industry-university partnerships
networking, e-community
production management

Tauno OTTO
Jyri PAPSTEL
Jyri RIIVES

KNOWLEDGE MANAGEMENT IN THE FRAMEWORK OF TECHNOLOGICAL RESOURCES NETWORK

Competition between manufacturers and continuous growth of clients' expectations force enterprises to re-estimate economic priorities and consider more effective operation. These are the hidden origins of worldwide globalisation and success of modern telecommunication systems.
Nowadays entrepreneurship is more characterised in constraints of resources, emerged by running appreciation energy, qualified human assets, materials, equipment, information, and other resources. That is the key problem to be solved by searching for effective solutions and their implementations. The aim of this paper is to propose proficient use of divided technological resources solved by advisory system.
Networked co-operation and concept of virtual enterprise can be advanced only via exact description of technological resources and developing corresponding advisory database system. The proposed concept of the system is tripartite. The first sectoral level involves general description of technological features of industrial sector enterprises. Second level includes specification and detailed description of technological possibilities of an enterprise. Third level comprises problem solving module, involving consulting expert system for selection of machining operation and corresponding parameters as well as data exchange, where participants can describe vacant and supply needed resources. The proposed system is in development phases in Estonia.

1. INTRODUCTION

Over the past few years, the Internet has been a market maker, a market destroyer, an industry change-agent, and even an inverter of traditional ways of conducting business. The Internet and Web technologies have presented established firms with both opportunities as well as threats. The use of Web technologies in inter-organizational business transactions and in inter-firm relationships has caught the attention of executives and industry experts. This phenomenon is popularly known as business-to-business (B2B) E-commerce. Several buzzwords such as E-hubs, Internet exchanges, E-markets, E-procurement, and E-exchanges have been coined by industry to refer to different models of B2B E-commerce (Ranganathan, 2003). However, only few of the started projects have been sustainable. A survey of organizations, in which enterprise systems management solutions were deployed, found that only 24% of the implementations were considered successful, 64% of management had mixed feelings about the success of the projects, and the remainder felt their projects were failures (Gallagher, 1998). Business-aid networks created so far in the world have problems in succeeding of cooperation of large and small sized enterprises,

mutual relationships between competitive enterprises and shortage of really participating enterprises.

It might be useful to compare the industrial sector with another branch – banking. Surprisingly, there are many similarities between the two and the banking industry may therefore include some useful lessons. What have banks done to survive in the new economic environment? Several strategies are immediately apparent (Taosanidis, 2002):

- They offer customers a personal adviser
- They exploit the advantages of new technologies, not only for in-bank services but also to provide electronic services to customers
- They merge or make strategic alliances to overcome competitive threats

The aim of this paper is to propose the development of online system for enhancing proficient and shared use of technological resources supported by online advisory system. The system identifies the bottlenecks (lack of technological knowledge, development problems related to technological resources) of the production system through adequately designed web interface, back-office database system and methodology.

2. SECTORAL NETWORKING

The following forms of organisational networking can be distinguished:

- Cluster
- Virtual enterprise
- Extended enterprise
- Cooperation network

Clusters are mostly defined by geographic regions. Encouraging cooperation between them enables to set higher business targets and reduce manufacturing costs. Due to intensive growth of Internet the geographic borders are not playing such an important role. Last decade brought with a term ‘virtual enterprise”. However, it turned out, that work on the ICT support of a virtual organisation should primarily be based on a clear model of the virtual organisation itself (Wijk, 1999).

The proposed model of the system has three levels. Sectoral (e.g. sector of metal engineering, machinery and apparatus industries) level involves general description of technological features of industrial sector enterprises. The level is self-managed by sectoral umbrella organisations, taking responsibility. The knowledge base connects also clusters of suppliers and logistics providers, consultancy firms, educational organizations and universities to handle local resources for larger subcontract orders and production volumes (see Fig. 1).

The following fields are important as a basis of common knowledge sharing: address; management; main activities; main products and technologies; references; contacts; and general information (turnover, export significance, spoken languages, number of employees, quality certificates). Following such a model enterprises of Estonian engineering industries were investigated in 2003, whereas 70 enterprises from five regions were mapped as clusters shown in Table 1.

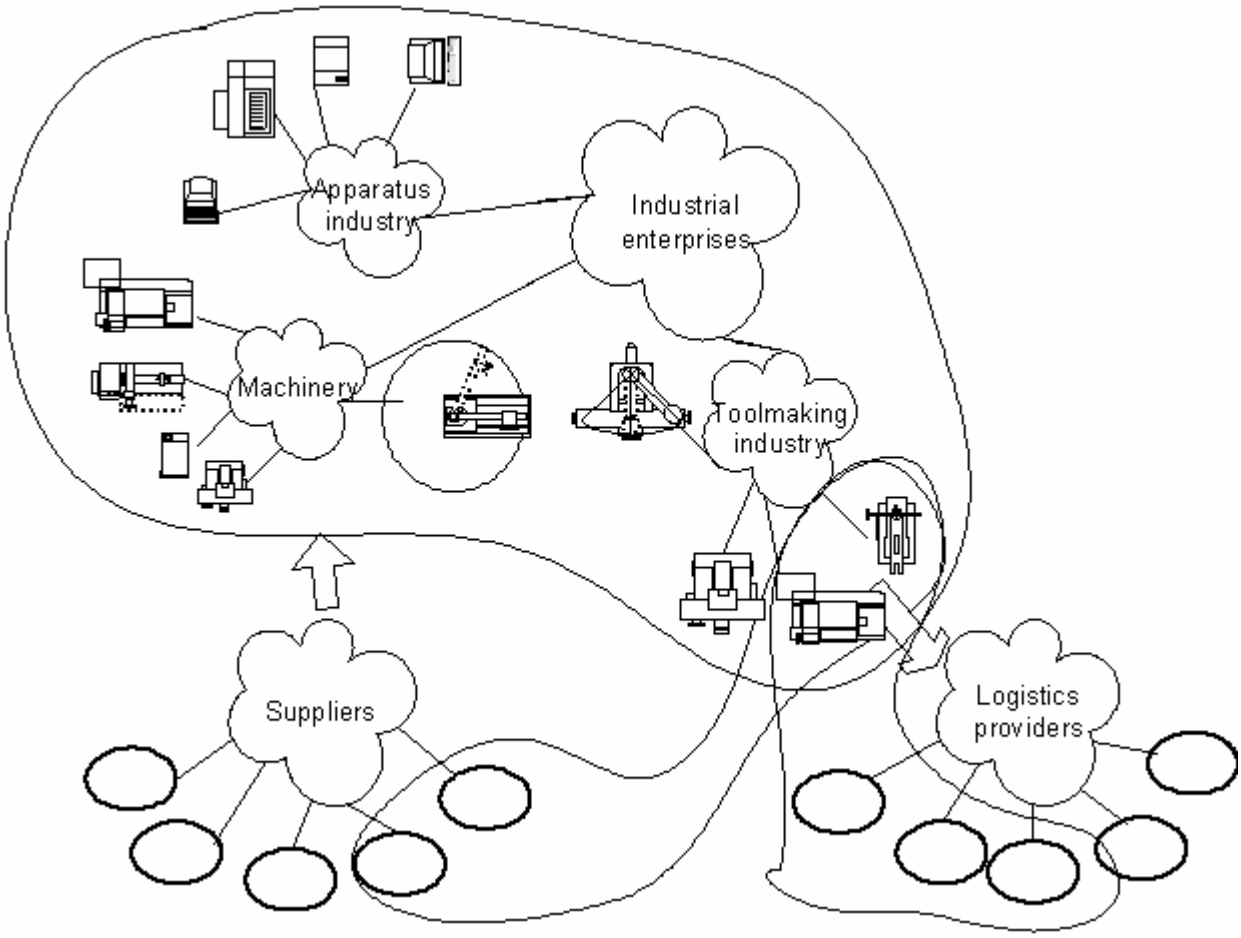
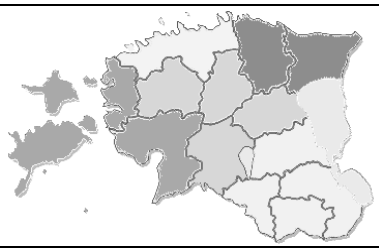


Fig. 1 Clusters of engineering industries

Table 1 Regional distribution of clusters of engineering industries in Estonia

	North-Estonia	Central Estonia	West-Estonia	South-Estonia	East-Estonia
Machinery	9	3	-	1	4
Metal engineering	12	4	2	9	6
Apparatus engineering	2	-	-	1	-
Tools engineering	7	-	-	1	-
Transportation engineering	-	-	1	1	-
Agricultural engineering	2	1	-	3	1

3. SHARED USE OF TECHNOLOGICAL RESOURCES

Enterprise level of the proposed network includes multilingual specification and detailed description of technological possibilities of an enterprise, increasing the export opportunities of SMEs through technological networking. Scheme of virtual database solution for development of technological resources network is presented on Fig. 2.

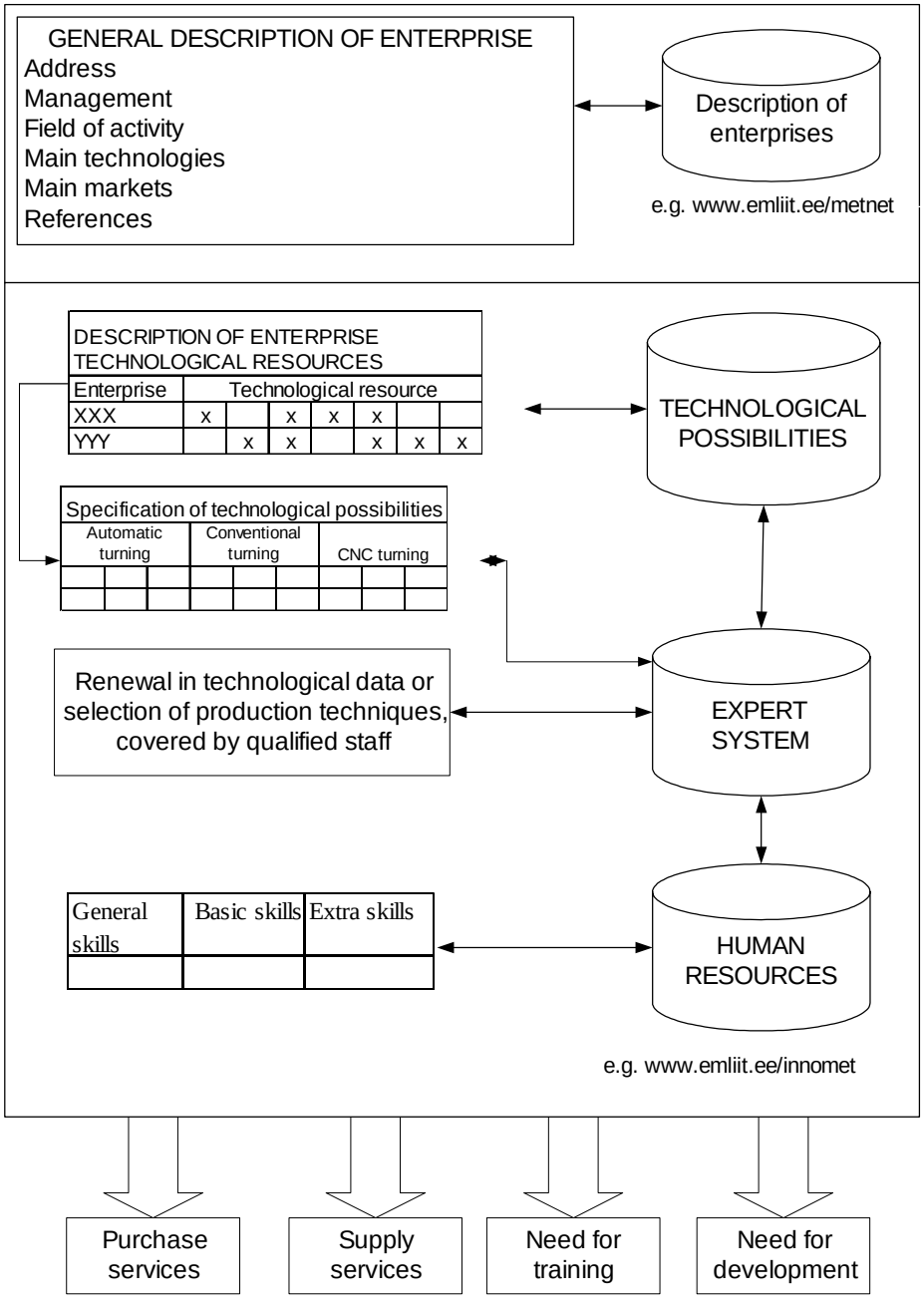


Fig. 2 Information flow in virtual database solution for development of technological resources network

Technological possibilities involve specification of technological processes, e.g. turning, milling, drilling, welding, etc., followed by selection of corresponding subclasses. When selecting a subclass, the next step is input of adequate data, i.e. bar and chuck capacity, maximal length of work piece.

Level of problem solving can be realised by following options:

- opinion of current expert system, advising management board/marketing department of an enterprise to evaluate current production potential and need for updates in technology;
- supporting man agent ability in focussing on own core manufacturing to stay competitive in business;
- support in out sourcing of non core business competitive manufacturing – support in creation manufacturing network for those product modules, components or final assembly;
- inquiry through the system, approach to scientific authorities. Universities and consultant companies have the key role, acting as authorised bodies, predicting need for advanced technologies in forecast of 5 years. For community valuable is mapped need for investments into new technologies for the next 5 years;
- data exchange or business-aid network, where participants can describe vacant and supply needed resources. The resources in current context are defined as technological possibilities characterised by precise specifications.

4. SHARING OF TECHNOLOGICAL KNOWLEDGE IN THE CONTEXT OF TECHNOLOGICAL RESOURCES

As a result of continuing advances in modern manufacturing technology, human resources usually assume the roles of supervisory controllers responsible for functions of monitoring and intervening in technological operations in a man-machine hybrid system (Chan, 2003) . Given that education provides individuals with various skills that transfer into the workplace, there is a clear need for education providers to be aware of skills and competencies required by industry. At the macro level, the improvement of the human resource will result in national gain, and at the micro level businesses and enterprises will benefit from better trained workforce and knowledge transferral (Peacock 2002).

In order to create the virtual sector based cooperation system, a database is introduced as an open access type system, which structure includes three main parts:

1) All the relevant education institutions, study programmes, re-training programmes and links to e-learning platforms of the sector in detail;

2) Private sector - human resources and labour force demand taking into account present situation and strategic development of manufacturing sector, and based on the existing employee qualification standards - detailed human competence system. An example of visual output of needed and existing level of competence in the company based on professions and skills is shown on Fig. 3.

3) Public and support organisations who need surveys and analysis related to human resources in private sector.

Fig. 3 Needed and existing level of competence in the company based on professions and skills

Therefore the proposed integrated system model includes also a database of existing educational opportunities – different levels of study programmes; industrial needs for human resources based on the employee qualification standards (see Fig. 3). It focuses on enhancement of the competence of employees and industry to act successfully on the market in order to strengthen the competitiveness of the manufacturing industry. This will bring together a critical mass of "customers" and "suppliers" for resolving above-mentioned shortcomings. Companies will be motivated to renew information in certain periods, as this tool can be effectively used for companies' own human resources evaluation and development. The system can also be made use of in the development of trans-national skills' passports in Europe. The system operates with terms like Vocation (i.e. profession, described within boundaries of a current enterprise), Skill, Inquiry and Profession. Such a demo system module has already been developed in Estonia called INNOMET in order to

map different angles of skills and qualifications (general skills, specific skills, personal skills, etc) in companies. Skills are directly connected to technological resources, defining what knowledge is needed to obtain expected level of competence. Companies following ISO certification rules can find it helpful.

The enterprise users are asked to fill an electronic table, consisting of following fields:

- Profession – professions described in the system
- Current number of employees
- Qualification certificates, describing which certificates the persons working at corresponding profession have
- Number of employees over 50 years – current number of persons in age over 50

Expected need for workforce during the period – the user can enter the number of expected need for workforce for the next 5 years. According to the gaps in qualifications specific training programmes can be developed. Both lack of specific qualified labour force and specific training needs can be identified with the INNOMET database in long perspective.

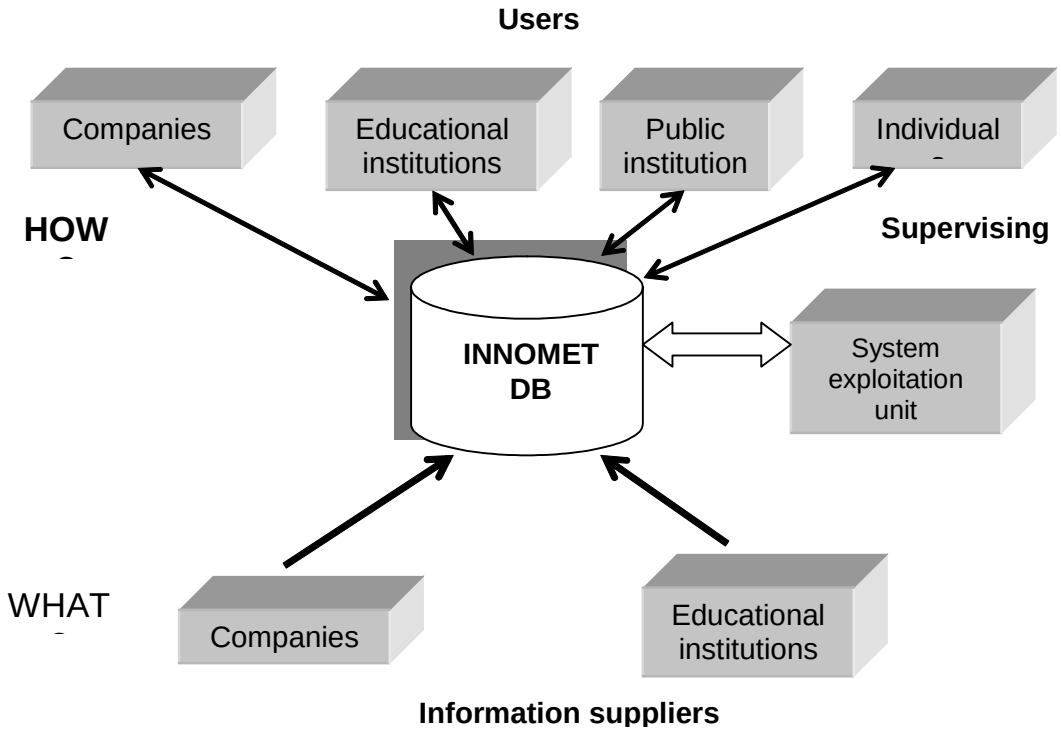


Fig. 3 Information flow in virtual database solution for development of integrated human resources network

5. CONCLUSIONS AND FURTHER ACTIVITIES

The system is capable for monitoring quality and quantity of human and technological resources in every participating enterprise of the network. A common key matrix is used in order to connect the terms of enterprise and educational organisations – to define knowledge

based links between the technology, corresponding profession (company level) and vocation (obtained through education). This will give companies the opportunity and benefit to upgrade technological resources within the state of art of manufacturing. For increasing mutual trust the professional non-profit organisations as well as local authorities should take the initiative in creation or support such networked systems.

Results at this phase are used to revise and develop the INNOMET database test version. However in long perspective when a critical mass of companies are involved to the system results could be used as a basis for the educational institutions in order to elaborate complementary study and training programmes and modification of existing ones.

In long-term this system can contribute to a better efficiency and transparency of needed technology, education and training in this sector based on private sector demand.

The system also enables evaluation of regional needs for technology transfer and vocational needs at governmental level, and serves as a tool for compiling study national or regional agreements.

The main practical result of the proposed system is to supply enterprises and educational institutions with the updated information related to the needs and structure as well as about the opportunities to find needed technological resources. An important step towards this goal is to define and understand the needs for the manufacturing industry on global.

Regularly updated data by enterprises and educational institutions will contribute to the development of a time based information system as supporting environment by everyday business planning and knowledge sharing.

Feasibility of localisation issues is one of the focal points to address scalability of online web based system as well as development of sustainable export of the service and business case. As a result, the quality of both production technology and cooperation between research institutions and private sector companies is expected to improve through interaction and networking between enterprises, as well as enterprises and academia. The current solution is focused on the sector of metalworking, machinery and apparatus engineering. The proposed business model can be transferred to other industrial sectors (wood processing, chemical industry, construction materials industry, etc).

Acknowledgement: The current research was supported by Estonian Science Foundation Grant no 5363 and Leonardo project INNOMET.

REFERENCES

[1] Chan, A.H.S., Shum, V.W.Y., Law, H. W., Hui, I.K. (2003), Precise effects of control position, indicator type, and scale side on human performance, Int J Adv Manuf Technol 22: 380-386

[2] Gallagher, S. (1998), Beat the systems management odds, Information Week, vol. 675, pp. 61-76.

[3] Jacoliene van Wijk, Daisy Geurts, René Bultje (1999), 7 steps to virtuality, Objects, Components and the Virtual Enterprise '98 Proceedings, http://www.cs.tcd.ie/Virtues/ocve98/proceedings/005.html

[4] Peacock, N., Ladkin, A. (2002), 'Exploring relationships between higher education and industry', Industry and Higher Education, Vol 16, No 6, pp 393-401.

[5] Ranganathan, C. (2003), 'Evaluating the options for business-to business a-exchanges', Information Systems Management, 2003 Vol. 20, No. 3, pp 22-28

[6] Taousanidis, N. (2002), 'New challenges for European higher education', Industry and Higher Education, Vol 16, No 5, pp 289-294.