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# INTEREST

## Integrating Research and Standardisation

STREP

Priority 8

D03 - Report on the results of the indicator analysis

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| **Dissemination Level** | | |
| **PU** | Public | XXXXXXXX |
| **PP** | Restricted to other programme participants (including the Commission Services) | |
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# Content

# 1. Introduction

The overall aim of this report is to clarify the feasibility of and provide results for an indicator-based approach to the linkage between research and standardisation by developing a matrix linking the science and technology base of companies and their standardisation activities. In contrast to the micro-level approaches followed in D02 of the INTEREST project, using survey data from FP5 project participants, this report covers the utilisation of indicator-based macro-approaches to the overall question regarding the linkage between research and standardisation. Standards as such not have been broadly used as indicators in the broader context of technology analysis as tools to assess the diffusion and emergence of technologies (Blind 2004; Hawkins 1996). However, databases such as PERINORM[1] have proved to be fruitful for approaches dealing with research on standards and standardisation (Blind 2005; Blind, Gauch 2005), but it is (unfortunately) not feasible to use the database to address this special research question on the knowledge flows from research to standardisation. Other approaches that might be based on concordance between different classifications, like an ICS (International Classification of Standards) and the IPC (International Patent Classification) might shed a deeper insight into such approaches but are not available on a detailed and disaggregated level.[2] Other approaches based on citation structures like the analysis of patents citing publications cannot be utilised either, since no coherent standard or patent databases linking patents and standards are available covering a broad range of technical fields.[3] In the light of the above mentioned problems, we chose a different approach, based on available data on the membership of organisations and their representatives in Technical Committees (TC) of formal SDOs (Standards Development Organisations). The analysis thereby describes the links between research and standardisation using information such as membership in TCs, by linking this information to the representation of these organisations and representatives in patent, trademark and publication databases. This information is relevant in two respects. First, it should provide structural information on the links between research and standardisation activities and second, should thereby also provide information on knowledge flows between research and standardisation. Even though such an approach is mostly limited to the description of information flows of codified knowledge, the indica-

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1 PERINORM is a database edited by AFNOR, BSI and DIN covering national and international standards.

2 See the concordance on an aggregated level by Blind (2004).

3 There exist special databases from SDOs like the ETSI patent database which might be used for such purposes, but such analysis would be limited to the telecommunication sector.

tor may also be interpreted as partly covering information flows of tacit knowledge as the indicator is based on the participation in Technical Committees.

The remainder of the report is structured as follows. First a description of the followed approach along with advantages and disadvantages is given. It is discussed which indicators have been chosen to develop a matrix between research output and standardisation input and why these indicators have been chosen. Next, the results of the chosen approach are presented and afterwards discussed in a final concluding section.

## 2. Approach

As described above, our approach is based on participation information in SDOs as well as the portfolio of IPR and scientific output of organisations and their representatives. To collect comparable data on SDOs, the INTEREST project screened publicly available information on TC memberships of European and national SDOs. Unfortunately, only the chairmen of the TCs are available in most cases. Therefore the sample is possibly biased towards important actors in the 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, the INTEREST team chose to limit the analysis to the chairmen of the TCs, which is a systematic covering 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 this project. 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 and publications in commercially available databases. In the case of patents, data from ESPACE Access (DVD Version) was used covering patent applications filed at the European Patent Office (EPO) and patent applications filed at 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 input dimension of the matrix. 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. An overview of the used classification can be found in the Annex. The Technical Committees were categorised according to this classification, based on the title and objective of the TC. 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.[4]

In case of scientific publications, searches were conducted using the Science Citation Index (SCI) available through the host STN. In order to attain an initial overview on the share of publications relevant for standardisation, queries identifying publications with either "standards", "standardization" or "standardisation" in the publication title were conducted. Such publications might be interpreted as directly addressing standardisation as a key issue of the content of the publication. A closer inspection of this data revealed that standardisation can have a multitude of meanings diverging from the meaning of standardisation used in this project. Standardisation therefore also describes mathematical procedures, procedures in medical research and is often used as a synonym for calibration of instruments etc. Still the amount of publications identified as being concerned with standardisation or standards is comparably low, with around 1 or 2 publications per 1,000 publications over all technical fields and for each timeframe. Moreover, queries using the representative name together with the organisation name were conducted to analyse which of the Chairmen are active in publication activities. In contrast to the approach followed in the patent analysis, the INTEREST team did not conduct searches using the organisation name only, since this would lead to an inconsistent picture especially regarding universities which have a tendency to broad "publication portfolios" compared to companies, due to the fact that university researchers have more degrees of freedom regarding their research. In contrast, research activities of companies are more focused towards certain aspects of research which will also be covered by their patenting activities. Still, some tests were conducted with a random sample of chairing organisations with very inconsistent results which did not produce interpretable output. Moreover, we considered measuring the involvement of European SDOs in research by querying the SCI for abbreviations and full names of ETSI, CEN and CENELEC. This approach had to be dismissed, due to the fact that CEN is also

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4 In the Community Innovation Survey, around one third of the companies also apply for patents.

very often used as abbreviation for "centre" in the SCI. Even though searches were conducted using CEN in conjunction with Belgium as country of origin the results could not be cleaned adequately.

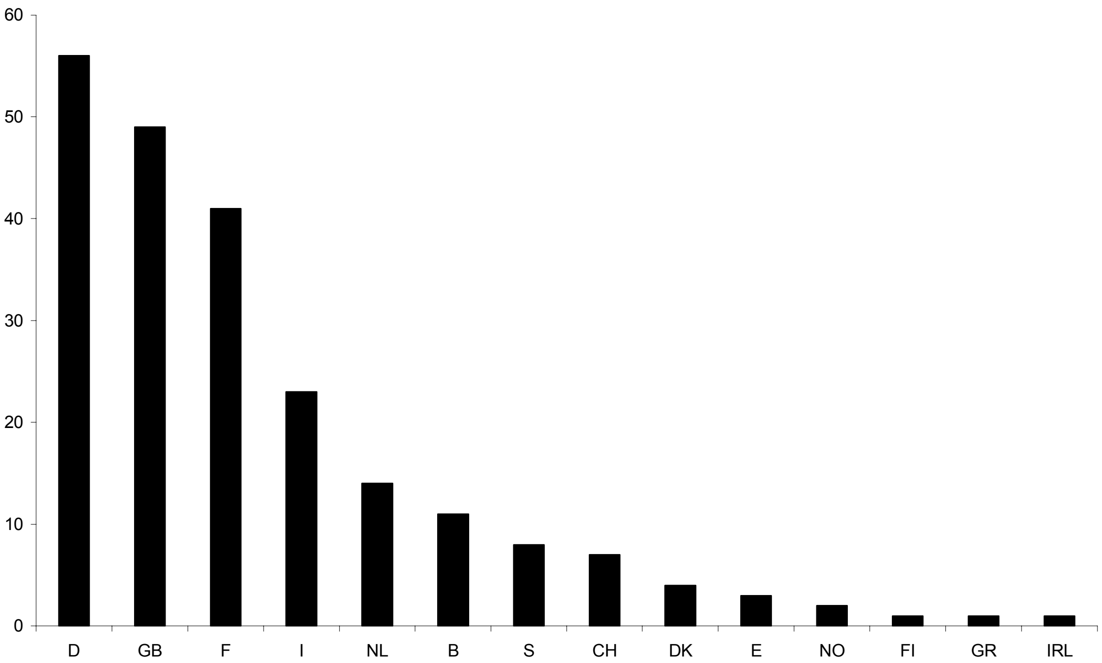
Moreover, searches in trademark databases were conducted analysing both international registrations filed at the WIPO and European community trademarks filed at the Office of Harmonization for the Internal Market (OHIM), using databases hosted by Questel Orbit. Still the absolute number of results was too low and too biased towards companies to yield meaningful results. Moreover analyses based on trademarks are better suited for the analysis of research/commercialisation links due to their market focus. It was therefore concluded to exclude them from the report.

Overall, it was concluded that patents as an input indicator into the standardisation process produced the most stable and valid results. The matrix of research output and standardisation input therefore is based on the patent analyses.

# 3. Results

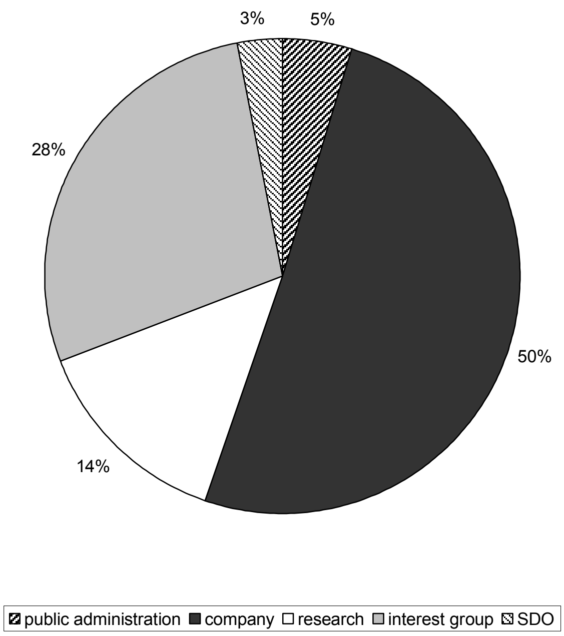
In order to attain a better overview over the sample, some simple statistics were conducted regarding the type of organisation and the country the organisation is located. Regarding the countries a strong dominance of organisations from Germany, the United Kingdom and France is clearly visible. Even though one might argue that especially regarding multinational companies such information is only partly valid, it nevertheless shows that standardisation is dominated by organisations from some countries. It also has to be kept in mind that the country information is only available for the chairing organisations. More insight could be gathered if complete member lists were available.

**Figure 3.1. Distribution by countries of origin of participating organisations in formal standardisation at CEN, CENELEC and ETSI in 2005 (TC chairing organisations only) (Source: INTEREST, Fraunhofer ISI)**



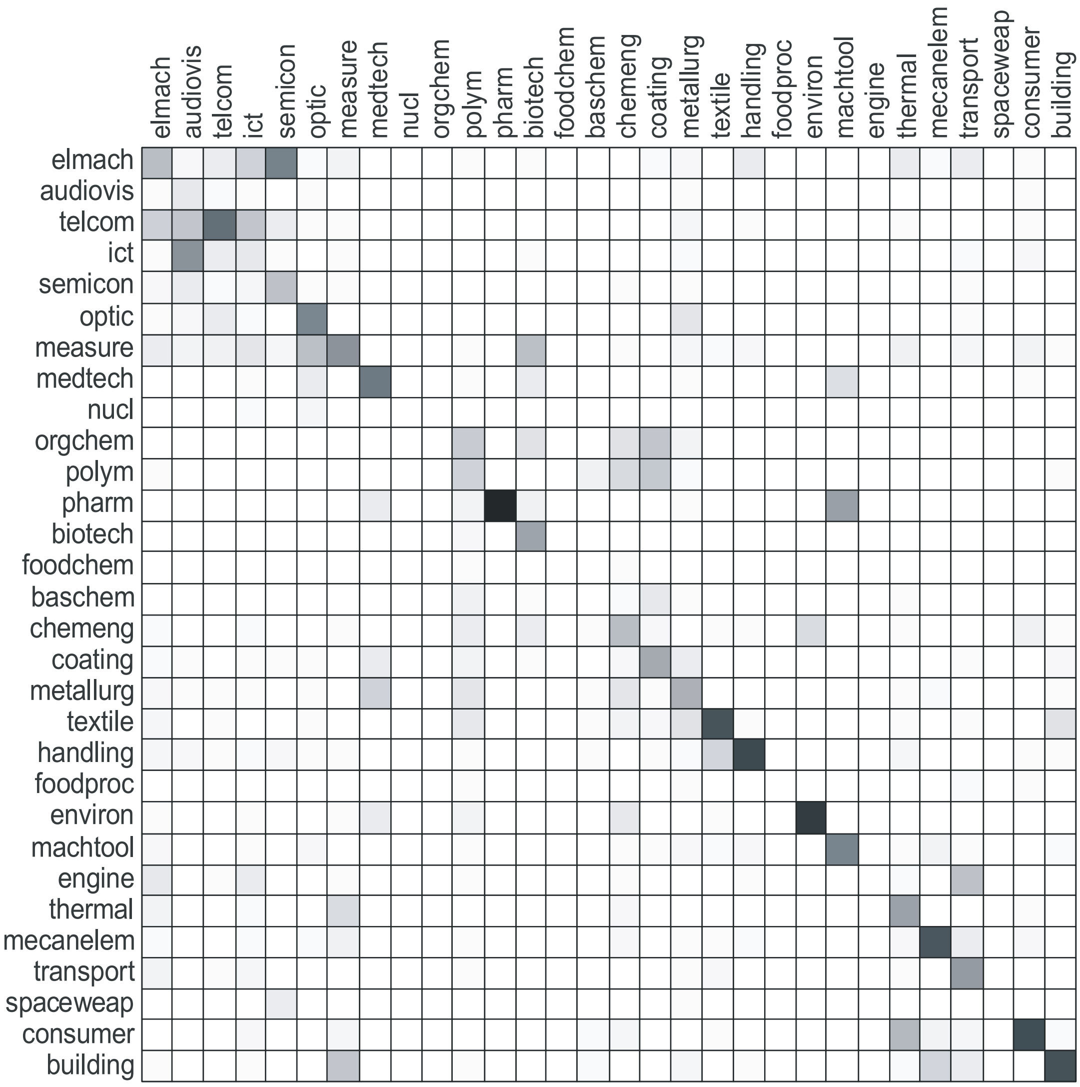

Regarding the organisation type, a strong dominance of companies can be observed, with 50 percent of all organisations chairing a Technical Committee (see Figure 3.2). 14 percent of the organisations categorised are from the field of "research" (i.e. public or private research institutes, universities, governmental labs). 28 percent were categorised as interest groups like trade associations or umbrella organisations. The remainder consists of public administrations (5%) and national SDOs (3%).

**Figure 3.2 Distribution by organisation type of organisations in formal standardisation at CEN, CENELEC and ETSI (TC chairing organisations only) (Source: INTEREST, Fraunhofer ISI)**



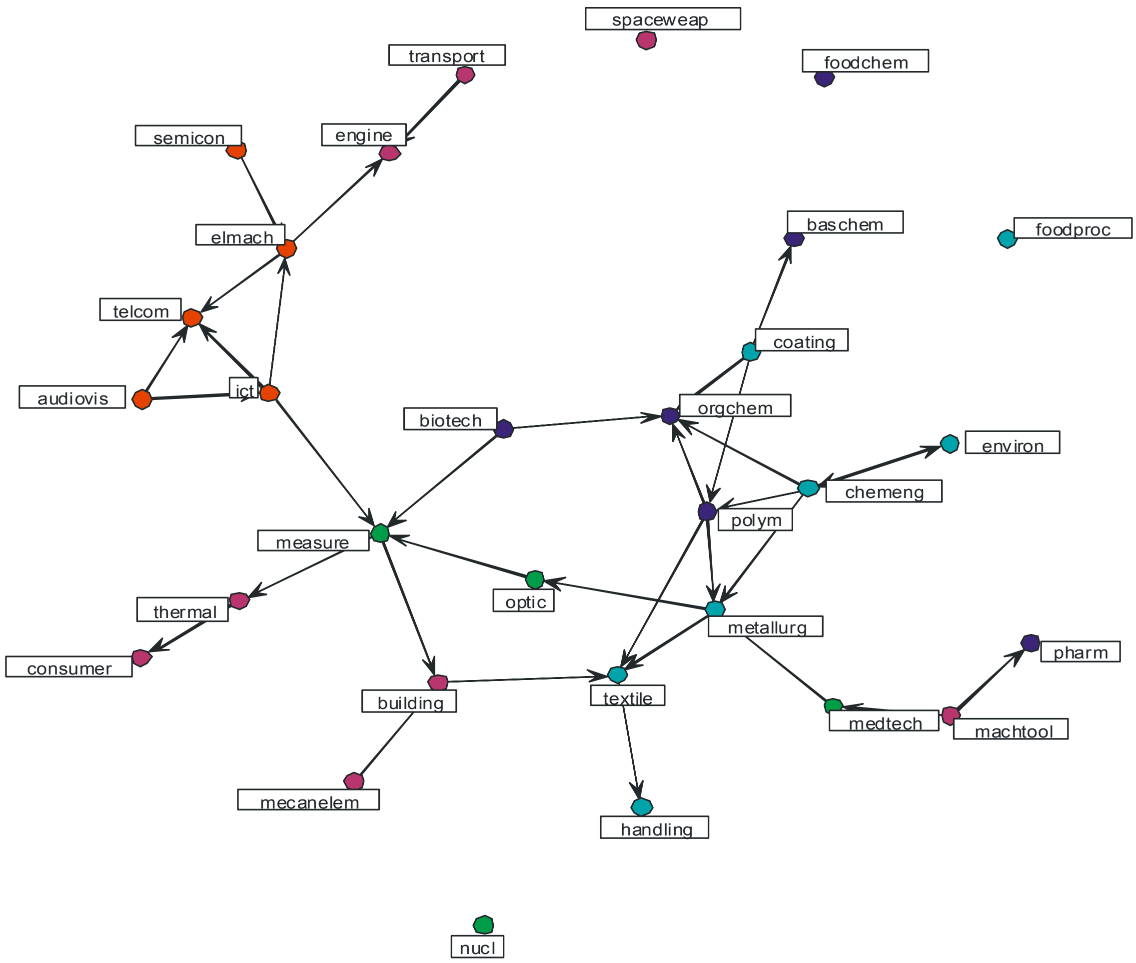

The above mentioned approach regarding the patent portfolio analysis is condensed into Figure 3.3. Using a visualisation method called Sociomatrix, a method with its origins in network analysis, a matrix was produced linking the research output in form of patents classified according to their main classification 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 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. A list of the abbreviations used in the matrix can be found in the Annex.

**Figure 3.3 Sociomatrix of TC groups classified in technical fields (columns) and patent portfolios (rows) of these groups (Source: INTEREST, 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 research 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.[5] 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. Still, it is not suited to visualise the connection of the standardisation activities via the overlap of research portfolios. To visualise these connections, the matrix can be interpreted as a two-dimensional vector space spanning the dimensions of standardisation activities and research activities. The links in this space can be visualised as a set of directed graphs as is done in Figure 3.4. The different colours of the vertices of the network represent the five main technological fields of the OST/INPI/ISI classification.

**Figure 3.4 Network representation of standardisation activity/research activity (isolates kept in representation) (Source: INTEREST, Fraunhofer ISI)**




5 The years represent the priority dates of the patent applications, namely the year of the first application of a patent at a patent office either national or international. The cut-off year 2003 is due to the 18 month disclosure period of the EPO and the WIPO.

When Interpreting this visualisation, it has to be kept in mind that the network is "directed", meaning that arrows in this figure describe a "direction" from the standardisation activities of the TC groups towards technical fields they were not categorised in based on the TC titles. TCs active in "Biotechnology" therefore have aspects in their portfolios towards the fields of "Analysis, measurement, control technology" and "Organic fine chemistry", but TCs in "Analysis, measurement, control technology" have no strong links towards "Biotechnology".[6] The only link featuring a strong symmetric connection between TC groups is the link between "chemical engineering" and "environmental technology". Links might be understood as similarities in the research portfolio of organisations in different standardisation contexts. The analysis of such links might be valuable to establish support structures between TCs, based on the pool of shared technical knowledge. Therefore overlaying structures based on the analysis of research output as input for standardisation might enable TCs to build meta structures for specific standardisation problems that require specific tacit knowledge from other fields of technology (e.g. aspects of optics in measurement or mechanical elements in building). Moreover, this might be especially valuable for standardisation that requires specific aspects of emerging fields of technology or interdisciplinary research results. The arrows therefore mainly describe how TCs might support other TCs in special aspects of their standardisation activities. An analysis to facilitate institutional solutions would require more detailed data, like membership lists. The results of this analysis are therefore to be understood as explorative results and examples for further activities in this direction.

Regarding the links between the TC groups, the field of electrical engineering (red vertices) is connected strongly within its main field. The TCs active in electrical machinery also have aspects in their technology portfolio in common with engines. Similar patterns can be found for information technology linked to measurement and control technology. In contrast, no strong links from subfields from other main fields e.g. process engineering towards the main field of electrical engineering can be observed. Regarding the main field of instruments (green vertices), strong links can be observed within the main field between optics and measurement and control technology. Links to other main technology fields exist from measurement and control technology towards thermal technology and building. This is mostly due to the aspect of sensor technology in the field of instruments. Other links go from medical technology towards the field of materials and metallurgy. In the main field of chemistry and pharmaceuticals (dark blue verti-

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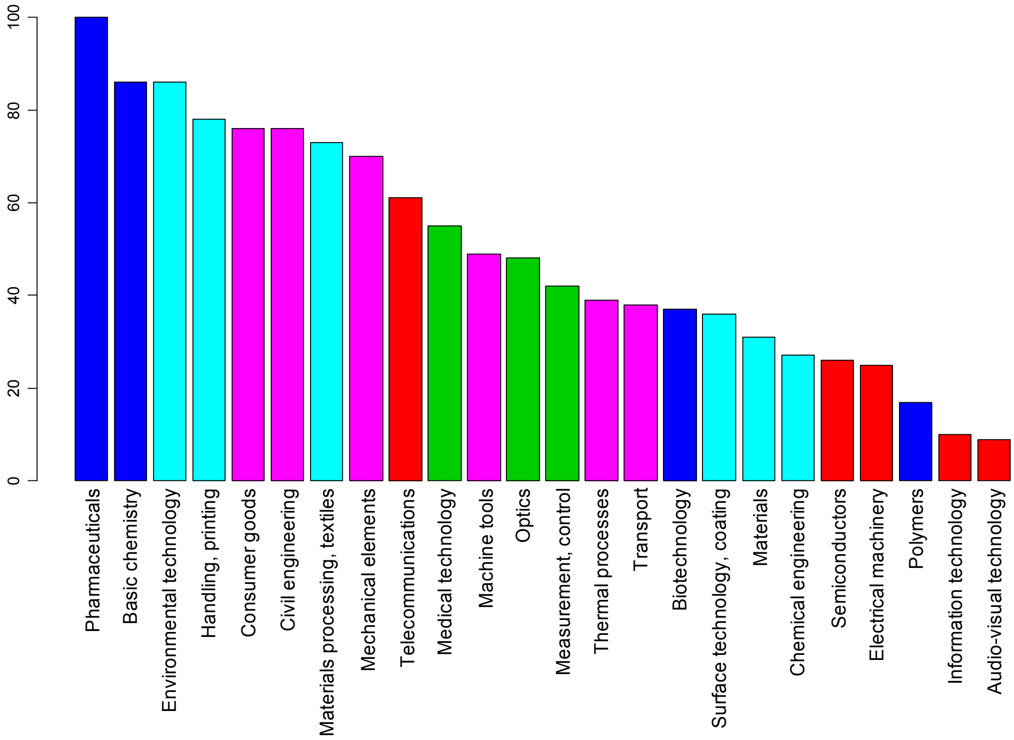
[6] "Strong" in this context means more than 10% of the patent portfolio in another field. Link values below 9% have been omitted from visualisation.

ces), the sub-fields polymers and biotechnology are both linked to organic chemistry. Polymers also have links to both aspects of material processing including textile, paper and metals. In the main field of process engineering (light blue vertices), strong links between the different sub-fields can be observed albeit not as dense as can be observed, in the electrical engineering field. Regarding links to other main fields, especially coating technology has strong links to the TC groups in the field of chemistry. Strong links exist to mostly all material-based aspects of this main field, like basic chemistry, organic chemistry and polymers. In this field also the only strong mutual linkage can be observed between environmental technology and chemical engineering. Still, both of these sub-fields belong to the same main field of process engineering. Finally, the field of mechanical engineering shows a very scattered pattern with few and mostly dyadic links inside the main field. The group of TCs categorised in the technical field of transport has links to pumps and engines.

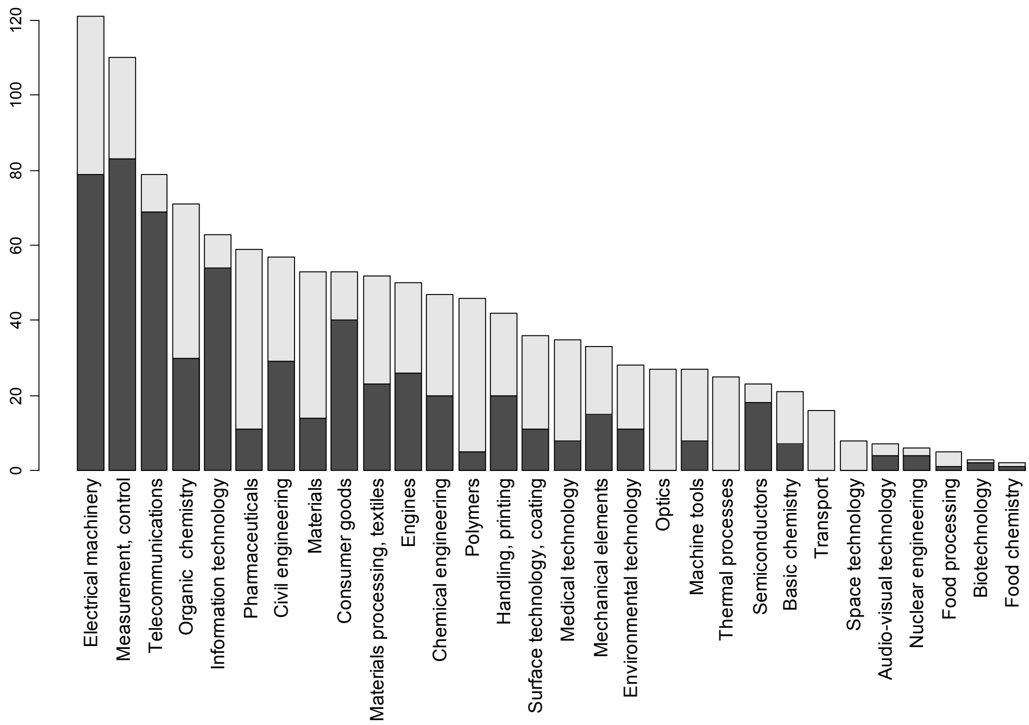
In order to give an impression of the extent of technical focus and links between the different TC groups, one might look at some basic measures taken from methods of network analysis. An indicator for the technical focus might be the percentage of the patent portfolio in the field that corresponds to the categorisation of the TCs into technical fields prepared at the beginning of the analysis process. This measure is provided in figure 3.5. Another measure which reflects the influence of other TC groups from other fields on each TC group might be the sum of the percentage points from other fields towards the TC group. This measure is provided in figure 3.6. In both figures the colours indicating the main technical fields have been kept according to figure 3.4.

**Figure 3.5 Percentage of the patent portfolio in categorized technical fields (Source: INTEREST, Fraunhofer ISI)**




The strongest focussing regarding the relationship between research output and standardisation input of organisations chairing Technical Committees is given in the field of standardisation of pharmaceuticals. 100% of the patent portfolio can be classified in the field of pharmaceuticals and the organisations have not filed patents in other fields. Very high values with around 85% of patents in the assigned fields are found for basic chemistry and environmental technology. Overall focussing of research activities in the light of standardisation activities seems to be heterogeneous in the 5 main fields, with instruments and mechanical engineering taking up middle positions and process engineering and chemistry/pharmacy scattered between high and low focussing. Electrical engineering seems to be less focused regarding the link between research and standardisation, with telecommunications taking up a middle rank. TC groups from the main field of electrical engineering take up the lowest position. The only exception is telecommunication.

**Figure 3.6 Sum of percentages of other TC groups towards TC group in categorized technical fields (Source: INTEREST, Fraunhofer ISI)**




The other measure indicating the influence of other technical subfields on a TC group is provided in figure 3.6. To distinguish between influences from other fields, the sum of percentages from other field was analysed according to its origin. The sum of percentages of influence from other fields in the same main field is depicted as the black bars; the influence originated from other main fields is depicted as grey bars. Both bars are stacked indicating the total sum of percentages from other fields.

Electrical machinery and measurement and control technology have the highest value on this indicator. Still, notably the most influence on these two fields comes from within the main field. Especially in the case of technical subfields from the main field of electrical engineering, the share of influence from within the main field is very high regarding the total influence from any other fields.[7] Low ratios between influence from within the main technical field and from sub fields that are not in the same main field can be found for pharmaceuticals, polymers, thermal processes, transport, food processing and medical technology.

7 As the number of subfields within a main field is almost equal for all cases, comparing the shares and absolute values between the sub fields is tolerable.

# 4. Conclusion

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 research 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. Still there is variance between the research fields regarding the overlap between the patent portfolios from other organisations participating in other TCs. Remarkably, ICT seems to be both very closed to other influences and highly connected in terms of research links within the main field of electrical engineering. Other main research and technology fields show overlaps. It must therefore be concluded that the link between research and standardisation is also influenced by specifics of the technical and research fields. For example, organisations engaged in ICT research show a very special constellation with strong system-environment differentiation in standardisation and a high interconnection among special aspects of research activities reflected by the research output.

Even though these seem very plausible findings, it also means that organisations in standardisation have the tendency to be highly specialised in their research activities. This in turn means that the allocation of resources to standardisation activities potentially fit into the overall research activities of the participating organisation. In organisations like universities, where researchers have more degrees of freedom and research activities are more diversified, the overall lack of a unified research mission might be a barrier for researchers who want to engage in standardisation as there is a need to justify the resources needed against a missing background of an overall organisation-wide research mission.[8] This is especially true when the organisational units (research chairs, company department etc.) are highly dependent on a centralised allocation of resources. A better understanding on the individual level regarding the motives for participation and the subjective experienced barriers are therefore important, to understand what motivates individual researchers from different contexts to engage in standardisation activities. This has also been done in WP1 in the task of surveying researchers (see Deliverable D02). To counterpoint the results in this report highlighting aspects of technical and research fields, the report on the survey among researchers will also focus more closely on other aspects like type of organisation or context of re-

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[8] On the other hand a diversity of research missions foster technology transfer (Rahm et al. 1988). However those results mostly reflect technology transfers from university to industry.

search. As the link between research and standardisation in ICT research shows significantly different patterns, the deliverable on the survey among researchers will also analyse special aspects of this field in detail.

# 5. References

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# ANNEX A

**Systematic of OST/INPI/ISI of five technology areas and thirty sub-areas defined by IPC symbols,**

| | **Area** | **IPC code** |
|---|---|---|
| **I.** | **Electrical engineering** | |
| 1. | Electrical machinery and apparatus, | F21; G05F; H01B,C,F,G,H,J,K,M, |
| | electrical energy | R,T; H02; H05B,C,F,K |
| 2. | Audio-visual technology | G09F,G; G11B; H03F,G,J; |
| | | H04N-003,-005,-009,-013,-015, |
| | | -017,R,S |
| 3. | Telecommunications | G08C; H01P,Q; H03B,C,D,H, K,L,M; H04B,H,J,K,L,M, N-001, |
| | | -007,-011,Q |
| 4. | Information technology | G06; G11C; G10L |
| 5. | Semiconductors | H01L |
| **II.** | **Instruments** | |
| 6. | Optics | G02; G03B,C,D,F,G,H; H01S |
| 7. | Analysis, measurement, control technology | G01B,C,D,F,G,H,J,K,L,M,N, P,R,S,V, W; G04; G05B,D; G07; |
| | | G08B,G; G09B,C,D; G12 |
| 8. | Medical technology | A61B,C,D,F,G,H,J,L,M,N |
| 9. | Nuclear engineering | G01T; G21; H05G,H |
| **III.** | **Chemistry, pharmaceuticals** | |
| 10. | Organic fine chemistry | C07C,D,F,H,J,K |
| 11. | Macromolecular chemistry, polymers | C08B,F,G,H,K,L; C09D,J;C13L |

| | | |
|---|---|---|
| 12. | Pharmaceuticals, cosmetics | A61K |
| 13. | Biotechnology | C07G; C12M,N,P,Q,R,S |
| 14. | Agriculture, food chemistry | A01H; A21D; A23B,C,D,F,G,J,K, L; C12C,F,G,H,J; C13D,F,J,K |
| 15. | Chemical and petrol industry, basic materials chemistry | A01N; C05; C07B; C08C; C09B,C,F, G,H,K; C10B,C,F, G,H,J,K,L,M; C11B,C,D |
| **IV.** | **Process engineering, special equipment** | |
| 16. | Chemical engineering | B01B,D (without -046 to -053), F,J,L;B02C; B03; B04; B05B; B06; B07; B08; F25J; F26 |
| 17. | Surface technology, coating | B05C,D; B32; C23; C25; C30 |
| 18. | Materials, metallurgy | C01; C03C; C04; C21; C22; B22 |
| 19. | Materials processing, textiles, paper | A41H; A43D; A46D; B28; B29; B31; C03B; C08J; C14; D01; D02; D03; D04B,C,G,H; D05; D06B,C,G,H,J,L,M,P,Q; D21 |
| 20. | Handling, printing | B25J; B41; B65B,C,D,F,G,H; B66; B67 |
| 21. | Agricultural and food processing, machinery and apparatus | A01B,C,D,F,G,J,K,L,M; A21B,C; A22; A23N,P; B02B; C12L; C13C,G,H |
| 22. | Environmental technology | A62D; B01D-046 to -053; B09; C02; F01N; F23G,J |

**V. Mechanical engineering, machinery**

| | | |
|---|---|---|
| 23. | Machine tools | B21; B23; B24; B26D,F; B27; B30 |
| 24. | Engines, pumpes, turbines | F01B,C,D,K,L,M,P; F02; F03; F04; F23R |
| 25. | Thermal processes and apparatus | F22; F23B,C,D,H,K,L,M,N,Q; F24; F25B,C; F27; F28 |
| 26. | Mechanical elements | F15; F16; F17; G05G |
| 27. | Transport | B60; B61; B62; B63B,C,H,J; B64B,C,D,F |
| 28. | Space technology, weapons | B63G; B64G; C06; F41; F42 |
| 29. | Consumer goods and equipment | A24; A41B,C,D,F,G; A42; A43B, C; A44; A45; A46B; A47; A62B,C; A63; B25B,C,D,F,G,H; B26B; B42; B43; B44; B68; D04D; D06F,N; D07; F25D; G10B,C,D,F,G,H,K |
| 30. | Civil engineering, building, mining | E01;E02;E03;E04;E05;E06;E21 |