

ENHANCEMENTS IN PERFORMANCE THROUGH VIRTUAL COLLABORATION AMONG SMEs Potentials, Needs, and Research Challenges

Jannicke Baalsrud Hauge,
Bremen Institute of Industrial Engineering and Applied Work Science, GERMANY
baa@biba.uni-bremen.de

Ali Imtiaz,
*Research Institute for Operations Management (FIR) at Aachen University of Technology,
GERMANY*
Ali.Imtiaz@fir.rwth-aachen.de

Mirko Auerbach,
*Research Institute for Operations Management (FIR) at Aachen University of Technology,
GERMANY*
Mirko.Auerbach@fir.rwth-aachen.de

Jens Eschenbächer,
Bremen Institute of Industrial Engineering and Applied Work Science, GERMANY
esc@biba.uni-bremen.de

Marcus Seifert,
Bremen Institute of Industrial Engineering and Applied Work Science, GERMANY
sf@biba.uni-bremen.de

To compete and to thrive in the current global markets it is imperative for the regional businesses to form sustainable collaborative networks. Further, virtual inter-organisational collaboration not only requires changes in the organisational structure but also the increase the dependence on readily available information. The efficiency and effectiveness of this information depends on suitable collaboration tools; especially on the ICT infrastructure as well a trust and cultural understanding between collaborating partners. Especially for SMEs the ability for efficient networked collaboration is of key importance. At the moment, there are no affordable and customizable ERP tools for such a networked collaboration among SMEs.

This article presents a research approach focusing on the relevant challenges for the development and introduction of a collaboration tool based upon open source capabilities with industry specific ERP functionalities.

1. INTRODUCTION

Globalisation has led to fierce competition, customer driven markets and higher complexity in products, as a consequence there is a trend towards constantly changing partnerships characterises in the working environment of European manufacturing industry [Scheer, 2002, Sherman, 1996, Frederix, 2003]. This industry is vital to the European economy as it sustains 23.7 million jobs, an output of 1800 billion € (21% of EU GDP), and a positive contribution to the EU balance of payments (net of +120 billion € or 1.4% of GDP in 2001 [Enterprise Europe, 2002]). Therefore, the ability to maintain and develop the competitiveness of European manufacturing industry is essential for the prosperity of the EU. Regarding the challenges of globalisation and the emerging networked economy, it has been recognised that significant improvements in the competitiveness can only emerge as a result of the combination of information and communication technologies with new managerial and organisational techniques [COM 2002] and with a shift from goods based to knowledge based products [Thoben, 2003]. The European manufacturing industry has dealt with these challenges for years and a clear trend toward concentrating on key competencies, which actually forced companies to outsource production steps to various other partners [Meyer, 2004] resulting in a collaborative production of highly complex, often knowledge intensive products has been observed.

The success of collaboration is not only a matter of finding a partner with the right key competencies, but more a question of having the right ICT tools for seamless information processing and the right people to perform the daily collaboration work as well as on the ability of the participating organisations to act in a dynamical environment. Typical ICT tools needed for fast and seamless information processing within large companies are ERP and CRM tools and for intra- organisational collaboration the newest SCM tools also provide some of the required functionalities. Up to recently, such tools have been quite expensive to buy and their implementation required a high degree of IT competencies within the company. Even though large industries enterprises play a more and more dominating role in the European manufacturing industry, the SMEs, mostly acting as suppliers to larger ones still remain the backbone of the economy, esp. in the Eastern European Countries. However, if the SMEs intend to survive and thrive, they need to stay competitive by higher efficiency and productivity; therefore there is a need of a fast, reliable integrating support system at an affordable price fostering collaboration between SMEs. In order to keep the cost and the access on a low level, such a collaboration tool should be open source based and offer just the needed functionalities.

2. THEORETICAL BACKGROUND

The European Charter for Small Enterprises, adopted by the General Affairs Council in Lisbon on 13th of June 2000 and endorsed at the Feira European Council on 19-20th of June the same year, recognizes that small businesses are the backbone of Europe's economy and the key to our competitiveness. Tool and die making

workshops supply the European industry with customised mechanical components. Typically for these workshops is that they offer fairly knowledge intensive services and products to their customers and that these products and services are developed in close collaboration with other enterprises as well as the customer. The business is order-based, labour-intensive and most of the workshops are SMEs and typically they have one-of-a-kind production. Tool and die makers' customers are demanding industries from almost all branches where the manufacturing of goods is taking place: automotive industry, textile industry, IT & electrical industry, aerospace, etc.

2.1 Organisational aspects

In today's world, competition at every level of business activity is fierce; therefore only those enterprises that can minimise their costs will stay in the market and maybe as a winner. In the manufacturing business, costs are directly related to two ratios, productivity and efficiency. The related figures to these two characteristics show the worth of the money spent. This is where managers try to pull the lever. Several ways can be found to achieve higher productivity or better efficiency, but for the European manufacturing industry there has been a shift towards knowledge extensive products and services combined with a higher degree of collaborative production [Frederix, 2003], often based upon the concept of virtual organisations and extended products (compare **Figure 1**).

Looking at the supply chain of the manufacturing industry, it is obvious that the tool and die making workshops play a major role as suppliers of knowledge intensive services and products. Therefore, every change that large manufactures do to their supply strategies, leads to new requirement which a tool and die making workshop has to meet in order to stay as a supplier. Up to now, the tool and die making workshops have been able to meet these new requirements with high quality products and services as well as an excellent educated workforce but as the non-European competition from other SMEs as well from large enterprises growth, this isn't possible any more.

Furthermore, the one-of-a-kind production results in high costs and risks, since more complex products in terms of functionalities and high quality demands engage more complex and expensive manufacturing technologies. The range of needed manufacturing technologies comprises traditional as well as more innovative and expensive technologies. These are seldom all in-house, so there is need for sharing capacities (machines, materials, machine operator) and knowledge resources (technologies, competences).

The one- of a kind- product offered by the tooling industry fulfils the requirement of being an extended product. Complex extended products require various key competencies and hence it is often a collaborative product. The extended product includes a combination of a physical product (like the tool itself) and associated services/enhancements (like the engineering services offered) in order to improve the marketability [Baalsrud Hauge, 2004]. As shown in **Figure 1** an extended product consists of tangible and intangible assets. Consequently, tangible products can be intelligent, highly customised, and user-friendly and include embedded features like maintenance whereas intangible extended products are information and knowledge intensive and can consist of services, engineering,

software, etc. [Thoben, 2003]. The co-operation includes both material and information flows in order to accelerate the co-operation within the value chain.¹

Fitted into a typical manufacturing network, could mean that some suppliers delivers raw materials, some parts of the physical/tangible products, which builds the core of the extended product, whereas other either support with some specific manufacturing technology and engineering services depending on the specific customer's requirement.

However, looking at the layer model below it becomes obvious, that workshops producing the customised product in collaboration do have quite much in common with virtual organisations, for which general business models are available.

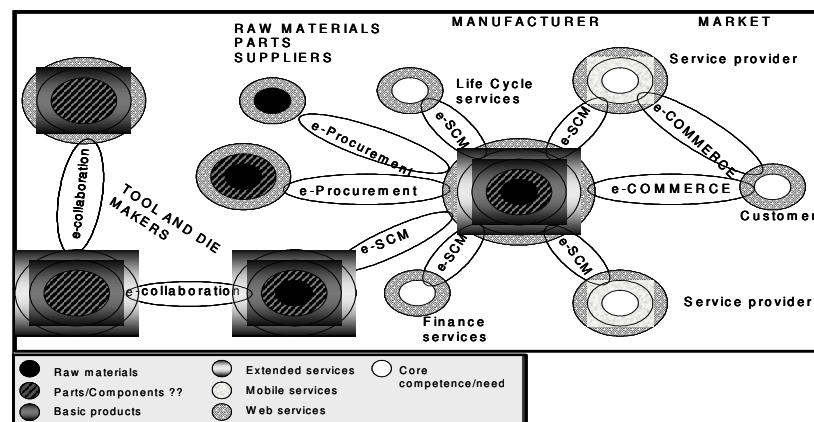


Figure 1: virtual organization, and extended product [based upon Oliveira 2000]

Toolmakers are operating in a highly dynamic market and are therefore forced to adapt their organisation and technologies to dynamic requirements as well as to constantly optimise their business processes in order to stay competitive. They have long experience with expertise, knowledge and competences-sharing as well as to mediate lessons learned throughout a cluster. So the basic premise for the collaborative work, the sharing culture is well developed and caused by the strong competition, a lot of workshops have organised themselves in tool-clusters or in associations. It is expected, that this trend will remain during the next decade.

2.2 Technical aspects

Additional to the challenges facing the organisational aspect of a virtual enterprise, the up coming and implementation of new IC Technologies among SMEs has opened new possibilities for collaboration but on the other side due to their limited financial and human resources they neither have a genuine need nor the possibility to implement the different ERP and SCM systems of their customers. However, in order to be able to process information in an efficient way and thereby stay in the market they need at least to be able to connect to such systems.

¹ Michael Porter Value chain model can be seen as appropriate

Collaboration platforms

Over the past years, a diversification has taken place regarding the categorisation of information systems. **Figure 2** below presents a systematic view of respective categories ordered by document management functions as well as communication and collaboration support. Furthermore, the figure shows an overview over the diverse categories of tools.

Setting boundaries between the mappings of individual collaboration tools to the categories is difficult, as individual tools can often be attributed to more than one category. Thus, the mapping is carried out according the most fitting category per tool. Further categories such as PIM, workflow, group work support and e-learning could also be added to the figure

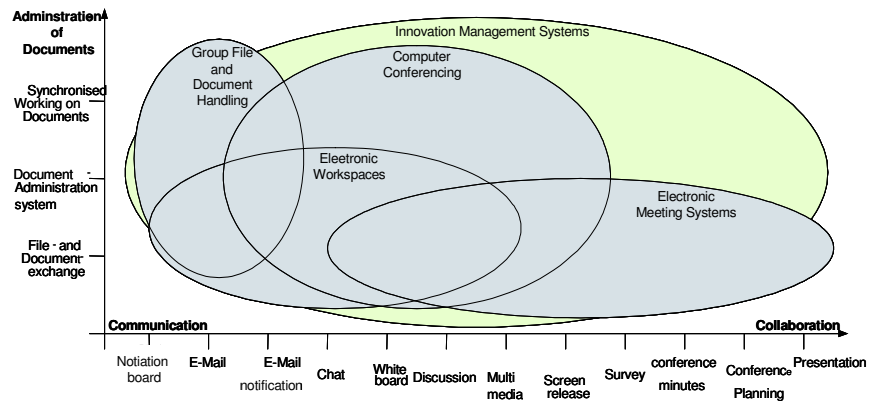


Figure 2: Categorisation of Tools [Based upon Bafoutsou/Mentzas 2002]

The combination of individual categories can contribute to the creation of new categories. Furthermore, group work support is increasingly being integrated into current OS, meaning the categories can be even further extended. For example, if one chooses to extend the above categories by their temporal and spatial dimensions a complete methodology can be created which is presented in Table 1 below.

Functional category	Temporal dimension		Spatial dimension	
	Synchronou s	Asynchronous	Co-located	Remote
Group file & document handling	✓	✓		✓
Computer conferencing	✓	✓		✓
Electronic meeting Systems	✓	✓	✓	✓
Electronic workspace	✓	✓		✓

Table 1: Temporal and spatial differentiation of collaboration systems [Bafoutsou/Mentzas 2002]

As has been shown, group work and document management are always distributed applications and can be synchronous or asynchronous. Similarly, conference systems can be co-located or remote. On the other hand, electronic workspaces generally represent synchronous or asynchronous communication and collaboration support.

The above mentioned collaboration tools are indeed usable for improving collaboration, but they do not solve the problem with getting the information automatically out of internal ERP systems neither do they offer the functionality of an ERP system inside the enterprise

ERP-systems

Many large companies have implemented ERP-Solutions but they are still restricted to internal and/or enterprise level. The solutions are more or less customised and even though much work has been carried out in the field of Enterprise application Integration(EAI) to solve problems with different data exchange formats and application which are not interoperable, most of this work is concentrated within an enterprise. In a dynamic business networks, the participating partners change, and with each change it is to expect that different ERP- systems needs to be connected to each other, either through defining specific interfaces or redundant data management has to be expected. This is one of the main obstacles networked businesses have to deal with.

According to various studies [Meyer, 2004]; only a few SMEs in Eastern Europe have implemented ERP-system. One reason is the lack of financial and human resources needed. Another reason is that the functionalities of these standardized applications do not fulfil the specific requirements of the tool and die making industry. Only about 30 percent of all ERP system's functionalities listed are common among all the industries. Therefore, based on preceding figures it is imperative to narrow the focus from all industries to individual industries and find out their core ERP functionalities that could supports collaborative network among companies

Even though it has been stated that the SMEs build the backbone of the European economy hardly any research have been carried out in order to establish information transfer and sharing among business networks for collaborative efforts supporting the competitiveness of SMEs. Some descriptions and procedures regarding the introduction of single tools and methods for network business in the tooling industry can be found in the literature, but a holistic approach is still missing. Appropriate models, methods and in particular a methodology of integrating is lacking for the tool and die making industry through open ERP solutions in distributed and globally dispersed entrepreneurial networks

3. MAIN RESEARCH CHALLENGES AND APPROACH

Even though there is a need of collaboration among enterprises, the past has shown that due to different goals among the partners and rapid changes of processes, collaboration are complex to handle. Additional, in dynamic and flexible networks, common experience is often lacking often resulting in the lack of trust. European collaboration networks also need to deal with the cultural aspect.

The above mentioned problems are relevant for almost all collaborations and mainly the identified problems can be classified into three categories:

- Interoperability, management and organizational models
- Sharing culture and technology transfer
- Cheap and effective software solutions based on open standards

Based upon this, it can be stated that for the tool and die workshop problems are mainly related to their production management and resource planning, as well as to e-collaboration but also with respect to management of customer relations and e-collaboration in carrying out their day-to-day business. Collaboration processes represent a key factor in the competitiveness of tool and die making clusters. By suitably improving these processes, clusters will be able to strengthen their position as suppliers. In order to effect such an improvement, we suggest the implementation of a collaboration platform utilizing emerging, innovative technologies made available to participating SMEs at the lowest possible cost.

In order to integrate the component into the overall supply chain, as well the SMEs' existing individual back-end enterprise systems, the solution will be augmented with (adaptive) service modules, allowing fast and flexible, standardised interfacing.

Based upon this, the idea of our research is to develop a collaboration tool with ERP functionalities for the tool and die making industry. Since this tool is supposed to be affordable for SMEs and interoperable, it will be based upon open source technologies. Not only the establishment of an IT infrastructure for supporting collaboration will a part of the research, but the SMEs will also be taught how the structured information sharing along complex and networked value chains can be accomplished. Therefore, our research project integrates both affordable open ERP-Solution and business interoperability driven approaches with information and communication technology (ICT) methodologies and instruments in order to develop and implement an innovative integration among SMEs of tool and die making industry.

For the networking of SMEs and other players in this sector it is imperative to have a collaborative development based on the open-source IT systems developed in the project as an internet based platform. To make the project results and particularly the open source ERP-application easily available for a wide range of users, a download service will be implemented on this platform. It will enable the partners to download relevant source-code, install it using the help from the online manuals or request support from the IT partners. In addition to that, all other project results will be disseminated via the platform.

Due to the nature of the project in which the tool clusters are involved, they still struggle to find the right organisational model for collaboration. The project will therefore emphasise on this aspect, since this a key to successful collaboration.

The project initiative is going to leverage the common goals with regard to different aspects identified so far. To harmonize the efforts of the different partners, it has been categorized into four main modules with each module achieving distinct goals and helping to achieve the final vision. The relation between the modules can be seen in Figure 3

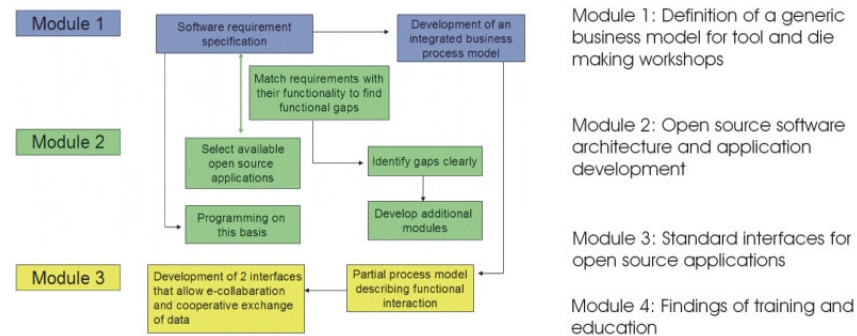


Figure 3: Tool East modules

- **Module I: Definition of a generic business process model for tool and die making workshops**

Modelling the business process is an essential part of any information based business networking development process. Deriving from the business model, the software requirement specification will be formulated as the basis for software development. It specifies the required behaviour of a system

The performed survey of suitable process models shows that the Aachner PPC[Luczak,1999] model seems suitable for analysing the end user business processes and to collect the user requirements. However, this model is not very well known outside the German speaking area, therefore we found it necessary to also match this model with the SCOR[SCC2006]. At the moment it seems that the Aachner PPC model is more suitable, because it is more flexible and more detailed, but these results need to be verified and determined during the next couple of months. Additionally, two main challenges were identified: First is that there is a large diversity in running processes within the tool and die making workshops (SMEs) – these differences were analysed using morphology and process landscapes. The second point focuses on one of a kind production that leads to some specific requirements for the CRM functionalities for the Tool-East software.

- **Module II: Open source software architecture and application development (adaptation and improvement of one existing open source ERP solution; the development of another new open source ERP application is not the ambition)**

In order to develop software for SMEs as large group of companies which are not well served by the strong software suppliers the project will come up with an enlarged open source ERP-system with CRM-functionalities. The first objective of module-II is to evaluate and select the best open source solution available as basis for the intended specific development. The second objective is to develop additional modules to support processes described in the business process model. SMEs will be included in this work and to a very early stage a first prototype will be available in order to receive a first feedback.

First results of a survey performed by the business process analysis have shown that the following functionalities are relevant: 'inter-operability and inter-communication', 'organisational structure and multi-site planning',

'production planning and control', project management', Engineering and master data management', material management/ requirement planning', 'purchase and procurement', 'outbound logistics and distributions' are core functionalities where as 'Financial accountant' and 'human resource' functionalities are not so relevant.

- **Module III: Standard interfaces for open source applications**
Competitive forces are driving technology efforts towards e-collaboration and cooperative exchange of data and applications within and across corporate boundaries. That means that intelligent interfaces have to support the exchange of data. Evolving new technologies provides an array of services to effectively design and develop integration and collaborative solutions that connect different systems like ERP, CRM, or other internal systems, as well as connectivity with partners, vendors, and other service providers. For SMEs not only the integration of large systems is problematic but also the possibility to import existing data stored e.g. in Microsoft Excel files or other individually programmed databases in order not to retype all information manually. The strategy is to provide additional functionality via interfaces, so the technical possibilities and latest development will be examined and evaluated.
- **Module IV: Training and education**
The findings of training and education module are critical to develop a methodology to carry out personnel training, establishing an appropriate relationship between classroom, on-site, and e-learning modules. It has to meet the different stakeholder groups' individual requirements and training needs.

This common structure facilitates the integration of different aspects. Different modules will be integrated to develop a synchronized open source ERP application in close relationship with each SME in the consortium.

4. CONCLUSIONS AND SUMMARY

The project Tool-East will provide a cost-efficient ERP application for tool and die making workshops on the basis of existing open source ERP applications. Within the project the open source application will be adapted and modified for the specific requirements of this branch. The new adapted and modified ERP application supports the efficient coordination of intra-enterprise order processing and strengthens competition and competitiveness of Eastern European SMEs. Primarily, orders management, work planning, resource allocation and CRM need to be optimised and linked together in a dynamic work environment. Moreover ERP applications are necessary for the electronic collaboration in dynamic business networks. To enable industrial cluster to e-collaboration the consisting process and data standards (for example ROSETTANET, ebXML etc.) will be considered for the Tool-East project.

This project focuses as a core on the use of open source technology for the development of an integrated business application for tool and die making enterprises with high performance regarding availability, safety and maintainability at the very onset. Further on this will be enriched by enabling coordination between the different players in this sector. Strengthening the open source initiative in

general and particularly in this field of business opens an enormous potential for SMEs. A successful case study and dissemination platform in the specific branch addressed in this project will pave the way for future initiatives. Since demands for business software from other branches with specific SME structures are predominantly comparable, therefore results and concepts from this project can be transferred, so that a large impact can be assumed.

For the long term success it is essential for the tool and die making industry to continue to set on innovative business strategies long time in advanced. Such a strategy comprises participation in dynamic business networks. Two main challenges for a successful participation of tool and die making workshops in dynamic business network is to coordinate intra-enterprise order processing and that they bring their core capabilities into a flexible network.

Acknowledgements

This work has been partly funded by the European Commission through IST Project *Tool-East: Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshops* (No. IST-FP6-027802). The authors wish to acknowledge the Commission for their support. We also wish to acknowledge our gratitude and appreciation to all the Tool-East project partners for their contribution during the development of various ideas and concepts presented in this paper

6. REFERENCES

- [Bafoutsou/Mentzas 2002]: Bafoutsou, G., Mentzas, G.(2002): "Review and functional classification of collaborative systems", *International Journal of Information Management* , 22, 2002, S. 281-305.
- [Baalsrud Hauge, 2004], Baalsrud Hauge et al.(2004): Enhancing e-commerce business models of selected SMEs by a multi-mode approach in *International Journal of Internet and Enterprise Management*, p.122, Vol.2, 2004
- [COM 2002]: European Commission, COM 2002, 714, *Industrial Policy in an Enlarged Europe*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of Regions
- [Frederix, 2003]: Frederix, F.(2003): Cooperation in Dynamic Networked Organizations, p.221 In Gasòs,J. Thoben, K.-D. (Eds.): *E-Business Applications – Technologies for Tomorrow's Solutions*; Advanced Information Processing Series, Springer, 2003,
- [Enterprise Europe 2002]: enterprise Europe (2002), No 8, July-September 2002
- [Thoben, 2003]: Thoben, K.-D., Eschenbächer, J., Jagdev, H.S.:Emerging Concepts in E-Business and Extended Products; in: Gasos, J., Thoben, K.-D. (Eds.): *E-Business Applications – Technologies for Tomorrow's Solutions*; Advanced Information Processing Series, Springer, 2003, pp. 17 - 37
- [Meyer, 2004]: Meyer, M et al(2004): Plug and do Business- ERP of the next generation for efficient order processing in dynamic business networks in: *International Journal of Internet and Enterprise Management*, pp.153 Vol.2, 2004
- [Luczak, 1999]: Holger Luczak, Walter Eversheim: *Produktionsplanung und -steuerung: Grundlagen, Gestaltung und Konzepte. 2. Auflage.*: Springer-Verlag (1999), ISBN 3-540-65559-X
- [Oliveira, 2000]: Oliveira *et al.* (2000) 'SMARTISAN-moving e-commerce to extended product', Helsinki Conference Proceedings.
- [Scheer, 2002]: Scheer, A.-W., Griebel, O., Hans, S., Zang, S.(2002): *Geschäftsprozessmanagement – The 2nd wave*. In: *Information Management & Consulting*, 17, 2002 Sonderausgabe, pp. 9-14.
- [Sherman, 1996]: Sherman, Heidemarie(1996): "Globalisierung: Transnationale Unternehmen auf dem Vormarsch", *Ifo Schnelldienst*, Nr. 23, 1996
- [SCC2006]:Supply Chain Council: SCOR 7.0 overview booklet. More Information will be found on <http://www.supply-chain.org/page.wv?section=SCOR+Model&name=SCOR+Model>