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# MONITORING OF TECHNOLOGICAL RESOURCES FOR EXTENDED USAGE

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***Abstract***
*In the global large corporations production is dissipated into smaller and flexible units. Extended enterprise is a concept, where a company is made up not just of its employees, board members and executives, but also its business partners, its suppliers, and even its customers. The other case is organising co-operation network between the companies using similar resources and producing similar products (for example tool making companies). In this paper a concept of web-based system for raising the agility and competitiveness of such manufacturing situations is proposed. Ways of estimation of the need for new technologies or technological resources are described. A specific tools' engineering group including several clusters of partner groups is used as a case to verify feasibility of the proposed approach.*

***Keywords:*** *technological resources management, virtual enterprise, networking*

## 1. INTRODUCTION

Fields of machine building, metal and apparatus engineering can be characterised as a rising trend in Estonia. At the same time the following overall tendencies has to be taken into account in manufacturing industry:

- general globalisation;
- shrinkage of markets and formation of integrated manufacturing capacities;
- increasing quality requirements and growing clients' expectations to contractors;
- urgent demand for well trained personnel;
- continuous appreciation of resources.

These trends have direct impact to competitive position of enterprise and they force looking for new ways targeted for raising the marketing feasibility. From aforementioned an idea of current research has been derived, proposing clusters and co-operation networks as means for raising productivity and efficiency of an enterprise and thereby also for upgrading competitive ability. Only in co-operation can be realised macro contract development projects, impayable for single enterprises. Likewise, it has to be taken into consideration that we are living and working in conditions of restricted resources (machinery, software, IT solutions, etc.). Costs of resources are progressively increasing. Therefore concentrated attention has to be paid to rational or even shared use of resources.
Requirements for shortening of cycle times, increase in quality and rational use of resources create main preconditions of need for special forms of co-operation.

## 2. INTERORGANISATIONAL CO-OPERATION AND CO-OPERATIONAL NETWORKS AS MAIN DIRECTIONS OF FURTHER SECTORAL DEVELOPMENT

Manufacturing can be described as a transformation process, where inputs are transformed into outputs as products, details, knowledge.
Nowadays production is characterised in variety of orders and relatively short-time duration of order execution. In practice it is necessary for successful competing in the market of end production to ensure high quality and short production run. The following standpoints are important:

- increase in production flexibility have declining effect to self-cost;
- shorter preparation periods and manufacturing-friendly designed products decrease additional manufacturing costs and therefore also self-cost of products in case of modification of production range;
- the number of created production subdivisions used modern planning methods decrease relative importance of overhead costs;
- flexibility and adaptivity of organisation is effective;
- planning is effective only in case of proper organisation and management.

Enterprise consisting of buildings, machinery, technologies and staff is situated in concrete educational, legislational, financial, economical and political environment. As a matter of fact, enterprise and its surroundings together form physical business environment. Enterprise can be more or less related with other ambient enterprises and supporting structures. It gives content to the term "co-operation" as well as to the different realisation possibilities. Functional associations departing borders of a single enterprise or rigidly structured group of enterprises (concern) are described on Fig. 1.
Common functional associations (industrial structures) of nowadays economic life (Fig. 2) are following:

- strategic alliance;
- cluster;
- virtual enterprise;
- extended enterprise;
- co-operation network.

Terms with somewhat different meanings are sometimes used interchangeably, creating confusion and a need for more precise definitions.

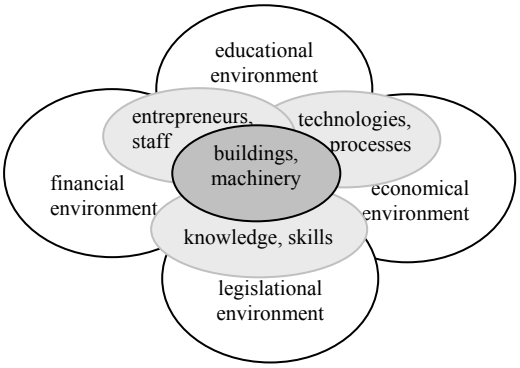


Fig. 1 Business environment

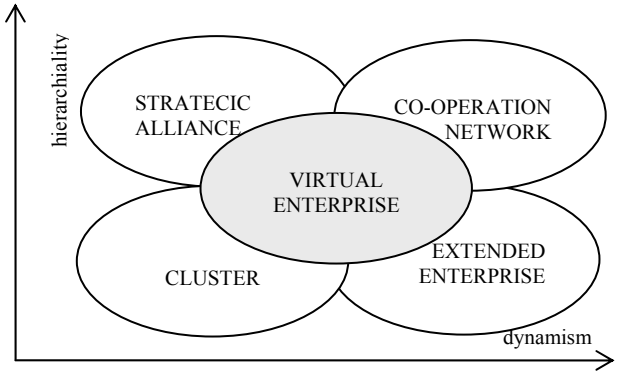


Fig. 2 Functional associations

Strategic alliance is a long-term co-operation agreement between two or more independent partners, sharing resources to obtain essential strategic advantages: expansion of market share, broadening of technological basis.

Industrial clusters, as these networks of relationships are known, link competing businesses and competing suppliers with collaborative research institutions, public and private sources of financing, government regulatory and development agencies, and new institutions built for the sole purpose of organizing and energizing these relationships (Abramson, 1998).

Cluster groups are geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also co-operate (London Development Agency, 2004).

Due to intensive growth of Internet the geographic borders are not playing such an important role. Last decade brought with a term 'virtual enterprise'. The virtual enterprise is a set of co-operating (legally) independent organisations, based on modern telecommunication means, which to the outside world provide a set of services and a functionality as if they were one organisation. 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).

A co-operation or business network consists of several firms that have ongoing communication and interaction, and might have a certain level of interdependence, but that need not operate in related industries or be geographically concentrated in space.

The term 'extended enterprise' represents the concept that a company is made up not just of its employees, its board members, and executives, but also its business partners, its suppliers, and even its customers. The extended enterprise can only be successful if all of the component groups and individuals have the information they need in order to do business effectively (Information Builders, 2004).

Modern production can be managed only via looking for complex solutions. Globalisation and integration are origins for establishing business networks. When nodes and interim connections are defined and located in a certain area a structure will be constituted. General goals of network are as follows:

- allocate activities or operations for the sake of better efforts of co-operation;
- share knowledge and/or information for strengthening competitive ability;
- divide goals, assignments and jobs for obtaining higher professionalism in shorter time and lower costs.

There are several different means for networks. The main differences between network and cluster are represented in Table 1.

Table 1. Network *versus* cluster

| Network | Cluster |
|---|---|
| Networks enable enterprises to obtain access to specific services with lower costs | Clusters attract necessary services into the region |
| Networks have restricted membership | Clusters have open membership |
| Networks are based on contractual links | Clusters are based on social values, ensuring trust and encouraging interorganisational communication |
| Networks make providing complex products easier to enterprises | Clusters promote demand for other enterprises |
| Networks are based on co-operation | Clusters involve both competition and co-operation |
| Networks have common business interest | Clusters have collective vision |

## 3. TECHNOLOGICAL POSSIBILITIES OF MANUFACTURING ENTERPRISE

Technological possibilities of manufacturing enterprise evolve on the basis of technological possibilities of machinery (machine tools, presses, welding equipment, etc). Technological possibilities can be defined as a set of characteristics of the current device, robot, production module or system for performing some technological task.

In Table 2 is represented a set of technological possibilities of single exemplary machine tool. This set can be considered as a set $\{TV_{TP},\}$, where entities ($v_1$, $v_2$… $v_m$) represent both in quantitative and qualitative way the functional characteristics of this machine tool.

The range of production to be manufactured is a general measure of technological possibilities. This means, that as a rule for manufacturing simple and uniform products is not rational to use too complicated machinery. The adequate situation is shown on Fig 3.

As it can be seen from Fig 3, the unrealised technological possibilities

$$TV=TV_{TP}-TV_D \quad (1)$$

take in this exemplary case quite a big part. Consequently use of complex machine tool for manufacturing a simple detail is uneconomic.

Table 2. General overview of technological possibilities of CNC lathe IP420PF40

| Workpiece system | Cutting tool system | Kinematic system |
|---|---|---|
| Max length of workpiece L=1250 mm | Tool holding mechanism: revolver head (RP) | Controllable coordinates; X, Z |
| Max diameter of workpiece D=250 mm | Number of cutting tools in revolver head: 12 | Power of main electric engine: N= 30 kW |
| Max diameter of bar material DL=40 mm | Tool change time: t=6 s | Fast speed rates: Z=8000 mm/min X=4000 mm/min |

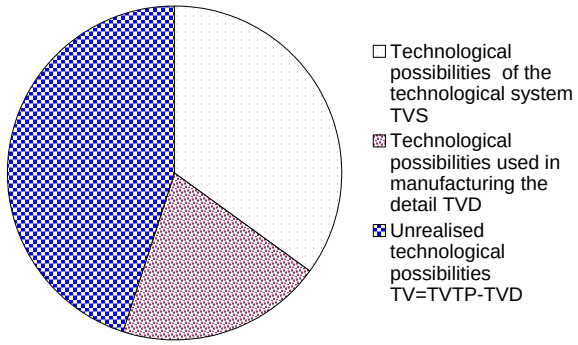


Fig. 3 Technological possibilities $TV_{TP}$ and use of a machine tool $TV_D$, belonging into technological system $TV_S$

On the basis of technological possibilities of separate machines belonging into system are formed possibilities of the whole system (Fig. 4). General technological possibilities ($TV^U$) represent potential of the manufacturing system, i.e. what kinds of works are feasible in the system. One can say that the greater are technological possibilities of devices belonging in the system, the greater is also potentiality of the whole system.

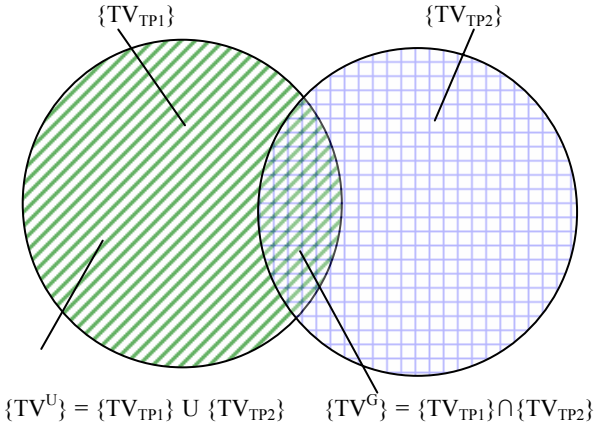


Fig. 4 Interpretation of technological possibilities

Guaranteed technological possibilities ($TV^G$) state this part of characteristics of industrial devices, common for all devices of the system. Large intersection area permits organise the production in the system in more flexible way. Technological possibilities play important role in designing operational and route technologies, but also in management of whole production process.

## 4. STRUCTURE AND REALISATION OF TECHNOLOGICAL RESOURCES DATABASE

Information has become a key foundation for organisational growth. Organisations use information to set goals, determine the gap between goals and achievements, determine actions to reach goals, and create new products and services to enhance organisational performance (Watson, 2002). For mapping technological resources of an enterprise and using these on purpose of developing future co-operation network as well as for capability analysis of subparts of enterprise or single enterprises is necessary to systematise and arrange all the technological possibilities depending on their nature. Technological possibilities are considered as hierarchic associations, whereas definition of technological possibility acts as basis for classifying. In classification four levels can be distinguished.

- Group definition. Process method is the basis of group definition (e.g. machining, sheet material processing, welding, casting, finishing, EDM, powder metallurgy, electro-chemical methods, engineering methods).
- Type definition. Processing mode is the basis when defining type in corresponding group.
- Class definition. Classification of technological possibilities is based on technology utilisable on current machines (e.g. automated turning, semi-automated turning, universal turning, etc.)
- Parametric definition. Parametric definition is based on finding features characterising possibility of processing current workable detail on the machines of enterprise (see Fig. 5).

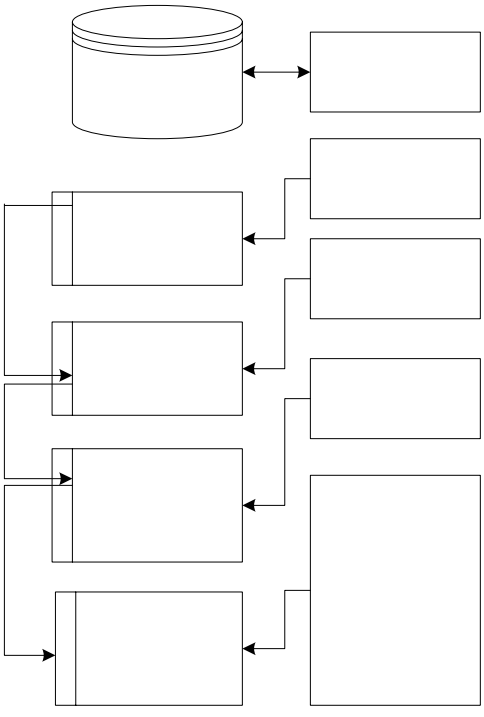

Fig. 5 Structure of the technological possibilities database

Knowledge of technological possibilities is important regarding from three aspects:

- What kind of products the enterprise is able to manufacture (product –set of machine tools)?
- What are technological possibilities of different enterprises (similarities, differences)? – it enables to organise co-operation as rationally as possible

- When technological possibilities of enterprise are fixed in some field, then how is possible to manufacture a product or group of products as rationally as possible?

Regarding to co-operation networks the main goal is sharing of production stages of complex product between similar enterprises, obtaining thus higher quality, shortening of cycle times and rational use of existing resources. In the proposed database model the product can be described by using characteristic data, for instance for the rotational parts (Fig. 6):

- d – max diameter of processing
- l – max length of processing
- IT – quality class of processing
- Ra – surface roughness parameter

Lathe can be described using following data:

- L – max distance between centres
- D – max diameter above support
- T – inner diameter of spindle
- TK – quality class of the machine tool
- PK – surface quality parameter derived from processing method

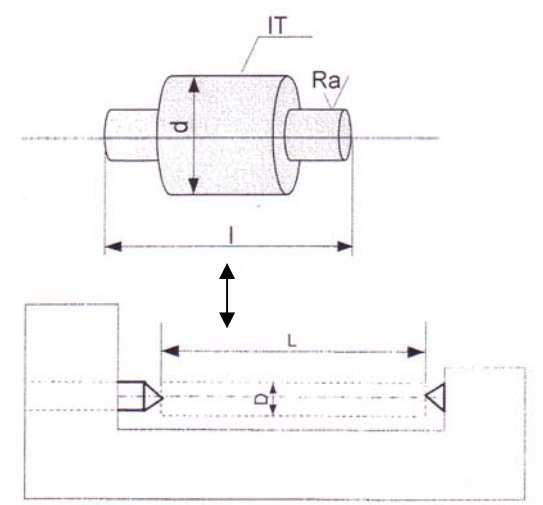


Fig. 6 Description of product and corresponding machine tool

Level of problem solving can be realised by following options (Otto, 2004):

- advice of current expert system, advising management board/marketing department of an enterprise to evaluate current production potential and need for updates in technology;
- supporting manufacturing 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.

The partial screenshot of such a database is shown on Fig. 7. In the current view can be seen a view to parameters management window, where kind “CNC” of type “Turning” belonging into group “Machining” is managed according to scheme Fig. 6.


Fig. 7 A screenshot from pilot version of database Innoclus, describing technological possibilities of the group of Estonian engineering industries enterprises

## 4. CONCLUSIONS AND FURTHER ACTIVITIES

The proposed model is capable for monitoring quality and quantity of technological resources in every participating enterprise of the network.

Results at this phase are used to revise and develop the INNOCLUS database test version. In a long perspective when a critical mass of companies are involved the system results can support the strategic planning of technology transfer as well as it could be used as a basis for the industrial enterprises in order to elaborate co-operation networks and develop towards extended enterprises.

The current solution is focused on the sector of metalworking, machinery and apparatus engineering. The proposed model can be transferred also to other industrial sectors (wood processing, chemical industry, construction materials industry, etc).

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