contexts according to the Frascati Manual is provided in figure 7.3. In relation to the taxonomies screened by Godin (2006) we integrated a taxonomy of 1941 by Stevens (1941) which provides more granularity for the "experimental development" branch of the OECD taxonomy. These categories include: test-tube or bench research, pilot plant, improvement, trouble shooting and technical control of process and quality. These categories are understood as stages that occur in the order mentioned above. For clarification we chose to present the part of the taxonomy that relates to the taxonomy of Stevens in a different colour.

Figure 7.3: Classification of research context according to the Frascati Manual 2002

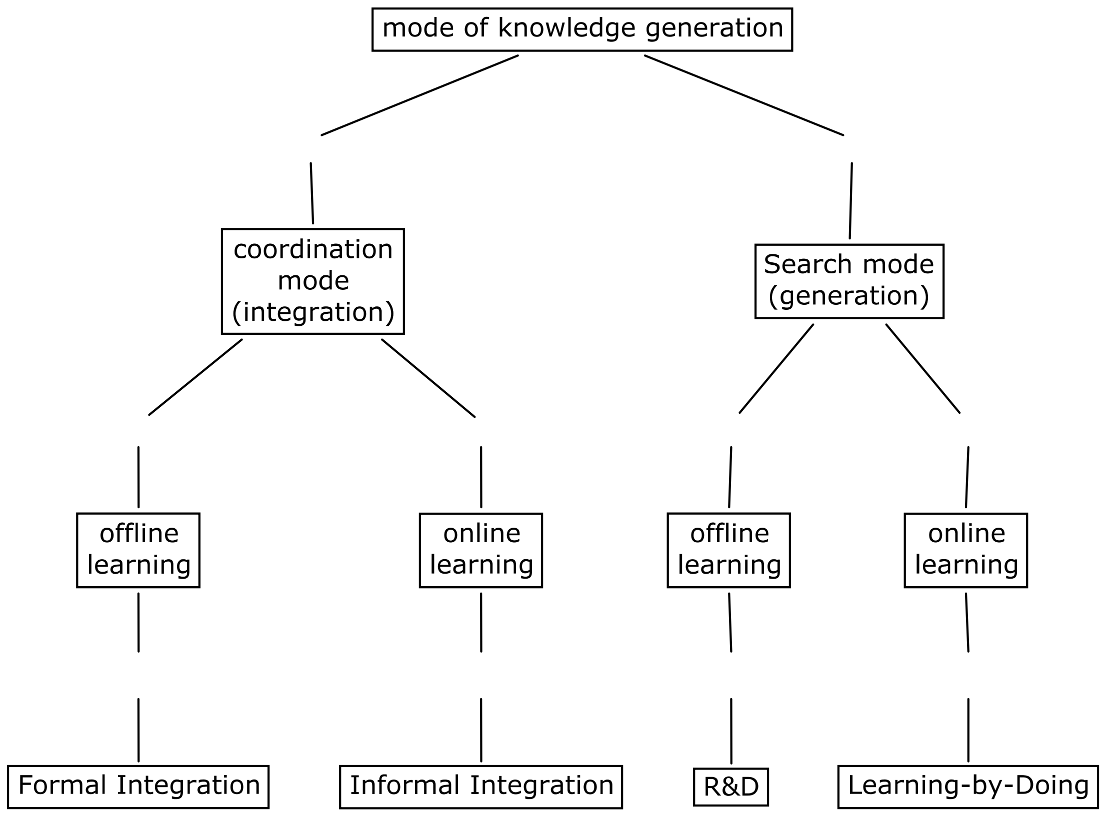
(adapted integrating Stevens 1941)



The definition of the Frascati Manual reflected in the above branch of the taxonomy can also be related to Stoke (1994) who classifies research activities by two dimensions, basic understanding and practical application of research. Still, the typology of Stoke excludes experimental development which we found to be an important aspect regarding the link between research and standardisation, especially in the case where practical tacit knowledge (engineers) in contrast to the theoretical tacit knowledge (scientists) is of importance in standardisation processes.

Another classification that can be relevant for a taxonomy of the research standardisation link and captures information about the research context and mode of knowledge production can be found in Foray (2004). His typology, based on ideas from Steinmueller (2002), differentiates between search and coordination models of knowledge creation, i.e. the generation of new knowledge vs. the integration of knowledge. The first type, i.e. knowledge generation, is characterised by search processes regarding unexplored or even underexploited phenomena in nature. This type is closely related to research processes as it focuses on the generation of new knowledge. The second type of knowledge generation aims at the production of integrative knowledge. The need for integrative knowledge results from increasing complexity in the realm of technology and is especially important in the area of industrial applications and there especially when complementary or network goods and services are important. Standards are, together with common platforms or regulations, one form of integrative knowledge. The second type thereby highlights the coordination aspect of knowledge generation. Foray (2004) integrates Steinmueller's view by adding the notion of different learning mechanisms involved in the generation of new knowledge. His distinction focuses around off-line learning and on-line learning. According to Foray, off-line is the prime mechanism applied in formal research and development processes, which he describes as sheltered and isolated from the regular production process of goods and services. On-line learning refers to a more organic approach to knowledge generation and can best be described as learning-by-doing. On-line learning does not necessarily limit the view to repetitive tasks or effects of specialisation but also includes "performing of experiments during the production of goods and services" Foray (2004). The typology according to this model is important in two ways. First it integrates the notion of differences in the process of knowledge production outside the R&D realm and second it highlights the differences between the results of research (the result of a search process) and the results of standardisation, which are the result of a coordination process.

Figure 7.4: Modes of knowledge generation according to Foray (2004)



Unfortunately these dimensions of knowledge production put forward by Foray are hard to quantify and are not necessarily purely distinctive when observing the overall approach of a researcher, i.e. research work being focused on the production of new knowledge in one task and integration of knowledge in another part. Still, they have to be part of the taxonomy to aid further research on the research standardisation link and to point the way to a more basic understanding of the differences of knowledge produced by research and the way standardisation can be understood in terms of a coordination of research results.

Apart from the type of organisation and the context of research another frame of research activity is important: the scientific field. The dimension of the scientific field represents the third and final pole of the taxonomy regarding the framing of research activities and the research standardisation link.

7.1.3 The framing of research work III – the state and composition of scientific fields

Apart from the actual locus of the research work, i.e. the organisation, and the aims research is conducted for, i.e. the mode or context of research, another albeit larger context of research is important to grasp the link between research and standardisation. This larger and more complex frame of research is captured by the notion of the scientific field.[8] Unfortunately taxonomies regarding scientific fields are very sketchy. Most of them providing neither the degree of disaggregation required or, and here is the more crucial aspect, do not fit the specific problem of the research/standardisation link, i.e. the link between production of knowledge and the selection and closure of knowledge by standardisation.

The scientific field as the locus of reference for researchers, i.e. the network of other researchers and, on a more abstract level, the locus of discourse of which the outcome is the accreditation of legitimacy to represent and act in scientific manner as the objectified representation of the habitus of researchers.[9] For the purpose of this taxonomy we adapt a more straightforward interpretation of the scientific field by extracting the network aspect of the scientific field and its structure. In this way we can distinguish the scientific field by two aspects: its composition representing the structure of the field and its "state", i.e. the degree of emergence as a "new" scientific field. The former dimension can be related to the notion of homogenous and heterogeneous fields, i.e. fields consisting of elements that are comparable by certain other dimensions (type of organisation, research context, nationality etc.) or fields that represent a "mix" of such entities that are grouped to different outcome of the dimensions. The state of the scientific field is more temporal in nature. It reflects the scientific field in a larger context and describes the degree of "novelty" in the structure, not necessarily the novelty in epistemological approaches, of the network of actors.[10] The idea of emergent and stable configurations of scientific fields, originally put forward by Callon (1997) an be linked to three other dimensions relating to a) knowledge, b)

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8 To account for the fact that not only "direct" research results, i.e. publications and science based knowledge, can be input to standardisation the correct formulation should be scientific or technical field. Even though there are differences of theoretical nature between the two concepts our taxonomy captures the underlying logics of both at the same time due to the abstraction level we chose for description.

9 On the precise notion of the scientific field: Bourdieu (2004; 1975)

10 An example of an emergent field might be nanotechnology or biotechnology, both representing new ways of using the scientific methods of the larger disciplines they grew from and building new instruments and methods that are specific to their activities.

state of the world and c) modalities of action. A table summarising these aspects is provided in table 6.1. Similar ideas that relate more general to environments of organisations have been developed by Thompson (1967) relating to a two-dimensional matrix of homogenous/heterogenous and stable/shifting factors of the environment. Another classic classification has been developed by Lawrence and Lorsch (1967) relating to high vs. low dynamics and high vs. low diversity of the environment. The advantage of our approach is that all these aspects are captured in our multifaceted concept of scientific (and technical) fields. It also allows us to extent our focus beyond the idea of "scientific fields" towards a more general, albeit complex, notion of the environment. We also thereby extend the focus beyond the notion of a pure "demand environment" as proposed by Bozeman (2000). Still, the physical locus of research and standardisation (the organisation) and the more general of symbolic locus of research and standardisation (the field) have to be demarcated.[11]

The dimension of emergent vs. stable configurations of actor networks also has an impact on the input dimension of standardisation, i.e. the degree to which knowledge is available in codified form and to a high degree represented as tacit knowledge inseparably bound to the researcher unless it can be transformed to codified knowledge in the form of material or symbolic artefacts (publications, patents, products, prototypes, etc. One might also include in our case: standards). The ratio of tacit to codified knowledge that is relevant in a scientific field therefore has a direct impact on the input component of standardisation, or, in simple terms, the necessity to integrate researchers in standardisation processes to produce what Iversen & Werle (2006) refer to as "input legitimacy" in standardisation. Figure 7.5 presents this branch of the taxonomy.

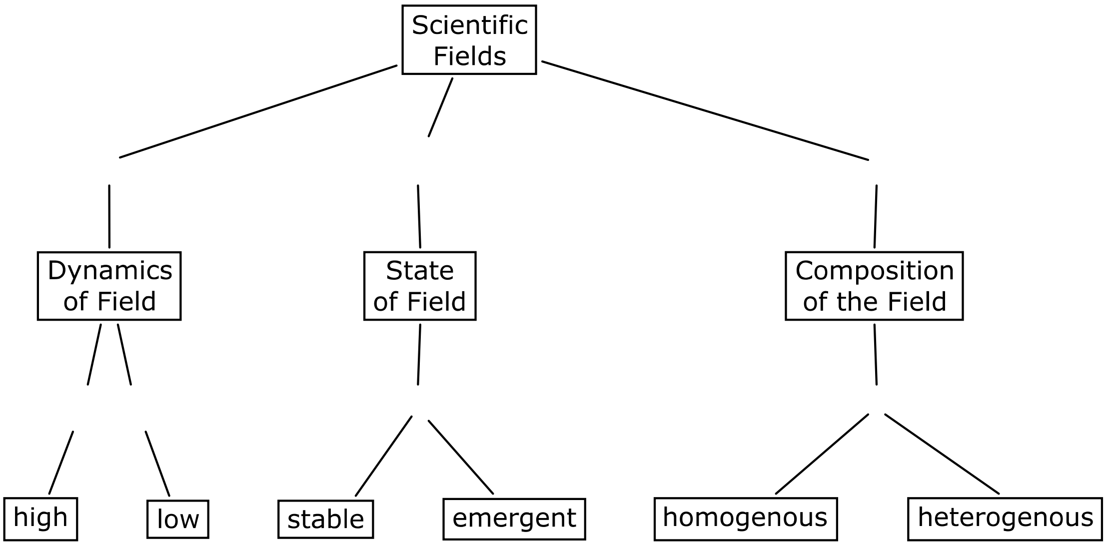
11 Advocates of laboratory studies (e.g. Knorr-Certina (1984) would argue that the scientific field is already embedded in the organisation and therefore needs no special attention. We argue, in line with Borudieu (2004) that the laboratory is just on entity of the field that itself is embedded in the scientific field but only captures a microcosm of this field embedded in a larger field.

Table 6.1: Characteristics of Emergent and Stable Configurations of Actor Networks

	Emergent configurations	**Stable configurations**
Knowledge	Statements + instruments + embodied skills	Statements are information because embodied competences are duplicated
	Non-substitutability between codified and embodied knowledge	Codified knowledge and embodied knowledge are relatively substitutable
	Private knowledge: rival and exclusive	Knowledge is public – i. e. non-rival, non-exclusive, within the network where it circulates
	Knowledge replication = laboratory replication	Replication of knowledge = coding and replication of strings and symbols
	Local knowledge is generalised through successive and costly translations	The degree of universality of knowledge is measured by the length of the network
States of the world	Lists of identity of social and natural entities constantly reconfiguring	Lists and identity of social and natural entities are known
	States of the world revealed, ex post, through trials and interactions	All states of the world are known ex ante and the probability of their occurrence can be calculated
	Uncertain and vague knowledge uses	Uses of knowledge are predictable
Modalities of action	Programmes only exist ex post, as the outcome of action and learning	Research programmes (problems + operation) are defined ex ante and provide a framework for action (coordination)
	Cooperation is an obligatory passage point for action i. e. for translating identities and interests and for negotiating the content of knowledge	Cooperation is a strategy for cost and risk sharing or for consolidation of power positions
		Rational expectations

Source: (Callon 1997)

Figure 7.5: Taxonomy of scientific fields



7.1.4 The role of resources – economic vs. knowledge resources

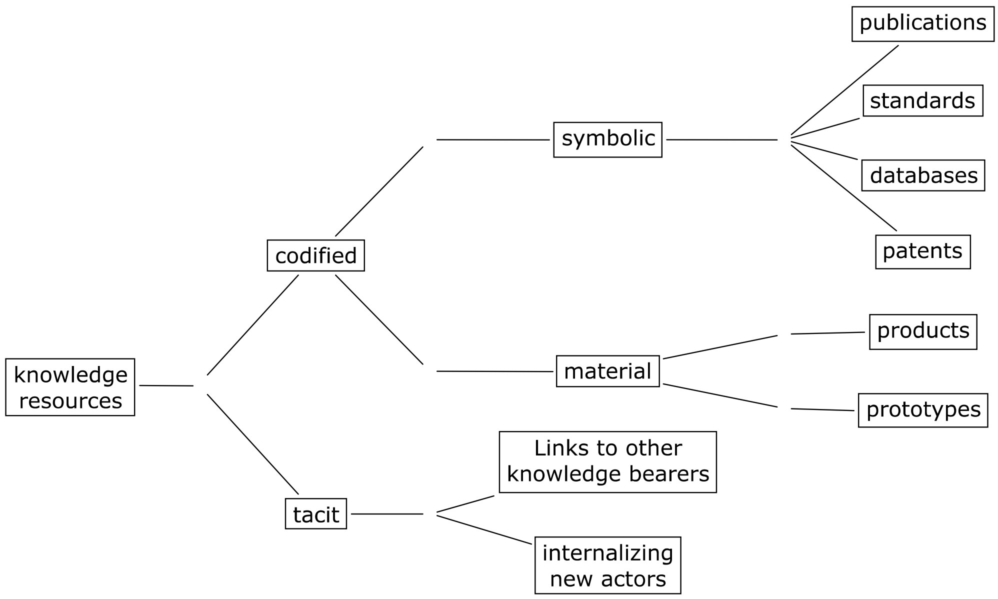
Apart from the frame of research consisting of the scientific field, the context of research and the organisation another factor emerged as important regarding the research/standardisation linkage which refers to the input dimension of research. To simplify the taxonomy we chose a level of abstraction that captures a notion of input that can be used to describe both the research and standardisation input dimension with respect to the resources that are used to drive the processes (financial resources) and are the direct result of the processed entity (knowledge resources). Generally we further distinguish the financial resources by two dimensions, as resources from public or private sources and how the basis on which these resources are provided, i.e. dependent on performance or independent of performance.[12] The dimension of knowledge resources is differentiated into codified and tacit resources. The codified resources, which are differentiated into material and symbolic resources, include the most common codified resources that determine the research-standardisation link.[13] The material input, i.e. products and prototypes can either be justified as input for both standardisation and research processes. In the first case the material input acts as reference or starting point for standardisation activities, in the second case it can be the basis of research activities. The symbolic representations of knowledge (publications, patents etc.) are also interchangeably useful in both processes, even though they may be used differently (i.e. as legal documents in the form of IPR or as knowledge input for further research, as starting point for research or corpus of selection in standardisation in the case of publications etc.). The integration of tacit knowledge can be, due to the fixed link to the actor who possesses it, only be gathered either by links to these knowledge-bearers or by integration of these knowledge-bearers into the organisations or processes. Tacit knowledge, the knowledge that is represented in the researchers and leads to the fact that they "know more than they can tell" (Polanyi 1966), can be transformed into codified, or, more precisely, explicit knowledge. Still, this is only possible to some extent and is usually believed to be, taking into account the depth and complexity of the tacit knowledge, an endeavour that can not be achieved without

12 Performance in this view is not directly linked to the quality of the output of the process but captures the notion of funding for activities that are linked to projects or contracts vs. funding that is provided independent from its usage.

13 The notion of standards as resources can also be used in the realm of standardisation as an input, e.g. as standards transferred from one entity (a technical committee, another SDO) to the SDO as well as internal circulation of the standard (older versions of the standards as basis for the next generation of standards). An indication for the relevance of the latter aspect can be found in the citation networks of standards.

difficulty. As we argued above, the degree of tacit knowledge, i.e. the ratio of knowledge that is mostly inseparable from the researcher and the knowledge represented as an material or symbolic artefact, is highest in scientific fields that are either highly dynamic or emergent or both. We will come to this fact later when discussing the role of tacit and codified knowledge as demarcation criteria in technology transfer processes.

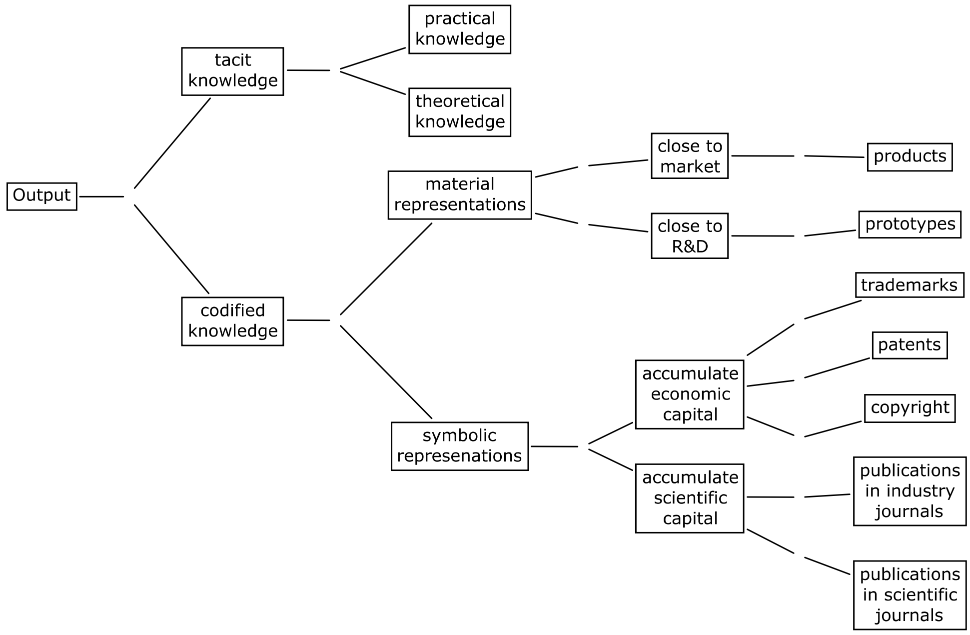
Figure 7.6: Taxonomy of knowledge input into research or standardisation



7.1.5 The research output dimension - Differences in type of knowledge

Regarding the output dimension of research we chose to adopt a closer focus on the knowledge component. Keeping the differentiation between tacit and codified knowledge as well as the subcategories of material and symbolic output of codified knowledge we also include categories to differentiate the types of capital to which the output is directly aimed, i.e. to gather scientific capital vs. economic capital. We moreover differentiate the relation of this output to the closeness to the market vs. closeness to R&D by differentiating between prototypes (close to R&D) vs. products (close to market). Regarding tacit knowledge we differentiate between theoretical knowledge and contrast it to practical knowledge. The reason to do this is to capture the above mentioned difference between off-line and on-line modes of knowledge production as well as the difference between research activities and development activities.

Figure 7.7: Taxonomy of research knowledge output and referring representations



In contrast to the input dimension, which we captured at a higher abstraction level we chose to be more concrete in the research output dimension as some facets of the specificity of scientific knowledge production can be important to capture certain phenomena in the research-standardisation link, e.g. the difference between theoretical and practical knowledge to account for different types of standards that represent the relation to material artefacts against other types of standards that do not necessarily require a practical knowledge like terminology standards.

Another way to classify knowledge was condensed by Gorman (2002). In his work on technology transfer and types of knowledge he differentiates between four types of knowledge: declarative (information), procedural (skills), judgment and wisdom. As the third and fourth category do not provide for clarification of the link between research and standardisation we chose to stick to the simpler terms theoretical knowledge and practical knowledge. Both are, to some extent, congruent to the dimensions of Gorman as theoretical knowledge represents a knowledge that encompasses information while practical knowledge is more focused on skills rather than theoretical information about a given object.

7.2 The dimension of standardisation

As we have now attempted to provide a taxonomy of relevant aspects of research that are important for an assessment of the link between research and standardisation the next step is in providing a taxonomy of the realm of standardisation. As in our taxonomy of research the focus shall again highlight aspects of the organisational setting, the process of operation regarding the function of the realm as well as types of output, or more precise in this context the economic effects of the outcome, that are bound to the result of said operations. At some points distinctions between process and organisational setting have to be made. This is necessary to deconstruct pseudo-linkages, like the implicit strictness of the link between certain aspects of process and organisational design, e.g. certain ways of consensus development which are implicitly linked to formal or informal organisations but do not account for special types like consortia following the same, or similar, rules of consensus without having the status of formal SDOs. Without these distinctions such differences would stay undiscovered and thereby would provide an incomplete picture of the link between research and standardisation. Main aspects of this taxonomy therefore include:

- The process of standardisation, including notions of timing, openness etc.
- The organisational setting of standardisation organisations.
- Elementary issues of the process of standardisation that transforms the research into standards.
- Typologies referring to the result of standardisation by the commitment and effects they have.

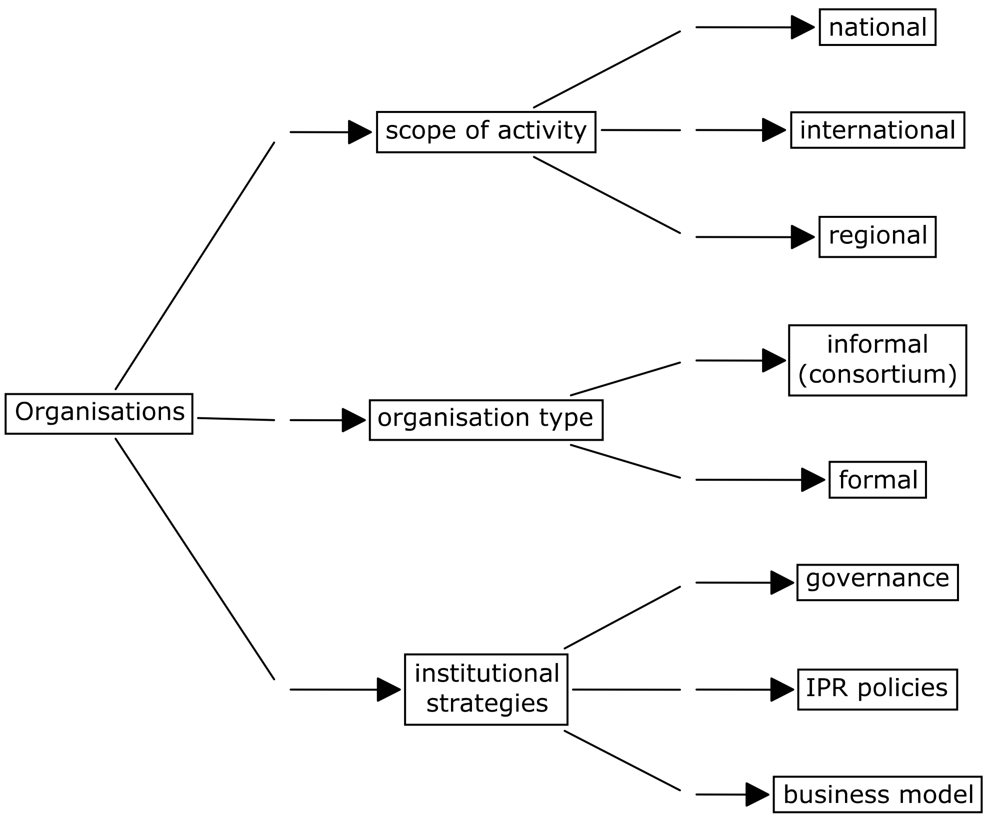
7.2.1 The origin of standards I – organisational perspective

To build a taxonomy of the research-standardisation link one also has to include the types of standard-developing organisations (SDOs). The reason to do this lies in the fact that a taxonomy that fails to capture these different types of standardisation organisations lacks important information that can be valuable to generate new research questions and provides information necessary to use the taxonomy beyond its function as a classification tool. Standardisation organisations can be classified in a number of ways. We chose the three most common classifications of SDOs as they are sufficient to capture the relevant dimensions of a research standardisation link. The first differentiation can be made between informal and formal SDOs. The former, sometimes referred to in the literature as consortia or fora standardisation, describes a meta-organisation consisting of stakeholders that coordinate their assets towards a mutual agreement using instruments like patent pools as mechanisms of coordination described in the case studies. In some cases, like IEEE and W3C the character of meta-organisation is transformed into a long-term institutional arrangement that can be compared to formal SDOs. These bodies, even though they are not "formal" standards bodies in the closer sense of the word, use mechanisms regarding consensus development that are comparable to those of formal SDOs. We therefore chose to include items regarding the factual organisation of the process in a separate dimension rather than in the organisation dimensions to account for these facts. This specificity of standardisation can be compared to the specificity of research where we chose to differentiate between the context of research (basic research, applied research and experimental development) and the locus of research (the organisation, the laboratory, etc.). Just as experimental development can be located in universities and classify universities as the locus of basic research, one can also, to some extent at least, find "formal" mechanisms of consensus in "informal" SDOs.

The second means of classification of standardisation organisations relates to their scope of activity. This dimension relates to the direct function of the organisation in question, like national SDOs producing national standards but are also representatives in "higher-level" standardisation organisations like ISO or other SDOs covering a supranational region. Also the classification does not relate to the context of diffusion of the standard, like GSM implemented outside of Europe.

The third criteria relates to findings from the NOREST (Networking organisations – Research into standardisation) project funded in the 6th framework that created a classification of organisations by some criteria that are also relevant for the link between research and standardisation. These dimensions include the IPR policies, governance and business models of the standardisation organisations.

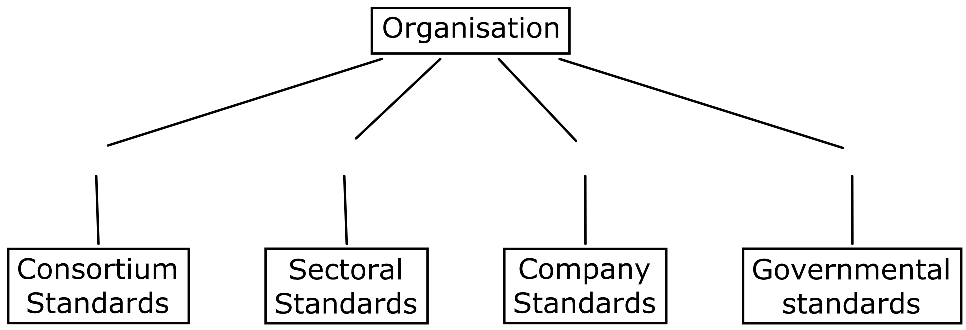
Figure 7.8: Taxonomy of standardisation organisations



Another way to categorize the organisations has been provided by deVries (2006).[14] His classification differentiates by the type of organisation a standard can be produced by. This classification encompasses consortium standards, set by an alliance of companies and/or other organisations. The second category, sectoral standards, describes standards which are set by organisations that unite parties in a certain branch of business. Governmental standards are set by governmental agencies, excluding SDOs. Finally de Vries refers to company standards, which describes standards that are either referenced to standards developed outside the companies or enterprises boundaries and are partly or in a modified way integrated into the companies practice.

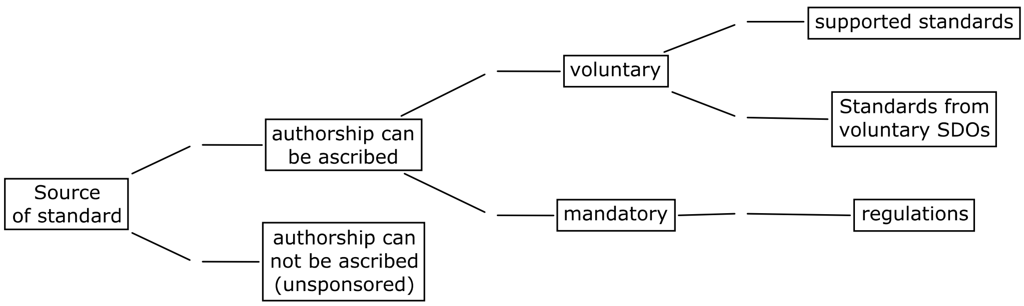
14 Actually de Vries (2006) used this classification to categorize standards in "by" their origin. We use this typology directly as a representation of different types of organisations in spite of a classification of their products.

Figure 7.9: Taxonomy of standardisation organisations according to focus



Apart from the organisational setting standards are developed in another dimension which relates to standards in a more general way. This dimension is important for a link between research and standardisation as it also includes mechanisms that evolve in an uncoordinated way without the explicit ascribable origin. Another way to classify standards therefore is, in a way, a layer above the just described as it captures the difference between standards that can be directly related to its origin vs. standards that are disjunctive from its origin, or, to be more precise, where the impact of the standard is hard to be described by the efforts of one entity like a consortium, formal SDO, a company or alliances thereof. This classification developed by David and Greenstein (1990), basically distinguishes between four types of standards. The first type of standards, termed unsponsored standards, the keyboard layout QWERTY being the most well known, are characterized as "a set of specifications which are well documented, but for which no author is identifiable." (Blind 2004b). The second group, known as sponsored standards, in which individuals or groups own property rights related to a set of specifications. In contrast to the first two types, sometimes also referred to as de facto standards, the third type of standards relates to standards that are developed in voluntary standardisation organisations in contrast to the fourth group, which describes mandatory standards in contrast to voluntary standards. As the first type is by nature voluntary as there is no entity supporting it and origin is unclear, the dimension of voluntary vs. mandatory only can usefully be applied to the group of standards for which this authorship can be ascribed. We therefore chose to classify these standards accordingly to Figure 7.10.

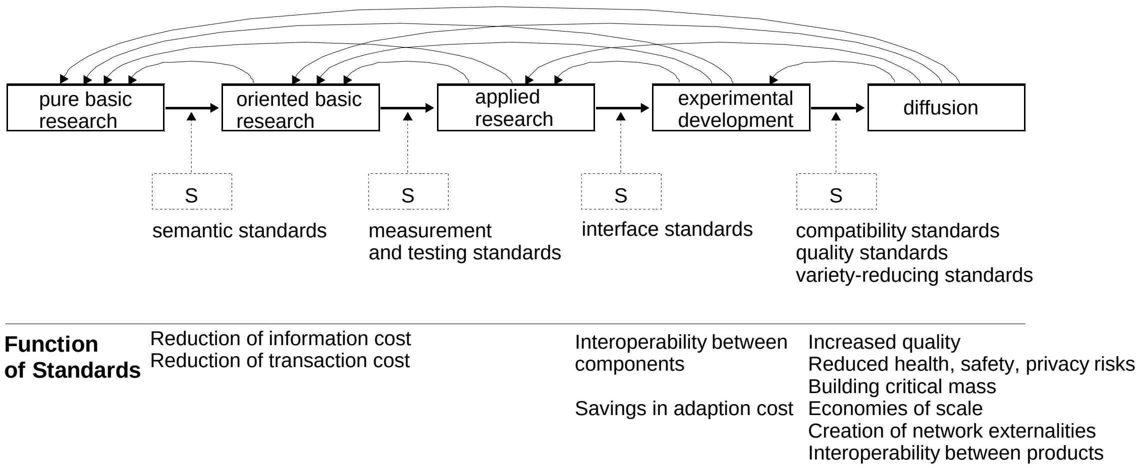
Figure 7.10: Taxonomy of Standards classified by authorship and degree of commitment



7.2.2 Functional Classification - Economic perspective

Apart from the possibility to classify a standard by its origin, whether ascribable or not as more abstract notion of origin, and the commitment of a standard, a standard can also be classified according to its economic effects. These effects, which can both be positive or negative, provide a basis for classification. The most commonly used classification of standards regarding their economic effects has been developed by David (1987). David classifies standards into four classes, as standards which are a) relevant for facilitation of compatibility or interoperability in complex technologies (compatibility and interface standards), standards that b) discriminate between quality or safety of products, services or processes (quality and safety standards). Such standards by either setting a minimum level of quality or safety provide the basis for discrimination between different quality or safety levels. Economically such standards are beneficent for customers, intermediaries or (industrial) users as by signalling that a minimum of quality or safety is guaranteed (mostly by certification of legitimate instances) transaction costs and search costs are reduced. Another economic effect of standards is c) the reduction of the amount of coexisting or even competing solutions (variety reducing standards) to specific problems leading to economies of scale and, according to Swann (2000) shape technical trajectories. The classification of the effects of standards, even though it not directly relates to the research-standardisation link, can be used complementary to provide information on benefits, but also potential problems, that are linked to standards and standardisation. It therefore can be interpreted as a mediator to shape incentives for participation to standardisation and therefore is a justified as part of the self-assessment as well as potential outcome of standardisation activities in economic terms. Another reason, which we partly where able to replicate using the survey data in the INTEREST project there is a relation between the timing in the innovation process and the relevance reported by the respondents for certain types of standards. This notion can be linked to the idea of development-related standardisation (EBN). The concept of development-related standardisation relates to three distinct phases in the innovation process that are linked to certain types of standards. The first phase includes definition, measurement and testing standards and reference models and is timely situated between basic research and pre-competitive research. The second standardisation phase includes performance and interface standards and is situated between pre-competitive research and market introduction. The third and final phase includes application-specific standards and descriptive standards and is situated between market introduction and market oriented R&D.

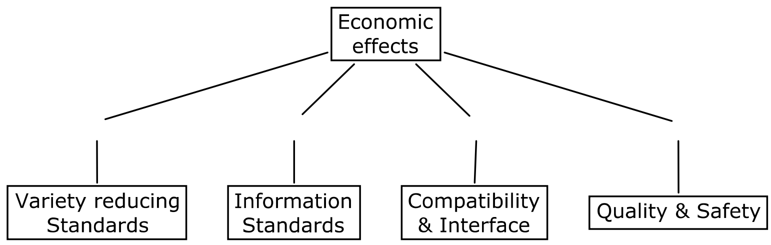
Figure 7.11: Linear model of knowledge and technology transfers regarding standardisation



Using our empirical data we found that a distinct pattern emerged in regard to the relative importance of certain types of standards for certain communities. Excluding the overall high relevance of interface and compatibility standards due to the high amount of ICT-related researchers in the sample we found that the relative relevance of different types of standards follows the prediction from our model with peaks of relevance in initial stages and a levelling out regarding the relevance for certain types of standards towards later stages in the innovation process (see figure 7.11).

Even though we are aware of the fact that these results do not provide enough distinctiveness for taxonomy development, i.e. there is no absolute and deterministic relation between research context and relevance for a certain type of standards, the underlying dimension of economic effects still is worthwhile to be included in the taxonomy.[15] The branch of the taxonomy classifying the economic effects of standards is provided in figure 7.12.

Figure 7.12: Taxonomy of economic effects of standards



7.2.3 Process dimension of standardisation

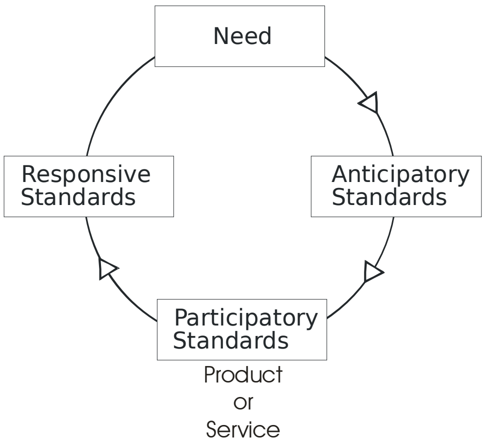
Another factor that is disjunctive from the economic effect of standards, and, as we discussed above, from the organisational setting of the SDO, the process dimension of standardisation plays a relevant role for building a taxonomy of the research/standardisation link. In the following we took the results from several typologies of processes including the notion of timing of the standardisation process, the actual target of the processes, i.e. development or maintenance of standards, the reference to the object that is to be standardised, i.e. a selection process or a designing process, and the dimension of consensus described by a multitude of different aspects. Even though the latter dimension usually is solely ascribed to formal SDOs, the existence of consortia (e.g. W3C, IEEE) that are not formal SDOs like CEN, ETSI or CENELEC adhering to similar rules and processes calls for a distinction between the type of organisation and the actual practice adopted in these organisations.

The idea of timing of the standardisation process was initially applied by Stuurman (1995) and in a comparable way by Sherif (2001). This dimension refers to certain types, like the notion of development-related standardisation discussed above, that represent different timings of the process. The type of anticipatory standardisation refers to standardisation that produces "those standards that are essential for

15 This taxonomy relates to product standards. There are notions to implement a taxonomy for service standards as well. This endeavour has been taken up by de Vries (2006) and most recently Blind (2006a). To reduce the complexity of this taxonomy we chose to not implement these taxonomies. Still, our taxonomy due to its multi-faceted nature can be extended by these dimensions.

widespread acceptance of a device or service" (Sherif 2001). Such types include basic infrastructure standards, like ISDN, TCP/IP or SSL, just to name a few from the realm of ICT. Participatory standardisation develops standards that "proceed in lock step with implementations to test the specifications before adopting them" (Sherif 2001). Finally responsive standardisation produces standards that standards "codify a product or service that has been sold with some success, or define the expected quality of a service and performance level of the technology" (Sherif 2001). While the first stage describes standardisation activities that are preliminary to developed products the second and third type refer to standardisation activity that are either synchronous to product development, i.e. solve standardisation problems as soon as possible while early product life-cycles, or occur after certain products have already gained presence in the marketplace (see figure 7.13).

Figure 7.13: Timing of standardisation activities according to Sherif (2001)



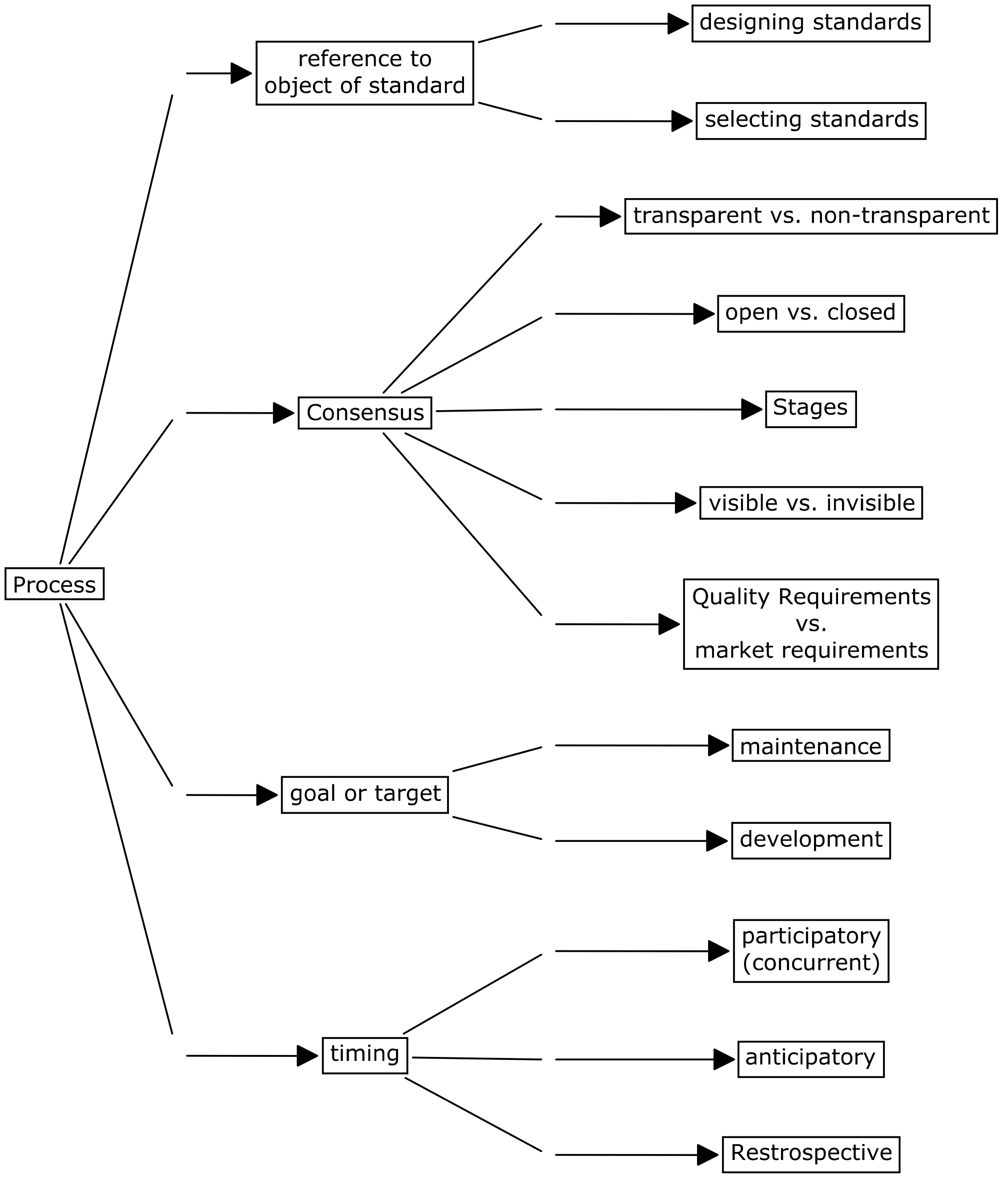
Regarding the link between research and standardisation it is also relevant to distinguish between different goals of standardisation processes referring to development of standards or maintenance of standards. This is due to the fact that different types of researchers might be relevant at either development stage or maintenance stage. In the case of maintenance of standards researchers might be a valuable input to adapt the next version of a standard to the actual research progress in the field.

The next dimension refers to the process of either selecting or designing standards. De Vries (2006) points out that even though usually encompasses a design process as well as an approval process sometimes "the design is available already and the only thing the standards-setting organization has to do is to decide to adopt a document developed already by a company or another standardization organization." (de Vries 2006).

The difference between the dimension of goals and reference to the entity that is to be standardised is the difference between the mode of selection and the reason for selection. While the first describes if a standardisation process is aimed at development of standards or maintenance of existing standards the second dimension relates to the fact if knowledge is selected from a pool of available knowledge or if (ex ante) rules are set without a clear knowledge of future events, i.e. the distinction between proactive and reactive standardisation. Both dimensions are therefore disjunctive. This also might include proactive maintenance of standards as a category, i.e. changes in standards that relate to possible future events.

The dimension of consensus represents our last genuine process-dimension. This dimension is usually directly related to the above discussed distinction of formal, informal or de facto standards. Still, as some informal bodies adopt similar principles as formal bodies it is justified to categorize it into a separate dimension. This dimension relates to a number of aspects of consensus like transparency, openness, visibility of the process, etc.

Figure 7.14: Taxonomy of the process dimension of standardisation



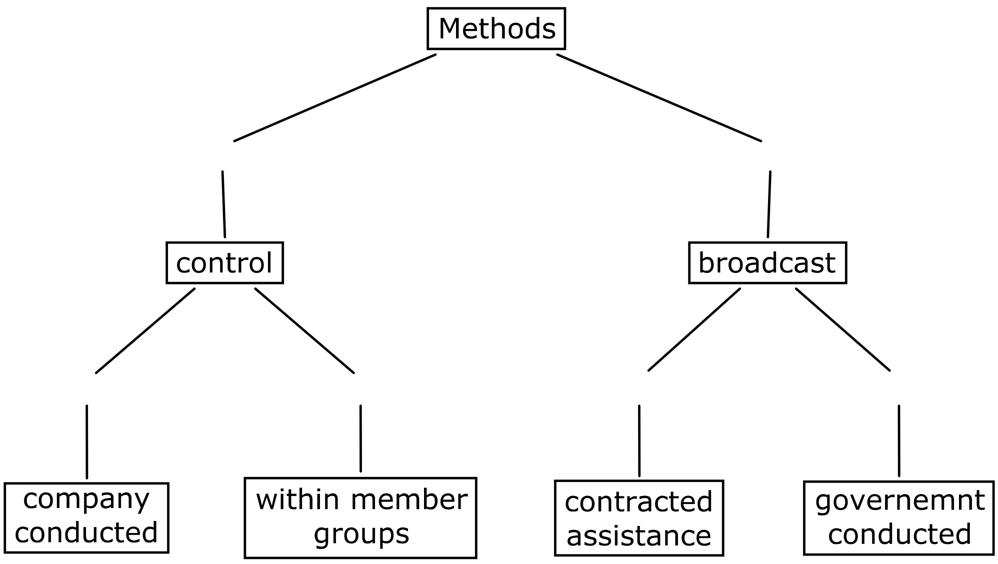
7.3 The dimension of Knowledge and technology transfer

Now that the boundary conditions for a taxonomy of the research-standardisation link is set by classifying both types of organisations in research as well as standardisation, the modes of production of the respective outputs of research and standardisation, the input side for research and standardisation and the specificity of scientific and technical fields we now can proceed to the actual taxonomy of the link between research and standardisation, i.e. the taxonomy of the knowledge and technology transfer processes and mechanisms that transport relevant knowledge from one realm to the other. As a special type of technology transfer, which has to regard the specificity of the transfer between the realm of research and the realm of standardisation, we can draw from previous typologies of knowledge and technology transfer mechanisms and link those to the results of the research already undergone in the INTEREST project.

7.3.1 Modes of standardisation strategies

Regarding knowledge and technology transfer a typology of Kremic (2003) highlights archetypical differences between the methods and rationale of technology transfer between government research organisations and companies. A simplified representation of this typology is provided in figure 7.15. Kremic (2003) generally differentiates between controlled approaches mostly followed by companies and corporations and broadcast approaches used by governmental bodies (with the exception of cross-border technology transfer). Kremic also highlights that government agencies rely more on the activities of individual transfer agents, rather than on activities of the agency, an approach that is reflected by our notion of the actor-based self-organizing mode of the research/standardisation link.

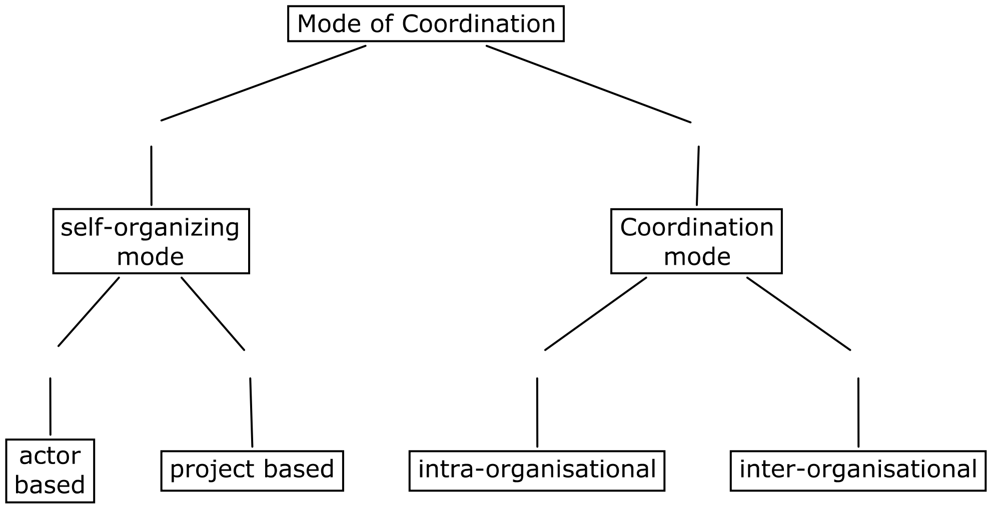
Figure 7.15: Technology transfer approaches according to Kremic (2003)



We found this taxonomy to be too broad to account for the specificity of the link between research and standardisation. We therefore chose to distil this dimension of the taxonomy of the research-standardisation link from the results of our previous research in the INTEREST project. As observed in the case studies two main lines of standardisation modes can be distilled. The first mode, or coordination mode, reflects a research-standardisation link that is embedded in the organisational structure, either by positions of actors or departments or both. The second mode represents the mode of self-organisation. The first mode can be differentiated into an inter-organisational perspective, i.e. an enterprise-wide or research alliance strategy, and an intra-organisational perspective, e.g. departments or layers in the organisation that are not centrally coordinated by a higher level entity.

This mode can further be differentiated by actor-based mode of standardisation activities, e.g. the engagement of actors based on their high visibility or excellent expertise or a project based approach, in which standardisation strategies and activities are the, mostly temporary, result of certain activities. A representation of this branch of the taxonomy can be found in figure 7.16.

Figure 7.16: Modes of coordination in standardisation strategies



7.3.2 Motives for knowledge and technology transfer between research and standardisation

In our research regarding the link between research and standardisation we found, apart from the organisational strategies and approaches discussed above, that certain motives are dominating the link between research and standardisation. Using a taxonomy of motivations for knowledge and technology tranfered distilled by Kumar et al. (1996) we could classify these motivations into clusters. The taxonomy of Kumar et al. (1996) being based on a massive screening of literature at that time is a very good and solid basis to build this branch of the taxonomy. Accordingly motivations to participate in knowledge and technology transfer can be classified into the following five categories: economic, social, operational, strategic and personal. Using these categories as guidelines and the detailed lists of factors subsumed under these categories in the taxonomy by Kumar et al. we were able to build a taxonomy of motivations for knowledge and technology transfer which is general in the approach of using established motivation factors for knowledge and technology transfer while at the same time maintaining a focus due to the specificity of this special type of transfer.

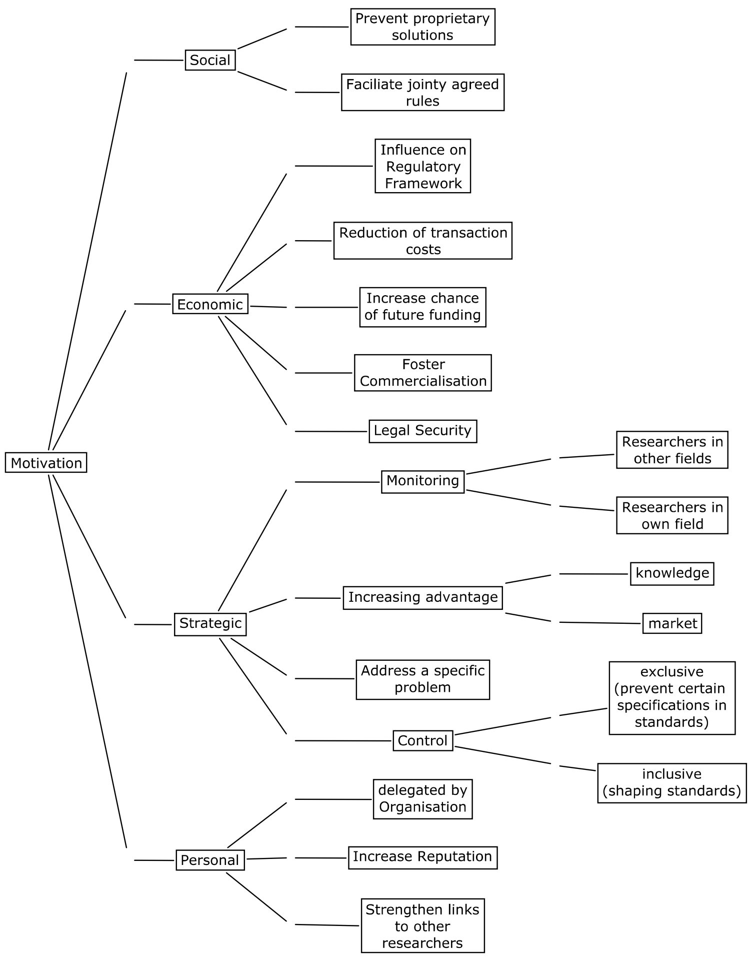
The *personal* factors, i.e. factors that are directly related to the participant and not necessarily to his organisations are the increase in personal reputation and the increase of links to other researchers. Another motive relating to the personal level is the strengthening links to other researchers. The final personal motive relates to the increase in personal reputation.

Even though the taxonomy developed by Kumar et al. (1996) differentiates between economic, global and operational we chose to collapse this dimension to a broader economic category. The reason to do so is that these factors are to highly confounded and do not allow for a proper demarcation against each other. Still we chose to demarcate the notion of strategic factors (not directly aimed at economic factors) and social factors.

The *economic* factors to participate in standardisation are the commercialisation of research results and the chance for future funding, the motive of commercialisation of research results through standardisation activities, the reduction of transaction legal motives, like the potential influence on the regulatory framework or legal security in new scientific and technical fields.

The *strategic* motives for participation, the largest group according to our classification, consist of the strategy to use standardisation to address particular technical problems represents the most important motive for participation regardless of organisational setting. Motives to exert control on the outcome of the standardisation process either by exclusion of specifications or inclusion of specifications are also part of the strategic motives. Still, the positive aspect, inclusion of specifications, is a stronger motive for participation. Lead-time advantage by participation in standardisation either in the market or in technical know-how represent other factors of strategic motives. Finally, the monitoring of other participants in the standardisation process, differentiated by researchers from the field of the respondent or other fields, complete the strategic factors to participate. In this case findings from Blind and Thumm (2004) and Blind (2006b) should be noted as they find an inverse relationship between participation in standardisation and intensities for R&D and patent activities. The strategic aspect of monitoring therefore should not be neglected as part of the taxonomy. The branch of the taxonomy reflecting this dimension is provided in figure 7.17.

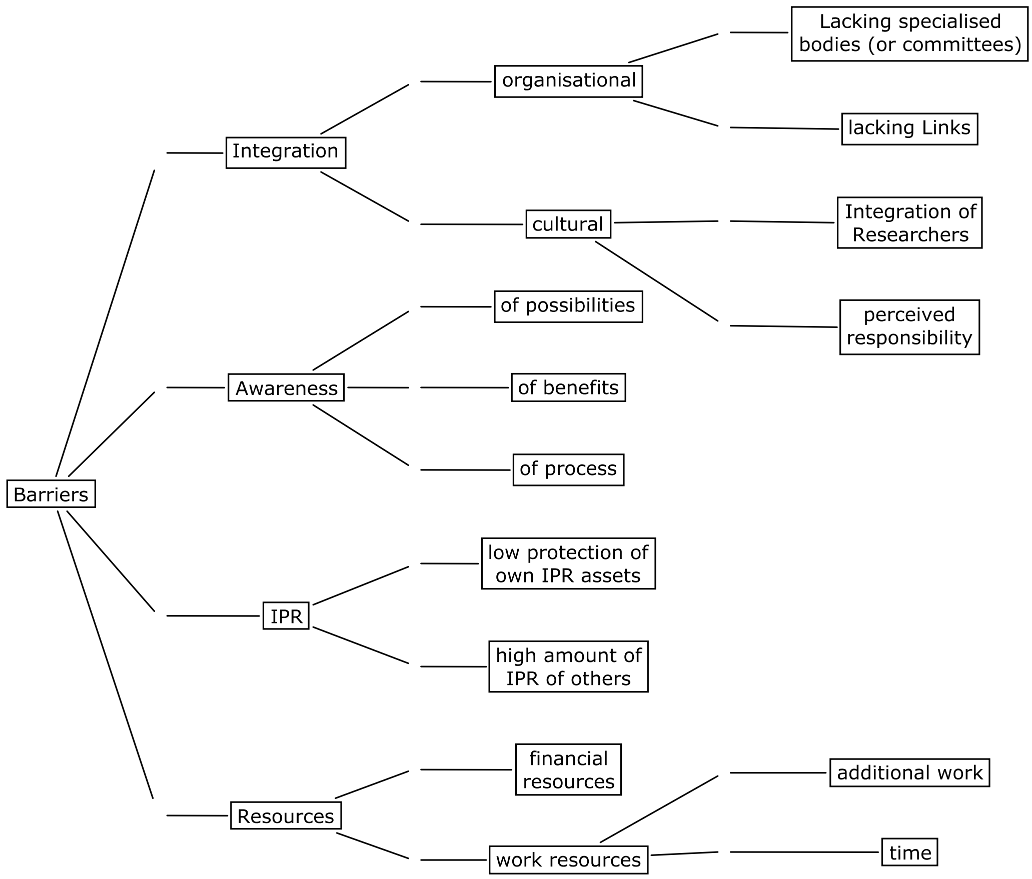
Figure 7.17: Classification of motivations of researchers to participate in standardisation



7.3.3 Barriers to the transfer of knowledge between research and standardisation

To classify the barriers to transfer of researcher participation in standardisation we broadly tried to distinguish between factors that relate to Intellectual Property, barriers of integration of research and standardisation by organisational and cultural factors, the resources of researchers, both in financial terms and in terms of workload and barriers that relate to lack of awareness of researchers. Even though it can not be assumed that the barriers from each category occur in perfect isolation from each other the proposed taxonomy provides a good overview on the different aspects barriers for the transfer of knowledge between research and standardisation can stem from.

Figure 7.18: Taxonomy of barriers in the transfer from research to standardisation



7.3.4 Incentives for participation in standardisation

As we have now taken a look at motives and barriers for participation in standardisation, both which are based on either the subjective assessment of the potential participants or their organisations, this category now will take a look at incentives regarding the participation of researchers in standardisation. While the first dimension, the motives for participation, aim at answering the question why researchers actually participate in standardisation activities and the second dimension, the barriers to participation, are focused on the reasons why researchers do not participate the dimension of incentives captures what could drive non-participating but interested researchers to participate in such a process.

Generally we found that the incentives for participation can be broadly categorised into four categories: economic, process related, scientific (or research related) and support oriented.

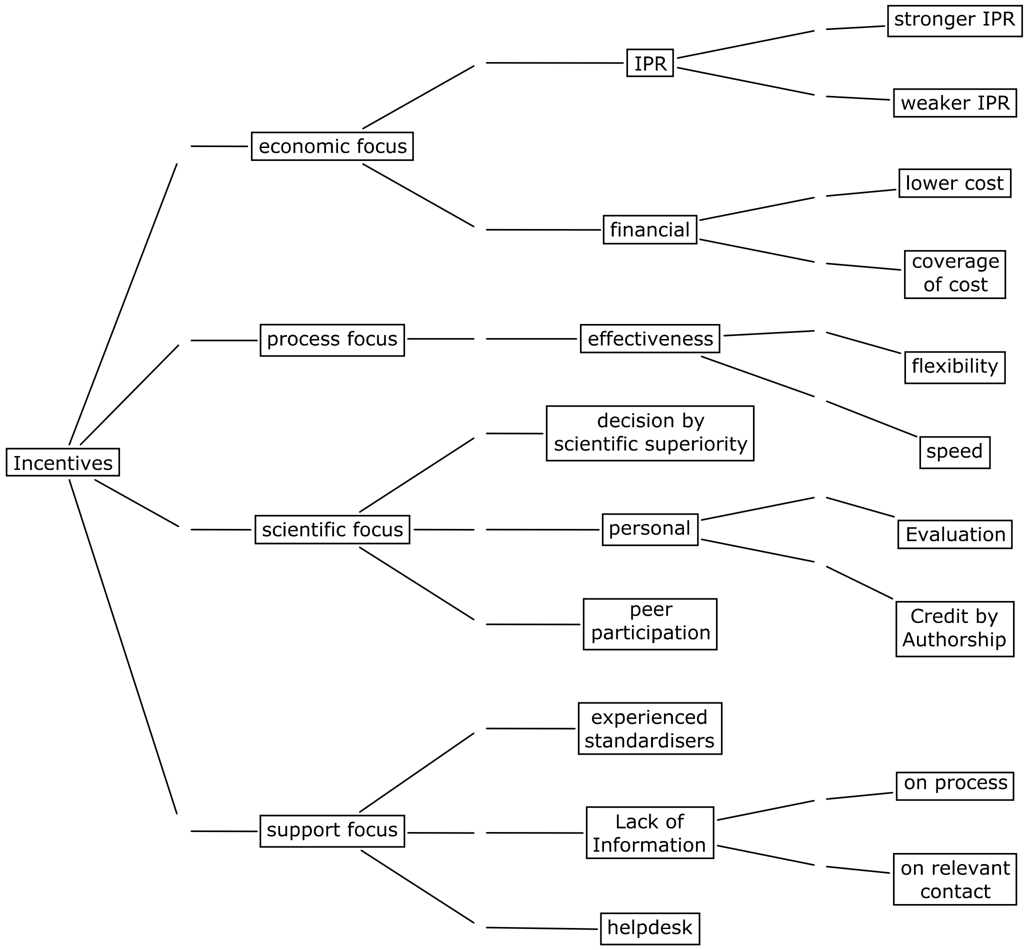
The economic focus of incentives for participation are includes those directly related to the appropriation of the output produced by researchers and the underlying financial incentives for participation, i.e. incentives that relate to the cost for participation. As we found in the case studies and in the results of the analysis of the INTEREST survey especially the coverage of the cost, not necessarily the absolute level of cost is a very relevant incentive for researchers that could mediate participation. Therefore changes regarding the financial issues are not necessarily linked to the cost of standsardisation processes as such but more to the resources provided by funders. The case studies validated this, especially when reconsidering that standardisation activities is, at least in RTOs, linked to projects and the rationale of the funders to provide adequate funding for participation.

The scientific focus is, in contrast to the economic focus, mostly linked to the accumulation of scientific capital, i.e. positive recognition be the peer groups of the researchers. In general two major strands of scientific incentives can be isolated, either those that are directly related to the researcher, i.e. positive evaluation for participation activities or credit for the authorship of the standard, contrasted to those that are related either to technology, or, more precisely, the guidance of consensus to be oriented along scientific superiority of the technology, and finally an effect of critical mass in participation of other peers.

The support focus captures the incentives that are related to either to information about standardisation or to direct support in the form of helpdesks or the help from experienced standardisers.

The process focus finally captures incentives that are directly related to the process of standardisation. This dimension corresponds to the fact that changes in the process of standardisation could mediate participation of researchers. Examples from our survey regarding this, which have also been mentioned in the case studies, refer to speed and flexibility of standardisation processes.

Figure 7.19: Taxonomy of incentives for participating of researchers in standardisation



7.3.5 Taxonomy of mechanisms of the research standardisation link

The final dimension captures the different mechanisms that can mediate the research and standardisation link from a knowledge and technology transfer perspective. The taxonomy of these mechanisms is based on a classification of technology transfer mechanisms developed by Bongers & Vandenberg (2003). As the taxonomy relates the link between research and standardisation to knowledge and technology transfer mechanisms the starting point is the different types of transfer objects, in our case different types of knowledge. Generally we differentiate between mechanisms that help to transport tacit knowledge vs. codified knowledge into standardisation. To enrich the taxonomy we also tried to find representation of concrete mechanisms that can mediate the transfer from research to standardisation. In the case of codified knowledge we tried to differentiate between the transfer media, i.e. material and symbolic representations of codified knowledge. Still, as we have found as the result of the other research results from the INTEREST project that tacit knowledge seems to be the most relevant type of knowledge for standardisation, since it is only represented in actors and can not be transported without the integration of these, we concentrated mostly on a classification of mechanisms that relate to the transfer of tacit knowledge. As we have argued above a perspective that shrinks the link between research and standardisation to a one-way relationship is insufficient for a proper assessment of the research standardisation linkage we also included mechanisms of feedbacks, i.e. integration of standards and standardisation into the realm of research. The overall aim of this dimension of the taxonomy is therefore to describe the link between research output and standardisation input and in addition the integration of both realms by mutual activities and interrelations.

Regarding tacit knowledge mechanisms for integration of research and standardisation we focused on four basic mechanisms: mobility, participation, cooperation and informal contacts. The common denominator of all those mechanisms is that they involve, at least to some extent, actors or organisational and institutional structures that integrate the tacit knowledge of those actors. Even though it would be valuable to differentiate according to these two sub-dimensions it would lead to a unjustified degree of complexity in the taxonomy and was therefore omitted to increase the practical usability of the taxonomy.

The dimension of mobility captures all mechanisms that relate directly to a change in the affiliation of the actors. These mechanisms having both the effect to bring research and standardisation closer together as distinct realms will also provide a potential channel for standardisation to interact with researchers on actor-level. Mobility mechanisms include dual positions both in research and standardisation organisations on an employment basis, exchange of personnel or spin-offs from research organisations that can act as a link between research work and standardisation work. Examples for such spin-offs might be a screening of project results for relevant standardisation aspects by SDOs and recommendations to the Commission to support spin-offs from these projects under the premise that the members will participate in standardisation activities. Thereby both the link between research activities conducted in projects funded by the commission and innovative activity, i.e. the transformation from research into marketable goods, as well as the link between research and standardisation can be strengthened.

In contrast to mobility, that relates to changes in affiliation of actors the other mechanisms concern either the interaction of actors or organisational changes that do not directly affect the affiliation of the actors. The most obvious integration of research and standardisation by means of interaction of research and standardisation is the dimension of cooperation. Cooperation as such can be split into three sub-categories: joined R&D, sharing of facilities and education/training. In the case of joined R&D the integration of research output and standardisation input is generated by integration of standardisation into the research process as such either as topic in the light of research processes in terms of contract research conducted at the watershed between research and standardisation, as co-financing for research that helps to integrate specific technology-related knowledge into standards or by consulting services and contract research that involves both researcher and standardisation organisations. Another way to integrate research and standardisation is by sharing facilities of research and standardisation organisations. One could think about research results being tested in specific standardisation facilities, e.g. testbeds or certification centres that do not aim directly at certification of the products in question but rather as means of research activity how new prototypes fit into existing standards. Another way might be the location of branches of standardisation organisations in large research clusters. The impact of this would be to generate tacit knowledge at both ends and provides tacit information for actors from both realms. For the standardisation side this could be knowledge on what they might be confronted with in the near future regarding the products that might emerge but also which actors might be relevant for the future. For researchers the information generated in such a process might be which standards they could implement in early stages to leverage their research results, which we found to be an important motive for participation in standardisation, especially when referring to specific technical problems. Another mechanism to strengthen the link between research and standardisation might be the geographical co-location of research and standardisation facilities that might result in cross-boundary interaction of researchers and standardisers.

The dimension of education and training in a cooperative way might also help to mediate the flows of tacit knowledge in the future and also provide a solution to the incentives we categorized as support-focused. By integration of standardisation into the education system, and thereby also partly into the research system, the knowledge about the benefits of standardisation as well as the process of standardisation will be leveraged. As we found that helpdesks seem to be a weak incentive the natural integration of research and standardisation by education might yield more positive results which will lead to a better integration of both realms in the future. The mechanisms to do this can encompass short-term and long-term strategies as noted in the taxonomy. While the short-term perspective are mostly aimed at interactions that do not intervene with the organisational setting of research organisations the long-term perspective requires adaptations regarding research (and education) organisations.

The category of participation describes the classical interaction between research and standardisation by means of participation of researchers in standardisation processes. Still the direct participation of researchers in standardisation can occur in a number of ways, either by participation as voting member of Technical Committees or Consortia or as scientific consultant with relevant tacit knowledge of the scientific and technical field to provide help on producing better standards.

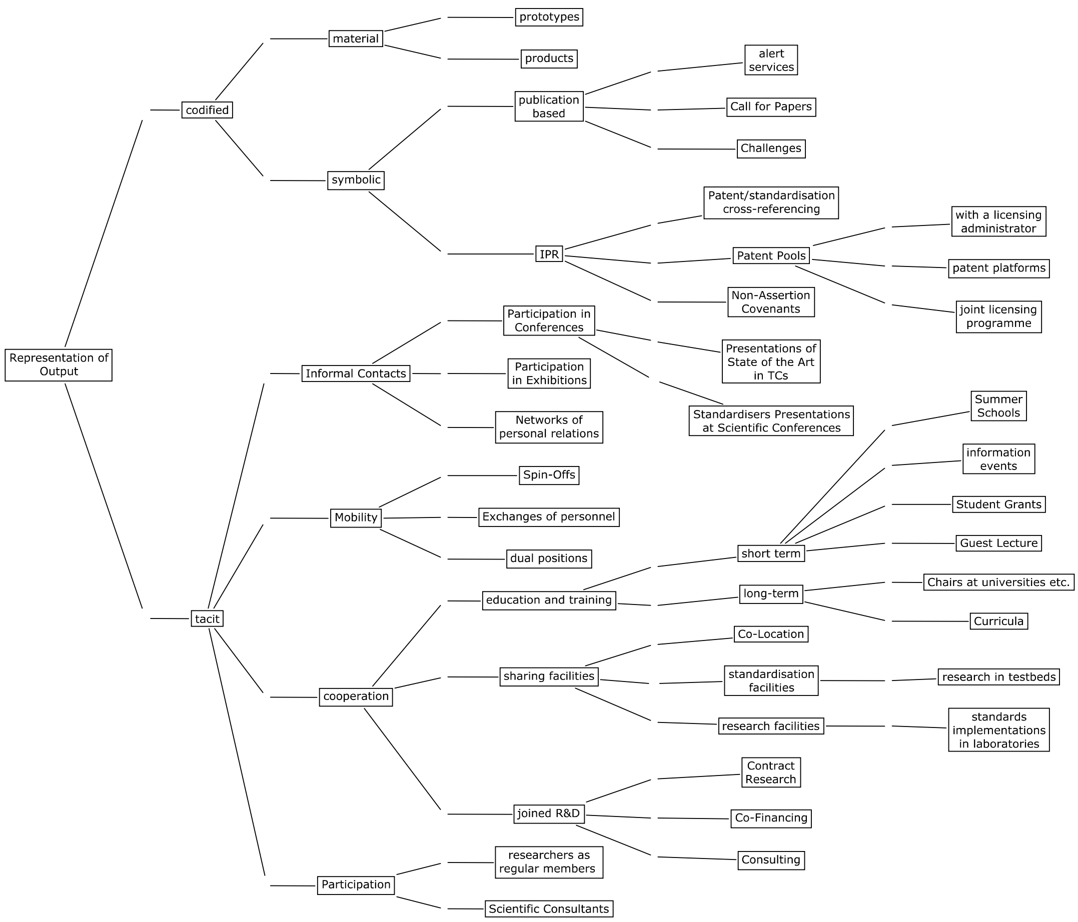
The category of informal contacts encompasses all the types of interaction that are not directly subsetable to the other categories but are necessary to provide a complete picture of technology transfer mechanisms between research and standardisation.

Regarding the dimension of the potential mechanisms to integrate research and standardisation by transfer of codified knowledge we again differentiate by types of codified knowledge to differentiate material and symbolic representations of codified knowledge. Publication based mechanisms to integrate research and standardisation could be call for papers in thematic journals that are not necessarily related to standardisation with the special focus on standardisation in the field of the journal. This would also lead to a higher awareness for standardisation in the respective scientific fields and provide researchers with incentives to acquaint themselves with the issue of standardisation. An alternative to this might be challenges, including prices for best solutions or best practice, initiated by standardisation organisations aiming at specific communities. These two mechanisms are active in that they foster the production of new knowledge in a field. Regarding passive mechanisms alert services informing standardisers of relevant developments in their field of interest could have a positive impact on the transfer of knowledge from research to standardisation. Still, such a mechanism would lack the positive feedback effect on research, i.e. it will not raise awareness in the relevant research communities.

Regarding IPR the mechanisms to transfer research to standardisation is mostly dominated by patent pools which can be categorized to different subclasses. Related mechanisms are Non-Assertion Covenants, i.e. a legal document that implies that an IPR holder will not assert patents in regard of a standard and proclaim a defensive rather than offensive use of their IPR assets, are another mechanism and can be seen as an alternative to classic patent pools.

Another aspect to indirectly link research and standardisation could be a stronger cross-referencing of the standardisation and patent system regarding mutual citation in their documents. Approaches like the integration of standards into the pool of document types of relevant documents could raise the awareness for standards, especially for researchers that use patents as knowledge base and are not necessarily aware of standards. The direction of this harmonization can also be interpreted into the other direction by a unified way of citing patents in standardisation documents and making these available to researchers. Both aspects have already been integrated, e.g. the patent database provided by ETSI or the planned initiative of the European Patent Office to use standards as an additional source to determine state of the art.

Figure 7.20: Mechanisms of the research-standardisation link



7.4 Integration of the dimensions of taxonomies

To retain the different entities, or dimensions, of the knowledge and technology transfer we chose to use the heuristic of the Contingent Effectiveness Model developed by Bozeman (2000). The original model of Bozeman, differentiates by the endpoints of the transfer process, i.e. Transfer Agent and Transfer Recipient, the type of knowledge as the Transfer Object and specifics of the Demand Environment for this Transfer Object (mostly bound to the economic character of the knowledge to be transferred) and the Transfer Medium (e.g. publications, patents etc.).

In order to account for the differences in environment of both the realm of R&D and the realm of standardisation and to account at the same time for the idea of different frames of activities, i.e. the research frame and the standardisation frame, we assume that the science and technology fields have to be taxonomized for both realms. The reason for this lies in the level of abstraction. Even "if" both realms are aimed at the same content, e.g. Information and Communication Technology, Nanotechnology, Mechanical Engineering, etc., the dynamics, homogeneity and stability of the two fields can be very different. An example might be a rather static and homogenous field in standardisation that is counterfactuated, on the level of content, by a highly dynamic research and technology field.

The Transfer Agent and Transfer Recipient (in our case research and standardisation) are, organisationally, embedded in these fields and are more or less directly affected by it. In contrast to Bozeman, who is not specific on the actual mechanisms that lead to the transfer of knowledge, or more precise, the difference between a transfer that follows certain mechanisms or a transfer that just seems to happen out of thin air, we differentiate by this but are, due to the highly contingent nature of the latter type of transfer[16], focused on the mechanisms. These mechanisms also define how a research output actually can become a standardisation input, i.e. a change in the way knowledge is used by the Transfer Agent and the Transfer Recipient.

This switch of the Transfer Object, i.e. the switch between the knowledge as product of a generation process and a source of selection towards standardisation, is important to understand the nature of knowledge and technology transfer between research and standardisation. These mechanisms however, which also but not exclusively include

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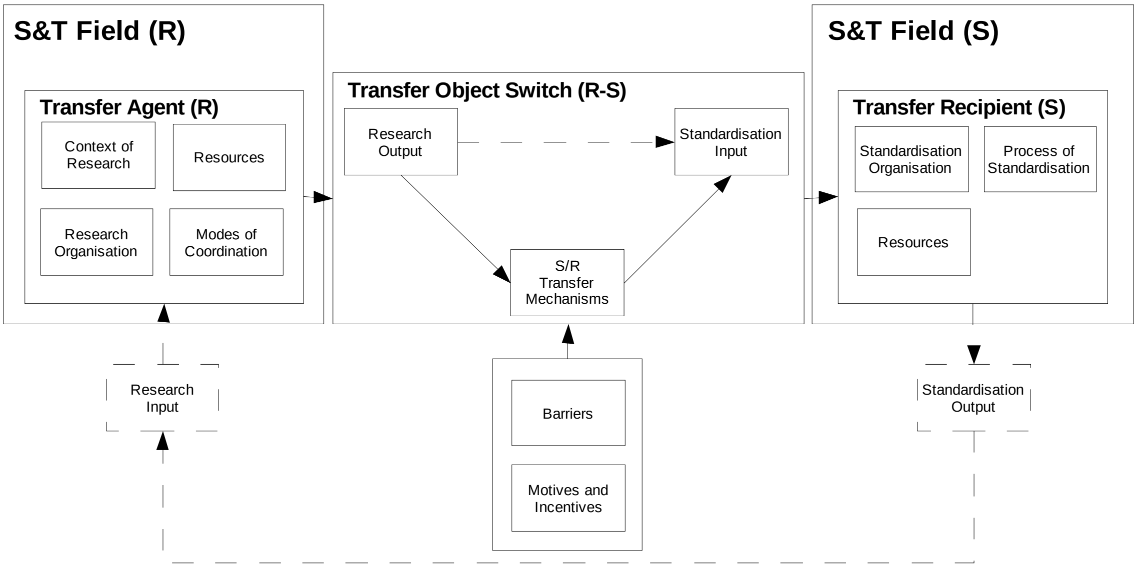
16 We therefore chose to represent this absence of specific mechanisms as the direct relation between research and standardisation as a dashed line.

the participation in standardisation, are bound to barriers and motives of participants as well as, in the case of non-participants, incentives for participation. Even though the dimensions of motives and incentives are similar in nature the differentiation between the two is important to also describe the existence of the transfer (barriers and motives) as well as the absence (barriers and incentives). Below the level of the environment the nature of the participating organisations, its strategies and resources and contexts of knowledge production or integration play a significant role.

Figure 7.21: An integrated model of the research-standardisation taxonomies



The link between research and standardisation is the "bridge" between both realms. The question that should be answered by this part of the taxonomy is: "How can the link between research and standardisation be described keeping constant the aspects described in the other parts of the taxonomy?" This separation of attributes of the Transfer Agent/Transfer Recipient and the environment they are embedded in from the actual process of transfer is necessary to derive the basis for a typology of the research standardisation link. Moreover incentives, motives and barriers need to be considered to form a coherent picture.

8. Indicator based approach and the empirical taxonomy

In the following a different approach to link research and standardisation towards a taxonomy is developed. In contrast to the theoretical approach this taxonomy is based on empirical material extracted from the Perinorm database. In some cases the identification of potential standardisation opportunities might be a barrier to participation. Moreover, a researcher's problem might not just be to identify the relevant SDO. Probably finding out that in European standardisation ETSI is about telecommunications, CENELEC about electrical engineering and CEN is responsible for all remaining standardisation aspects will not take long for a researcher. Finding a suitable Technical Committee on the other hand might take a rather discouraging amount of time. In this context, a researcher might have the following question: Which standardisation body and which technical committee would be interesting for me?[17]

This question should be considered both reasonable and plausible from a researcher's perspective who knows little about standardisation.[18] Even though the community of standardisation researchers might very well know some answers to resolve such disorientation they usually will not be consulted directly. An alternative to relying on such embodied knowledge could be to use bibliographic data on the output of European SDOs, i.e. CEN, ETSI and CENELEC, to derive a taxonomy to provide consultation in such choices. To establish such a taxonomy and account for it's validity two tasks need to be addressed.

One of these tasks relate to the research-standardisation link. To make such a taxonomy based on the "output" of standardisation activities a valid piece of information the link between research output and activities in Technical Committees has to be analysed, or, in more abstract terms, the structure of the realm of R&D has to be reflected in the structure of the realm of standardisation. The second task then relates to the problem which methods are suitable to transform information on the structure of the standardisation output of Technical Committees in a taxonomy.[19]

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17 This chapter will not cover the plethora of informal standardisation bodies which are a fact of life in ICT standardisation. Rather the focus will be on a more general approach limited to formal standardisation on European level covered by ETSI, CEN and CENELEC. The issue of complementary or substitutive relationship between formal and informal standardisation in ICT is covered in another paper by Blind & Gauch (2005).

18 Casting a critical look at the current efforts to educate researchers in standardisation matters in Europe the amount of knowledge regarding standardisation might at best be limited to knowledge about some standards that are directly relevant for their work.

19 Structure in this case should at first be understood as a thematic structure. In case, functional differentiation can be established as a fact in the first task this thematic structure also reflects the organisational structure of the standardisation landscape.

This chapter therefore covers two aspects. First, the link between research output and standardisation activities of Technical Committees of CEN, CENELEC and ETSI are analysed. Second, bibliometric methods are employed using data from the database PERINORM on the output of Technical Committees to build a taxonomy.

Usually in quantitative works on the relation between R&D and standardisation this is done by using a concordance "linking" patent output to standards outputs. One example of such a concordance has been developed by Blind (Blind 2004a), which links classes from the International classification of standards (ICS) to classes of the International Patent Classification (IPC). The approach used in this chapter is different as it uses participation information in SDOs as well as the portfolio of IPR of organisations and their representatives. To collect comparable data on SDOs, publicly available information on Technical Committee membership at ETSI, CEN and CENELEC were screened. Unfortunately, only the chairmen of Technical Committees are available in most cases. Therefore the sample is possibly biased towards important actors in these Technical Committees. Contact with various SDOs revealed that most Technical Committees more or less organise themselves differently, also resulting in different policies regarding the confidentiality of their member lists.

In order to produce comparable results at the trade-off in a biased sample, we limited the analysis to the chairmen of the Technical Committees, which is a systematic approach covering all technology fields. An analysis working with complete member lists would of course lead to a much richer and detailed picture and allow for far more advanced analysis, but due to the above stated reasons, could not be conducted. In total, information from 178 CEN chairs, 27 CENELEC chairs and 19 ETSI chairs could be used to produce the results. The data provided in the retrieved lists by the SDOs was used, to identify their research output in the form of patents available in bibliographic databases. In the case of patents, data from ESPACE Access (DVD Version) was used covering patent appli-cations filed at the European Patent Office (EPO) and the World Intellectual Property Organisation (WIPO). National patent data statistics were not produced, because European and international patent applications are much more valuable than national applications (Grupp, Schmoch 1999).

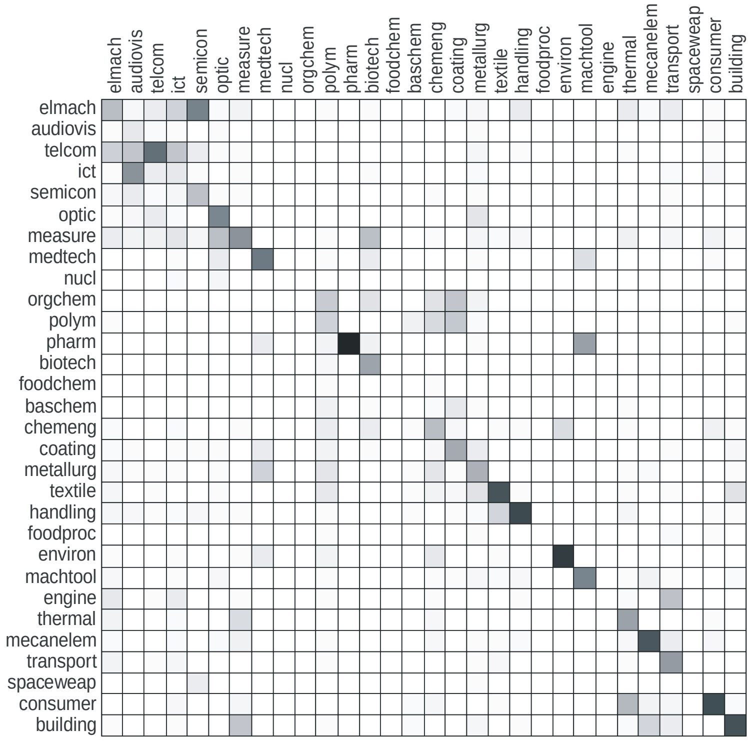
The patents were categorised according to different classification schemes with a varying number of classes (from 5 very broad classes to 45 classes). To allow for an optimal proportion of richness in detail and complexity of the results, a scheme based on the OST/INPI/ISI classification of 1997 was chosen to produce the R&D output dimension. The OST/INPI/ISI systematic of technical fields consists of 5 fields and 30 subfields covering the whole range of the seventh version of the International Patent Classification. Classification was done on the level of sub-fields. The Technical

Committees were categorised according to this classification, based on the title and objective of the Technical Committee. This was done without the knowledge of the outcome of the patent analysis, to prevent the results being biased by the coder. The Technical Committees were classified to represent the patent classes they would file patents in if the Technical Committee produced the technology and knowledge according to their title. A Technical Committee engaged in the standardisation of escalators would thereby ex ante be classified in the technical field containing the IPC class B66b (SECTION B – PERFORMING OPERATIONS; TRANSPORTING, B 66 HOISTING; LIFTING; HAULING, B 66 B ELEVATORS; ESCALATORS OR MOVING WALK-WAYS).

This very time-consuming process is necessary to later produce the matrix between patents and standardisation and requires a profound knowledge of the International Patent Classification. In a next step, the patent portfolios of the chairing organisations were produced, using the above mentioned classification in technical fields developed by OST/INPI/ISI. The classification is based on the main classes of the identified patents. Due to the fact that not all of the chairing organisations apply for patents in adequate numbers only 30 percent of the Technical Committees could be used to conduct the patent analysis and the resulting Matrix describing standardisation activity and technology portfolio.

The above mentioned approach regarding the patent portfolio analysis is condensed into Figure 8.1. Using a visualisation method called Sociomatrix, a method with its origins in network analysis, a matrix was produced linking the research output in form of patents classified according to their main classification in the IPC (rows) to the standardisation activities of the classified groups of Technical Committees from which the chairing organisations issued those patents (columns). The shade of the cells represents the percentage of patents of a TC group that falls into a certain technical field. The darker the shade of the cell, the more patents are represented in the technical field. The shade of the cells is moreover normalised to the sum of all patents in a column. A 100% black shade thereby means that 100% of the patents of the TCs in a column are represented in one technical field. The strong (i.e. darkly shaded) diagonal of the matrix shows that organisations chairing organisations in Technical Committees at CEN, ETSI or CENELEC are rather focused in their research activities towards their activities in standardisation. The matrix should be interpreted based on the columns as representation of standardisation activity as identifier for the research output. For example, the TCs classified to the technical field of coatings also have aspects in their research portfolios regarding organic chemistry and polymers.

Figure 8.1: Sociomatrix of TC groups classified in technical fields (columns) and patent portfolios (rows) of these groups



Source: INTEREST project, Fraunhofer ISI

Interestingly, the portfolio of the TC chairs in the area of electrical engineering is not as focused as in the other fields of standardisation activities. This might be due to the fact that these fields represent the majority of CENELEC and ETSI members, while the other fields represent the CEN members. Another interpretation might be that these fields are strongly connected among each other in R&D activities. Some columns like nuclear technology or environmental technologies are empty, since either a) no TCs were classified in this technical field or b) the organisations chairing the TCs produced no or a relatively low (less than 10) patents between 1980 and 2003. The representation of the results as a sociomatrix is valuable to show the relative strength of the matrix diagonal and a quick overview on the breadth of the technology portfolio. Overall, the link between research and standardisation among the organisations participating in standardisation is rather high. Organisations participating are usually focused regarding this link, i.e. the main activities in R&D, represented by the patent portfolios, are also the main activities in standardisation processes as in almost all cases the categorisation of the organisation in technical fields corresponds with the highest values in the sub-fields of the patent portfolio. It is therefore justified to deduce that the structure of Technical Committees reflects the inflow of knowledge. Therefore, the output of these Technical Committees can be used to derive a taxonomy that should help researchers and their organisations to identify relevant Technical Committees.

As described in the sociomatrix the focus chairing organisations in R&D activities is reflected in their standardisation activities. It is therefore justified to use output data of Technical Committees to build a taxonomy to guide other R&D organisation and researchers in identifying suitable Technical Committees as locus of standardisation activity. The basis of this taxonomy is to use the ICS classes of the standards produced by these Technical Committees. Fortunately, all standards produced by formal bodies are classified according to the International Classification for Standards (ICS). The ICS is a hierarchical classification consisting of three levels and covers 40 fields on first level, 392 at second level and 909 fields on third level. In contrast to patents categorized by the International Classification for Patents (IPC) the classification of standards is not divided into main and supplementary classes. The following method therefore has to take into account the fields standards are classified to without and use all the fields covered by a standard for means of calculation. As the ICS is freely available and is disseminated with a concise index of keywords a research can determine which ICS field his research results can fit. Still, the problem remains, that he has no information which technical committees are engaged in this line of standardisation work.

The data used was extracted from Perinorm, a database covering a broad array of national, regional and international standards with bibliographic information on ICS field, origin of the document, time of publication etc. produced by AFNOR, BSI and DIN covering national, European and international standards from, 22 countries. The data used relates to the active stock of standards produced by CEN, CENELEC and ETSI. We chose the range of ICS classes between first level 11 and 97 using data on second level. We refrained from using data on third level as the absolute number of occurrences at this level was too low in many fields leading to biased results. In contrast analysis on first level produced relatively broad results lacking depth of detail with a high number of Technical Committees subsumed on each class. As a trade-off information on level 2 provided enough detail for the analysis and a researcher should still be able to use the taxonomy as a starting point for further information gathering.

Regarding the method to produce the taxonomy there are basically two potential measures, a) the share of standards in a given ICS field produced in a Technical Committee of all standards produced in this field and b) specialisation profiles for each Technical Committee covering ICS classes. A high share would be a signal, that a Technical Committee has a high influence in a given area of standardisation activities. Still, such a measure might produce misleading results as in some cases. For instance, it would favour "older" Technical Committees, as they potentially have produced more standards in a given field over a longer time of existence. "Younger" Technical Committees founded just recently might have produced only a few standards in the recent past. The share of those Technical Committees would be lower due to their short time of existence, even though they might be highly interesting for a researcher or an R&D organisation as they could cover more recent aspects of standardisation. Using the share alone information would be lost. We therefore chose to calculate specialisation indices on the output of technical committees of the standards active stock of standards produced by technical committees of CEN, CENELEC and ETSI.[20] The logic of specialisation indices is a pattern match of the universe of the standards produced by these three standardisation bodies. The mathematical formulation of specialisation indices is

$$RPA_{kj} = 100 * \tanh \ln [(P_{kj}/\sum_j P_{kj})/(\sum_k P_{kj}/\sum_{kj} P_{kj})]$$

where Pkj represents the number of occurrences in a technical committee k in ICS field j. The result is a measure that ranges between -100, describing total under-specialisation and +100 for total over-specialisation in a given field j of a technical committee k. This measurement was calculated on a 351*483 matrix, where 483 technical committees where taken into account and 351 ICS fields. After the calculation of the specialisation matrix information was extracted for every field used in the analysis with a high cut-off point of a minimum specialisation level of 90. This is useful, as a) the number of 351 fields is rather high and b) the number of Technical Committees is high enough to lead to very polarized specialisation profiles.

The resulting matrix of specialisation indices was then analysed for every ICS class on second level. The result is a list of Technical Committees for every ICS class analysed featuring Technical Committees in a field. The result of the computations are provided in Appendix A of this report. A random sample of 10 ICS fields is provided in table 8.1.

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20 Unfortunately the Perinorm field referencing the committee does not account for all standards. In some cases the issuing body is mentioned instead of the committee. This might lead to some irregularities in the calculation. Still, this information was kept in the calculation to reduce bias towards the technical committees that are not mentioned in this field.

Table 8.1: Sample of the taxonomy of ICS field and Technical Committee specialized in this field

11.160 - First aid
CEN/TC 215 Respiratory and anaesthetic equipment
CEN/TC 192 Fire service equipment
CEN/TC 239 Rescue systems
13.220 - Protection against fire
CLC/TC 20 Electric cables
CEN/TC 191 Fixed fire fighting systems
CEN/TC 127 Fire safety in buildings
CEN/TC 72 Automatic fire detection systems
CEN/TC 70 Manual means of fire fighting equipment
CEN/TC 192 Fire service equipment
CEN/TC 263 Secure storage of case, valuables and data media
CEN/TC 282 Installation and equipment for LNG
27.080 - Heat pumps
CLC/TC 61 Safety of household and similar electrical appliances
CEN/TC 113 Heat pumps and air conditioning units
CEN/TC 182 Refrigerating systems - Safety and environmental requirements
CEN/TC 299 Gas-fired absorption appliances and domestic gas-fired washing and drying appliances
31.040 – Resistors
CLC/TC 40XA Capacitors
CECC-CENELEC Electronic Components Committee
CLC/TC 40XB Fixed resistors
CECC/WG 4C Thermistors
CECC/WG 4B Potentiometers
33.070 - Mobile services
ETSI/TC SMG Special Mobile Group
ETSI/TC RES Radio Equipment and Systems
ETSI/STC RES 3 Digitales European Cordless Telecommunications
ETSI/STC SMG 11
ETSI/STC SMG 4 DATA
ETSI/STC SMG 3 Network Aspects
CLC/TC 106X Electromagnetic fields in the human environment
ETSI/STC SMG 2 Radio Aspects
ETSI/STC SMG 7
ETSI/STC NA 2 Numbering, Addressing, Routing & Interworking
ETSI/STC SMG 1 Services and Facilities
ETSI/EP TETRA
ETSI/WG DECT 2
ETSI/WG ERM EMC
ETSI/STC SMG 8
ETSI/WG DECT 1
ETSI/WG DECT 4
ETSI/STC SMG 9
ETSI/WG TETRA 6
ETSI/WG DECT 5
ETSI/WG TETRA 4
ETSI/WG TETRA 2
ETSI/WG TETRA 1
ETSI/WG DECT 3
33.170 - Television and radio broadcasting

ETSI/EBU Joint Technical Committee
ETSI/TC SES Satellite Earth Stations
CLC/TC 206 Consumer equipment for entertainment and information and related subsystems
CLC/TC 203 Electronic entertainment and educational systems for household and similar use
CLC/TC 207 Radio Data System
43.120 - Electric road vehicles
CEN/TC 301 Electrically propelled road vehicles
CLC/TC 69X Electrical systems for electric road vehicles
CLC/BTWG 93-1 Conductors cars
59.120 - Textile machinery
CEN/TC 214 Textile machinery and machinery for dry-cleaning and industrial laundry
73.100 - Mining equipment
CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements
CEN/TC 305 Potentially explosive atmosperes - Explosion prevention and protection
CLC/SC 31-4 Increased safety
CEN/TC 196 Machines for underground mines – Safety
91.090 - External structures
CLC/TC 61 Safety of household and similar electrical appliances
CEN/TC 33 Window, door, shutter, building hardware and curtain walling
CEN/TC 229 Precast concrete products

Source: INTEREST project, Fraunhofer ISI

9. Recommendations

The broad approach of the INTEREST project employing both qualitative and quantitative information at both the micro level of the research organisation and the individual researcher as well as on the macro level identifying relations between the research and standardisation realm led to a number of new insights regarding the role of standards in research as well as the role of standardisation organisations and policy makers. In the following a number of recommendations will be assembled that can help to close the gap between research and standardisation. The recommendations are aimed at policy makers, standardisation or research organisations. Some of the recommendations require that actors from multiple stakeholder groups have to interact.

9.1 Financial Support and Funding

The lack of resources is one of the strongest barriers to standardisation work. The problem to obtain and justify adequate resources for standardisation work is especially common in universities and applied research organisations with limited base funding and strong project-based and contract research orientation.

Most funding agencies are still unaware of the benefits of standards for the economy and society. Judging by the level of support for standards-setting activities as part of R&D projects, hardly any research funding organisation considers standards as a legitimate and valuable tool for dissemination, or for the production of sustainable results (the EU being half an exception). Policy makers should therefore integrate standards-related aspects into their funding principles and promote standards as part of project evaluation and in calls for proposals for funding. Also, the allocation of resources researcher organisations plan to allocate to standardisation work in a research project should be realistic. Additionally, standardisation aspects may be part of the evaluation criteria of the proposal. Here policy makers and decision makers in funding matters should network with relevant SSBs as well as R&D organisations participating in standardisation is required to estimate such related cost.

After the ‘Standards, measurement and Testing’ domain has disappeared from the European Framework Programmes (FPs), standardisation projects need to compete with others for funding under the individual R&D programmes. For a higher percentage of normative research part of an R&D programme’s budget could be managed by ESOs (or SSBs) and spent on projects with a potential for standardisation. In Germany, for example, this could also imply that an SSB is assigned the status of a Project Management Agency.

SSBs should lobby for a higher degree of importance to be assigned to standards aspects in R&D project proposals. This could be achieved, for example, by a dedicated sub-panel evaluating proposals with respect to their potential and importance for ongoing or future standardisation activities – which, in turn, could be partly based on CEN/STAR's (Standardisation and Research) prioritised needs.

9.2 Awareness of standards

Low awareness of standards in parts of the research community is a problem which has a number of negative effects on the research standardisation link. Most notably low awareness leads to a low participation of researchers in standardisation as standardisation is not actively perceived as a potential field of activity.

Raising the awareness of standards and standardisation can not be achieved solely by providing adequate funding. To raise awareness of standards research organisations and standardisation organisations should both try to highlight benefits of standardisation work.

SSBs should co-locate standards events with scientific conferences. This would provide SSBs with the opportunity to introduce researchers to the problems and benefits of standards setting. This could also be done through promotional activities such as, for example, dedicated workshops, seminars, or 'taster courses'.

R&D organisations that are faced with the problem to motivate and identify researchers in their organisation should consider establishing a "standardisation culture" in their organisation. The best way to establish such a culture is to raise the perceived value of standards as sources of information. One way to establish such a culture would be to maintain a list of implementers of specific standards. Such a list could provide a common ground for internal discussion on the standards and provide synergies between research departments and generally raise the importance and relevance of those standards. In addition, the benefits of participation in standards-setting as plattform for exchange of knowledge and as event to meet potential collaboration partners should be promoted, e. g. by the publication of best or good practice cases..

9.3 Positive evaluation of standardisation work

Standardisation work is often not perceived as an activity that presents research organisations and researchers with valuable benefits. Apart from issues of funding related to in chapter 9.1 other evaluation mechanisms can be implemented by policy makers and the research organisations. Currently researchers and partly also research organisations have little incentive to participate in standardisation work and to contribute to the publication of standards.

Considering the public good character as well as the role of standards as means of technology transfer the role of standards and standardisation should be strengthened in the evaluation of institutions receiving public funding. To achieve this policy makers should include standardisation work in the evaluation of research organisations in a similar fashion like patenting, publishing scientific journals and further transfer and implementation activities. This would also provide an adequate incentive for participation of research organisations to provide interested researchers with a contingent of time to do standardisation work.

Apart from the problem of a lack of incentive to engage in standardisation work as an organisation there also exist similar problems at the micro level. Research organisations might be faced with the problem to motivate researchers to engage in standardisation and might have to stick to the delegation of researchers instead of providing adequate voluntary incentive schemes. Research organisations should therefore consider standardisation work as criterion for internal evaluation. By honouring standardisation work more researchers will be willing to participate which might lead to more researchers participating in total. The development of awareness for the role of standards and standardisation, which will lead to a more intensive and intrinsically motivated participation, is certainly more efficient than delegating researchers to standardisation meetings, because the individual researcher just knows better where, when and how to engage in standardisation.

9.4 Education and training

Standardisation is currently only featured in very few curricula. The knowledge about standards imparted in the education system is therefore rather low. The absence of standards-related topics from the curricula leads to the effects of low awareness which we discussed above. Moreover, researchers are not educated with relevant knowledge about standardisation processes and procedures.

Integrating standardisation in curricula should be encouraged as such knowledge is a pre-condition for awareness in future generations of researchers. Training researchers in what active participation entails, and possibly how to co-ordinate standardisation activities in their project is the second step. Many organisations involved in standardisation already have effective mechanisms in place how to organise the transfer of research results into standardisation. Best practice examples could be communicated to others by policy makers or standardisation organisations. To actually reach the research community information needs to be actively distributed and made available on easy-to-find web pages. Corporate and universities' Technology Transfer Departments would be natural contact points here. In co-operation with these departments SSBs can organise dedicated 'information days'.

9.5 Adaptation of standardisation processes

From the researchers' perspective, standardisation processes will need to be better adapted to their specific requirements to make active participation a realistic and worthwhile option. This has two aspects to it – time and flexibility. First, the processes as such would need to be shorter – few researchers are interested in spending too much time on committee work (a lack of information / relevant education may well contribute to this; see also below). Here, the leaner processes leading to 'New Deliverables' that have been introduced by several ESOs and other bodies should be very useful. Also, reducing the sequentiality of R&D and standardisation would be helpful ('co-normative research'), as would a higher level of pro-active standardisation.

Second, the rather static structure of formal technical committees (e.g., CEN TC/WG, or equivalent) should be extended to accommodate new topics that are not being dealt with by existing technical committees – the necessity to establish a new WG or Work Item before R&D results can be fed into the standardisation system typically implies a considerable delay before work can commence. However, as the creation of a Work Item prior to starting activity is one of the obligations behind the transparency required in the good practices of standardisation, as defined in particular by the WTO, it cannot be omitted. Ways need to be devised that satisfy both the good practices and the researchers' requirements. Related to this are new topics that could be associated with more than one TC; in such situations, additional delays are likely to occur until the TCs involved have come to an agreement. Ad-hoc groups, following the same procedures as 'normal' WGs but (initially) operating outside the TC/WG structure might be a solution here. Here as well, mechanisms like 'Workshops' (CEN) or 'Industry Specification Groups' (ETSI) that deploy a leaner process than formal technical groups and can be also established on an ad-hoc basis are a simple yet efficient tool. Such existing mechanisms, however, need to be better promoted in the research community.

The direct transformation of research results into workable standards will hardly be possible in most cases. Rather, research findings typically need to be complemented by real-world implementation experience (obviously, this does not hold for terminology standards). This could initially be based on 'New Deliverables', revised versions of which that incorporate such experience could then be fed into the 'traditional' process.

Individual memberships should be made possible for individual researchers. While this is being done by several SSBs (most notably by fora and consortia), membership of the ESOs is limited to companies and national bodies, respectively (with the notable exception of CEN workshops). Temporary individual membership would considerably lower the barrier to entry to standardisation for researchers, and would enable them to contribute precisely to those aspects of a standard for which their research is important.

9.6 Closer Integration of research and standardisation

Currently research and standardisation are in most cases distinct realms. There are few organisations that integrate both the production of knowledge in research and the work of standardisation organisations, namely achieving consensus on future technology paths. On the one hand the functional differentiation of organisations can have beneficial effects and increase efficiency in both realms. On the other hand, a closer integration of research and standardisation while maintaining the division of labor between research organisations and standardisation organisations can increase knowledge flows in both directions and produce valuable knowledge spillovers. In cases where the cost of transforming standardisation organisations is very high, mechanisms of integration can help to reduce frictions between research and standardisation.

Exchange of personnel between research organisations and standardisation organisations should intensify the relationship between research and standardisation. On the one hand, this should enable research organisation to acquire process knowledge of standardisation processes that can then be the basis to inform other researchers and developers interested in standardisation work. On the other hand, hiring researchers by standardisation bodies even on a part-time level will give the chance that new trends in research and technology will be acknowledged earlier and collaboration with research organisations becomes more effective.

Another way to integrate research and standardisation is to encourage the sharing of facilities of research and standardisation organisations. This would provide the opportunity to test research results in specific standardisation facilities, e.g. test beds or certification centres that do not aim directly at certification of the products in question, but rather as a means of researching how new prototypes fit into existing standards.

Co-operation between professional associations and standardisation organisations should be encouraged. Co-operation with, for instance, international research umbrella organisations (e.g., the International Federation for Information Processing (IFIP), the world-wide umbrella organisation of the national ICT societies) could simplify the information flow from these societies (i.e., the R&D domain) into standards setting.

9.7 Monitoring of R&D Activities

Learning about current R&D trends and activities is essential for SSBs for several reasons. For one, it will provide information on ongoing activities that are of potential relevance for ongoing standardisation activities. Moreover, incorporating (cutting edge) research findings will help attract researchers, which, in turn, will further improve the technical quality and relevance of the standards. Also, such information may help identify new areas of standardisation, and to initiate activities accordingly. Even with more mature technologies timely knowledge about plans for new projects will offer SSBs the opportunity to incorporate research findings from the outset (this may be important for standards maintenance). R&D organisations are performing similar exercises to identify promising new fields of research and active researchers.

Such monitoring may deploy various information sources. Most publicly funded research programmes, whether at national, European, or international level, maintain public web sites from which information about individual projects can be retrieved. The same holds for conferences. At the European level, policy documents, white and green papers, and other documentation indicating future R&D trends and research policies are available. However, more comprehensive standards foresight approaches should try to involve active researchers directly via surveys or workshops.

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11. Recommended literature and information sources

INTEREST Project Deliverables

D01 – Literature Survey;

http://www-i4.informatik.rwth-aachen.de/Interest/D01.pdf

D02 – Report on the results of the survey among researchers;

http://www-i4.informatik.rwth-aachen.de/Interest/D02.pdf

D03 – Report on the results of the indicator analysis;

http://www-i4.informatik.rwth-aachen.de/Interest/D03.pdf

D04 – Report on Case Studies;

http://www-i4.informatik.rwth-aachen.de/Interest/D04.pdf

D05 – Draft Taxonomy of the link between Research Standardisation

http://www-i4.informatik.rwth-aachen.de/Interest/D05.pdf

D 09 – Final taxonomies and manuals

http://www-i4.informatik.rwth-aachen.de/Interest/D09.pdf

Interesting Links (to Cordis etc + FhG etc, era-watch etc)

A Sectoral e-Business Observatory

http://www.ebusiness-watch.org/

Cordis

- news services

  http://cordis.europa.eu/guidance/services4.htm
- information services

  http://cordis.europa.eu/guidance/services2.htm
- R&D related link compilation

  http://cordis.europa.eu/guidance/links.htm
- search

  http://cordis.europa.eu/search/index.cfm
- ERA link

  http://cordis.europa.eu/eralink/home_en.html

IPR helpdesk

http://www.ipr-helpdesk.org/index.html

Papers

Several papers addressing various issues relating to the link between research and standardisation have been published. Please contact:

Knut Blind (knut.blind@isi.fraunhofer.de)

Stephan Gauch (stephan.gauch@isi.fraunhofer.de)

Kai Jakobs (kai.jakobs@i4.informatik.rwth-aachen.de)

Rudi Bekkers (bekkers@dialogic.nl)

Eric J. Iversen (eric.iversen@nifustep.no)

for further information.

Appendix A - Empirical Taxonomy linking ICS fields to Technical committees of ETSI, CENELEC and CEN

11.020

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100 CEN/TC 251 Health informatics

100 CEN/TC 257 Symbols and information provided with medical devices and nomenclature for regulatory data exchange

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11.040

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100 CEN/TC 170 Ophthalmic optics

100 CEN/TC 205 Non-active medical devices

100 CEN/TC 215 Respiratory and anaesthetic equipment

100 CLC/TC 62 Electrical equipment in medical practice

98 CEN/TC 206 Biocompatibility of medical and dental materials and devices

100 CEN/TC 285 Non-active surgical implants

100 CEN/TC 257 Symbols and information provided with medical devices and nomenclature for regulatory data exchange

99 CEN/TC 239 Rescue systems

100 CEN/TC 258 Clinical investigation of medical devices

100 CEN/CLC JWG/AIMD Joint Working Group on Active Implantable Medical Devices

100 CEN/CENELEC Arbeitsgruppe für Zertifizierung

100 CEN/TC 259 Medical alarms and signals

11.060

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100 CEN/TC 55 Dentistry

99 CEN/TC 206 Biocompatibility of medical and dental materials and devices

100 CEN/TC 258 Clinical investigation of medical devices

11.080

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100 CEN/TC 233 Biotechnology

100 CEN/TC 102 Sterilizers for medical purposes

96 CEN/TC 206 Biocompatibility of medical and dental materials and devices
100 CEN/TC 204 Sterilization of medical devices
100 CEN/TC 216 Chemical disinfectants and antiseptics

11.100
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100 CEN/TC 140 In-vitro-diagnostic systems
100 CEN/TC 206 Biocompatibility of medical and dental materials and devices
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11.120
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100 CEN/TC 205 Non-active medical devices
100 CEN/TC 206 Biocompatibility of medical and dental materials and devices
100 CEN/TC 257 Symbols and information provided with medical devices and nomenclature for regulatory data exchange
100 CEN/TC 316 Medical devices utilizing tissues

11.140
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100 CEN/TC 205 Non-active medical devices
99 CEN/TC 215 Respiratory and anaesthetic equipment
98 CLC/TC 62 Electrical equipment in medical practice
100 CEN/TC 123 Lasers and laser related equipment
100 CEN/TC 239 Rescue systems
100 CEN/TC 324 Castors and Wheels
100 CEN/TC 258 Clinical investigation of medical devices

11.160
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99 CEN/TC 215 Respiratory and anaesthetic equipment
100 CEN/TC 192 Fire service equipment
100 CEN/TC 239 Rescue systems

11.180
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96 CEN/TC 261 Packaging
99 CEN/TC 170 Ophthalmic optics
100 CEN/TC 293 Technical aids for the disabled persons

11.200
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100 CEN/TC 205 Non-active medical devices
100 CEN/TC 285 Non-active surgical implants

13.040
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91 CEN/TC 121 Welding
99 CEN/TC 122 Ergonomics
100 CEN/TC 114 Safety of machinery
97 CEN/CLC Joint Task Force Power Engineering
100 CEN/TC 264 Air quality
100 CEN/TC 137 Assessment of workplace exposure
100 CEN/TC 270 Internal combustion engines
99 CEN/TC 301 Electrically propelled road vehicles
100 CEN/TC 243 Cleanroom technology
100 CLC/TC 216 Gas detectors
100 CLC/SC 101 Electrostatic sensitive devices

13.060
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98 CEN/TC 164 Water supply
100 CEN/TC 230 Water analysis
100 CEN/TC 165 Waste water engineering
94 CEN/TC 269 Shell and watertube boilers
96 CEN/TC 292 Characterization of waste
100 CEN/TC 308 Characterization of sludges

13.080
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100 CEN/TC 341 Geotechnische Erkundung und Untersuchung

13.100
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98 CEN European Committee for Standardization
100 CEN/TC 122 Ergonomics

13.110
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100 CEN/TC 122 Ergonomics
100 CEN/TC 114 Safety of machinery
100 CLC/TC 44X Safety of machinery - Electrotechnical aspects
99 CEN/TC 169 Light and lighting

13.120
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100 CLC/TC 61 Safety of household and similar electrical appliances
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13.140
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100 CEN/TC 211 Acoustics
98 CEN/TC 122 Ergonomics

13.160
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98 CEN/TC 151 Construction equipment and building material machines - Safety
94 CEN/TC 256 Railway applications
100 CEN/TC 231 Mechanical vibration and shock
99 CEN/TC 150 Industrial trucks - Safety

13.180
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96 CEN European Committee for Standardization
99 CEN/TC 278 Road transport and traffic telematics
100 CEN/TC 122 Ergonomics

13.200
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100 CEN/TC 136 Sport, playground and other recreational equipment
100 CEN/TC 226 Road equipment

13.220

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95 CLC/TC 20 Electric cables

100 CEN/TC 191 Fixed fire fighting systems

100 CEN/TC 127 Fire safety in buildings

100 CEN/TC 72 Automatic fire detection systems

100 CEN/TC 70 Manual means of fire fighting equipment

100 CEN/TC 192 Fire service equipment

98 CEN/TC 263 Secure storage of cas, valuables and data media

93 CEN/TC 282 Installation and equipment for LNG

13.230

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99 CEN/TC 33 Window, door, shutter, building hardware and curtain walling

98 CEN/TC 129 Glass in building

100 CEN/TC 191 Fixed fire fighting systems

99 CEN/TC 114 Safety of machinery

100 CLC/SC 31-9 Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres

100 CEN/TC 305 Potentially explosive atmosperes - Explosion prevention and protection

100 CEN/TC 270 Internal combustion engines

13.240

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100 CEN/TC 69 Industrial valves

100 CEN/TC 268 Cryogenic vessels

13.260

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100 CLC/TC 78 Equipment and tools for live working

100 CLC/TC 64 Electrical installations of buildings

99 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology

100 CLC/TC 17D Low-voltage switchgear and controllgear assemblies

100 CEN/TC 301 Electrically propelled road vehicles

100 CLC/SC 9XB Electromechanical material on board rolling stock

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13.280

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99 CEN/TC 162 Protective clothing including hand and arm protection and lifejackets

100 CLC/TC 62 Electrical equipment in medical practice

100 CEN/TC 85 Eye-protective equipment

99 CEN/TC 114 Safety of machinery

100 CLC/TC 106X Electromagnetic fields in the human environment

100 CLC/TC 76 Optical radiation safety and laser equipment

100 CLC/SC 211A Low frequency EM radiation

100 CLC/SC 211B High frequency EM radiation

13.300

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98 CEN/TC 261 Packaging

97 CEN/TC 23 Transportable gas cylinders

100 CEN/TC 256 Railway applications

100 CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations

100 CEN/TC 296 Tanks for transport of dangerous goods

100 CEN/TC 320 Tranportation services

13.310

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100 CEN/TC 33 Window, door, shutter, building hardware and curtain walling

99 CEN/TC 129 Glass in building

100 CLC/TC 79 Alarm systems

100 CEN/TC 263 Secure storage of cas, valuables and data media

100 CEN/TC 325 Prevention of crime by urban planing and building design

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13.320

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99 CEN/TC 191 Fixed fire fighting systems

100 CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements

100 CLC/TC 79 Alarm systems

98 CEN/TC 10 Passenge, goods and service lifts

100 CLC/SC 31-9 Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres

100 CLC/TC 216 Gas detectors

13.340

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100 CEN/TC 162 Protective clothing including hand and arm protection and lifejackets

100 CEN/TC 79 Respiratory protective devices

100 CEN/TC 85 Eye-protective equipment

99 CLC/TC 78 Equipment and tools for live working

100 CEN/TC 158 Head protection

100 CEN/TC 160 Protection against falls from height including working belts

98 CEN/TC 53 Temporary works equipment

100 CEN/TC 161 Foot and leg protectors

100 CEN/TC 159 Hearing protectors

17.020

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99 CEN European Committee for Standardization

100 CEN/TC 290 Dimensional and geometrical product specifications and verification

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17.040

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96 CEN/TC 227 Road materials

99 CEN/TC 184 Advanced technical ceramics

100 CEN/TC 262 Metallic and other inorganic coatings

100 CEN/TC 290 Dimensional and geometrical product specifications and verification

97 CEN/TC 197 Pumps

97 CEN/TC 190 Foundry technology

17.060
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100 CLC/SC 31-9 Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres
100 CEN/TC 332 Laboratory equipment
100 CEN/CLC/WG/NAWI Non-automatic weighing instruments

17.100
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99 CEN/TC 121 Welding
100 CEN/TC 141 Pressure gauges - Thermometers - Means of measuring and/or recording temperature in the cold chain
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17.120
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99 CEN European Committee for Standardization
97 CEN/TC 215 Respiratory and anaesthetic equipment
100 CEN/TC 271 Surface treatment equipment - Safety
100 CEN/TC 237 Gas meters
100 CEN/TC 318 Hydrometry

17.140
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100 CEN/TC 211 Acoustics
100 CLC/TC 59X Consumer information related to household electrical appliances
98 CEN/TC 226 Road equipment
91 CLC/TC 2 Rotating machinery
100 CEN/TC 126 Acoustic properties of building products and of buildings
94 CEN/TC 197 Pumps
100 CEN/TC 214 Textile machinery and machinery for drycleanining and industrial laundry
97 CEN/TC 150 Industrial trucks - Safety
98 CEN/TC 255 Hand-hel, non-electric power tools - Safety
96 CEN/TC 301 Electrically propelled road vehicles

95 CEN/TC 201 Leather and imitation leather goods and footwear manufacturing machinery - Safety
99 CEN/TC 186 Industrial thermoprocessing - Safety
98 CEN/TC 198 Printing and paper machinery - Safety
99 CEN/TC 202 Foundry machinery
98 CEN/TC 232 Compressors - Safety

17.160
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100 CLC/TC 86BXA Fibre optic connectors
100 CEN/TC 231 Mechanical vibration and shock
100 CLC/TC 2 Rotating machinery
100 CEN/TC 274 Aircraft ground support equipment

17.180
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100 CEN/TC 139 Paints and varnishes
99 CEN/TC 89 Thermal performance of buildings and building components
100 CEN/TC 276 Surface active agents
100 CEN/TC 169 Light and lighting

17.200
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98 CEN/TC 227 Road materials
100 CEN/TC 205 Non-active medical devices
99 CEN/TC 110 Heat exchangers
100 CEN/TC 176 Heat meters
100 CEN/TC 327 Animal feding stuffs - Methods of sampling and analysis
100 CEN/TC 141 Pressure gauges - Thermometers - Means of measuring and/or recording temperature in the cold chain
100 CLC/BTWG 68-2 Tubes for thermocouples
100 CLC/BTWG 69-2 Compensated connectors for thermo-electric sensors
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17.220
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100 CLC/TC 210 Electromagnetic compatibility
94 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems

96 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus

99 CLC/TC 106X Electromagnetic fields in the human environment

100 CLC/TC 38X Instrument Transformers

100 CLC/BTWG 72-2 Guide for the performance of metallic pipe and cable locators

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17.240

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99 CLC/TC 62 Electrical equipment in medical practice

99 CEN/TC 114 Safety of machinery

100 CLC/BTTF 111-3 Instrumentation for ionizing radiation measurement and protection

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19.020

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97 CEN European Committee for Standardization

100 CEN/CLC/TC 1 Criteria for conformity assessment bodies

19.040

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93 CENELEC Europäisches Komitee für Elektrotechnische Normung

99 ETSI/TC EE Equipment Engineering

19.060

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94 CENELEC Europäisches Komitee für Elektrotechnische Normung

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19.080

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92 CENELEC Europäisches Komitee für Elektrotechnische Normung

100 CLC/TC 66X Electrical and electronic test and measuring instrument, systems and accessories

100 CLC/BTTF 85-1 Erection and operation of electrical test equipment

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19.100

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100 CEN/TC 138 Non-destructive testing

96 CEN/TC 190 Foundry technology

21.060
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100 CEN/TC 185 Threaded and non-threaded mechanical fasteners and accessories
95 CEN/TC 124 Timber structures
95 CEN/TC 74 Metallic flanges and their joints

21.100
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100 CEN European Committee for Standardization

21.120
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100 CEN European Committee for Standardization

21.140
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98 CEN European Committee for Standardization
100 Material, equipment and offshore structures for petroleum and natural gas industries
100 CEN/TC 197 Pumps
100 CEN/TC 108 Sealing materials and lubricants for gas appliances and gas equipment
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21.160
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99 CEN European Committee for Standardization
100 CEN/TC 256 Railway applications

21.180
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100 CEN/TC 324 Castors and Wheels

21.200
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99 CEN European Committee for Standardization

100 Material, equipment and offshore structures for petroleum and natural gas industries

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23.040

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100 CEN/TC 155 Plastics piping systems and ducting systems

95 CEN/TC 165 Waste water engineering

93 CEN/TC 215 Respiratory and anaesthetic equipment

92 Material, equipment and offshore structures for petroleum and natural gas industries

100 CEN/TC 218 Rubber and plastics hoses and hose assemblies

98 CEN/TC 133 Copper and copper alloys

100 CEN/TC 74 Metallic flanges and their joints

98 CEN/TC 234 Gas supply

98 CEN/TC 192 Fire service equipment

98 CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations

100 CEN/TC 107 Pre-fabricated district heating pipe systems

100 CEN/TC 108 Sealing materials and lubricants for gas appliances and gas equipment

100 CEN/TC 208 Elastomeric seals for joints in pipework and pipelines

98 CEN/TC 219 Cathodic protection

92 CEN/TC 282 Installation and equipment for LNG

100 CEN/TC 203 Cast iron pipe, fittings and their joints

100 CEN/TC 267 Industrial piping and pipelines

97 CEN/TC 266 Thermoplastic static tanks

100 CEN/TC 342 Flexible Metallschläuch, Schlauchleitunge, Bälge und Kompensatoren

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23.060

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94 CEN/TC 155 Plastics piping systems and ducting systems

95 CEN/TC 164 Water supply

97 CEN/TC 215 Respiratory and anaesthetic equipment

100 CEN/TC 23 Transportable gas cylinders

100 CEN/TC 69 Industrial valves

100 CEN/TC 286 Liquified petroleum gas equipment and accessories

98 CEN/TC 268 Cryogenic vessels

100 CEN/TC 58 Safety and control devices for gas-burners and gas-burning appliances
98 CEN/TC 234 Gas supply
100 CEN/TC 181 Dedicated liquefied petroleum gas appliances
98 CEN/TC 296 Tanks for transport of dangerous goods
98 CEN/TC 107 Pre-fabricated district heating pipe systems
100 CEN/TC 235 Gas pressure regulators and associated safety shut-off/relief devices for use in gas transmission and distribution
100 CEN/TC 236 Non industrial manually operated shut-off valves for gas and particular combinations valves-other products

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23.080
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96 CLC/TC 61 Safety of household and similar electrical appliances
98 Material, equipment and offshore structures for petroleum and natural gas industries
100 CEN/TC 233 Biotechnology
98 CEN/CLC Joint Task Force Power Engineering
98 CEN/TC 268 Cryogenic vessels
100 CEN/TC 197 Pumps
100 CEN/TC 137 Assessment of workplace exposure
100 CEN/TC 232 Compressors - Safety

23.100
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100 CEN/TC 218 Rubber and plastics hoses and hose assemblies
100 CEN/TC 114 Safety of machinery

23.120
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93 CLC/TC 61 Safety of household and similar electrical appliances
100 CEN/TC 191 Fixed fire fighting systems
100 CEN/TC 114 Safety of machinery
100 CEN/TC 156 Ventilation for buildings
99 CEN/CLC Joint Task Force Power Engineering
100 CEN/TC 110 Heat exchangers
100 CEN/TC 113 Heat pumps and air conditioning units

100 CEN/TC 299 Gas-fired sorption appliances and domestic gas-fired washing and drying appliances

100 CEN/TC 195 Air filters for general air cleaning

23.140

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98 CLC/TC 61 Safety of household and similar electrical appliances

100 Material, equipment and offshore structures for petroleum and natural gas industries

100 CEN/TC 114 Safety of machinery

100 CEN/TC 234 Gas supply

100 CEN/TC 113 Heat pumps and air conditioning units

100 CEN/TC 232 Compressors - Safety

23.160

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100 CEN/TC 232 Compressors - Safety

25.060

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100 CEN/TC 143 Machine tools - Safety

25.080

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100 CLC/TC 61F Hand-held and transportable electric motor operated tools

98 CEN/TC 151 Construction equipment and building material machines - Safety

98 CLC/TC 210 Electromagnetic compatibility

100 CEN/TC 143 Machine tools - Safety

25.100

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98 CEN European Committee for Standardization

99 CLC/TC 61F Hand-held and transportable electric motor operated tools

100 CEN/TC 143 Machine tools - Safety

100 CEN/TC 173 Brushware

25.120

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100 CEN/TC 190 Foundry technology

100 CEN/TC 143 Machine tools - Safety

100 CEN/TC 202 Foundry machinery

25.140

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100 CLC/TC 61F Hand-held and transportable electric motor operated tools

100 CEN/TC 231 Mechanical vibration and shock

100 CEN/TC 255 Hand-hel, non-electric power tools - Safety

25.160

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100 CEN/TC 121 Welding

100 CLC/TC 26A Electric arc welding equipment

100 CLC/TC 26B Electric resistance welding

25.180

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100 CEN/TC 186 Industrial thermoprocessing - Safety

100 CEN/TC 271 Surface treatment equipment - Safety

25.220

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100 CEN/TC 139 Paints and varnishes

98 CEN/TC 132 Aluminium and aluminium alloys

96 CEN/TC 184 Advanced technical ceramics

100 CEN/TC 262 Metallic and other inorganic coatings

100 CEN/TC 240 Thermal spraying and thermally sprayed coatings

98 CEN/TC 107 Pre-fabricated district heating pipe systems

96 CEN/TC 219 Cathodic protection

99 CEN/TC 271 Surface treatment equipment - Safety

27.020

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100 CEN/TC 270 Internal combustion engines

27.040
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97 Material, equipment and offshore structures for petroleum and natural gas industries
100 CEN/CLC Joint Task Force Power Engineering
100 CEN/TC 269 Shell and watertube boilers

27.060
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96 Material, equipment and offshore structures for petroleum and natural gas industries
100 CEN/TC 110 Heat exchangers
100 CEN/TC 269 Shell and watertube boilers
100 CEN/TC 58 Safety and control devices for gas-burners and gas-burning appliances
98 CEN/TC 234 Gas supply
99 CEN/TC 181 Dedicated liquefied petroleum gas appliances
100 CEN/TC 47 Atomizing oil burners and their components - Functio, safet, testing
99 CLC/TC 44X Safety of machinery - Electrotechnical aspects
100 CEN/TC 238 Test gase, test pressures and categories of appliances
100 CEN/TC 131 Gas burners using fans

27.070
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94 CENELEC Europäisches Komitee für Elektrotechnische Normung
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27.080
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98 CLC/TC 61 Safety of household and similar electrical appliances
100 CEN/TC 113 Heat pumps and air conditioning units
100 CEN/TC 182 Refrigerating systems - Safety and environmental requirements
100 CEN/TC 299 Gas-fired sorption appliances and domestic gas-fired washing and drying appliances
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27.100

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100 CEN/CLC Joint Task Force Power Engineering

100 CEN/TC 269 Shell and watertube boilers

27.120

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94 CENELEC Europäisches Komitee für Elektrotechnische Normung

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27.140

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92 CENELEC Europäisches Komitee für Elektrotechnische Normung

100 CEN/CLC Joint Task Force Power Engineering

27.160

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100 CEN/TC 312 Thermal solar systems and components

100 CLC/TC 82 Solar photovoltaic energy systems

100 CLC/BTTF 86-2 Solar photovoltaic energy systems

27.180

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100 CEN/CLC Joint Task Force Power Engineering

100 CLC/TC 88 Wind turbine systems

27.220

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100 CEN/TC 89 Thermal performance of buildings and building components

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29.020

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92 CENELEC Europäisches Komitee für Elektrotechnische Normung

97 CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements

95 CLC/SC 210A EMC products

99 CLC/TC 64 Electrical installations of buildings

100 CLC/TC 44X Safety of machinery - Electrotechnical aspects

100 CLC/BTTF 68-6 Physical characteristics of electrical energy

100 CLC/BTTF 116-3 Waste from electrical and electronic equipment

100 CLC/BTTF 114-1 Protection against corrosion by stray current from direct current systems
100 CLC/TC 218 Qualification of electrical installation contractors
100 CLC/BTTF 85-1 Erection and operation of electrical test equipment
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29.030
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93 CENELEC Europäisches Komitee für Elektrotechnische Normung
100 CLC/TC CECC/SC 51X Magnetic components/cores and soft magnetic materials
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29.035
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92 CENELEC Europäisches Komitee für Elektrotechnische Normung
99 CLC/TC 46X Communication cables

29.040
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93 CENELEC Europäisches Komitee für Elektrotechnische Normung
100 CLC/BTWG 99-1

29.050
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97 CLC/TC 20 Electric cables
100 CLC/SC 64B Electrical installations of buildings - Protection against thermal effects
100 CECC/WG 4C Thermistors

29.060
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100 CLC/TC 20 Electric cables
92 CLC/SC 46XC Multicor, multipair and quad data communication cables
96 CLC/SC 64B Electrical installations of buildings - Protection against thermal effects
100 CLC/TC 55 Winding wires
100 CLC/TC 7 Overhead electrical Conductors

29.080

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98 CLC/TC 9X Electrical and electronic applications for railways
100 CLC/TC 2 Rotating machinery
96 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus
100 CLC/TC 17C High-voltage enclosed switchgear and controlgear
100 CLC/TC 17A High-voltage switchgear and controlgear
100 CLC/TC 36A Insulated bushings
100 CLC/TC 28A Insulation coordination for low-voltage equipment
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29.100
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91 CENELEC Europäisches Komitee für Elektrotechnische Normung
100 CLC/TC 17D Low-voltage switchgear and controllgear assemblies
100 CLC/TC CECC/SC 51X Magnetic components/cores and soft magnetic materials
100 CLC/BTTF 68-3 IK code

29.120
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92 CLC/TC 14 Power transformers
95 CLC/TC 9X Electrical and electronic applications for railways
100 CLC/TC 23E Circuit breakers and similar devices for household and similar applications
94 CLC/TC 48B LF connectors
96 CECC-CENELEC Electronic Components Committee
100 CLC/TC 94 Relays
98 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus
96 CLC/SC 64A Electrical installations of buildings - Protection against electric shock
100 CLC/TC 23B Switches for household and similar fixed electrical installations
100 CLC/BTTF 56-2 Low voltage fuses
99 CLC/TC 17A High-voltage switchgear and controlgear
100 CLC/TC 213 Cable management
96 CLC/TC 69X Electrical systems for electric road vehicles
98 CLC/SC 23JX Switches and sensors

100 CLC/BTTF 63-5 Static measuring relays
100 CLC/TC 32A High-voltage fuses
100 CLC/BTWG 112-1 Plug, socket-outlets and couplers for industrial purposes
100 CLC/BTWG 79-1 Conversion adaptors for industrial use
100 CLC/TC 23X Europlug and socket outlets
100 CLC/BTWG 78-4 Relays with forcibly actuted contacts

29.130

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100 CLC/TC 17B Low-voltage switchgear and controlgear including dimensional standardization
93 CLC/TC 9X Electrical and electronic applications for railways
91 CLC/TC 23E Circuit breakers and similar devices for household and similar applications
99 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus
100 CLC/TC 17C High-voltage enclosed switchgear and controlgear
100 CLC/TC 17A High-voltage switchgear and controlgear
100 CLC/TC 17D Low-voltage switchgear and controllgear assemblies

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29.140

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100 CLC/TC 34Z Luminaires and associated equipment
98 CEN/TC 169 Light and lighting
92 CLC/SC 9XB Electromechanical material on board rolling stock
100 CLC/BTTF 60-2 Electrical discharge lamp installations
100 CLC/BTTF 85-2 Energy efficiency of household lighting sources

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29.160

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97 CEN/TC 211 Acoustics
100 CLC/TC 2 Rotating machinery
99 CEN/TC 270 Internal combustion engines
100 CLC/BTTF 60-4 Uninterruptable Power-supply Systems

29.180

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98 CLC/TC 40XA Capacitors
100 CLC/TC 14 Power transformers
98 CLC/SC 9XA Communicatio, signalling and processing systems
100 CLC/BTTF 72-3 Electrical installations for lighting and beaconing of aerodromes
100 CLC/TC 96 Small power transformer, reactors and power supply units - Safety requirements
100 CECC/WG 12 Magnetic components - inductive wound components
100 CLC/BTTF 64-1 Isolating and safety isolating transformers
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29.200
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93 CLC/TC 61 Safety of household and similar electrical appliances
99 CLC/TC 9X Electrical and electronic applications for railways
100 CEN/TC 293 Technical aids for the disabled persons
100 CLC/TC 22X Power electronics
100 CLC/BTTF 60-4 Uninterruptable Power-supply Systems
100 CECC/WG 7 Rectifier diodes and thyristors
100 CLC/BTTF 62-8 Emergency lighting systems
100 CLC/BTTF 64-2 Supply of electrical and electronic equipment
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29.220
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100 CLC/TC 21X Secondary cells and batteries

29.240
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96 CLC/TC 20 Electric cables
94 CLC/TC 17B Low-voltage switchgear and controlgear including dimensional standardization
100 CEN/TC 124 Timber structures
99 CLC/TC 64 Electrical installations of buildings
99 CLC/TC 13 Equipment for electrical energy measurement and load control
100 CLC/TC 7 Overhead electrical Conductors
100 CLC/TC 11 Overhead electrical lines exceeding 1 kV a.c.
100 CLC/BTTF 62-3 Operation of electrical installations
100 CLC/BTTF 60-1 Assembly of electronic equipment

100 CLC/TC 99X Power installations exceeding 1 kV a.c.

29.260

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100 CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements

100 CLC/SC 31-9 Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres

100 CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations

99 CEN/TC 305 Potentially explosive atmosperes - Explosion prevention and protection

100 CLC/SC 31-4 Increased safety

100 CLC/SC 31-3 Intrinsically safe apparatus and systems

100 CLC/SC 31-2 Flameproof enclosures

100 CLC/SC 31-8 Electrostatic painting and finishing equipment

100 CLC/SC 31-7 Pressurization and other techniques

100 CLC/BTTF 62-4 Live-line washing systems for power installations with rated voltages above 1 kV

100 CLC/SC 31-1 Installation rules

100 CLC/SC 31-6 Encapsulation

29.280

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100 CLC/TC 9X Electrical and electronic applications for railways

100 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus

100 CLC/SC 9XA Communicatio, signalling and processing systems

100 CLC/SC 9XB Electromechanical material on board rolling stock

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99 CECC-CENELEC Electronic Components Committee

99 CEN/TC 58 Safety and control devices for gas-burners and gas-burning appliances

100 CLC/TC CECC/WG-QAP Quality assessment prodcedures

100 CLC/SC 101 Electrostatic sensitive devices

100 CLC/BTTF 116-3 Waste from electrical and electronic equipment
100 CLC/BTTF 101-3 Avionic equipmen, systems and associated components
100 CECC-TF-ESD Task Force Electrostatic sensitive devices

31.040
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92 CLC/TC 40XA Capacitors
100 CECC-CENELEC Electronic Components Committee
100 CLC/TC 40XB Fixed resistors
100 CECC/WG 4C Thermistors
100 CECC/WG 4B Potentiometers

31.060
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100 CLC/TC 40XA Capacitors

31.080
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100 CLC/BTTF 97-1 Known Good Die
100 CECC/WG 5 Semiconductor diodes and transistors
100 CECC/WG 20 Optoelectronic components and liquid crysal displays
100 CECC/WG 7 Rectifier diodes and thyristors
100 CLC/TC CECC Automotive users group

31.100
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100 CECC/WG 11 Electro-optical devices
100 CECC/WG 13 Microwave tubes

31.120
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100 CECC/WG 11 Electro-optical devices
100 CECC/WG 20 Optoelectronic components and liquid crysal displays
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31.140
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100 CLC/TC 49 Piezoelectric devices for frequency control and selection

100 CLC/BTTF 63-2 Advanced technical ceramics

31.160

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96 CLC/TC 210 Electromagnetic compatibility

100 CLC/TC 40XA Capacitors

100 CLC/TC 49 Piezoelectric devices for frequency control and selection

99 CECC-CENELEC Electronic Components Committee

100 CLC/SC 205A Mains communicating systems

31.180

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92 CENELEC Europäisches Komitee für Elektrotechnische Normung

92 CECC-CENELEC Electronic Components Committee

100 CLC/SC 52 Printed circuits

31.190

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91 CENELEC Europäisches Komitee für Elektrotechnische Normung

100 CECC-CENELEC Electronic Components Committee

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100 CLC/TC 217 Electronic Design Automation

100 CECC/WG 9 Semiconductor integrated circuits

100 CLC/SC 47AX Film and hybrid integrated circuits

31.220

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100 CLC/TC 48B LF connectors

100 CECC-CENELEC Electronic Components Committee

92 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems

98 CLC/TC 46D RF Connectors

100 CLC/TC 203 Electronic entertainment and educational systems for household and similar use

100 CLC/SC 23JX Switches and sensors

100 CLC/TC 48B Requirements for a telecommunicaton connector for the connection of IT equipment amongst each other and to broadband networks
100 CECC/WG 12 Magnetic components - inductive wound components
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31.240
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91 CENELEC Europäisches Komitee für Elektrotechnische Normung
98 CLC/TC 210 Electromagnetic compatibility
100 CLC/TC 49 Piezoelectric devices for frequency control and selection
100 CECC/WG 5 Semiconductor diodes and transistors

31.260
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98 CEN/TC 85 Eye-protective equipment
100 CEN/TC 123 Lasers and laser related equipment
98 CLC/TC 205 Home and Building Electronic Systems
100 CLC/TC 44X Safety of machinery - Electrotechnical aspects
100 CECC/WG 11 Electro-optical devices
100 CLC/TC 76 Optical radiation safety and laser equipment
100 CECC/WG 20 Optoelectronic components and liquid crysal displays
100 CLC/TC 86D Semiconductor optoelectronic devices

33.020
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91 European Telecommunications Standards Institute
100 ETSI/TC NA Network Aspects
99 ETSI/TC TE Terminal Equipment
94 ETSI/TC TM Transmission and Multiplexing
95 ETSI/EBU Joint Technical Committee
100 ETSI/TC EE Equipment Engineering
100 ETSI/TC MTS Methods for Testing and Spezification
100 ETSI/TC HF Human Factors
100 ETSI/STC TM 3 Architectur, Functional Requirements and Interfaces of Transmission Networks
100 ETSI/STC HF 1 Telecommunication Services
100 ETSI/STC NA 5 Broadband Networks

100 ETSI/STC SPS 3 Digital Switching
100 ETSI/TC TMN
100 ETSI/EP BRAN
100 CLC/TC 207 Radio Data System
100 ETSI/STC TE 1 Telematics Videotex
100 ETSI/STC NA 4 Network Architecture Operation, Maintenanc, Principles and Performance
100 ETSI/WG ERM RP 01
100 ETSI/EP MTA
100 ETSI/WG ERM RP 08
100 ETSI/STC TM 4 Radio Relay Systems

33.040
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99 European Telecommunications Standards Institute
95 ETSI/TC SPS Signallin, Protocol & Switching
100 ETSI/TC NA Network Aspects
99 ETSI/TC TE Terminal Equipment
100 ETSI/TC TM Transmission and Multiplexing
100 ETSI/TC BT Business Telekommunikations
99 ETSI/TC EE Equipment Engineering
92 ETSI/TC MTS Methods for Testing and Spezification
98 ETSI/TC HF Human Factors
97 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology
100 CLC/SC 205A Mains communicating systems
100 ETSI/STC TM 3 Architectur, Functional Requirements and Interfaces of Transmission Networks
96 CLC/TC 215 Electrotechnical aspects of telecommunication equipment
94 ETSI/STC HF 1 Telecommunication Services
99 ETSI/STC SPS 3 Digital Switching
100 ETSI/TC TMN
98 ETSI/STC NA 2 Numberin, Addressin, Routing & Interworking
98 ETSI/STC SPS 2 Signalling Network and Mobility Applications
100 CLC/TC 81X Lightning protection
100 ETSI/STC TM 1 Transmission Equipmen, Fibres & Cables
100 ETSI/ECMA TC 32
100 ETSI/STC BT 2 Business Telekommunikations Network Performance

100 ETSI/STC HF 2 People with Special Needs

100 ETSI/EP ATA

100 ETSI/STC EE 3 Mechanical Structure

33.050

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97 European Telecommunications Standards Institute

100 ETSI/TC TE Terminal Equipment

97 CEN/TC 300 Sea-going vessels and marine technology

100 ETSI/TC EE Equipment Engineering

100 ETSI/TC HF Human Factors

99 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology

100 CEN/CLC/IT/WG/CSC Information technology; Working Group - Character Sets and their Coding

100 CLC/TC 106X Electromagnetic fields in the human environment

100 CEN/TC 304 Information and communications technologies - European localization requirements

100 ETSI/STC HF 1 Telecommunication Services

100 ETSI/STC HF 3 Usability Evaluation

100 ETSI/STC EE 1 Environmental Conditions

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97 European Telecommunications Standards Institute

100 ETSI/TC RES Radio Equipment and Systems

99 ETSI/TC TM Transmission and Multiplexing

100 ETSI/TC SES Satellite Earth Stations

95 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems

100 CLC/TC 209 Cable networks for television signal, sound and interactive services

98 CLC/TC 215 Electrotechnical aspects of telecommunication equipment

100 ETSI/TC PS Paging Systems

99 ETSI/EP BRAN

100 ETSI/WG ERM RP 05

100 ETSI/WG ERM EMC

100 ETSI/WG ERM RP 01

100 ETSI/STC SES 5 E/S for Mobile Services

33.070

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100 ETSI/TC SMG Special Mobile Group

93 European Telecommunications Standards Institute

99 ETSI/TC RES Radio Equipment and Systems

100 ETSI/STC RES 3 Digitales European Cordless Telecommunications

100 ETSI/STC SMG 11

100 ETSI/STC SMG 4 DATA

100 ETSI/STC SMG 3 Network Aspects

95 CLC/TC 106X Electromagnetic fields in the human environment

100 ETSI/STC SMG 2 Radio Aspects

100 ETSI/STC SMG 7

94 ETSI/STC NA 2 Numberin, Addressin, Routing & Interworking

100 ETSI/STC SMG 1 Services and Facilities

100 ETSI/EP TETRA

100 ETSI/WG DECT 2

98 ETSI/WG ERM EMC

100 ETSI/STC SMG 8

100 ETSI/WG DECT 1

100 ETSI/WG DECT 4

100 ETSI/STC SMG 9

100 ETSI/WG TETRA 6

100 ETSI/WG DECT 5

100 ETSI/WG TETRA 4

100 ETSI/WG TETRA 2

100 ETSI/WG TETRA 1

100 ETSI/WG DECT 3

33.080

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97 European Telecommunications Standards Institute

100 ETSI/TC SPS Signallin, Protocol & Switching

99 ETSI/TC NA Network Aspects

98 ETSI/TC TE Terminal Equipment

100 ETSI/STC SPS 5 Customer Acess to the ISDN

100 ETSI/STC SPS 1 Network Interconnection and Signalling

94 CLC/TC 215 Electrotechnical aspects of telecommunication equipment
99 ETSI/STC NA 5 Broadband Networks
93 ETSI/STC SPS 3 Digital Switching
99 ETSI/STC NA 2 Numberin, Addressin, Routing & Interworking
100 ETSI/STC SPS 2 Signalling Network and Mobility Applications
100 ETSI/STC TE 2 Telematics: Facsimil, Document Handling and Transfer
99 ETSI/EP MTA
100 ETSI/STC NA 1 User Interfaces Services and Charging
100 ETSI/STC NA 8

33.100

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97 ETSI/TC RES Radio Equipment and Systems
100 CLC/TC 210 Electromagnetic compatibility
97 CLC/TC 40XA Capacitors
97 CLC/TC 9X Electrical and electronic applications for railways
92 CLC/TC 79 Alarm systems
97 ETSI/TC EE Equipment Engineering
100 CLC/SC 210A EMC products
98 CEN/TC 10 Passenge, goods and service lifts
99 CLC/TC 209 Cable networks for television signal, sound and interactive services
91 CEN/TC 98 Lifting platforms
94 CLC/SC 205A Mains communicating systems
100 CLC/TC 106X Electromagnetic fields in the human environment
96 CLC/SC 9XB Electromechanical material on board rolling stock
100 CLC/TC 22X Power electronics
100 CEN/TC 148 Continuous handling equipment and systems - Safety
100 CLC/BTTF 63-5 Static measuring relays
100 CLC/BTTF 60-4 Uninterruptable Power-supply Systems
100 CLC/BTTF 71-3 Infrared free air applications
100 ETSI/WG ERM RP 05
100 CLC/TC 26B Electric resistance welding
100 ETSI/WG ERM EMC
100 ETSI/WG ERM RP 01
100 CLC/BTTF 69-3 Road traffic signal systems

33.120

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100 CLC/TC 46X Communication cables
91 CLC/TC 49 Piezoelectric devices for frequency control and selection
100 CLC/SC 46XC Multicor, multipair and quad data communication cables
100 CLC/SC 46XA Coaxial cables
100 CLC/TC 46D RF Connectors

33.140
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94 CENELEC Europäisches Komitee für Elektrotechnische Normung
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33.160
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100 ETSI/EBU Joint Technical Committee
100 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems
98 ETSI/TC HF Human Factors
97 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology
100 CLC/TC 203 Electronic entertainment and educational systems for household and similar use
100 ETSI/STC NA 5 Broadband Networks
100 CLC/TC 207 Radio Data System
99 ETSI/STC TE 1 Telematics Videotex
100 CLC/BTTF 63-1 Safety requirements for mains operated electronic and related apparatus for household and similar general use
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100 ETSI/EBU Joint Technical Committee
97 ETSI/TC SES Satellite Earth Stations
100 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems
99 CLC/TC 203 Electronic entertainment and educational systems for household and similar use
100 CLC/TC 207 Radio Data System

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97 ETSI/TC TM Transmission and Multiplexing
100 CLC/TC 86BXA Fibre optic connectors
100 CLC/TC 86A Optical fibres and fibre cables
97 CECC-CENELEC Electronic Components Committee
98 CLC/TC 76 Optical radiation safety and laser equipment
100 CLC/TC CECC/SC 86BXB Fibre optic passive components
97 CLC/TC 7 Overhead electrical Conductors
99 CLC/TC 81X Lightning protection
99 ETSI/STC TE 1 Telematics Videotex

33.200
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91 CENELEC Europäisches Komitee für Elektrotechnische Normung
100 CLC/TC 23B Switches for household and similar fixed electrical installations
100 CLC/SC 9XA Communicatio, signalling and processing systems
100 CEN/TC 294 Communication systems for meters and remote reading of meters
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35.020
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99 CEN/TC 211 Acoustics
98 CLC/TC 210 Electromagnetic compatibility
98 CEN/TC 122 Ergonomics
100 CLC/TC 217 Electronic Design Automation
100 CLC/SC 210A EMC products
100 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology
100 CEN/TC 263 Secure storage of cas, valuables and data media
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35.040
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98 ETSI/TC NA Network Aspects
91 CEN/TC 224 Machine-readable card, related device interfaces and operations
99 CEN/TC 251 Health informatics
100 CEN/TC 225 Bar coding

99 CLC/TC 13 Equipment for electrical energy measurement and load control
100 CEN/TC 331 Postal services
100 CEN/CLC/IT/WG/CSC Information technology; Working Group - Character Sets and their Coding
100 CEN/TC 304 Information and communications technologies - European localization requirements
100 ETSI/STC NA 5 Broadband Networks

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98 CEN European Committee for Standardization
100 CLC/TC 217 Electronic Design Automation
99 CLC/TC 65CX Fieldbus

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99 CEN European Committee for Standardization
100 CEN/TC 122 Ergonomics
100 CLC/TC 217 Electronic Design Automation
100 CEN/TC 225 Bar coding
100 CEN/TC 304 Information and communications technologies - European localization requirements
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35.100
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99 CEN European Committee for Standardization
91 ETSI/TC SPS Signallin, Protocol & Switching
98 CEN/TC 278 Road transport and traffic telematics
92 CLC/TC 205 Home and Building Electronic Systems
93 ETSI/STC RES 3 Digitales European Cordless Telecommunications
100 ETSI/TC MTS Methods for Testing and Spezification
99 CLC/TC 13 Equipment for electrical energy measurement and load control
100 CLC/TC 65CX Fieldbus
98 ETSI/STC TM 3 Architectur, Functional Requirements and Interfaces of Transmission Networks

100 CEN/TC 294 Communication systems for meters and remote reading of meters

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99 European Telecommunications Standards Institute

100 ETSI/TC NA Network Aspects

100 ETSI/TC BT Business Telekommunikations

97 CLC/TC 86A Optical fibres and fibre cables

100 ETSI/STC TM 3 Architectur, Functional Requirements and Interfaces of Transmission Networks

100 CLC/TC 215 Electrotechnical aspects of telecommunication equipment

100 ETSI/STC SPS 3 Digital Switching

100 ETSI/TC TMN

100 ETSI/STC NA 4 Network Architecture Operation, Maintenanc, Principles and Performance

100 CEN/CLC/IT Information technology

100 ETSI/STC BT 3 Service Aspects

100 ETSI/STC BT 1 Private Networking Aspects

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100 CEN European Committee for Standardization

98 CEN/TC 251 Health informatics

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100 CEN/TC 278 Road transport and traffic telematics

100 CLC/TC 65CX Fieldbus

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99 CEN European Committee for Standardization

93 European Telecommunications Standards Institute

100 ETSI/TC TE Terminal Equipment

98 CEN/TC 211 Acoustics

97 CEN/TC 224 Machine-readable card, related device interfaces and operations

99 CEN/TC 122 Ergonomics
100 CEN/TC 225 Bar coding
100 CEN/CLC/IT Information technology

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99 European Telecommunications Standards Institute
92 ETSI/TC SPS Signallin, Protocol & Switching
96 ETSI/TC TE Terminal Equipment
98 ETSI/TC TM Transmission and Multiplexing
98 ETSI/TC BT Business Telekommunikations
100 CLC/TC 13 Equipment for electrical energy measurement and load control
100 CLC/TC 65CX Fieldbus
100 ETSI/STC TM 3 Architectur, Functional Requirements and Interfaces of Transmission Networks
100 ETSI/STC SPS 3 Digital Switching
100 CEN/CLC/IT/WG Zugriff zu Paketier-/Depaketiereinrichtungen
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35.220
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100 CEN European Committee for Standardization

35.240
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94 CEN European Committee for Standardization
100 CEN/TC 224 Machine-readable card, related device interfaces and operations
100 CEN/TC 251 Health informatics
100 CEN/TC 278 Road transport and traffic telematics
100 CEN/TC 310 Advanced Manufacturing Technologies
99 CLC/TC 217 Electronic Design Automation
100 CEN/TC 287 Geographic information
93 ETSI/TC HF Human Factors
100 CEN/TC 331 Postal services
95 CEN/TC 119 Swap bodies for combined goods transport
100 CEN/TC 247 Controls for mechanical building services
97 CLC/SC 9XA Communicatio, signalling and processing systems

98 CEN/TC 257 Symbols and information provided with medical devices and nomenclature for regulatory data exchange
94 CLC/TC 69X Electrical systems for electric road vehicles
99 ETSI/STC TE 1 Telematics Videotex
100 CEN/CLC/AMT/WG/ARC Advanced Manufacture Technology Working Group Architecture
100 ETSI/EP MTA 4
100 CEN/TC 311 Information Systems Engineering

35.260
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100 CEN/TC 211 Acoustics
100 CLC/TC 108 Safety of electronic equipment within the fields of audio/vide, information technology and communication technology
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37.040
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91 CLC/TC 61 Safety of household and similar electrical appliances
96 CLC/TC 34Z Luminaires and associated equipment
100 CEN/TC 138 Non-destructive testing
100 CLC/TC 206 Consumer equipment for entertainment and information and related subsystems
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37.060
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98 CLC/TC 61 Safety of household and similar electrical appliances
100 CLC/TC 34Z Luminaires and associated equipment

37.080
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99 CEN European Committee for Standardization

37.100
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97 CEN European Committee for Standardization
100 CEN/TC 198 Printing and paper machinery - Safety

39.040

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99 CLC/TC 61 Safety of household and similar electrical appliances

100 CLC/TC 72 Automatic controls for household use

100 CEN/TC 226 Road equipment

100 CLC/TC 13 Equipment for electrical energy measurement and load control

100 CLC/TC 23B Switches for household and similar fixed electrical installations

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39.060

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92 CEN European Committee for Standardization

100 CEN/TC 283 Precious metals - Applications in jewellery and associated products

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43.020

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100 CEN/TC 326 Gas supply for Natural Gas Vehicles

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98 CEN European Committee for Standardization

100 CEN/TC 278 Road transport and traffic telematics

100 CLC/TC 64 Electrical installations of buildings

100 CEN/TC 245 Leisure accommodation vehicles

100 CEN/TC 181 Dedicated liquefied petroleum gas appliances

100 CEN/TC 301 Electrically propelled road vehicles

100 CLC/BTTF 63-4 Electronic taximeters and parking meters

43.060

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100 CEN/TC 23 Transportable gas cylinders

100 CEN/TC 286 Liquified petroleum gas equipment and accessories

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43.080

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100 CEN/TC 278 Road transport and traffic telematics

100 CEN/TC 286 Liquified petroleum gas equipment and accessories

100 CEN/TC 119 Swap bodies for combined goods transport
100 CEN/TC 296 Tanks for transport of dangerous goods

43.100
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100 CLC/TC 64 Electrical installations of buildings
100 CEN/TC 245 Leisure accommodation vehicles
100 CEN/TC 181 Dedicated liquefied petroleum gas appliances

43.120
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100 CEN/TC 301 Electrically propelled road vehicles
100 CLC/TC 69X Electrical systems for electric road vehicles
100 CLC/BTWG 93-1 Conductors cars

43.140
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100 CEN/TC 162 Protective clothing including hand and arm protection and lifejackets

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45.020
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100 CEN/TC 256 Railway applications
100 CLC/TC 9X Electrical and electronic applications for railways
100 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus
100 CLC/SC 9XA Communicatio, signalling and processing systems

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45.040
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100 CEN/TC 256 Railway applications

45.060
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97 CLC/TC 20 Electric cables
100 CEN/TC 256 Railway applications
100 CEN/TC 278 Road transport and traffic telematics
100 CLC/TC 9X Electrical and electronic applications for railways

99 CLC/SC 9XC Electric supply and earthing systems for public transport equipment and ancillary apparatus
100 CLC/SC 9XA Communicatio, signalling and processing systems
100 CLC/SC 9XB Electromechanical material on board rolling stock
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45.080
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100 CEN/TC 256 Railway applications

45.100
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100 CEN/TC 242 Safety requirements for passenger transportation by rope
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47.020
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100 CEN/TC 300 Sea-going vessels and marine technology
100 CEN/TC 15 Inland navigation vessels
97 CEN/TC 181 Dedicated liquefied petroleum gas appliances
100 CEN/TC 147 Cranes - safety
100 CEN/TC 219 Cathodic protection
100 ETSI/WG ERM RP 01

47.040
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100 CEN/TC 211 Acoustics

47.060
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98 CEN/TC 211 Acoustics
100 CEN/TC 15 Inland navigation vessels

47.080
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100 CEN European Committee for Standardization
100 CEN/TC 15 Inland navigation vessels

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94 CENELEC Europäisches Komitee für Elektrotechnische Normung
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49.025
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100 CEN European Committee for Standardization

49.030
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100 CEN European Committee for Standardization

49.035
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100 CEN European Committee for Standardization

49.040
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100 CEN European Committee for Standardization

49.060
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100 CLC/TC 21X Secondary cells and batteries
100 CLC/TC 107X Process management for avionics

49.090
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99 European Telecommunications Standards Institute
100 ETSI/TC RES Radio Equipment and Systems
100 ETSI/WG ERM RP 05

49.100
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100 CEN/TC 218 Rubber and plastics hoses and hose assemblies
100 CEN/TC 274 Aircraft ground support equipment

53.060
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99 CEN/TC 231 Mechanical vibration and shock

100 CEN/TC 150 Industrial trucks - Safety
100 CEN/TC 324 Castors and Wheels

  53.080
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100 CEN/TC 168 Chain, rope, webbin, sling and accessories - safety
100 CEN/TC 98 Lifting platforms
100 CEN/TC 149 Power-operated warehouse equipment

  53.100
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100 CEN/TC 151 Construction equipment and building material machines - Safety
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  55.100
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100 CEN/TC 261 Packaging

  55.120
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100 CEN/TC 261 Packaging
100 CEN/TC 102 Sterilizers for medical purposes

  55.130
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100 CEN/TC 261 Packaging

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100 CEN/TC 261 Packaging

  55.160
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100 CEN/TC 261 Packaging

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100 CEN/TC 261 Packaging

98 CEN/TC 175 Round and sawn timber

100 CEN/TC 168 Chain, rope, webbin, sling and accessories - safety

100 CEN/TC 119 Swap bodies for combined goods transport

100 CEN/TC 280 Offshore containers

55.200

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100 CEN/TC 146 Packaging machines - safety

55.230

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100 CLC/TC 61 Safety of household and similar electrical appliances

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59.040

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100 CEN/TC 222 Feather and down as filling material for any articl, as well as finished articles filled with feather and down

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59.060

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100 CEN/TC 248 Textiles and textile products

59.080

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100 CEN/TC 248 Textiles and textile products

99 CEN/TC 134 Resilient and textile floor coverings

100 CEN/TC 189 Geotextiles and geotextile-related products

95 CEN/TC 217 Surfaces for sport areas

100 CLC/BTWG 99-1

59.100

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100 CEN/TC 249 Plastics

59.120

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100 CEN/TC 214 Textile machinery and machinery for drycleanining and industrial laundry

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59.140
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100 CEN/TC 289 Leather
100 CEN/TC 201 Leather and imitation leather goods and footwear manufacturing machinery - Safety
100 CEN/TC 200 Tannery machinery - Safety

61.020
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100 CEN/TC 248 Textiles and textile products
98 CEN/TC 162 Protective clothing including hand and arm protection and lifejackets
100 CEN/TC 122 Ergonomics
100 CEN/TC 222 Feather and down as filling material for any articl, as well as finished articles filled with feather and down
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61.040
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100 CEN/TC 248 Textiles and textile products

61.060
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97 CEN/TC 193 Adhesives
100 CEN/TC 309 Footwear
100 CEN/TC 201 Leather and imitation leather goods and footwear manufacturing machinery - Safety
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61.080
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100 CLC/TC 61 Safety of household and similar electrical appliances
100 CEN/TC 260 Fertilizers and liming materials
100 CLC/TC 44X Safety of machinery - Electrotechnical aspects
100 CEN/TC 201 Leather and imitation leather goods and footwear manufacturing machinery - Safety
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65.020
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94 CENELEC Europäisches Komitee für Elektrotechnische Normung

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65.040

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99 CLC/TC 61 Safety of household and similar electrical appliances

91 CEN/TC 250 Structural eurocodes

100 CEN/TC 144 Tractors and machinery for agriculture and forestry

100 CEN/TC 153 Food processing machinery - safety and hygiene specifications

100 CEN/TC 229 Precast concrete products

100 CEN/TC 284 Greenhouses

65.060

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100 CLC/TC 61F Hand-held and transportable electric motor operated tools

100 CEN/TC 144 Tractors and machinery for agriculture and forestry

100 CEN/TC 334 Irrigation techniques

65.080

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100 CEN/TC 260 Fertilizers and liming materials

100 CEN/TC 223 Soil improvers and growing media

65.100

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100 CEN/TC 275 Food analysis - Horizontal methods

65.120

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100 CEN/TC 327 Animal feding stuffs - Methods of sampling and analysis

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65.150

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99 CLC/TC 61 Safety of household and similar electrical appliances

100 CEN/TC 248 Textiles and textile products

100 CEN/TC 230 Water analysis

67.050

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100 CEN/TC 275 Food analysis - Horizontal methods

99 CEN/TC 216 Chemical disinfectants and antiseptics

67.060

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100 CEN/TC 275 Food analysis - Horizontal methods

67.080

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100 CEN/TC 275 Food analysis - Horizontal methods

67.100

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100 CEN/TC 302 Milk and milk products - Methods of sampling and analysis

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67.120

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100 CEN/TC 275 Food analysis - Horizontal methods

100 CEN/TC 327 Animal feding stuffs - Methods of sampling and analysis

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67.140

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100 CEN/TC 275 Food analysis - Horizontal methods

67.160

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99 CEN/TC 275 Food analysis - Horizontal methods

100 CEN/TC 174 Fruit and vegetable juices - Methods of analysis

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67.180

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99 CEN European Committee for Standardization

100 CEN/TC 275 Food analysis - Horizontal methods

67.200

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100 CEN/TC 307 Oilseed,vegetable and animal fats and oil and their by-products - Methods of sampling and analysis

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67.220

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99 CEN European Committee for Standardization

100 CEN/TC 307 Oilseed,vegetable and animal fats and oil and their by-products - Methods of sampling and analysis

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67.230

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100 CEN/TC 275 Food analysis - Horizontal methods

100 CEN/TC 302 Milk and milk products - Methods of sampling and analysis

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67.250

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100 CEN/TC 194 Utensils in contact with food

100 CEN/TC 172 Pul, paper and board

94 CEN/TC 153 Food processing machinery - safety and hygiene specifications

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67.260

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100 CEN/TC 197 Pumps

100 CEN/TC 153 Food processing machinery - safety and hygiene specifications

100 CEN/TC 141 Pressure gauges - Thermometers - Means of measuring and/or recording temperature in the cold chain

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71.020

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100 CEN European Committee for Standardization

71.040

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95 CEN/TC 207 Furniture

99 CLC/SC 31-9 Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres
100 CEN/TC 332 Laboratory equipment

71.060
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100 CEN/TC 317 Derivates from coal from pyrolysis
100 CEN/TC 306 Lead and lead alloys

71.080
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100 CEN/TC 317 Derivates from coal from pyrolysis

71.100
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100 CEN/TC 164 Water supply
100 CEN/TC 38 Durability of wood and derived materials
100 CEN/TC 321 Explosives for civil use
100 CEN/TC 276 Surface active agents
100 CEN/TC 212 Fireworks
100 CEN/TC 216 Chemical disinfectants and antiseptics
96 CEN/TC 317 Derivates from coal from pyrolysis
100 CEN/TC 87 Gasfeuerzeuge

71.120
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99 CEN European Committee for Standardization
100 CEN/TC 132 Aluminium and aluminium alloys
100 CEN/TC 313 Centrifuges - Safety requirements

73.020
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97 CEN/TC 125 Masonry
100 CEN/TC 246 Natural stones

73.080
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100 CEN European Committee for Standardization

73.100

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100 CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements

100 CEN/TC 305 Potentially explosive atmosperes - Explosion prevention and protection

100 CLC/SC 31-4 Increased safety

100 CEN/TC 196 Machines for underground mines - Safety

75.020

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100 Material, equipment and offshore structures for petroleum and natural gas industries

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75.040

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100 CEN/TC 19 Petroleum product, lubricants and related products

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75.060

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100 CEN European Committee for Standardization

95 CEN/TC 19 Petroleum product, lubricants and related products

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75.080

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100 CEN/TC 19 Petroleum product, lubricants and related products

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75.100

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100 CEN/TC 19 Petroleum product, lubricants and related products

100 CEN/TC 256 Railway applications

100 CEN/TC 108 Sealing materials and lubricants for gas appliances and gas equipment

100 CLC/TC 7 Overhead electrical Conductors

75.120

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100 CEN/TC 19 Petroleum product, lubricants and related products

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75.140

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100 CEN/TC 19 Petroleum product, lubricants and related products

99 CEN/TC 154 Aggregates

100 CEN/TC 336 Bituminous binders

100 CEN/TC 317 Derivates from coal from pyrolysis

75.160

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100 CEN/TC 19 Petroleum product, lubricants and related products

94 CEN/TC 286 Liquified petroleum gas equipment and accessories

99 CEN/TC 305 Potentially explosive atmosperes - Explosion prevention and protection

100 CEN/TC 317 Derivates from coal from pyrolysis

100 CEN/TC 335 Solid biofuels

100 CEN/TC 281 Appliance, solid fuels and firestarters for barbecueing

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75.180

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98 CEN/TC 19 Petroleum product, lubricants and related products

100 Material, equipment and offshore structures for petroleum and natural gas industries

98 CEN/TC 234 Gas supply

97 CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations

100 CEN/TC 282 Installation and equipment for LNG

75.200

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100 Material, equipment and offshore structures for petroleum and natural gas industries

100 CEN/TC 218 Rubber and plastics hoses and hose assemblies

97 CEN/TC 69 Industrial valves

99 CEN/TC 286 Liquified petroleum gas equipment and accessories

100 CEN/TC 234 Gas supply

100 CEN/TC 221 Shop fabricated metallic tanks and equipment for storage tanks and for service stations
100 CEN/TC 282 Installation and equipment for LNG
100 CEN/TC 326 Gas supply for Natural Gas Vehicles

77.020
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100 CEN European Committee for Standardization

77.040
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98 CEN European Committee for Standardization
99 CEN/TC 132 Aluminium and aluminium alloys
93 CEN/TC 138 Non-destructive testing
100 CEN/TC 190 Foundry technology
100 CEN/TC 209 Zinc and zinc alloys
100 CEN/TC 306 Lead and lead alloys
100 CEN/TC 220 Tin and tin alloys

77.060
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99 CEN/TC 193 Adhesives
100 CEN/TC 262 Metallic and other inorganic coatings
99 Material, equipment and offshore structures for petroleum and natural gas industries
100 CEN/TC 219 Cathodic protection
100 CLC/BTTF 114-1 Protection against corrosion by stray current from direct current systems
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77.080
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99 CEN/TC 262 Metallic and other inorganic coatings
100 CEN/TC 69 Industrial valves
100 CEN/TC 190 Foundry technology

77.100
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100 CEN European Committee for Standardization

77.120
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100 CEN/TC 132 Aluminium and aluminium alloys
100 CEN/TC 133 Copper and copper alloys
99 CEN/TC 190 Foundry technology
100 CEN/TC 209 Zinc and zinc alloys
100 CEN/TC 306 Lead and lead alloys
100 CEN/TC 220 Tin and tin alloys

77.140
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100 CEN/TC 104 Concrete
99 CEN/TC 69 Industrial valves
100 CEN/TC 128 Roof covering products for discontinuous laying and products for wall cladding
100 CEN/TC 168 Chain, rope, webbin, sling and accessories - safety
98 CEN/TC 269 Shell and watertube boilers
100 CEN/TC 190 Foundry technology
100 CEN/TC 50 Lighting columns and spigots
100 CEN/TC 241 Gypsum and gypsum based products
100 CEN/TC 135 Execution of steel structures

77.150
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100 CEN/TC 132 Aluminium and aluminium alloys
100 CEN/TC 133 Copper and copper alloys
97 CEN/TC 128 Roof covering products for discontinuous laying and products for wall cladding
100 CEN/TC 190 Foundry technology
99 CEN/TC 209 Zinc and zinc alloys
94 CEN/TC 50 Lighting columns and spigots
100 CEN/TC 306 Lead and lead alloys
100 CEN/TC 220 Tin and tin alloys

77.160
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100 CEN European Committee for Standardization

100 CEN/TC 240 Thermal spraying and thermally sprayed coatings

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77.180

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100 CEN/TC 190 Foundry technology

100 CEN/TC 322 Equipments for making and shaping of metals - Safety requirements

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79.020

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100 CEN/TC 124 Timber structures

79.040

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100 CEN/TC 38 Durability of wood and derived materials

100 CEN/TC 175 Round and sawn timber

100 CEN/TC 124 Timber structures

79.060

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100 CEN/TC 112 Woodbased panels

100 CEN/TC 124 Timber structures

100 CEN/TC 91 Spanplatten; Formaldehyd

79.080

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99 CEN/TC 112 Woodbased panels

100 CEN/TC 175 Round and sawn timber

100 CEN/TC 124 Timber structures

79.100

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100 CEN/TC 134 Resilient and textile floor coverings

100 CEN/TC 99 Wallcoverings

79.120

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99 CLC/TC 61F Hand-held and transportable electric motor operated tools

100 CEN/TC 142 Woodworking machines - Safety

81.040

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100 CEN/TC 129 Glass in building

81.060

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100 CEN/TC 184 Advanced technical ceramics

100 CEN/TC 67 Ceramic tiles

81.080

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100 CEN/TC 187 Refractory products and materials

81.100

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100 CEN/TC 151 Construction equipment and building material machines - Safety

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83.040

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99 CEN/TC 249 Plastics

97 CEN/TC 194 Utensils in contact with food

100 CEN/TC 298 Pigments and extenders

83.060

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100 CEN/TC 249 Plastics

100 CEN/TC 108 Sealing materials and lubricants for gas appliances and gas equipment

100 CEN/TC 235 Gas pressure regulators and associated safety shut-off/relief devices for use in gas transmission and distribution

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83.080

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100 CEN/TC 249 Plastics

83.100

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100 CEN/TC 249 Plastics

83.120

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100 CEN/TC 249 Plastics

100 CEN/TC 50 Lighting columns and spigots

83.140

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100 CEN/TC 249 Plastics

98 CEN/TC 33 Window, door, shutter, building hardware and curtain walling

100 CEN/TC 128 Roof covering products for discontinuous laying and products for wall cladding

95 CEN/TC 163 Sanitary appliances

100 CEN/TC 108 Sealing materials and lubricants for gas appliances and gas equipment

100 CEN/TC 208 Elastomeric seals for joints in pipework and pipelines

100 CEN/TC 235 Gas pressure regulators and associated safety shut-off/relief devices for use in gas transmission and distribution

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83.160

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100 CEN/TC 141 Pressure gauges - Thermometers - Means of measuring and/or recording temperature in the cold chain

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83.180

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100 CEN/TC 193 Adhesives

100 CEN/TC 67 Ceramic tiles

100 CEN/TC 253 Self adhesive tapes

100 CEN/TC 241 Gypsum and gypsum based products

83.200

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100 CEN/TC 145 Rubber and plastics machines - safety

85.040

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100 CEN/TC 172 Pul, paper and board

85.060

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100 CEN/TC 172 Pul, paper and board

85.080

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100 CEN/TC 172 Pul, paper and board

85.100

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100 CEN/TC 198 Printing and paper machinery - Safety

87.020

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100 CEN/TC 139 Paints and varnishes

87.040

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100 CEN/TC 139 Paints and varnishes

87.060

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100 CEN/TC 139 Paints and varnishes
100 CEN/TC 298 Pigments and extenders

87.100

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98 CEN/TC 139 Paints and varnishes
100 CLC/TC 61F Hand-held and transportable electric motor operated tools
100 CLC/TC 31 Electrical apparatus for explosive atmospheres - General requirements
100 CEN/TC 271 Surface treatment equipment - Safety

100 CLC/SC 31-8 Electrostatic painting and finishing equipment
100 CLC/TC 204 Safety of electrostatic painting and finishing equipment

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91.010

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100 CEN/TC 250 Structural eurocodes
100 CEN/TC 167 Structural bearings

91.020

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100 CEN/TC 325 Prevention of crime by urban planing and building design

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91.040

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100 CEN/TC 152 Fairground and amusement park machinery and structures - Safety
100 CEN/TC 315 Spectator facilities

91.060

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100 CEN/TC 33 Window, door, shutter, building hardware and curtain walling
97 CEN/TC 125 Masonry
98 CEN/TC 89 Thermal performance of buildings and building components
100 CEN/TC 128 Roof covering products for discontinuous laying and products for wall cladding
99 CEN/TC 127 Fire safety in buildings
100 CEN/TC 166 Chimneys
96 CEN/TC 119 Swap bodies for combined goods transport
98 CEN/TC 303 Floor screeds and in-situ flooring in buildings
100 CEN/TC 297 Free-standing industrial chimneys
100 CEN/TC 323 Raised access floors
100 CEN/TC 277 Suspended ceilings

91.080

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93 CEN/TC 139 Paints and varnishes
100 CEN/TC 104 Concrete
100 CEN/TC 250 Structural eurocodes
100 CEN/TC 125 Masonry
100 CEN/TC 124 Timber structures
98 CEN/TC 177 Prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure
96 CEN/TC 219 Cathodic protection
100 CEN/TC 135 Execution of steel structures
100 CEN/TC 297 Free-standing industrial chimneys

91.090
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100 CLC/TC 61 Safety of household and similar electrical appliances
100 CEN/TC 33 Window, door, shutter, building hardware and curtain walling
100 CEN/TC 229 Precast concrete products

91.100
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99 CEN/TC 104 Concrete
100 CEN/TC 67 Ceramic tiles
100 CEN/TC 125 Masonry
100 CEN/TC 88 Thermal insulating materials and products
96 CEN/TC 89 Thermal performance of buildings and building components
100 CEN/TC 154 Aggregates
99 CEN/TC 128 Roof covering products for discontinuous laying and products for wall cladding
100 CEN/TC 51 Cement and building limes
100 CEN/TC 254 Flexible sheets for water proofing
99 CEN/TC 246 Natural stones
100 CEN/TC 177 Prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure
99 CEN/TC 336 Bituminous binders
100 CEN/TC 229 Precast concrete products
100 CEN/TC 303 Floor screeds and in-situ flooring in buildings
100 CEN/TC 241 Gypsum and gypsum based products
99 CEN/TC 314 Mastic Asphalt for waterproofing

91.120

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99 CEN/TC 250 Structural eurocodes

100 CEN/TC 89 Thermal performance of buildings and building components

100 CEN/TC 126 Acoustic properties of building products and of buildings

100 CLC/TC 81X Lightning protection

91.140

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98 CEN/TC 155 Plastics piping systems and ducting systems

97 CEN/TC 164 Water supply

99 CEN/TC 165 Waste water engineering

100 CEN/TC 163 Sanitary appliances

100 CEN/TC 156 Ventilation for buildings

96 CEN/TC 126 Acoustic properties of building products and of buildings

100 CEN/TC 10 Passenge, goods and service lifts

100 CLC/TC 64 Electrical installations of buildings

99 CEN/TC 234 Gas supply

96 CEN/TC 113 Heat pumps and air conditioning units

100 CLC/TC 13 Equipment for electrical energy measurement and load control

100 CLC/SC 64A Electrical installations of buildings - Protection against electric shock

100 CLC/SC 64B Electrical installations of buildings - Protection against thermal effects

100 CEN/TC 130 Space heating appliances without integral heat sources

100 CEN/TC 57 Central heating boilers

100 CEN/TC 109 Central heating boilers using gaseous fuels

98 CEN/TC 295 Residential solid fuel burning appliances

97 CEN/TC 107 Pre-fabricated district heating pipe systems

100 CEN/TC 48 Domestic gas-fired water heaters

94 CLC/TC 215 Electrotechnical aspects of telecommunication equipment

91 CEN/TC 312 Thermal solar systems and components

99 CEN/TC 195 Air filters for general air cleaning

99 CLC/TC 216 Gas detectors

100 CEN/TC 237 Gas meters

100 CEN/TC 228 Heating systems in buildings
100 CEN/TC 105 Valves and fittings to equip radiators
100 CEN/TC 238 Test gase, test pressures and categories of appliances
100 CEN/TC 92 Water meters
100 CEN/TC 171 Heat cost allocation
100 CLC/BTTF 60-3 Electrical equipment of non electrical cooking/heating appliances
100 CEN/TC 46 Oil stoves
100 CLC/BTTF 95-1

91.160
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99 CLC/TC 34Z Luminaires and associated equipment
100 CLC/TC 64 Electrical installations of buildings
100 CEN/TC 169 Light and lighting
100 CLC/BTTF 62-8 Emergency lighting systems

91.180
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100 CEN/TC 99 Wallcoverings

91.190
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100 CEN/TC 33 Window, door, shutter, building hardware and curtain walling

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91.200
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100 CEN/TC 53 Temporary works equipment

91.220
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91 CLC/TC 61F Hand-held and transportable electric motor operated tools
100 CEN/TC 151 Construction equipment and building material machines - Safety
100 CEN/TC 53 Temporary works equipment

93.020

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100 CEN/TC 250 Structural eurocodes

100 CEN/TC 53 Temporary works equipment

100 CEN/TC 229 Precast concrete products

100 CEN/TC 341 Geotechnische Erkundung und Untersuchung

100 CEN/TC 288 Execution of special geotechnical works

93.025

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100 CEN/TC 155 Plastics piping systems and ducting systems

100 CEN/TC 164 Water supply

93.030

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100 CEN/TC 155 Plastics piping systems and ducting systems

100 CEN/TC 165 Waste water engineering

93.040

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100 CEN/TC 250 Structural eurocodes

100 CEN/TC 135 Execution of steel structures

93.060

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100 CEN/TC 151 Construction equipment and building material machines - Safety

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93.080

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100 CEN/TC 227 Road materials

100 CEN/TC 226 Road equipment

100 CEN/TC 50 Lighting columns and spigots

98 CEN/TC 317 Derivates from coal from pyrolysis

100 CEN/TC 169 Light and lighting

100 CEN/TC 178 Paving units and kerbs

100 CLC/BTTF 69-3 Road traffic signal systems

100 CEN/TC 314 Mastic Asphalt for waterproofing

93.100

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100 CEN/TC 256 Railway applications

99 CEN/TC 154 Aggregates

100 CLC/TC 9X Electrical and electronic applications for railways

100 CLC/SC 9XA Communicatio, signalling and processing systems

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93.110

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100 CEN/TC 318 Hydrometry

93.120

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97 CLC/TC 20 Electric cables

100 CLC/BTTF 72-3 Electrical installations for lighting and beaconing of aerodromes

100 CLC/TC 97 Electrical installations for lighting and beaconing of aerodromes

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100 CEN/TC 15 Inland navigation vessels

100 CEN/TC 219 Cathodic protection

97.030

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100 CLC/TC 61 Safety of household and similar electrical appliances

99 CLC/TC 59X Consumer information related to household electrical appliances

100 CLC/BTTF 63-1 Safety requirements for mains operated electronic and related apparatus for household and similar general use

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97.040

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100 CLC/TC 61 Safety of household and similar electrical appliances

99 CEN/TC 194 Utensils in contact with food

99 CLC/TC 59X Consumer information related to household electrical appliances

100 CEN/TC 44 Household refrigerating appliances and commercial refrigerated cabinets
99 CEN/TC 181 Dedicated liquefied petroleum gas appliances
100 CEN/TC 49 Gas cooking appliances
99 CEN/TC 295 Residential solid fuel burning appliances
100 CEN/TC 106 Large kitchen appliances using gaseous fuels
100 CEN/TC 281 Appliance, solid fuels and firestarters for barbecueing
100 CLC/BTTF 60-3 Electrical equipment of non electrical cooking/heating appliances

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97.060

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100 CLC/TC 61 Safety of household and similar electrical appliances
100 CLC/TC 59X Consumer information related to household electrical appliances
100 CEN/TC 214 Textile machinery and machinery for drycleanining and industrial laundry
100 CEN/TC 299 Gas-fired sorption appliances and domestic gas-fired washing and drying appliances

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97.080

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100 CLC/TC 61 Safety of household and similar electrical appliances
100 CLC/TC 59X Consumer information related to household electrical appliances

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97.100

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97 CLC/TC 61 Safety of household and similar electrical appliances
99 CLC/TC 59X Consumer information related to household electrical appliances
100 CEN/TC 180 Non-domestic gas-fired overhead radiant heaters
97 CEN/TC 58 Safety and control devices for gas-burners and gas-burning appliances
100 CEN/TC 181 Dedicated liquefied petroleum gas appliances
99 CLC/SC 64B Electrical installations of buildings - Protection against thermal effects
99 CEN/TC 57 Central heating boilers

100 CEN/TC 295 Residential solid fuel burning appliances

98 CEN/TC 247 Controls for mechanical building services

100 CEN/TC 179 Gas-fired air heaters

100 CEN/TC 62 Independent gas-fired space heaters

100 CEN/TC 46 Oil stoves

100 CLC/BTWG 70-1 Charging controls for storage heating appliances

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100 CLC/TC 72 Automatic controls for household use

100 CLC/TC 205 Home and Building Electronic Systems

100 CLC/SC 205A Mains communicating systems

100 CEN/TC 247 Controls for mechanical building services

97 CLC/TC 203 Electronic entertainment and educational systems for household and similar use

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97.130

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100 CEN/TC 44 Household refrigerating appliances and commercial refrigerated cabinets

100 CEN/TC 291 Self-service shopping trolleys

97.140

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100 CEN/TC 207 Furniture

100 CEN/TC 222 Feather and down as filling material for any articl, as well as finished articles filled with feather and down

99 CEN/TC 252 Child use and care articles

99 CEN/TC 293 Technical aids for the disabled persons

100 CEN/TC 324 Castors and Wheels

97.145

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100 CEN/TC 165 Waste water engineering

100 CLC/TC 78 Equipment and tools for live working

100 CEN/TC 93 Ladders

97.150

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100 CEN/TC 134 Resilient and textile floor coverings
93 CEN/TC 127 Fire safety in buildings
100 CEN/TC 217 Surfaces for sport areas

97.160
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100 CEN/TC 248 Textiles and textile products
100 CEN/TC 222 Feather and down as filling material for any articl, as well as finished articles filled with feather and down
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97.170
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100 CLC/TC 61 Safety of household and similar electrical appliances
100 CLC/TC 59X Consumer information related to household electrical appliances
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97.180
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97 CEN European Committee for Standardization
100 CLC/TC 61 Safety of household and similar electrical appliances
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97.190
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97 CEN/TC 261 Packaging
100 CEN/TC 207 Furniture
100 CEN/TC 158 Head protection
100 CEN/TC 252 Child use and care articles

97.195
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100 CEN European Committee for Standardization

97.200
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95 CLC/TC 61 Safety of household and similar electrical appliances
100 CEN/TC 136 Sport, playground and other recreational equipment
98 CEN/TC 207 Furniture

100 CEN/TC 52 Safety of toys
97 CLC/TC 64 Electrical installations of buildings
99 CEN/TC 181 Dedicated liquefied petroleum gas appliances
99 CLC/SC 64A Electrical installations of buildings - Protection against electric shock
100 CEN/TC 152 Fairground and amusement park machinery and structures - Safety
100 CEN/TC 315 Spectator facilities

97.220

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98 CEN/TC 162 Protective clothing including hand and arm protection and lifejackets
100 CEN/TC 136 Sport, playground and other recreational equipment
92 CLC/TC 64 Electrical installations of buildings
100 CEN/TC 217 Surfaces for sport areas
98 CEN/TC 169 Light and lighting
100 CEN/TC 329 Tourism services
100 CEN/TC 315 Spectator facilities

Appendix B – Manuals for Integrating Research and Standardisation

Part I

Integrating research and standardisation – Guidelines for research organisations

Who should read this?

This guide has been designed to help researchers and organisations active in R&D, i.e. universities, research organisations and companies, to understand the relationship between research and standardisation, in order not only to successfully integrate their research results into standardisation, but also to learn about the options standardisation and standards provide for their research activities.

The guide will cover the following topics:

- How does an organisation or individual conducting research benefit from standardisation work?
- What are the incentives for researchers and research organisations to participate in standardisation?
- Which problems and barriers can be expected at the level of researchers and research organisations regarding the transfer of research results into standardisation, and how can they best be dealt with?
- What transfer mechanisms can help to optimise the interface between research and standardisation?
- How can these mechanisms be applied in practice and what aspects are to be considered?

The recommendations presented in this document are based on findings of the INTEREST project. INTEREST is a Specific Targeted Research Project (STReP) under the 6th Framework Programme (FP6). The INTEREST project conducted indicator-based analyses, a survey among researchers funded under the 5th Frame-work Programme and case studies in organisations active in R&D. The research was conducted by a consortium coordinated by the Fraunhofer Institute for Systems and Innovation Research (DE) and the project partners Dialogic (NL), the STEP Centre for Innovation Research (NO), RWTH Aachen (DE) and the National Physi-cal Laboratory (UK).

More information about this project may be found at:

http://www.interest-fp6.org

Standardisation – An overview

"Standards are not only technical questions. They determine the technology that will implement the Information Society, and consequently the way in which industry, users, consumers and administrations will benefit from it."

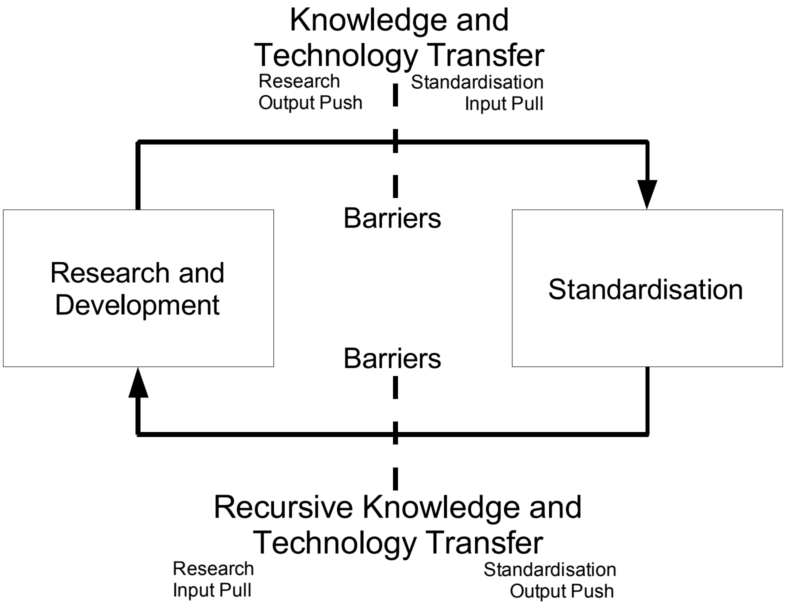
You can hardly put it more aptly than this quotation taken from a document published by the European Commission on 'Standardization and the Global Information Society'. Information and communication technologies will have a profound impact as the major enabler in the move from an industrial society to an information society and then to a knowledge society. Yet this transition will only take place reasonably smoothly if adequate standards are in place, which take into account not only the technical aspects, but also the characteristics of the specific environment within which they will have to function. This aspect, the fit between the state-of-the-art of technology and the context of use, represents one side of the phenomenon "standard". The other side highlights the process of creating and continuously maintaining the standard. This process involves the search for consensus between different parties, which can consist of companies, user organisations, and public authorities, but also public or private research institutes or universities can participate in this consensus process if they so choose.

The opportunities for individuals and their organisations to engage in this process of consensus are manifold. These days, a web of SDOs (Standards Developing Organisations) at national, regional or global level issue what is commonly referred to as 'de jure' standards – although none of their standards have official regulatory power. Examples of such SDOs are ISO and ITU at the global level, ETSI (European Telecommunications Standards Institute) and PASC (Pacific Area Standards Congress) at regional level, and ANSI (American National Standards Institute) and BSI (British Standards Institution) at the national level.

Likewise, a plethora of industry forums and consortia (a recent survey found more than 400), such as the WWW consortium, the ATM forum, and the Open Group, to name but a few of the well known ones, produce so-called 'de facto' standards. As a result, an almost impenetrable maze of what are generally called 'standards' exists, ranging from company-specific rules, over regional and national standards and norms, up to globally accepted standards.

Both formal SDOs and informal consortia together make up the world of standardisation and together comprise the group of standard-setting bodies (SSB). This maze of standard-setting bodies' (SSB) standards have one common denominator, i.e. their output is shaped by the standardisation input of knowledge and research results that are fed into the process, and additionally by the needs and interests of the parties involved. Research is not necessarily conducted with the aim to transform the results into standards. Such research is being performed, though, in the cases of pre- and co-normative research which is carried out with the specific goal of integrating the findings into standards. Still, other research can also be relevant to standardisation work, sometimes even without the researchers and their organisations being aware of it. The relation between research and standardisation can be described by the knowledge and information flows between the two realms, as shown in figure 1.

Figure 1: The relation between research and standardisation



This interaction of research and standardisation can be described in terms of knowledge and technology transfer. In one direction, research output is input to standards, in the other direction standards are a source of information for the research communities. In both directions, specific barriers exist that impede this transfer of knowledge.

Codified vs. tacit knowledge

Codified knowledge refers to the knowledge that is embedded in patents, scientific papers or reports, products, prototypes and instruments developed in R&D. Tacit knowledge refers to knowledge that stems from the practice of research and experimental development but is hard to put into words and is embodied in individuals and partly also in implicit routines of organisations. This "practitioner knowledge" plays an important role in the link between research and standardisation.

The benefits of standards and standardisation for organisations active in R&D

Research organisations mostly benefit from the effect of networking with other organisations through standardisation work and solving specific problems, like measurement and testing problems. Companies also benefit from the ability to shape the content of standards.

One of the major benefits encountered by research organisations that participate in standardisation is the resulting higher number of links to other organisations of different types. The INTEREST survey shows that universities and private research institutes feature higher collaboration intensity with companies and universities compared to organisations not active in standardisation. Moreover, active standardisation work is especially valuable for contacting with industry partners interested in similar topics.

Companies mostly benefit from standards in terms of new market opportunities, long-term profits and coordination. In this respect, formal standards have a positive impact on

- the reduction of production costs,
- the reduction of transaction costs,
- company cooperation, e.g. outsourcing of R&D and production processes,
- on internal communication, e. g. globalisation of R&D and production processes,
- the diffusion of new products and services,
- the variety of multi-component products and systems, and
- export sales.

This positive impact can be maximised if companies integrate their research output into standardisation, thus shaping future standards. Moreover, and probably more importantly, standardisation work can provide companies with the opportunity to actively shape new markets.

Standardisation work is not only beneficial for organisations. Individual researchers can also gain from standardisation work. Accordingly, R&D managers should also identify and highlight these benefits for individual employees during training and provide incentives to engage in standardisation work.

Incentives are keys

Keys to successful standardisation work: raise the awareness of researchers and developers for the associated benefits and provide incentives for them to become actively involved in standards setting.

The link between research and standardisation – Leveraging the results of research for research organisations and companies

In order to successfully transfer research results into standardisation, an organisation has to be aware of the relevance of the different types of standards in different research contexts.

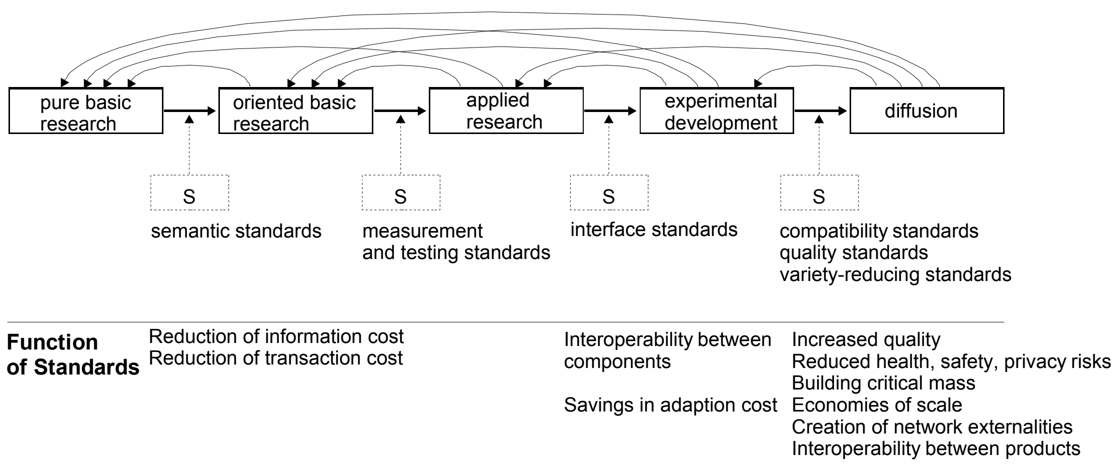
Standards become increasingly important, the closer a research activity is to the market.

This is linked to researchers' levels of interest in standards-setting. While basic researchers are less inclined to participate in standardisation, applied researchers are more frequently involved, and experimental developers top the list.

Frequently, standards from different 'domains' can be associated with the different categories of research (see figure 2). Typically, terminology and semantic standards are the first ones to be developed in a new area of technology, followed by standards for measurement and testing. Quality and safety as well as compatibility standards are the standards closest to the market.

One recent example for this succession of standards is nanotechnology. At the moment standardisation work is highly focused on terminology, measurement and testing. Only few organisations already consider quality and safety and compatibility in nanotechnology as the next field of standardisation activities.

Figure 2: A linear model of research and standardisation activities



Organisations performing **basic research** like universities and some public research organisations are predestined to engage in standardisation processes that relate to terminology, metrology, measurement and testing. Terminology standards have a generic character and may not provide a direct benefit, but an involvement may provide benefits indirectly. Research organisations that want to engage in standardisation work regarding terminology will have a good chance to network with organisations active in applied research or experimental development. Still, research organisations have to be aware of the specificity of their research field. In the field of ICT, compatibility standards are also highly relevant for the work of researchers and may provide additional opportunity for beneficial standardisation work.

Applied research is mostly performed by public and private research organisations and companies. The focus of applied research is to transform the results of basic research into prototypes and products that can be introduced to the market at a later stage. Applied researchers are, therefore, optimally positioned for standardisation work. Applied research organisations, especially Research and Technology Organisation (RTO; for example, Fraunhofer, TNO, etc.), stand to benefit from standardisation work. According to the European Association of Research and Technology Organisations (EARTO), the typical task of RTOs regarding standards is certification with a special focus on metrology. Organisations highly involved in applied research can benefit from activities in standardisation work for measurement and testing, from work relating to interface standards, as well as from providing services for certification. Applied research organisations benefit from standardisation work by contacts to other types of organisations, like universities and industry. This widens the opportunities to raise awareness for their research in industry and to pick up promising research trends in basic research.

Organisations active in **experimental development** also have to consider the role of standards in markets for new products and services. The strong focus on the market also highlights the importance of quality and safety standards, as well as compatibility standards. Especially in network industries like ICT, standardisation work concerning the latter type of standard can provide knowledge advantages for the organisation. Furthermore, influencing specifications towards own preferences and capabilities creates a competitive advantage compared to the companies not actively involved in standardisation.

Reasons for participation in standardisation work

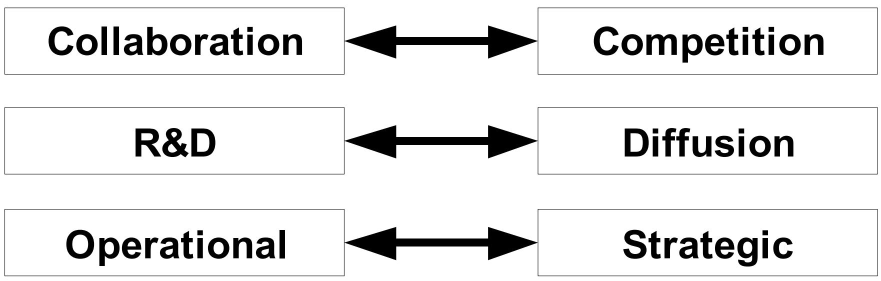
For an organisation interested in standardisation work, it is interesting to know why other organisations participate and what the main drivers for participation are. The motivation to participate in standardisation work is mainly driven by the perceived opportunities for both the research organisations and the individuals.

The most important opportunities to participate in standardisation are:

- Solution of specific technical problems
- Improved cooperation and strengthening links to other researchers and developers
- Improved dissemination of research results
- Improved chance of "future" funding
- Signal knowledge and capability to other actors

For a research organisation, these opportunities provide complementary options to the more general benefits that have been discussed above. The opportunities for organisations to participate in research can be described by the motives that organisations successfully apply in standardisation. These motives can be described according to opposing drivers for participation as in figure 3. An organisation should shape their standardisation work or strategies according to the goals they want to achieve.

Figure 3: Types of opportunities for research organisations in standardisation



Collaboration vs. Competition

Standardisation work is usually an activity that integrates a number of stakeholders. This provides an opportunity to improve cooperation and to strengthen links to other researchers. Standardisation work can also provide competitive advantage; it increases technical know-how developed during the standardisation process. Also, observing the other R&D organisations working on the same standard can yield knowledge that can be used towards a competitive advantage.

Collaboration	Competition
• foster new links to other organisations • improve existing cooperation with other organisations • identify organisations with similar research mission • identify partners for collaborative research projects • use standards as instrument of transparency	• monitor activities of researchers and experimental developers • increase lead-time advantage in new markets • increase lead-time advantage and technical know-how respective to non-participants

R&D (input) vs. Diffusion (output)

Standardisation activities help to actively disseminate research results. Even though standardisation work does not produce new knowledge per se, it helps to organise or structure existing knowledge and disseminate it among other participating organisations. Organisations active in standardisation therefore can both expand or enrich their knowledge and disseminate their knowledge at the same time.

From prototype to product through standardisation

The opportunity to solve specific technical problems in standardisation can help research organisations to turn their "prototypes" into "products" and at the same time raise the chances to shape the markets for these products.

Regarding development activities, standardisation provides the opportunity to solve specific technical problems. Standardisation work provides the opportunity to test prototypes, products or instruments required for research in an environment beyond the closed-off environment of an R&D laboratory or facility.

Standardisation work can also improve the chances of future funding. This holds especially true for organisations that want to apply for research programmes where standardisation activities can be an integral part of a project.

Standards lower R&D risks and costs

Organisations can lower their R&D risks and costs through standards and standardisation. When a company can influence the content of standards to its advantage, the risk is lower in the following development processes. The cost of R&D, especially in sequential innovation processes, can be reduced when the participants in standards work make their results generally available and further research can build upon it.

R&D (input)	Diffusion (output)
• address specific technical problems • test prototypes in standard-compliant settings and improve them • frequently match own technology with that of other participants • increase chance of future funding • reduce cost and risk of R&D • use standards as source of information	• improve dissemination of research results • foster commercialisation of research results • improve trade opportunities by shaping standards

Operational vs. strategic perspective

Standardisation work can also be approached from both an operational and a strategic perspective. Operational aspects relate to internal matters of the organisation like transaction costs or the adaptation of production processes. Organisations active in standardisation have an advantage in being better prepared for upcoming standards and the changes in related processes to allow continuous conformity.

Reducing liability risk through standards

Because standards reflect the current state of technology, they can help organisations to reduce their product liability risk. In questions of liability, legislators often fall back on a general clause which specifies that technical products are to be designed to recognised technical rules, such as standards.

Strategic aspects of standardisation relate to changes in the environment of the organisation or major changes in the position inside this framework, the shaping of future markets etc. Also, strategic aspects are more aimed at long-term changes with an external focus, like influencing regulatory frameworks or shaping future markets, while the operational perspective aims at short-term changes with an internal focus.

Operational	Strategic
• reduce transaction costs • reduce product liability • lower adaptation costs for standardised solutions	• influence regulatory framework • shape future technical fields • shape future markets • prevent proprietary solutions • increase reputation of the organisation and the individuals involved

Barriers and solutions to integrating research and standardisation

Standardisation work requires dedicated efforts (e.g. time, money and the will to engage in a process of negotiation with other stakeholders to finally settle on a consensus), and sometimes barriers need to be overcome. Some of these relate to researchers' and developers' awareness of the issues surrounding standards and standardisation, and the problem of the integration of their tacit knowledge into the standards process. Also, the right standardisation body needs to be selected in order to meet a specific goal. Fortunately, there are strategies to overcome some of these barriers for organisations willing to invest in standardisation.

Generally, the barriers to participation can be divided into three broad categories:

- resources required for participation (money, time, personnel, etc.)
- standardisation process (length, flexibility, IPR rules, integration of input, etc.)
- awareness and visibility of standards and standardisation (awareness of benefits, links to SSBs, helpdesks, etc.)

Usually some of the barriers are closely related, for example, certain aspects of the standardisation process such as the resources for participation or the awareness of the benefits of standardisation work affect the will to invest in participation. Also differences between research fields can be huge in terms of awareness.

Barriers, mutual adjustments and process knowledge

Not all barriers can be overcome by research organisations and companies alone. It is these barriers that tend to be the most crucial ones for research organisations. Long-lasting standardisation processes and the lack of resources like personnel and money are the strongest barriers in standardisation. A sustainable solution to these problems requires the cooperation of standards bodies. Still, the time required for standardisation, and the associated costs can be reduced by e.g. choosing the most appropriate type of standardisation output. This, in turn, requires adequate knowledge of the world of standards-setting.

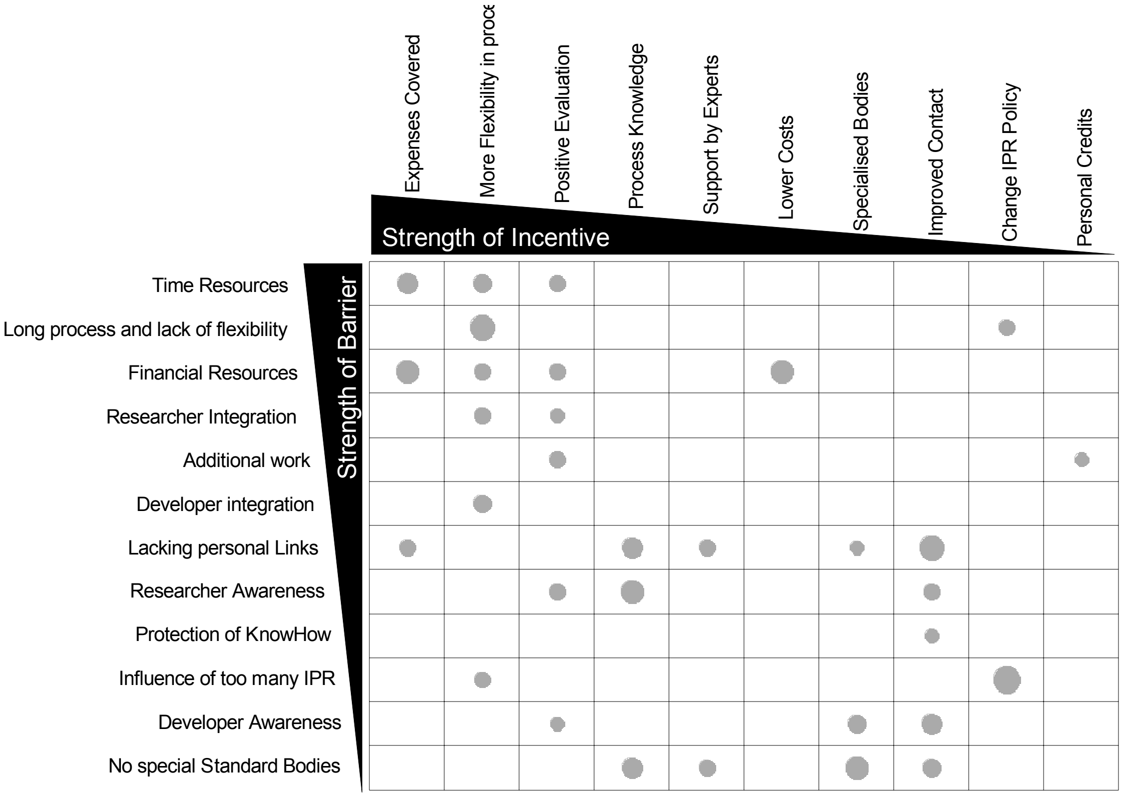
The barriers concerning cost of participation are among the strongest ones. At first sight, research organisations have only limited influence on the cost of standardisation work. However, research organisations have some degrees of freedom in shaping the cost of participation. One option is to have a closer look at the membership criteria of SSBs. Some formal bodies allow public research organisations or universities to participate "for free" as long as they can cover the expenses of personnel and travel. Moreover, research organisations also benefit indirectly by a higher chance to engage in projects and R&D collaborations with multi-national companies and thereby raise the chance of funding to cover additional expenses. Also, research organisations can choose between different types of deliverables available in certain standardisation bodies. One example is CEN workshop agreements which require less time and therefore fewer resources to establish. Most standardisation bodies provide such types of deliverables (see annex). Additionally, those organisation that seek to benefit from contacts to other organisations, like universities seeking contact to firms in their field, can check if it is possible to participate as observers rather than as full members.

Apart from problems relating to barriers that stem from the organisation of standardisation processes, some problems are genuinely rooted in the research realm. Most prominently, these include researchers' lack of awareness of the potential benefits of active participation in standards-setting, and the lack of incentives for researchers to actually participate.

The problem of awareness can be solved by informing researchers and developers of the benefits discussed above. A more fundamental way to solve this problem is to educate them regarding standardisation and the benefits they may derive from this work. Some of these benefits are not necessarily related to immediate personal benefits for the researchers, but are more geared to the – rather more 'anonymous' – benefits for the employer, and perhaps for society at large. Explicit recognition of active contributions to standards-setting would be a very good approach to overcome these barriers. In research organisations like universities, one means is to include standardisation work in the evaluation of individual researchers.

Regarding the problem of incentives, the INTEREST project compiled a matrix of problems and solutions based on the INTEREST survey. Figure 4 represents the relationship between the problems perceived by researchers and the solutions that would raise their propensity to participate in standardisation work.

Figure 4: The Problem-Solution Matrix (dot size represents strength of the problem-solution linkage)



Obviously, a positive evaluation of standardisation work sharpens the awareness of researchers and developers who perceive a number of barriers, like the additional workload and the time required. This incentive for participation is especially strong in the case of basic researchers and applied researchers. Research managers have to evaluate carefully which of these incentives are valuable for the individuals. This can be very different between research fields or types of organisation.

Designing incentives for researchers

Incorporating standardisation work in evaluations of researchers addresses a number of barriers and can lead to a higher propensity to participate in standardisation work. Educating researchers can raise their awareness for standards and standardisation work.

Honouring standardisation work should also make sense from the organisations' point of view when considering the benefits an organisation can gain from standardisation activity, like the opportunity to raise funding, acquisition of projects with companies or improved collaboration with other organisations.

Transfer mechanisms to bridge the gap between research and standardisation

In the following, mechanisms will be described that can help R&D organisations to integrate their tacit knowledge into the standardisation process, and to benefit from successful standards. Some of these mechanisms have not yet been put into practice, but should help devise ways of integrating the tacit knowledge of R&D organisations into standardisation. After all, these mechanisms have been successfully applied in other contexts of knowledge and technology transfer, and are therefore also worth considering in the transfer of knowledge from research to standardisation. The tacit component of knowledge, i.e. the knowledge of practitioners, can be crucial for successful standardisation. This is especially true in the case of new and emerging technological fields, and in fields that are very dynamic. Many of the benefits of standardisation activities are closely linked to the tacit knowledge that is available in an organisation and ultimately at the level of individuals. The mechanisms discussed here have to be considered in the context of the research organisation or company. Some of the mechanisms might not be suitable for certain types of organisations or in certain technical and scientific fields. Therefore, examples are provided as to how these abstract mechanisms might be directly put into practice. The focus of knowledge transfer will be on aspects of tacit knowledge that can proactively be used by research organisations to intensify the link between research and standardisation.

Standardisation culture

Most RTOs and also most SMEs follow a project-based approach to standardisation, i.e., standardisation activities are closely linked to short-term project-based activities. However, the INTEREST case studies found that the organisations that go beyond project-driven standardisation activity stand a better chance to benefit from the positive effects of standardisation work. Such organisations should consider how to establish their standardisation strategy, and slowly establish a "standardisation culture" in their organisation. The best way to establish such a culture is to raise the perceived value of standards as sources of information and, at a later stage, to provide the incentives discussed above to participate in standards-setting. One sample element of such a culture would be to maintain a list of implementers of specific standards.

A list of implementers of standards can help to raise the awareness and relevance of standards, and eventually trigger interest in standardisation work.

Such a list could provide a common ground for internal discussion on the standards and provide synergies between research departments and generally raise the importance and relevance of those standards. Moreover, such lists could help establish coherent implementations of standards across products or prototypes.

Participation

This is obviously one of the most direct ways of transferring research results into standardisation. Still, even if researchers are interested in standards and perceive the benefits of participation, the problem remains which standardisation organisation to join and where to participate. At the end of this document you will find a four-step guide on how to find the right standardisation body.

Informal contacts

Informal contacts are crucial in research and industry. The chat between sessions at a scientific conference with interesting researchers from the same (or sometimes completely different) fields can lead to new insights or ideas to conduct research. The industry contacts of applied researchers made during a trade show. The post-doc wanting to be hired by industry and knows who to contact for job opportunities. Examples are numerous. Standardisation can also be a vehicle to establish such contacts. Especially researchers from universities who want to interact more closely with industry can benefit greatly from participation in standardisation work, especially if they are interested in the big players in their fields.

Exchange of personnel

Exchange of personnel between research organisations and standardisation organisations can also intensify the relationship between research and standardisation. In this case, the main benefit for the organisation is to acquire process knowledge of standardisation processes that can then be the basis to inform other researchers and developers interested in standardisation work.

Dual positions

Dual positions is a mechanism that facilitates long-term relations between research and standardisation organisations. Dual positions allow an organisation to monitor ongoing standardisation activities and coordinate standardisation work from a perspective that includes both the ongoing research activities at the research organisation as well as ongoing standardisation activities at the standardisation body.

Sharing facilities

Another way to integrate research and standardisation is by sharing facilities of research and standardisation organisations. Research results being tested in specific standardisation facilities, e.g. test beds or certification centres that do not aim directly at certification of the products in question, but rather as a means of researching how new prototypes fit into existing standards.

Education and training

The dimension of education and training in a cooperative way might also help to mediate the flows of tacit knowledge in the future and also provide a solution to the incentives we categorised as support-focused. By integrating standardisation into the education system, and thereby also partly into the research system, knowledge about the benefits of standardisation as well as the process of standardisation will be leveraged.

As we found that helpdesks seem to be a weak incentive, the natural integration of research and standardisation by education may yield more positive results, which will lead to a better integration of both realms in the future. While the short-term perspectives are mostly aimed at interactions that do not intervene with the organisational setting of research organisations, the long-term perspective requires adaptations regarding research (and education) organisations.

Implementing the manual in practice. Who can do what and what must be considered?

This chapter is mostly aimed at R&D managers and should provide a guideline on how to organise standardisation involvement. Still, it can also provide valuable information for individuals who want to engage in standardisation and want informed themselves before approaching employers.

Not all of the aforementioned mechanisms can be applied by the same actors. Apart from the fact that some mechanisms require combined efforts from research and standardisation, different involvement on different institutional levels is also required in research. Basically, four levels can be identified. These four levels are the level of the research field, of the research programmes, of the organisation and of the individuals. All the levels have to be considered for a successful transfer of research results into standardisation. Also, the interactions of the levels must be taken into account. Some steps can be skipped in certain cases. Generally, the stronger the strategic orientation in R&D, the more crucial it should be to follow all the steps.

Step 1: The R&D field

On the level of the research field the most important task is to evaluate which types of standards are generally used in the research field. In some fields standards might play a rather marginal role, whereas in others standards have a huge impact on the field, like in the case of ICT. The assessment of the overall relevance of standards in a research field can help to guide the decision to engage in standardisation activities. Moreover, it might be relevant to consider the source of these standards. A good approach is to find answers to the following questions:

- How relevant are standards in your field of research?
- Are the standards used in the research field established by formal bodies like ETSI, CEN, CEN/ELEC, ISO or national standardisation bodies?
- Are certain aspects in a research field covered by formal organisations where other aspects are covered by consortia?
- Do formal or informal bodies "compete" for certain areas of technology in your research field?

Answering these questions can provide a quick overview over the field and also in a second step help to evaluate the role of standards in general and certain types of standards as well as the sources of these standards used in your organisation. This step might prove to be less trivial than it looks, but knowing more about the standardisation area will provide good decision criteria when in later steps the decision on how and where to get involved must be taken.

Step 2: Standards in your organisation

Armed with the information which standards are relevant and where they come from, the next step is to examine your organisation and assess the standards used in your organisation. In contrast to the more general evaluation of the field, it is important to take the context of your R&D activities into account. Such aspects are the type of organisation, i.e. university, company, public or private research organisation and the orientation towards basic research, applied research or experimental development. In case you are not engaged in R&D directly, you should strongly consider consulting your R&D staff in answering the following questions. Suitable guiding questions for this task are:

- Does your organisation use the most common standards used by other organisations of the same type in your R&D field?
- What standards are used by organisations with the same orientation regarding basic or applied research or experimental development?
- Do other types of organisations with a different orientation use different types of standards?
- Do you plan to interact more closely with other types of organisations using certain standards?
- Which individuals could be involved in standardisation activities? Approach them and ask for specific interests. Also consider the mechanisms to provide incentives discussed above.

You can benefit in two ways by evaluating these questions. First, you get a better impression of your own orientation towards standards in contrast to other organisations of similar or different nature and second, if you find that standards only play a marginal role in your organisation, whilst standards are important in other organisations in your field, you can compile a set of potential allies to commence standardisation activities with.

If you have followed the steps so far, you should have a fairly good impression of "what is going on" in your research area regarding standards. Apart from that, and maybe even more importantly, you may already have an impression which standardisation bodies are important in your field and whose standards are relevant in your organisation. These are the bodies you should turn to in case you want to engage in standardisation.

Step 3: Sources of funds and internal resources

Naturally, standardisation activities require resources, as already discussed above. Here it is important to distinguish between project-based approaches and long-term institutional approaches to standardisation. Regardless of your approach to standardisation, you should also check for the membership criteria of the standardisation body you are interested in. These modalities can vary greatly among the different SSBs. If you are interested in engaging in formal standardisation on European or international level, you should contact your national formal body for advice and further information.

- Determine the type of activity you want to engage in (full standard, workshop agreement) and try to estimate the associated cost based on membership fees, number of meetings to attend and cost of personnel.

If the focus of your organisation is strongly towards project-based R&D, look at the funding principles of the funding organisations you rely on the most. If these organisations do not provide the opportunity to cover standardisation activities, you should consider raising internal funds. Unfortunately, at present funding covering standardisation work is rare, with the exception of the European Commission. If your approach is aimed at long-term involvement, you should strongly consider using one of the mechanisms described above to strengthen your links to the standardisation organisations you are interested in and raise internal funds.

Step 4: Aligning interests and getting involved

Finally, you should evaluate the interests of the individuals identified in step 3 in the process and the incentives involved. Aligning the agenda of the organisation and the incentives of the potential participants will help you to become successfully involved in standardisation and reap the benefits from it.

Annex A: An overview of Standardisation Bodies and their Practices

This section will briefly discuss some examples of noteworthy attempts towards an improved integration of research output into standardisation.

IEEE

The Institute of Electrical and Electronics Engineers (IEEE) is not really a standards-setting body (SSB), rather it is a not-for-profit professional association for the advancement of technology that happens also to be active in standardisation. The IEEE Standards Association (IEEE-SA) is one of the IEEE's five 'technical communities'. Their activities are limited to various engineering domains, with foci on 'Instrumentation & Measurement', 'Power & Energy', and, perhaps most prominently, on ICT (here, especially the 802 series of standards). IEEE-SA offers both individual and corporate membership. Currently, over 20,000 people are working on IEEE standards. Non-members may contribute to standards, but are barred from voting. Membership in the IEEE is not a pre-requisite for SA membership.

IETF

Despite its highly-valued informality, the Internet Engineering Task Force (IETF) has – at the organisational level – established comparably formal links to the research community. The Internet Research Task Force (IRTF) "*investigates research topics related to the Internet protocols, applications, and technology*"[1]. IRTF is composed of a number of focused, long-term, small research groups (RGs[2]). Rules are in place for the formation of RGs; the proposed work has to be relevant, and an RG charter is required (identifying the chair(s), mailing list address, RG description, and membership policy). Membership of IRTF is strictly on a per-individual basis.

It is interesting to note that the output of the individual RGs is supposed to be both publishable in academic journals and useful as input to the IETF's working groups (WGs). That is, input to standardisation is not the sole purpose of an RG, and possibly not always the most important one. Rather, IRTF assumes the role of a facilitator; they aim

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1 The quotes are taken from Weinrib, A.; Postel, J.: IRTF Research Group Guidelines and Procedures, RFC 2014, October 1996, ftp://ftp.isi.edu/in-notes/rfc2014.txt.

2 At the time of writing (Sept. 2006), 13 RGs are active; http://www.irtf.org.

to foster “*cross-organizational collaboration, help to create a critical mass in important research areas, and add to the visibility and impact of the work*”.

Yet relevance of its research to the Internet community is the foremost criterion a proposed RG has to meet. However, input from IRTF is handled in the same way as any other input to IETF’s standards-setting process.

DIN

DIN, the German National Standards Organisation, promotes the concept of ‘R&D phase standardisation’[3]. “Many new technical systems are developed with such rapidity that standardisation in its traditional form cannot adequately keep pace“[4]. To accommodate such technologies, DIN have introduced new deliverables (TRs, PASs) and underlying ‘lightweight’ processes. These processes are supposed to work in parallel with R&D efforts. They allow adopting a proactive approach to standardisation at a very early stage of the R&D process. Obviously, this requires a “much higher involvement on the part of R&D experts”. Also, the approach aims at teaching the R&D stakeholders “to see standardisation in a new light: as an instrument that can be usefully applied to areas of rapid innovation and technological transfer”. Areas in which work has been done include, among others, laser technology, integrated optics, microsystems, information technology, environmental technology, and services.

Another, very different approach was the foundation of a ‘Research Network Standardisation’. This network aimed to support innovation and market acceptance of technologies through standardisation. A major difference was that this network was supposed to do research *about* standardisation (as opposed to research *for* standardisation).

CEN

CEN are running two activities relating to the interface between research and standardisation. One is CEN/STAR (Standardisation & Research). Having recognised that standardisation and R&D are interdependent, STAR aims to identify R&D work necessary to support standardisation, through both co-normative and pre-normative research

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3 This is similar to co-normative research. The major difference being that ‘R&D phase standardisation’ is triggered by R&D projects, whereas CNR is typically initiated by an SDO.

4 All quotes are taken from http://www.ebn.din.de/index.php?lang=en&na_id=ebn.

(CNR and PNR, respectively)[5]. They collect and register from all CEN/TCs specific needs for research that would assist the standards-setting process; these needs are subsequently prioritised. This prioritised list is communicated to the EC for potential future funding. The process of needs elicitation is supported through 'Trends Analysis Workshops', which aim to identify needs for new standards and for pre-normative or co-normative research[6]. The focus here is on projects that are co-sponsored by the European Commission. In addition, CEN/STAR is working towards a higher level of recognition of the importance of standards, and of the role research is playing in this context.

CEN workshops are a more generic tool to bring R&D closer to standards-setting. For medium-length projects (about 2 – 3 years), they offer the opportunity of developing standards (in the form of CEN Workshop Agreements, CWAs) within the lifetime of the project (which may be very helpful, given the EU's current funding policies for R&D projects).

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5 CNR interacts directly with ongoing and/or planned standardisation activities. PNR relates to activities which are likely to generate new matters for standardisation.

6 The COPRAS project (http://www.w3.org/2004/copras/) represents a complementary attempt. It aims to help IST projects to identify their potential for standardisation, and assists them in actually contributing to standards.

Recommended literature and information sources

INTEREST Project Deliverables

D01 – Literature Survey

http://www-i4.informatik.rwth-aachen.de/Interest/D01.pdf

D02 – Report on the results of the survey among researchers

http://www-i4.informatik.rwth-aachen.de/Interest/D02.pdf

D03 – Report on the results of the indicator analysis

http://www-i4.informatik.rwth-aachen.de/Interest/D03.pdf

D04 – Report on Case Studies

http://www-i4.informatik.rwth-aachen.de/Interest/D04.pdf

D05 – Draft Taxonomy of the link between Research Standardisation

http://www-i4.informatik.rwth-aachen.de/Interest/D05.pdf

D 09 – Final taxonomies and manuals

http://www-i4.informatik.rwth-aachen.de/Interest/D09.pdf

Interesting Links (to Cordis etc + FhG etc, era-watch etc)

A Sectoral e-Business Observatory

http://www.ebusiness-watch.org/

Cordis

- news services

  http://cordis.europa.eu/guidance/services4.htm
- information services

  http://cordis.europa.eu/guidance/services2.htm
- R&D-related link compilation

  http://cordis.europa.eu/guidance/links.htm
- search

  http://cordis.europa.eu/search/index.cfm
- ERA link

- http://cordis.europa.eu/eralink/home_en.html

IPR helpdesk

http://www.ipr-helpdesk.org/index.html

Papers

Several papers addressing various issues relating to the link between research and standardisation have been published. Please contact

Knut Blind (Knut.Blind@tu-berlin.de)

Stephan Gauch (stephan.gauch@isi.fraunhofer.de)

for further information.

Abbreviations

CEN	European Committee for Standardisation
CWA	CEN Workshop Agreement
DIN	Deutsches Institut für Normung
ESO	European Standards Organisation
ETSI	European Telecommunications Standards Institute
FP	Framework Programme
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEEE-SA	IEEE Standards Association
IETF	Internet Engineering Task Force
IFIP	International Federation for Information Processing
ISOC	Internet Society
IST	Information Society Technologies
PAS	Publicly Available Specification
R&D	Research & Development
RG	Research Group
RTO	Research and Technology Organisation
SDO	Standards Developing Organisation
SSB	Standards-Setting Body (i.e., either a (formal) SDO, or a standards consortium/ forum)
STAR	CEN Standardisation and Research
TC	Technical Committee
TR	Technical Report
WG	Working Group

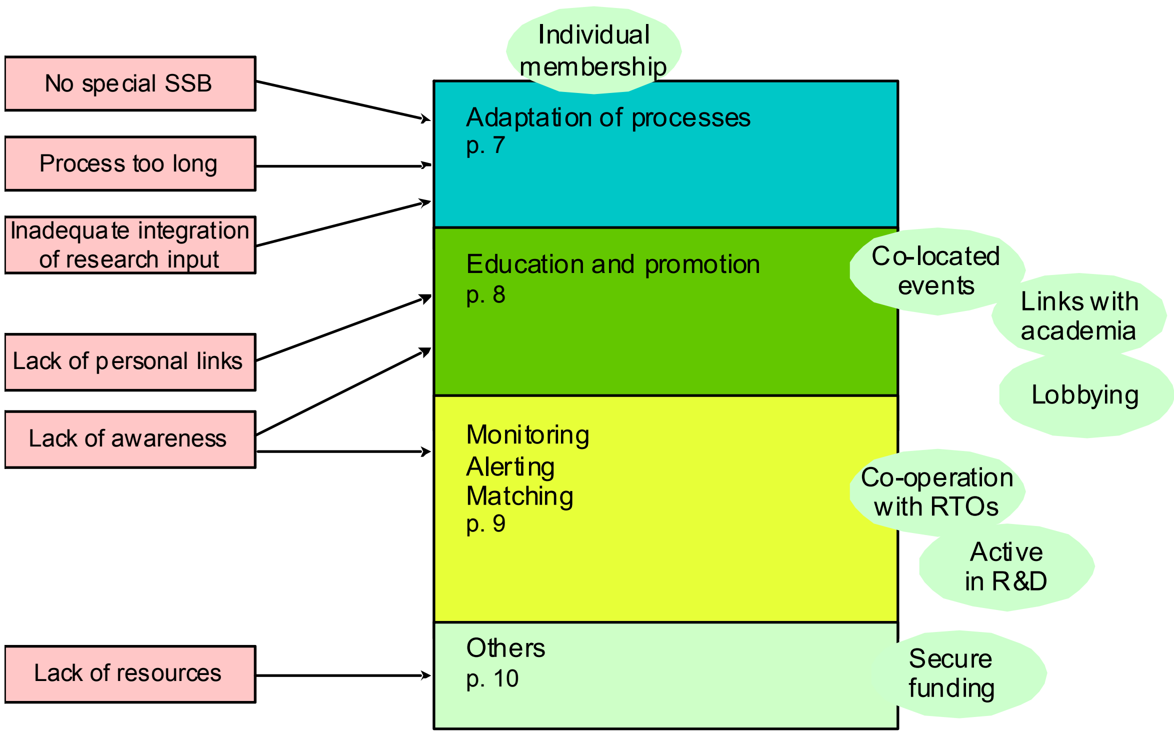
Part II

Integrating research and standardisation – Guidelines for standardisation organisations

Integrating Research and Standardisation
– What Standards Setting Bodies Could Do –

This document provides standards setting bodies with guidelines how to better incorporate findings from R&D activities into ongoing or future standards projects. Barriers to active participation of R&D people have been identified through a survey of over 500 project leaders of EU-sponsored projects, and 13 case studies. Ways how to overcome these barriers, or at least how to lower them, are identified.

The figure below shows the topics to be discussed in this document. For easy reference you will find the colour coding in the main text as well.



The recommendations presented in this document are based on findings of the INTEREST project. INTEREST is a Specific Targeted Research Project (STReP) under the 6th Framework Programme (FP6). The INTEREST project conducted indicator-based analyses, a survey among researchers funded under the 5th Frame-work Programme and case studies in organisations active in R&D. The research was conducted by a consortium coordinated by the Fraunhofer Institute for Systems and Innovation Research (DE) and the project partners Dialogic (NL), the STEP Centre for Innovation Research (NO), RWTH Aachen (DE) and the National Physi-cal Laboratory (UK).

More information about this project may be found at:

http://www.interest-fp6.org

Some introductory remarks

Standards are a proven mechanism for technology transfer, fostering the diffusion and utilisation of technology. They are also an important aspect of various fields of policy, like innovation, trade and environmental policies, play a vital role in the European market by promoting competitiveness and interoperability of products and services, and serve to protect consumers, health, safety of citizens and employees, and the environment. Standards are, therefore, the bridge between the technical domain and the economic, social and regulatory framework.

The development of new and improved (European) standards requires high quality technical information. This creates a fundamental inter-dependency between the standardisation and research communities. Research can, and should, support the development of new and improved standards through the provision of objective technical information. Standards Setting Bodies[1] (SSBs), in turn, need to effectively and efficiently deploy this information.

The need for a closer link from research to standardisation has also been recognised, for example, by the European Standards Organisations (ESOs):

> *"In the ICT domain, the link between R&D and standardization is of particular importance; standardization is in a position to leverage the consensus reached within an R&D project at the European and/or international level .....".*

Figure 1 shows the relation between research and standardisation in technology transfer.

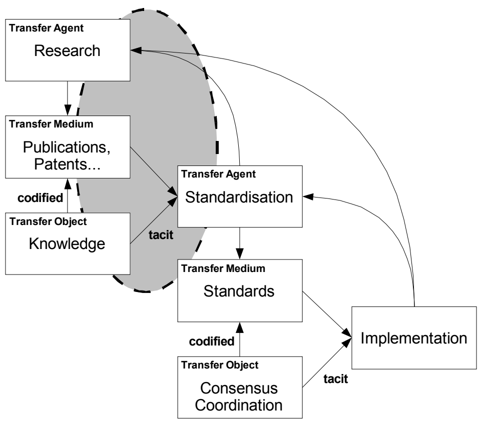


Figure 1: Research and Standardisation in a Simple Technology Transfer Model
Source: INTEREST Project, Deliverable 2, 2006

The grey-shaded area represents the domain where the activities of R&D and standardisation meet. The figure also shows that the two representations of knowledge (i.e., codified and tacit) can be transferred from R&D to standards setting. In particular, the transfer of tacit knowledge requires involvement of researchers in standardisation.

As it currently stands, there is ample (anecdotal) evidence that many publicly funded R&D projects fail to generate any sustainable impact simply because their findings do not make it

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[1] This term denotes both formal Standards Developing Organisations (SDOs, e.g., ISO, CEN, ETSI), and standards consortia/fora (e.g., the World Wide Web consortium or the OpenGroup).

[3] Please note that this document does not distinguish between different types of research conducting organisations (i.e., universities, Research and Technology Organisations (RTOs), and companies). Nor does it

back into the public domain (from where the funding came in the first place). In many cases, standardisation would be a very appropriate vehicle.

Improving standards through integration of research results

One can think of various new or improved ways of transferring knowledge from research to standardisation (see also below for some examples). Yet, to be successful a mandatory pre-requisite must not be ignored – the transfer needs to be mutually beneficial. That is, both the researcher and the corporate research manager will eventually ask "What's in it for me/us?". And they will expect convincing answers. To come up with such an answer, SSBs can quote the very real benefits participation in standards setting offers both individual researchers and organisations conducting research[3].

Motivations and barriers

For organisations, participation in standardisation offers the (strategic) prospect of re-shaping existing markets, or of the creation of new ones. In addition, it will give participating organisations the opportunity to influence technology in their favour, which in turn may give them a head start once the standard has been accepted. Moreover, participation in standards setting may serve as a means of intelligence gathering and, not unlike joint research efforts, help reduce R&D costs. Last, but unfortunately probably not least, preventing the emergence of a standard may also be a motive for participation[4].

For the individual researcher, the standards setting arena is a very effective forum for establishing co-operations among researchers, between (academic) researchers and industry, and between different industry partners. A recent survey by the INTEREST project has shown that standards setters show a higher intensity in collaborations than non-standards setters. Moreover, this forum can also serve as a monitor: first-hand knowledge of new developments and personal relations can be gained. These features alone should make participating in standardisation a worthwhile activity for many researchers. Also, at least in the ICT sector well-respected standards setters are very much sought after.

Also, over the last couple of years many SSBs, most notably the European bodies, have improved their processes, and/or introduced new ones, to meet their stakeholders' demands. In particular, the new 'lightweight' processes are highly suitable for standards initiatives emerging from (publicly funded) R&D projects with a limited life span. Yet, the barriers to active participation in standards setting as identified by the R&D community suggest that very little has changed in their perceptions of how standardisation works. To overcome these barriers is a major issue since direct participation in standards setting by researchers is crucial as it is the only way to tap into their invaluable tacit knowledge.

Thus, it seems that the information supply ('push'; see Figure 2 below) from the research community to the R&D community needs to be improved. It is for the standards community – who essentially present the demand side – to actively 'pull' researchers and research input into standardisation. SSBs have to find mechanisms that increase the original motivation of researchers to participate, remove the barriers where possible, and offer some additional

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distinguish between the different types of research (i.e., basic research, applied research and experimental development).

[4] SSBs will not be too keen to point this out, though.

[7] 'Request for Comments' – the Internet's series of specifications. Internet standards are part of this series.

incentives. Obviously, this is not a trivial task – researchers are primarily interested in the discovery of something new, not in the transposition of their findings into standards (which is frequently considered boring and a waste of time).

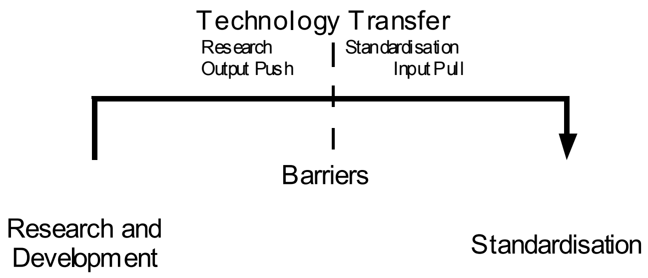


Figure 2: Information flows between research and standardisation
Source: INTEREST Project, Deliverable 2, 2006

Figure 3 shows a list of 'motivators' that could increase researchers' willingness to participate in standards setting. The statements shown were given in response to the survey question:

"I would consider participating in a standard-setting process ...
(please tick the five most important statements)".

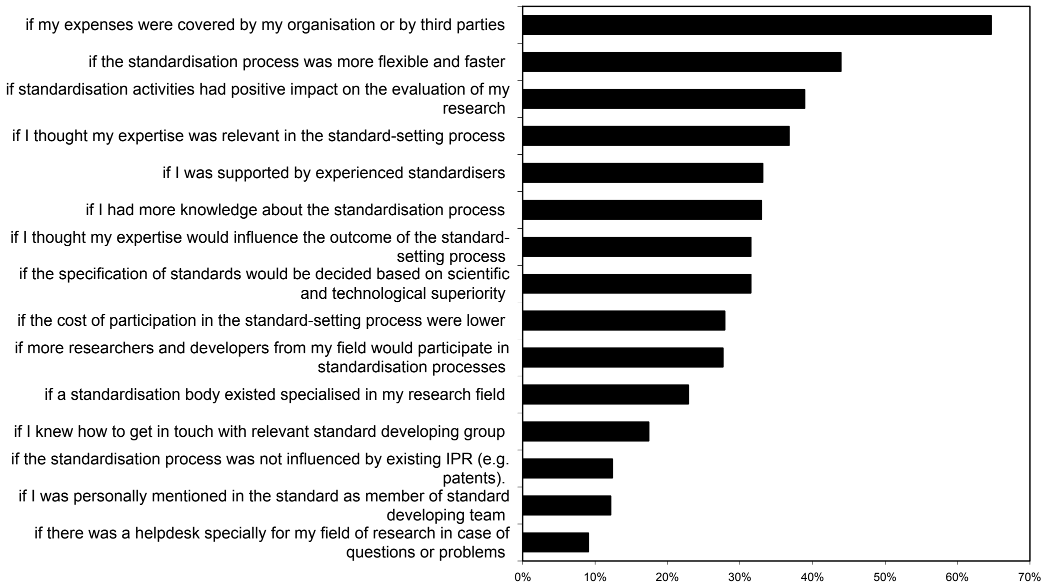


Figure 3: Most efficient incentives for participation in standardisation
Source: INTEREST Project, Deliverable 2, 2006

In contrast, Table 1 summarises these perceived barriers and the suggested high-level mechanisms to overcome them.

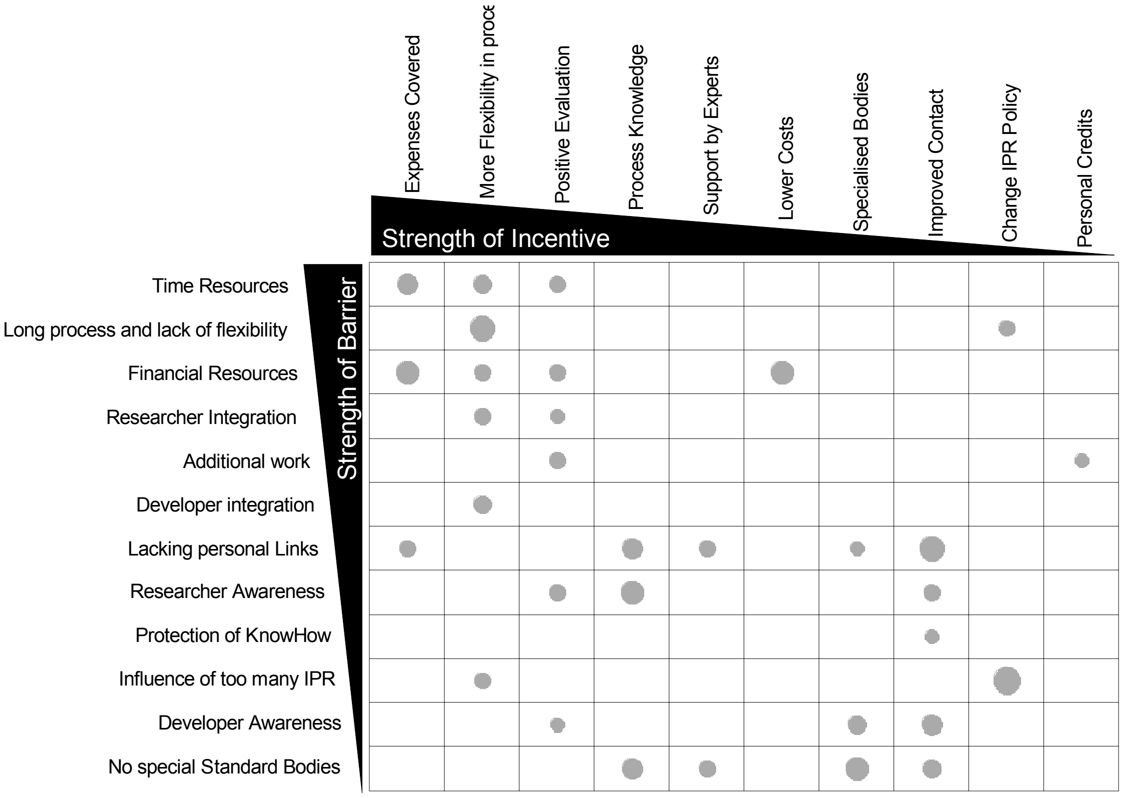


Table 1: Significant Relationships between Problems and Solutions
(dot size represents strength of the problem-solution linkage)
Based on: INTEREST Project, Deliverable 2, 2006

The four most important barriers to researchers' participation in standards setting include (each perceived by over 35% of the respondents; see Figure 3 above):

- My expenses are not covered by my organisation or by third parties.
  This is the most important barrier by far. Funding for standards setting activities is rarely (if ever) included in funding for R&D activities. Here, the funding organisations may have to revise their policies, e.g., by also taking into account, through co-funding, the time it takes to turn R&D results into standards. This holds particularly for publicly funded research.

- The standardisation process is not flexible and fast enough.
  Especially over the last couple of years many SDOs have streamlined their processes introduced new deliverables that emerge through fairly unbureaucratic, flexible and fast processes. It appears that the SDOs (most notably the ESOs) need to better communicate such improvements to their stakeholders.

- Standardisation activities do not have a positive impact on the evaluation of my research.
  It is indeed correct that contributions to standards have little or no impact on a researcher's recognition by his/her peers, and on chances for promotion or for better funding. Closer links between the two communities might help improve this situation.

- My expertise is not relevant in the standards setting process.
  Comments from SDOs suggest that an improved link from R&D to standards setting would be most desirable. This is further highlighted by the current (early 2007) initiative

by the ITU-T to improve their links with academia. Here again, this misconception could be clarified by a better communication by the SSBs.

The following section will elaborate on these – and other identified – issues, and will suggest a range of activities SSBs could embark upon to improve the links between standards setting and research.

What SSBs can do – mechanisms to bridge the gap between research and standardisation

The major obstacles identified by researchers (see Figure 2 above) may be grouped as follows (only those are listed that can at least partially be remedied by SSBs; we consider IPR-related aspects to be out of scope in this context):

- Inadequate process (for researchers' needs).
  This covers the issues 'R&D personnel integration', 'long process' ('time resources'), 'no special SSB'.
- Lack of awareness (on the side of R&D personnel).
- Lack of personal links to SSBs.

In the following, courses of action will be proposed that should help overcome these obstacles. Yet, the ramifications of these actions will be much broader, and should generally help improve SSBs' processes.

Adaptation of Processes (to address 'integration', 'long process', and 'no special SSB')

From the researchers' perspective, standardisation processes will need to be better adapted to their specific requirements to make active participation a realistic and worthwhile option. This has two aspects to it – time and flexibility. First, the processes as such would need to be shorter – few researchers are interested in spending too much time on committee work (a lack of information / relevant education may well contribute to this; see also below). Here, the leaner processes leading to 'New Deliverables' that have been introduced by several ESOs and other bodies should be very useful. Also, reducing the sequentiality of R&D and standardisation would be helpful ('co-normative research'), as would a higher level of pro-active standardisation.

Second, the rather static structure of formal technical committees (e.g., CEN TC/WG, or equivalent) should be extended to accommodate new topics that are not being dealt with by existing technical committees – the necessity to establish a new WG or Work Item before R&D results can be fed into the standardisation system typically implies a considerable delay before work can commence. However, as the creation of a Work Item prior to starting activity is one of the obligations behind the transparency required in the good practices of standardisation, as defined in particular by the WTO, it cannot be omitted. Ways need to be devised that satisfy both the good practices and the researchers' requirements. Related to this are new topics that could be associated with more than one TC; in such situations, additional delays are likely to occur until the TCs involved have come to an agreement. Ad-hoc groups, following the same procedures as 'normal' WGs but (initially) operating outside the TC/WG structure might be a solution here. Here as well, mechanisms like 'Workshops' (CEN; see Annex A) or 'Industry Specification Groups' (ETSI) that deploy a leaner process than formal technical groups and can be also established on an ad-hoc basis are a simple yet efficient tool. Such existing mechanisms, however, need to be better promoted in the research community.

The direct transformation of research results into workable standards will hardly be possible in most cases. Rather, research findings typically need to be complemented by real-world implementation experience (obviously, this does not hold for terminology standards). This could initially be based on 'New Deliverables', revised versions of which that incorporate such experience could then be fed into the 'traditional' process.

Monitoring and Alerting Service (to address 'Awareness' and partly 'lack of personal links')

R&D on the one hand, and standardisation on the other, are widely perceived as two entirely distinct and separate activities; the respective communities are largely unconnected. This is one of the major obstacles in the way of a better utilisation of research findings in standards setting. To overcome this problem, an improved flow of information between the communities would be a helpful first step. That is, SSBs need to monitor ongoing R&D initiatives in order to find potentially relevant activities, and to actively 'alert' the R&D community about any needs they have and opportunities they can provide. While this is being done in a limited way, further improvements are of paramount importance. To this end, a dedicated entity (MAM – monitoring, alerting, matching; see below), possibly operated jointly by several SSBs, could serve as a 'gateway' between the communities (see Figure 3; the ITU-T's 'technology watch' would be a simple representative of such an entity).

In the following, this entity's tasks will be discussed in some more detail.

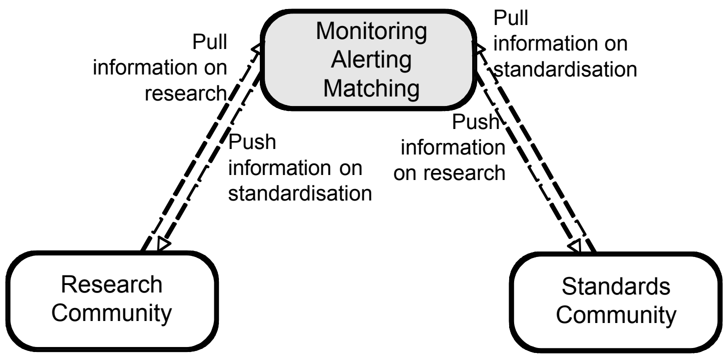


Figure 4: A one-stop-shop for information on research and standardisation activities

Monitoring of R&D Activities

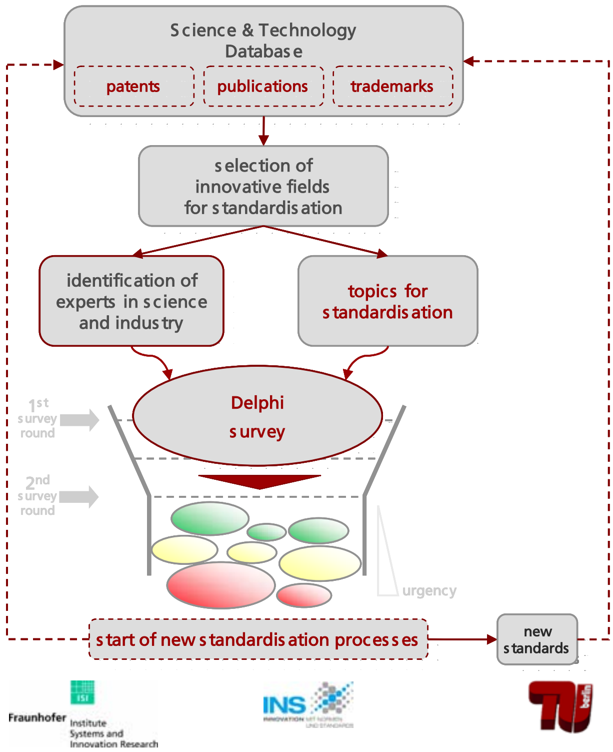
Learning about current R&D trends and activities is essential for SSBs for several reasons. For one, it will provide information on ongoing activities that are of potential relevance for ongoing standardisation activities (see also 'Matching' below). Moreover, incorporating (cutting edge) research findings will help attract researchers, which, in turn, will further improve the technical quality and relevance of the standards. Also, such information may help identify new areas of standardisation, and to initiate activities accordingly. Even with more mature technologies timely knowledge about plans for new projects will offer SSBs the opportunity to incorporate research findings from the outset (this may be important for standards maintenance). R&D organisations are performing similar exercises to identify promising new fields of research and active researchers.

Such monitoring may deploy various information sources. Most publicly funded research programmes, whether at national, European, or international level, maintain public web sites from which information about individual projects can be retrieved. The same holds for conferences. At the European level, policy documents, white and green papers, and other documentation indicating future R&D trends and research policies are available.

In the following box a new approach conducted in Germany is presented, which is an active monitoring process trying also to integrate or commit researchers more actively in standardisation processes.

Identification of innovative standardisation fields in Germany

On behalf of DIN, the German Institute for Standardisation, and funded by the German Federal Ministry of Economic Affairs and Technology BMWi, the Fraunhofer Institute for Systems and Innovation Research and the Chair of Innovation Economics at the Berlin University of Technology have developed a methodology to identify promising innovative fields for future standardisation within the programme "Promotion of Innovation and Marketability through Standardisation (INS)". Based on searches in science and technology databases, the areas of technology characterised by strong research activities by, German researchers both in public research organisations, like universities, and in companies actively involved in research, which are competitive on a global scale, are identified. In a first pilot exercise, nanotechnology, security and medical technology have been selected.



Source: Knut Blind and Kerstin Goluchowicz; Fraunhofer ISI and TU Berlin

The database research provides an information source to identify both important issues for standardisation in these three fields, and researchers in public organisations and industry who conduct significant publication and patenting activities, but in general have not yet been actively involved in standardisation. This information is used to perform a two-stage Delphi survey, which aims to identify the most relevant and most urgent future standardisation issues in the selected fields. The two survey rounds allow the involved experts to point to additional issues in the first survey round and to modify their assessments of the first round based on the overall assessments of all researchers. Furthermore, the two-stage process aims to increase the awareness of the research community to the benefits of standards and standardisation and encourage participation in standardisation processes. The final result of the Delphi survey will be a prioritised list of the relevant and urgent future standardisation topics, which will eventually lead to new standardisation processes and standards helping to coordinate innovative future fields.

Alerting of R&D People

Passive monitoring of ongoing and planned R&D activities is necessary but not sufficient. In addition, mechanisms need to be established to actively inform and alert the research community about ongoing and planned standardisation projects. Researchers are not normally aware of these projects, and such an alerting service would be a suitable way to improve this situation. The important bit here is that alerting needs to go beyond the mere publication of information. Rather, the identified target groups need to be actively informed ('information push').

Information to be conveyed would have to include a concise description of the technical goals of the standards project, its status and time frame (also indicating whether or not new input could still be incorporated), and any actively solicited contributions from the research side (if any, that is). Administrative information, such as, for example, contact information, a list of members active in the project, and scheduled meetings should also be made available.

Matching

Monitoring and alerting will help the standardisation and research communities to learn about ongoing relevant activities in the respective other sector. However, with all relevant information available, the new entity could also perform a matching function. It would be in an ideal position to match SSBs' needs for further research onto activities going on at the R&D side. Subsequently, contact between both groups could be established. For instance, researchers could be invited to present their work at a technical committee meeting, or vice versa; i.e., a technical committee representative could present standardisation activities and discuss future potential co-operation at a project meeting.

Education and Promotion (to address 'awareness' and partly 'lack of personal links')

Education of researchers and research managers about aspects relevant (to them) related to standards and standardisation is crucial. If the latter are not aware of the potential benefits of standardisation, researchers and developers will have difficulties obtaining their support for active participation in standards-setting activities, financial or otherwise. Obviously, though, researchers need to be aware of these advantages in the first place.

Apart from raising general awareness of potential benefits education on how, where, and when to participate is essential. Knowing which SSB or committee to address is a major pre-requisite for researchers to effectively join the standardisation process in time. Training researchers in what active participation entails, and possibly how to co-ordinate standardisation activities in their project is the second step. Many organisations involved in standardisation already have effective mechanisms in place how to organise the transfer of research results into standardisation. Their practices could be communicated to others.

To actually reach the research community information needs to be actively distributed and made available on easy-to-find web pages. Corporate and universities' Technology Transfer Departments would be natural contact points here. In co-operation with these departments SSBs can organise dedicated 'information days'

Some more specific suggestions

Numerous mechanisms can be envisaged to implement (aspects of) the above, and thus to improve the link between standardisation and research. These include, for example

- Offer individual membership in SSBs (for researchers)
  While this is being done by several SSBs (most notably by fora and consortia), membership of the ESOs is limited to companies and national bodies, respectively (with the notable exception of CEN workshops). Temporary individual membership would considerably lower the barrier to entry to standardisation for researchers, and would enable them to contribute precisely to those aspects of a standard for which their research is important (i.e., avoid any 'overhead').

- Lobby for greater importance of standards-related aspects in research projects' proposals & evaluation
  Judging by the level by which they support standards-setting activities as part of R&D projects, hardly any research funding organisation considers standards as a legitimate and valuable tool for dissemination, or for the production of sustainable results (the EU being half an exception). SSBs need to try and lobby for a higher degree of importance to be assigned to standards aspects in R&D project proposals. This could be achieved, for example, by a dedicated sub-panel evaluating proposals with respect to their potential and importance for ongoing or future standardisation activities – which, in turn, could be partly based on CEN/STAR's (Standardisation and Research) prioritised needs.

- Try to secure dedicated R&D money for SSBs/ESOs (from research programme budgets)
  After the 'Standards, measurement and Testing' domain has disappeared from the European Framework Programmes (FPs), normative projects need to compete with others for funding under the individual R&D programmes. For a higher percentage of normative research part of an R&D programme's budget could be managed by ESOs (or SSBs) and spent on projects with a potential for standardisation. In Germany, for example, this could also imply that an SSB is assigned the status of a Project Management Agency.

- Hold co-located standardisation and R&D events
  Scientific conferences are important for researchers from almost all disciplines. Thus, by co-locating standards events (formal technical committee meetings or similar) with major (topically related conferences) would give the opportunity to introduce researchers to the problems and benefits of standards setting. This could also be done through promotional activities such as, for example, dedicated workshops, seminars, or 'taster courses'.

- Co-operate with professional associations
  This is related to the above. Co-operation with, for instance, international research umbrella organisations (e.g., IFIP, the Int. Fed. for Inf. Processing, the world-wide umbrella organisation of the national ICT societies) could simplify the information flow from these societies (i.e., the R&D domain) into standards setting.

- Actively participate in (publicly funded) R&D projects
  SSBs playing an active role as partners in research projects could ensure that any standards-relevant output will be channelled to the appropriate committees or working groups. In fact, in many cases such dissemination activities would, in all likelihood, be the major or even the sole task of the SSB (i.e., no actual research work would be required from the SSBs). Projects suitable for such participation could be identified by the MAM entity (basically, a permanent successor of the Copras project).

- Forge closer links with academics / tertiary education (theses; IEC challenge, DIN-Preis, etc).
  "*The students of today are the stakeholders of tomorrow ....*". (Short) courses on standardisation, joint thesis supervision, internships, etc would all help to expose students to standardisation (something that hardly ever happens in an engineering/management curriculum). Likewise, exchange or personnel (e.g., internships for academics, temporary lectureships for SSB staff) should be considered. Dedicated prizes (like he DIN prize for students) or competitions (like the recent IEC challenge) would also be a useful means to attract students.

The above are only some examples of what could be done to improve the link between research and standardisation. In any case, it will be crucial that the SSBs take the initiative.

Current practice – some comments

> **Lessons from a Case Study**
>
> One company names large joint R&D projects as a way to co-ordinate research. As partners publish results early on, patents are not an issue. Thus, the prerequisites for standardisation are also given as the project serves as a test-bed for a new technology.

Many SSBs have developed mechanisms to better link research and the research community to standards setting. In the following, some brief findings from an analysis of 'current practices' will be provided. The Annex provides associated brief descriptions of very different such practices, focussing on DIN and CEN in Europe, and on the IEEE and the IETF at the US/international level.

All but IEEE have dedicated mechanisms in place to provide a link from research to standardisation. Being a professional organisation in the first place, the IEEE Standards Association are benefiting from implicit close links between standards setting and research through IEEE members (typically engineers and computer scientists) also active in standardisation. Obviously, establishing this type of link is a time consuming activity and will hardly be replicable by other SSBs (it might be easier for professional associations to move into standardisation).

> **Lessons from a Case Study**
>
> A best practice example for promoting standardisation within a company, is an intra-net site which lists all available standards combined with information on how and where to participate. This is to be complemented by a forum on standardisation where developers exchange their experiences with standardisation.

The Internet Research Task Force (IRTF) is the 'research arm' of the Internet Society (ISOC). The idea of organising the link from research to standardisation as two partner entities under a common organisational roof is appealing. However, all is not gold that glitters. For one, several of the IRTF's websites appear to be quite outdated. Moreover, between them the current Research Groups have so far only produced four RFCs[7], only one of which (from 2002) has reached the level of 'Proposed Standard'. Most of the output is in the form of ietf/irtf-drafts and, primarily, of research papers. This suggests that the traditional publication of research findings is still held in higher esteem than contributions to the standards setting process (even for those that have a higher-than-average interest in standardisation).

DIN is promoting the idea of 'research phase standardisation'. In principle, this could be a valuable approach to better integrate standardisation and R&D. However, so far it seems that only some publicly funded projects – of which DIN has been a member – have adopted this approach; genuine interest by industry seems to be limited.

CEN/STAR is a CEN Action Group in charge of developing "*a more efficient link between European Cooperative R&D and European standardisation*". A group dedicated to this task is certainly an asset. However, their means are limited, and they have to cover (too) much ground (all topics addressed by CEN). Thus, their effectiveness could certainly be improved, albeit hardly without additional funding.

CEN workshops are a very suitable mechanism to transfer project findings into something akin to a standard (a 'CEN Workshop Agreement'). However, their value could be further increased if dedicated mechanisms were in place to 'elevate' workshop agreements to full 'European Standard' and/or International Standard level (if so desired).

One major difference and one commonality may be observed between the more 'US-centric' approaches (IEEE and IETF) and the 'euro-centric' ones (DIN and CEN). The former refers to the way the link from R&D to standardisation is organised. IEEE's and IETF's approaches are continuous, and to a high degree based on individual, whether explicit (IETF) or implicit (IEEE). In contrast, both DIN and CEN prefer a more formal, temporary, project-based based approach. Seen from a distance, the latter seems to be more successful (albeit not exactly a raving success either). This holds primarily for the CEN workshops.

Brief summary and some additional advice

So far, this document has discussed the relevance of adequate links between standardisation and research, and discussed a number of barriers as perceived by researchers. SSBs can do something about some of these barriers, whereas the resolution of others would require the intervention of other entities (e.g., research funding agencies). Also, some comparably easily implemental mechanisms have been identified that should help improve the current situation. Finally, some comments on the current situation have been provided.

The various potential courses of action discussed above have very different time horizons. To get the ‘monitoring, alerting, matching’ entity up and running may take years, the same holds for the suggested modification of the standards setting processes. In contrast, some of the ‘more specific suggestions’ can be implemented fairly quickly, e.g., the take-up of lobby work, organisation of co-located standardisation and R&D events, the co-operation with professional associations. It would be advisable to start with some rather more short-term activities and evaluate their outcome before starting any major implementation tasks (or modifying the bylaws). In any case, however, SSBs wishing to implement some of these mechanisms need to be aware that it is not natural for researchers to actively participate in standards setting. Thus, adequate communication of any new mechanisms is crucial.

With a view towards long-lasting and sustainable links between standards setting and research, closer links with academia would be highly advisable. Students of relevant disciplines should be exposed to standards, and learn about the importance of standardisation, fairly early on. With the current switch of many national educational systems to a Bachelor/Master system this means that a course about (ICT) standardisation should be part of the Bachelor curriculum. In this context, co-operation between standards professionals and university lecturers would be most helpful for the development of such a course.

Along similar lines, and definitely not least: SSBs need to be aware that knowledge and research *about* standardisation is as important as research *for* standards setting. Especially ICT standards are becoming increasingly important (just think about the ‘Internet of Things’). Therefore, we need to develop an adequate understanding about the various issues surrounding standards and standardisation (their diffusion, adoption, and impact, why they emerge the way they do, how much they cost and what they bring, etc). Remember:

> *”Standards are not only technical questions. They determine the technology that will implement the Information Society, and consequently the way in which industry, users, consumers and administrations will benefit from it.”*

Recommended literature and information sources

INTEREST Project Deliverables

D01 – Literature Survey;
http://www-i4.informatik.rwth-aachen.de/Interest/D01.pdf

D02 – Report on the results of the survey among researchers;
http://www-i4.informatik.rwth-aachen.de/Interest/D02.pdf

D03 – Report on the results of the indicator analysis;
http://www-i4.informatik.rwth-aachen.de/Interest/D03.pdf

D04 – Report on Case Studies;
http://www-i4.informatik.rwth-aachen.de/Interest/D04.pdf

D05 – Draft Taxonomy of the link between Research Standardisation
http://www-i4.informatik.rwth-aachen.de/Interest/D05.pdf

D 09 – Final taxonomies and manuals
http://www-i4.informatik.rwth-aachen.de/Interest/D09.pdf

Interesting Links (to Cordis etc + FhG etc, era-watch etc)

A Sectoral e-Business Observatory
http://www.ebusiness-watch.org/

Cordis

- news services
  http://cordis.europa.eu/guidance/services4.htm
- information services
  http://cordis.europa.eu/guidance/services2.htm
- R&D related link compilation
  http://cordis.europa.eu/guidance/links.htm
- search
  http://cordis.europa.eu/search/index.cfm
- ERA link
  http://cordis.europa.eu/eralink/home_en.html

IPR helpdesk
http://www.ipr-helpdesk.org/index.html

Papers

Several papers addressing various issues relating to the link between research and standardisation have been published. Please contact

Kai Jakobs kai.jakobs@cs.rwth-aachen.de

for further information.

Annex A

Current practice – some examples

This section will briefly discuss some examples of noteworthy attempts towards an improved integration of research output into standardisation.

The IEEE

The Institute of Electrical and Electronics Engineers (IEEE) is not really a standards setting body (SSB). Rather, it is a not-for-profit professional association for the advancement of technology that happens to be also active in standardisation. The IEEE Standards Association (IEEE-SA) is one of the IEEE's five 'Technical Communities'. Their activities are limited to a number of engineering domains, with foci on 'Instrumentation & Measurement', 'Power & Energy', and, perhaps most prominently, on ICT (here, especially the 802 series of standards). IEEE-SA offer both individual and corporate membership. Currently, over 20,000 people are working on IEEE standards. Non-members may contribute to standards, but are barred from voting. Membership in the IEEE is no pre-requisite for SA membership.

The IETF

Despite their highly-valued informality, the Internet Engineering Task Force (IETF) have – at the organisational level – established comparably formal links to the research community. The Internet Research Task Force's (IRTF) goal is to "*investigate research topics related to the Internet protocols, applications, and technology*"[9]. The IRTF is a composed of a number of focused, long-term, small Research Groups (RGs[10]). Rules are in place for the formation of RGs; the proposed work has to be relevant, and an RG charter is required (identifying the Chair(s), mailing list address, RG description, and membership policy). Membership of the IRTF, as IETF's, is strictly on a per-individual basis.

It is interesting to note that the output of the individual RGs are supposed to be both publishable in academic journals and useful as input to the IETF's Working Groups (WGs). That is, input to standardisation is not the sole purpose of an RG, and possibly not always the most important one. Rather, the IRTF assumes the role of a facilitator; they aim to foster "*cross-organizational collaboration, help to create a critical mass in important research areas, and add to the visibility and impact of the work*".

Yet, relevance of its research to the Internet community is the foremost criteria a proposed RG has to meet. However, input from the IRTF is handled in the same way as any other input to the IETF's standards setting process.

DIN

DIN, the German National Standards Organisation, are promoting the concept of 'R&D phase standardisation'[11]. "Many new technical systems are developed with such rapidity that standardization in its traditional form cannot adequately keep pace"[12]. To accommodate such technologies, DIN have introduced new deliverables (TRs, PASs) and underlying

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[9] The quotes are taken from Weinrib, A.; Postel, J.: IRTF Research Group Guidelines and Procedures, RFC 2014, October 1996, ftp://ftp.isi.edu/in-notes/rfc2014.txt.

[10] At the time of writing (Sept. 2006), 13 RGs are active; http://www.irtf.org.

[11] This is similar to co-normative research. The major difference being that the former is triggered by R&D projects, whereas the latter is typically initiated by an SDO.

[12] All quotes are taken from http://www.ebn.din.de/index.php?lang=en&na_id=ebn.

‘lightweight’ processes. These processes are supposed to work in parallel with R&D efforts. They allow adopting a proactive approach to standardisation at a very early stage of the R&D process. Obviously, this requires a “much higher involvement on the part of R&D experts”. Also, the approach aims at teaching the R&D stakeholders “to see standardisation in a new light: as an instrument that can be usefully applied to areas of rapid innovation and technological transfer”. Areas in which work has been done include, among others, laser technology, integrated optics, microsystems, information technology, environmental technology, and services.

Another, very different approach was the foundation of a ‘Research Network Standardisation’. This network aimed to support innovation and market acceptance of technologies through standardisation. A major difference here was that this network was supposed to do research *about* standardisation (as opposed to research *for* standardisation).

CEN

CEN is running two activities relating to the interface between research and standardisation. One is CEN/STAR (Standardisation & Research). Having recognised that standardisation and R&D are interdependent, STAR aims to identify R&D work necessary to support standardisation, through both co-normative and pre-normative research collect and register from all CEN/TCs specific needs for research that would assist the standards setting process; these needs are subsequently prioritised,. This prioritised list is communicated to the European Commission for potential future funding. The process of needs elicitation is supported through ‘Trends Analysis Workshops’, which aim at identifying needs for new standards and for pre-normative or co-normative research[13]. The focus here is on projects that are co-sponsored by the European Commission. In addition, CEN/STAR is working towards a higher level of recognition of the importance of standards, and of the role research is plying in this context.

CEN Workshops are a more generic tool to bring R&D closer to standards setting. For medium-length projects (about 2 – 3 years) they offer the opportunity of developing standards (in the form of CEN Workshop Agreements, CWAs) within the lifetime of the project (which may be very helpful given the EU’s current funding policies for R&D projects).

[13] The Copras project (http://www.w3.org/2004/copras/) represents a complementing attempt. It aims at helping IST projects to identify their potential for standardisation, and assists them in actually contributing to standards.

Annex B

Abbreviations

CEN	European Committee for Standardization
CWA	CEN Workshop Agreement
DIN	Deutsches Institut für Normung
ESO	European Standards Organisation
ETSI	European Telecommunications Standards Institute
FP	Framework Programme
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEEE-SA	IEEE Standards Association
IETF	Internet Engineering Task Force
IFIP	International Federation for Information Processing
ISOC	Internet Society
IST	Information Society Technologies
PAS	Publicly Available Specification
R&D	Research & Development
RG	Research Group
RTO	Research and Technology Organisations
SDO	Standards Developing Organisation
SSB	Standards Setting Body (i.e., either a (formal) SDO, or a standards consortium/ forum)
STAR	CEN Standardisation and Research
TC	Technical Committee
TR	Technical Report
WG	Working Group