Interrelationships of technologies - the concept of home technology terms

Edgar L. Schiebel, Marianne Hörlesberger, Dominique Besagni, Ivana Roche, Claire François

Interrelationships of technologies – the concept of home technology terms

Edgar Schiebel [(1)], Marianne Hörlesberger [(1)]
Dominique Besagni [(2)], Ivana Roche [(2)], Claire François [(2)]

edgar.schiebel@ait.ac.at, marianne.hoerlesberger@ait.ac.at
dominique.besagni@inist.fr, ivana.roche@inist.fr, claire.francois@inist.fr

[(1)] AIT Austrian Institute of Technology GmbH, Tech Gate Vienna, Donau-City-Strasse 1, 1220 Vienna, Austria
[(2)] INIST - CNRS, 2 allée du Parc de Brabois, CS 10310, 54519 Vandoeuvre-les-Nancy cedex, France

---

Background

Nowadays technological progress and industrial innovation very often are induced by interdisciplinary research. As an example, applications of nanotechnology in biomedicine (Rojas-Chapana et al., 2006) combine research in many disciplines like physics, chemistry, microbiology, cell biology, and material science. In the cited case, all disciplines contribute to the design, synthesis and fabrication of biocompatible devices at the nanometer scale. Only little research has been performed to analyze interdisciplinary interrelation of technologies on the basis of research topics. The work of Morillo F., Bordons M., Gomez I. (Morillo et al., 2003) aimed to establish a tentative typology of disciplines by their degree of interdisciplinary research. They measured interdisciplinarity with indicators based on the multi-assignation of journals in subject categories, but not on the level of research issues like nanotubes, thin layers, etc.

In this contribution, we introduce a methodology to analyze the interrelationship of technologies on the basis of keywords present in bibliographic records. We consider these terms are a representation of the research topics diffused by means of their publication in the scientific literature. Key questions are: How can we demonstrate the interrelations between technologies on the basis of research items? Do keywords that occur most often in articles assigned to a technology reflect research issues and do they show interrelationships?

Methodology

Scientific literature consists of very well structured documents and most of them are represented under the form of bibliographic records and stored in databases like Web of Science, Scopus, PASCAL or others. For our analysis we used the PASCAL database. Technologies were defined on the basis of categories the database producer uses for the classification of the bibliographic records. In the project PromTech (PROMTECH, 2007), we defined 45 promising emerging technological fields. Later we published a method to assign the so-called home technology status to keywords: for each keyword, the technological field with the highest relative number of papers where a keyword occurred was addressed as its home technology. Then it was very easy to extract all keywords of the bibliographic records related to each technological field and to tag the corresponding home technology (Besagni et al., 2009). In this presentation, we used the common keywords across the different technological fields to show interrelations on the basis of their home technology terms.

Results

As a first result we could see that words occur with different probabilities in articles assigned to different technological field. For example "nanostructured materials" occurred with a probability of 0.61 in the field of molecular electronics and 0.31 in biotechnology respectively and with smaller values in 19 other fields. In consequence, "nanostructured materials" where tagged with molecular electronics as home technology, because of the highest probability of its occurrence in this technological field.

Most important *technological fields* and their home technology terms with a high relative occurrence in bibliographic records were: *surface treatment of metals* - surface treatments, coatings, non metal coating, metal coating, hot spraying; *ceramics*: experimental study, composite material, manufacturing, oxide ceramics, scanning electron microscopy; o*ptoelectronics*: optoelectronic device, light emitting diodes, light emitting diode, photodetector, organic light emitting diodes.

The interrelationship between technological fields on the basis of keywords was represented by a square matrix: rows and columns are the considered technological fields and the cell contains the number of home technology terms that occur in the bibliographic records of the corresponding technologies. For each technology the row represents the number of home technology terms from other technologies in its records. The sum of a row is called the import of terms and the sum of the column is called the export of terms. We found the highest number of exported terms in the following fields: mechanical working of metals; mechanical engineering, general; electrical energy and ceramics, and we observed the highest number of imported terms in mechanical engineering, general; mechanical transmissions; optoelectronics; surface treatment of metals and molecular electronics. The highest trade balance (export/import) could be seen at cristallisation, lixivation, separation; electrical engineering, general; ecology (animals, plants, cells); waste treatment; physical impact on biological material; electrical machines and the lowest at the following technology fields: mechanical engineering, general; molecular electronics; biotechnology; mechanical transmissions and optoelectronics.

We took the very innovative field of optoelectronics to examine the trade balance in more detail. The profile of this technology showed that magnetics, electrical energy, electronic circuits, molecular electronics and transistors are the technologies with the highest interrelation with optoelectronics: its most important trade partners. Bibliographic record in the field of molecular electronics show the highest number of terms with optoelectronics as a home technology. It is remarkable that there is no technology field with a positive trade balance for optoelectronics. In order to produce other interpretation of the content of the term flows coming in or going out the optoelectronic field, we employ a clustering approach to study, on one hand, the set of bibliographic records not related to the considered field and where we find at least one home technology term coming from optoelectronics and, on the other hand, the set of records related to the considered field and containing at least one home technology term coming from the other technological fields.

Conclusions

In our analysis we found that a database with a well-defined domain classification scheme and carefully assigned keywords is a very important source for the analysis of interrelations between

technological fields on the basis of terms. The concept of home technology terms gives us the possibility to assign terms to technologies in a pragmatic way. The findings show that the assigned terms make a lot of sense, with the exception of terms that occur very often like experimental study or terms that are not standardized. Taking sums of rows and columns the interrelation matrix reveals general views insight of technological fields concerning the source and drains distance or the so-called trade balance of technological fields. We could not reveal that basic oriented technologies have higher positive trade balance than applied research on a first glance. The trade balance profile gives a good view insight of single technologies and the most interrelated partner technologies. Driving technological progress in industry it is very important to know about important knowledge from related technologies to use one technology intensively in product or process innovation. On the other hand the export characteristics give an idea about the usability of knowledge in other areas an probably opens the dissemination of knowledge in other areas.

References

Besagni D., François C., Hörlesberger M., Roche I., Schiebel E. (2009): *Les émergences technologiques dans le domaine des dispositifs optoélectroniques : identification et caractérisation*, paper presented at the conference VSST (Veille Stratégique Scientifique et Economique), 30 - 31 March, Nancy

Morillo F., Bordons M., Gomez I. (2003): *Interdisciplinarity in science: A tentative typology of disciplines and research areas*, Journal of the American Society for Information Science and Technology, 54 (13), pp. 1237-1249, ISSN: 1532-2882, DOI: 10.1002/asi.10326

PROMTECH (2007): *Identification and Assessment of Promising Emerging Technological Fields in Europe*, final report July 2007, AIT, Vienna

Rojas-Chapana J.A., Giersig M. (2006): *Multi-walled carbon nanotubes and metallic nanoparticles and their application in biomedicine*, Journal of Nanoscience and Nanotechnology, 6 (2), pp. 316-321, ISSN: 1533-4880, DOI: 10.1166/jnn.2006.004