Laboratory for Machine Tools and Production Engineering

Toolmaking for the future

A global study of today's situation and future trends in the tooling industry

WZL RWTH AACHEN

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Preface

Challenging times need adequat solutions

Today's turbulent economic environment confronts the global tooling industry with serious challenges. Cost competition and the high demands of globalized value-adding chains put pressure on small- and medium-sized toolmakers. As an exclusive differentiation in price is not an option, new means for achieving sustainable competitive positions have to be found.

A promising approach for differentiation is to enhance the existing range of products by offering customer-specific services within so-called industrial product-service-systems. However, the lack of local presence inhibits the toolmakers' abilities to deliver these services to their global customers.

To address these challenges the European R&D-project TIPSS has the objective to develop suitable methods, techniques and technologies, for toolmakers to improve their local and global performance thus enabling them to offer industrial product-service-systems on a global scale. Based on an extensive survey, a global footprint of the existing service landscape and a portfolio of value-adding services are presented.

The interaction with many toolmaking companies as well as their customers all over the world gave us the opportunity to get valuable insights on the current situation of this particular industry and how the needs of the customers determine trends in services and cooperation in the near future. We are very pleased to be able to share these findings and support a favorable development in this key industry.

Sincerely yours,

Günther Schuh

Univ.-Prof. Dr.-Ing. Dipl.-Wirt. Ing.

Design of the survey

Structure of survey participation by region

The survey was carried out in two parts, starting with the customers and ending with the toolmakers themselves. In total, 278 companies in relevant economies all over the world have participated in the survey. 128 parts producing companies from 21 countries as well as 150 toolmakers from four regions of the world took part.

Fig. 1: Customer survey participation

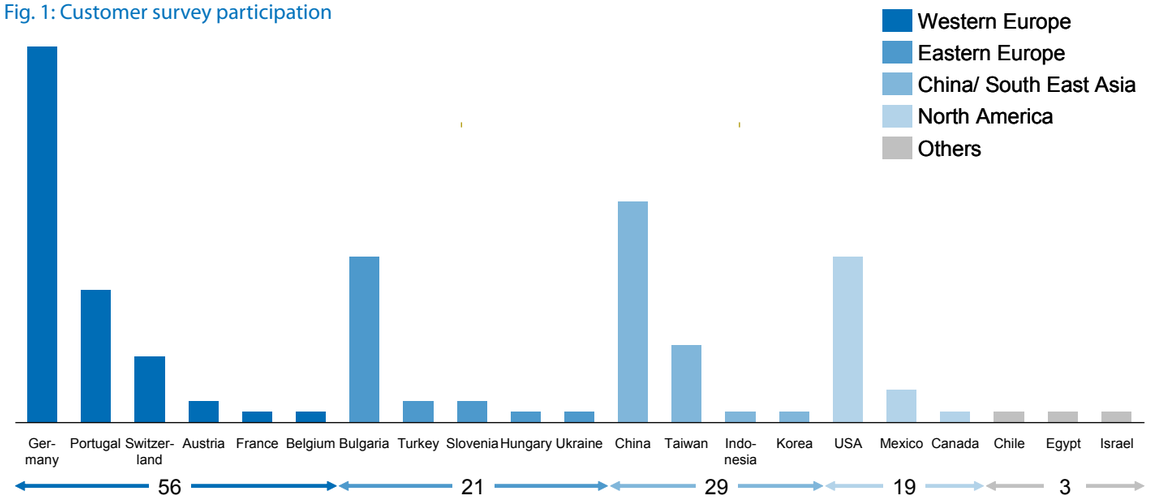
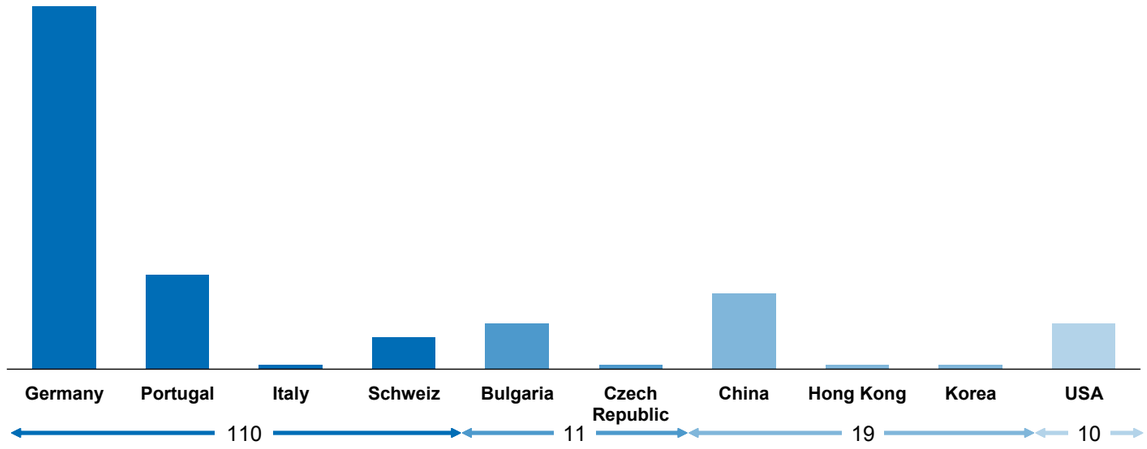


Fig. 2: Toolmaker survey participation



Structure of survey participation by industry and tool type

The figures below show in which industry sectors both toolmakers and customers that participated in the survey are active. Around 50 percent of all participants are doing business in the automotive and consumer products sectors (Fig. 3 and Fig. 4). The figures on the right give an overview of the production technologies used by the participating part producers respectively the tools used within these production technologies built by the toolmakers (Fig. 5 and Fig. 6).

Fig. 3: Industries served by customers

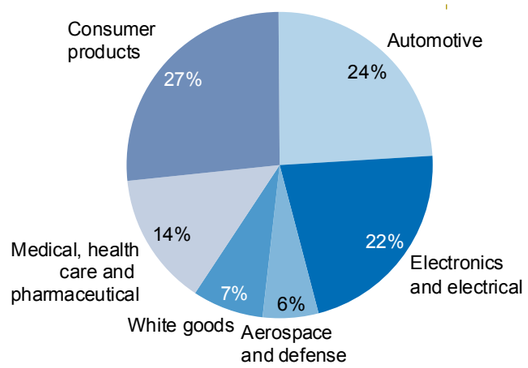


Fig. 5: Type of parts produced by customers

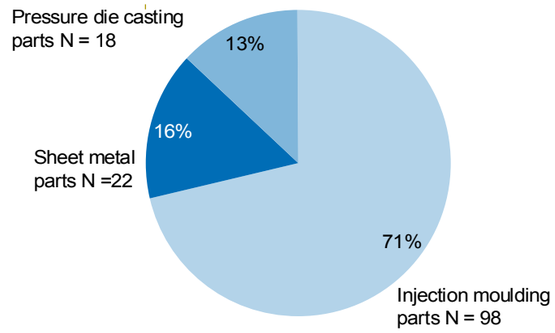


Fig. 4: Industries served by toolmakers

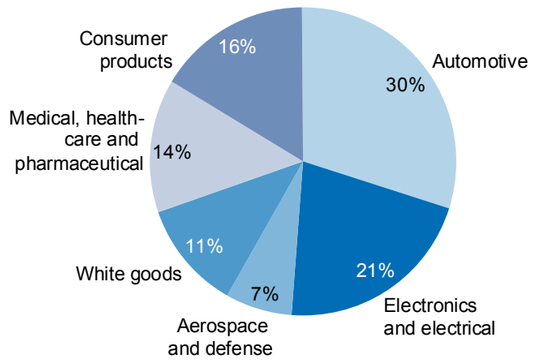
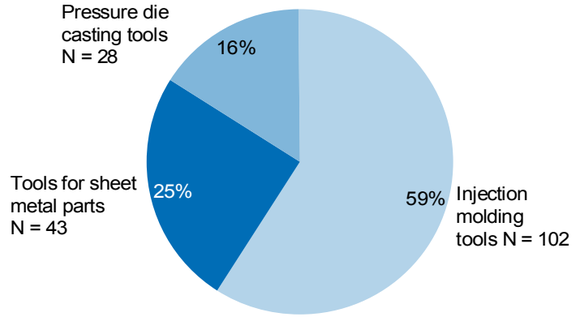


Fig. 6: Type of tools produced by toolmakers



Statistics

Financial aspects

One goal for the selection of survey participants was to accurately reflect the industry landscape of each region. As was expected, the average tool price (Fig. 7) of the tools produced by the study participants was the highest in Western Europe. The average tool price in China/ South East Asia on the other hand was substantially higher then expected, indicating that participants from this region produce rather larger or more complex tools than the industry average. This assumption was supported by the statistical analysis of the tool's dimensions (Fig. 9) and weight (Fig. 10). The predominant tools used by customers in all regions are smaller than 500mm by 500mm and weigh less than 500kg.
Concerning the size of the companies participating in the survey Figure 8 shows the average revenues of the toolmakers. Accurately reflecting the structure of the industry, the majority of toolmakers generates revenues of up to 3 Mio. EUR.

Fig. 7: Average tool price

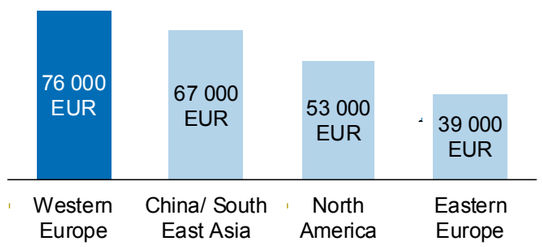
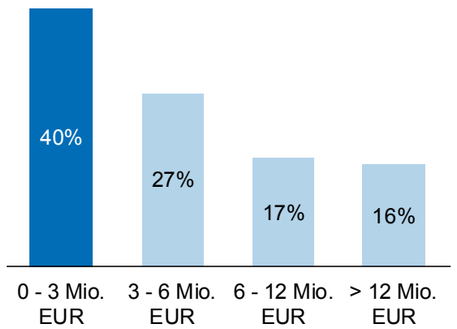


Fig. 8: Average revenue of toolmakers



Accurately reflecting the structure of the industry, the majority of toolmakers generates revenues of up to 3 Mio. EUR

Tool dimensions and weight

Fig. 9: Average tool dimensions

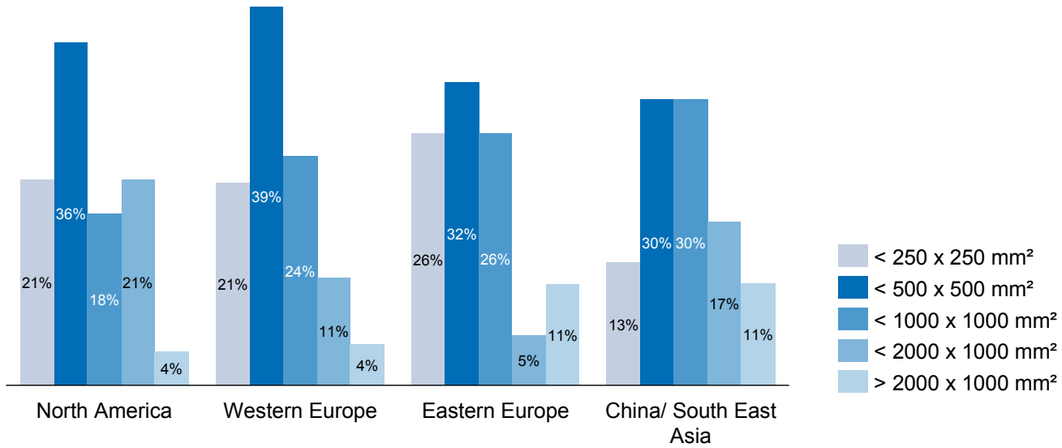
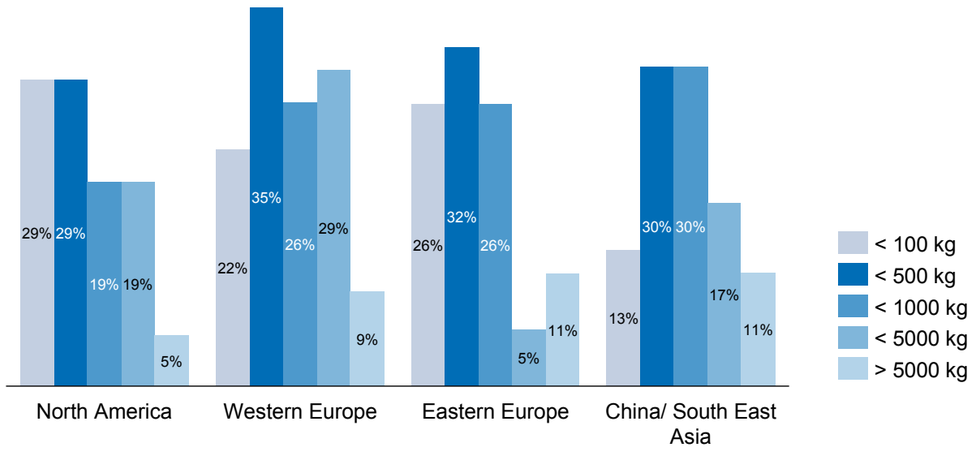


Fig. 10: Average tool weight



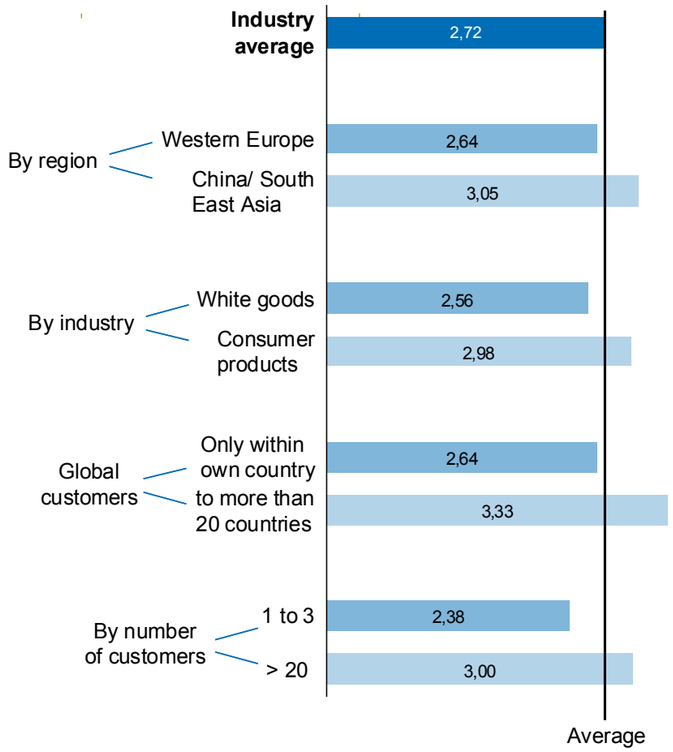
The predominant tools used by customers in all regions are smaller than 500mm by 500mm and weigh less than 500kg

General information

Perceived satisfaction in the tooling industry

In general the current business situation in the tooling industry is dissatisfactory – however toolmakers in certain regions and industries or with a diverse customer base seem to get along better then others. Figure 11 illustrates the level of satisfaction of the over- and underperformers of each category. It can be seen that Chinese/ South East Asian toolmakers are the most satisfied whereas their counterparts in Western Europe are the least satisfied. The largest difference in satisfaction can be noted for toolmakers serving global customer versus toolmakers that only act on a local level, the latter being the least satisfied. The same can be said for toolmakers having multiple customers versus the ones only doing business with a small number of parts producers.

Fig. 11: Level of satisfaction in the tooling industry



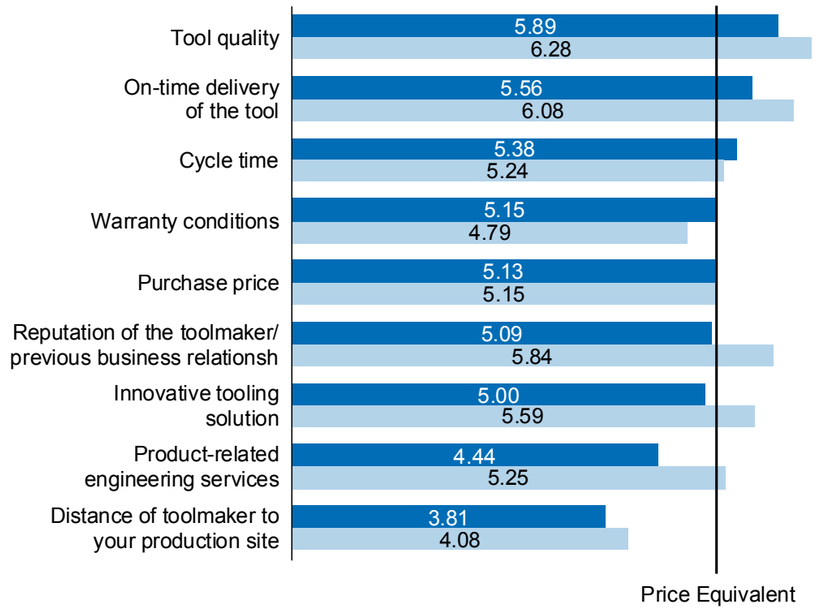
Note: Average value of answers given by the participants on a scale from 1 (dissatisfied) to 7 (satisfied)

In general the current business situation in the tooling industry is dissatisfactory

Selling points - toolmaker vs. customer perception

The widespread assumption that the most important criterion for a customer would be the purchase price of a tool has been disproved. Superior criteria turned out to be the quality of a tool followed by on-time delivery and short cycle time, showing that total cost assessment is gaining in importance.
Next to the absolute evaluation of the criteria it is especially interesting to note the differences between the toolmakers' evaluation and the actual evaluation by their customers. While toolmakers generally believed that previous relations to a customer would secure them future contracts, the customers displayed a higher willingness to switch suppliers. Vastly underestimated by the toolmakers was the necessity of offering adequate warranty conditions. The fact that both toolmakers and their customers evaluated the distance between customer and supplier as relatively unimportant shows that both sides do take part in the globalization of markets. However, this is no indication of how well they perform within these markets.

Fig. 12: Perceived differentiation criteria



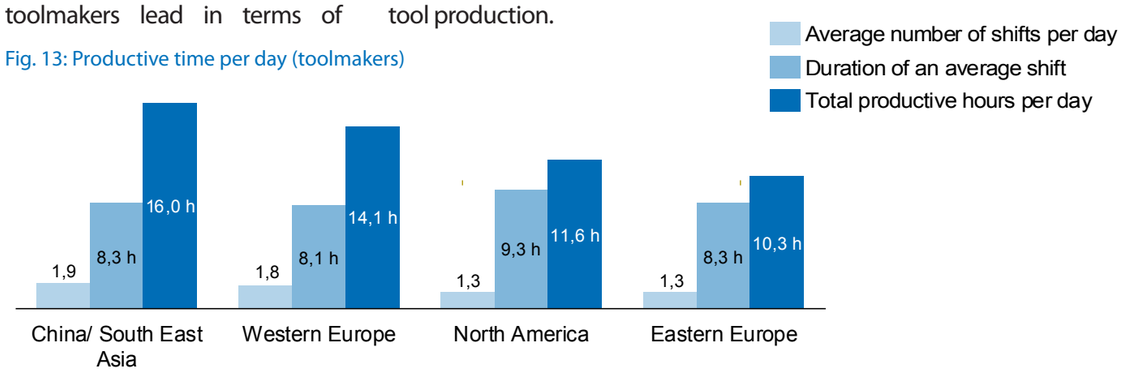
Note: Average value of answers given by the participants on a scale from 1 (unimportant) to 7 (important)

Price is not the most important criterion for differentiation

Production capacities and technical resources

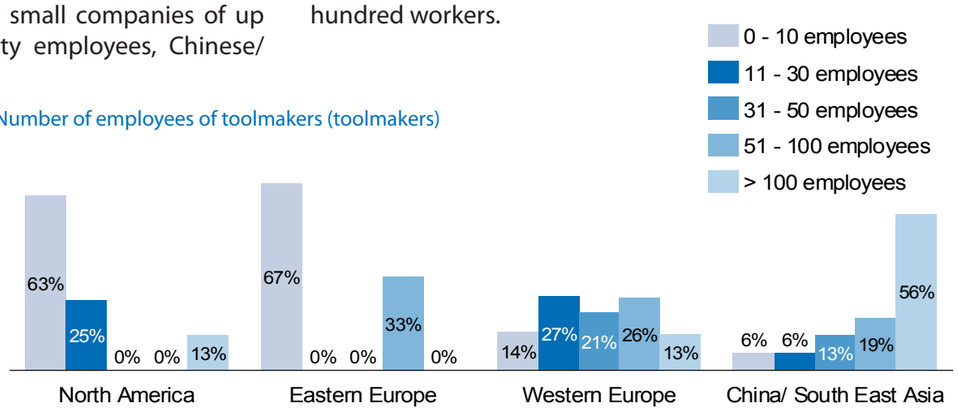
Chinese/ South East Asian toolmakers have the most productive time per day (Fig. 13). Even though North American toolmakers lead in terms of average shift duration, Chinese/ South East Asian and Western European toolmakers on average have a higher number of shifts for tool production.

Fig. 13: Productive time per day (toolmakers)



While toolmakers in North America and Eastern Europe are mostly small companies of up to thirty employees, Chinese/ South East Asian companies often employ more than a hundred workers.

Fig. 14: Number of employees of toolmakers (toolmakers)



Chinese and South East Asian toolmakers take the lead in terms of available productive time and manpower

Production hours per week

North American and Western European parts producers have more production hours per week available than their competitors in Eastern Europe and China/ South East Asia.
Longer production hours per week are an indication that productivity of parts producers in North America and Western Europe is still higher.

Fig. 15: Productive time per week (parts producers)

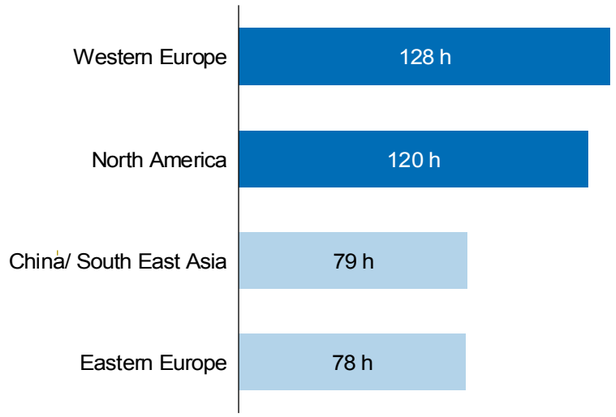
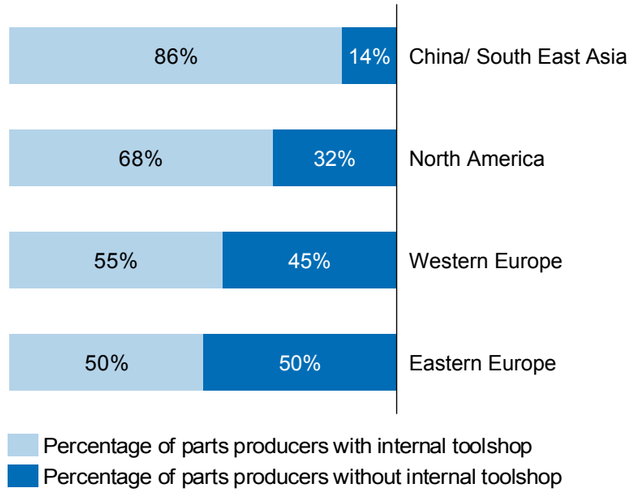


Fig. 16: Internal toolshops



Customers' production sites, especially in China, often have an internal toolshop indicating that service is usually done in-house with own resources.

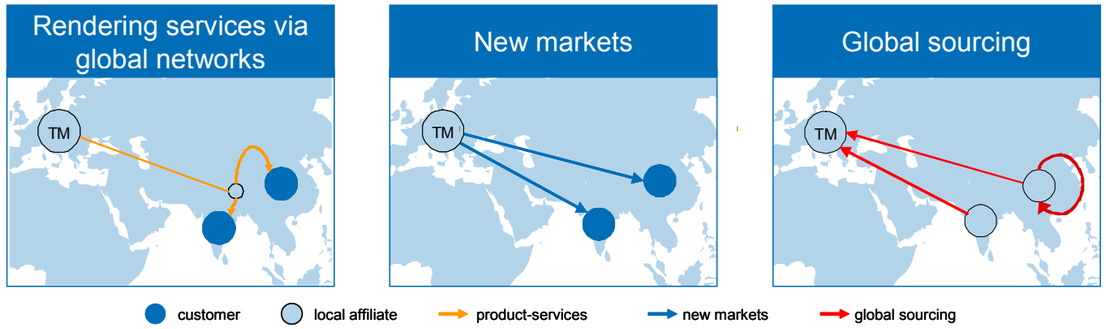
More production time per week is an indication that Western parts producers are still more productive than their counterparts in emerging markets.

Global footprint

Challenges and opportunities

The goal of the TIPSS project is to enable toolmakers to address global challenges - rendering services on a global level, entering new markets and sourcing globaly. Toolmakers that address these challenges adequately will be able to participate in the benefits globalized markets can bring. Those who do not will have a hard time to survive.

Fig. 17: Global challenges



- Vertical extension of the value chain (new product related services)
- Provision of product services through local partners

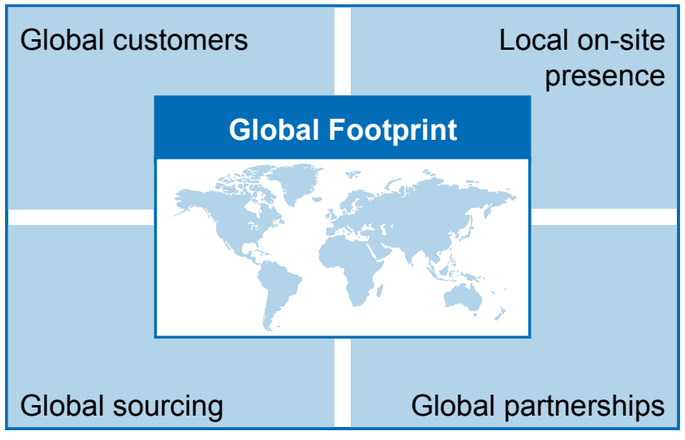
- Entering key market areas
- Partner networks create access to new customers

- Partner networks support global sourcing
- Tapping resources in global markets reduces the cost pressure

Through the global footprint, the survey tries to elaborate which the current status regarding these challenges and opportunities is and which tendencies, if any, can be observed. The global footprint focusses on four aspects:

- Global customers
- Local on-site presence
- Global partnerships
- Global sourcing

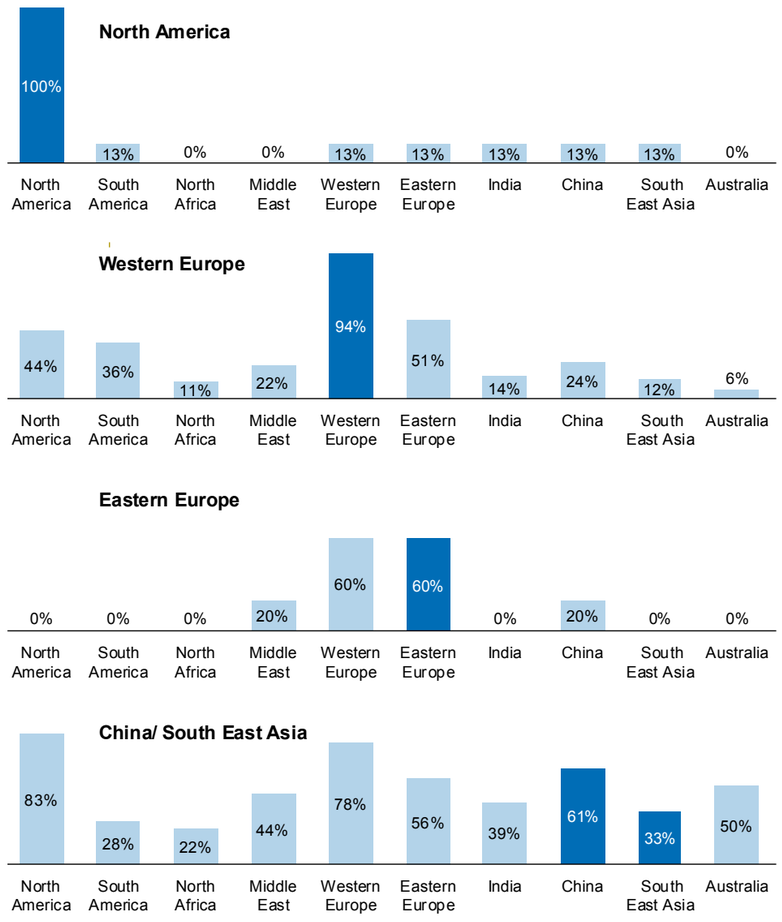
Fig. 18: Global footprint



Global customers

The first part of the global footprint investigates to which degree toolmakers currently take advantage of globalization by entering new markets to sell their tools. Figure 19 depicts the structure of the toolmakers' markets in each region. It can be seen that North American and Western European toolmakers still have a very strong focus on their own region. The regions China/ South East Asia and - to a lesser extent - Eastern Europe have a higher percentage of export to other regions. This shows on the one side, that North America and Western Europe are currently still target markets when it comes to parts production. On the other side it also shows that toolmakers in China/ South East Asia and Eastern Europe are using the globalization of markets more consequently for selling their tools.

Fig. 19: Structure of toolmakers' markets by region



Toolmakers in China and South East Asia use globalized markets more consequently for selling their tools

Global customers

The customer's perspective on global sourcing of tools is given in Figure 20. The illustration shows the ratio of global vs. local tool purchasing of companies within the different regions. Parts producing companies were asked to rank the top four countries from which they purchase tools. It can be seen that companies in Western Europe and China/ South East Asia frequently purchase tools from toolmakers within their own region.

The specific purchasing habits for each region are depicted in Figure 21. The illustrations show in detail where the main sources of tools for parts producing companies from each region are.

Fig. 20: Global vs. local tool purchasing

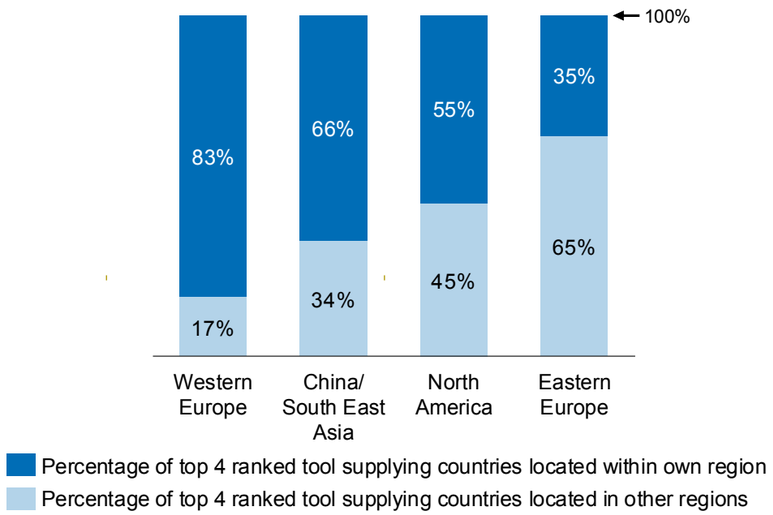
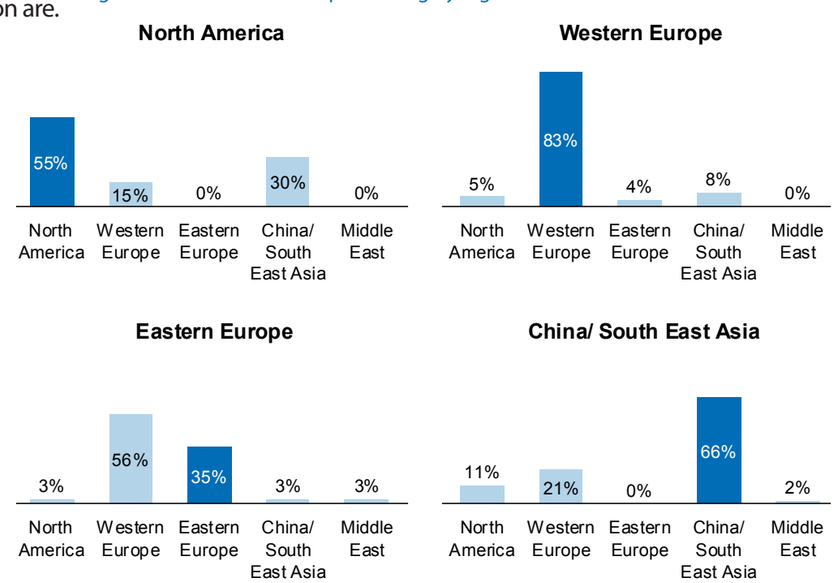


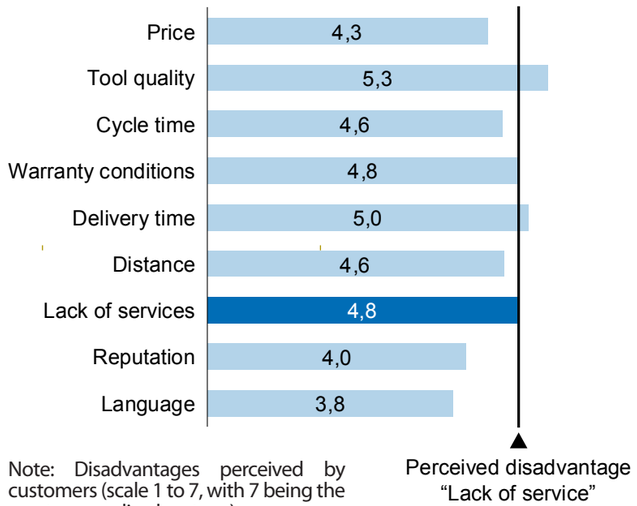
Fig. 21: Global vs. local tool purchasing by region



Customers were asked to rank the importance of several disadvantages they perceive when buying tools from toolmakers in other regions of the world on a one-to-seven scale, seven being the most severe disadvantage (right).

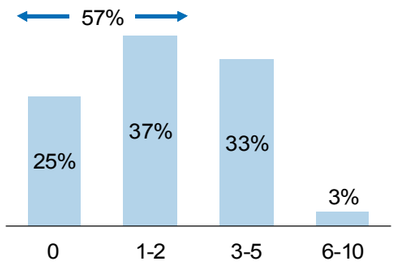
The evaluation shows, that a lack of services was ranked just after quality issues and delivery time, clearly implicating the importance for a toolmaker to be able to deliver services on a global level. However, even though service is seen as important, the majority of customers only has a very small number of external service partners for maintenance (Fig. 23). While 25 percent of the parts producing companies have no service partner at all, 57 percent have only two partners or less.

Fig. 22: Perceived disadvantages when purchasing foreign tools



Note: Disadvantages perceived by customers (scale 1 to 7, with 7 being the most severe disadvantage)

Fig. 23: Number of external service partners (customers)



Lack of service is a major obstacle for customers to buy tools on global markets

Local on-site presence

To draw a picture of the on-site presence of toolmakers at their customers' production sites regarding the provision of tool-related services, both the customers' as well as toolmakers' perspectives are given.
Figure 24 shows that a customer's toolmaker only performs tool-related services locally at the customer's production site in rare cases.
Since tools are only shipped back to the toolmaker in rare cases, this means that the customer usually performs maintenance with his on capacities.

While half of the toolmakers in North America, Western and Eastern Europe state that they never or hardly ever perform service at the customer's production site, toolmakers in China/ South East Asia seem to have a higher on-site presence.

Fig. 24: Percentage of tool-related service performed at the customer's production site (customers' perspective)

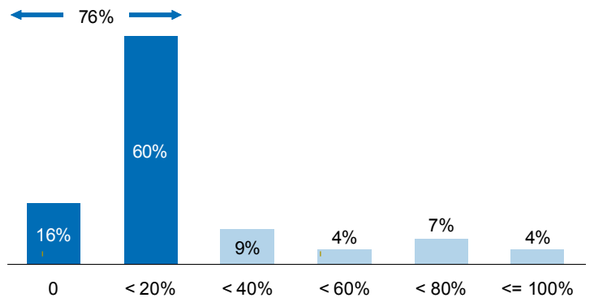


Fig. 25: Percentage of tools sent back to toolmakers for repair by region

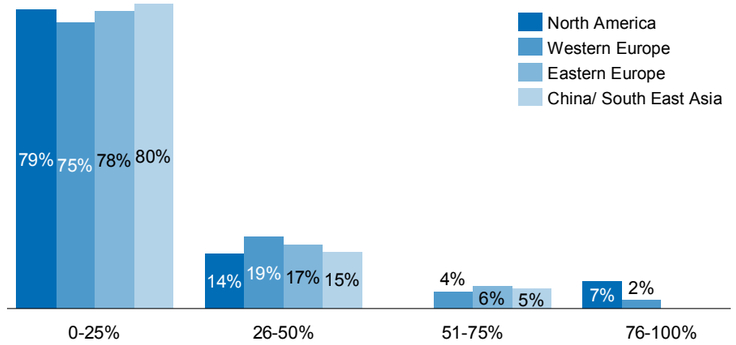
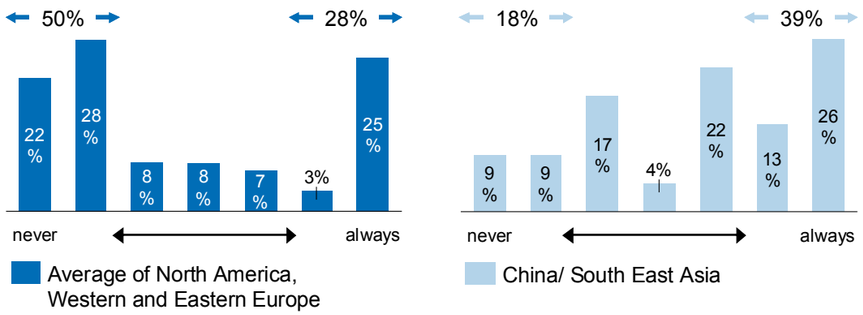


Fig. 26: Percentage of tool-related service performed at the customer's production site (toolmakers' perspective)



Global partnerships

Fig. 27: Percentage of toolmakers without partners for service provision

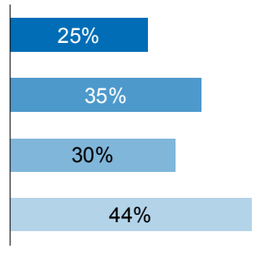
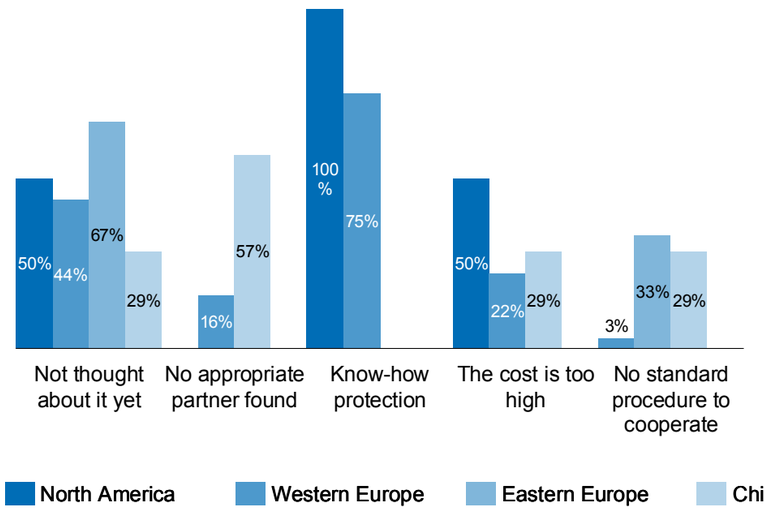


Fig. 28: Reasons for not having a partner for service provision



The third perspective of the global footprint investigates partnerships and other relationships between toolmakers in terms of backward and forward integration into each other's processes.
Toolmakers where asked whether or not they do have any partnerships regarding the provision of services. Figure 27 shows that a large part of the toolmakers, especially in China/ South East Asia, is currently not cooperating with other toolmakers for rendering tool-related services. Figure 28 illustrates the reasons why toolmakers choose not to cooperate. It sticks out that while North American and Western European toolmakers are worried about the protection of their know-how, Chinese/ South East Asian toolmakers simply have trouble finding appropriate partners.

Know-how protection and the lack of appropriate partners keep many toolmakers from cooperating with others

Global sourcing

The last perspective of the global footprint focuses on the ability of the toolmaker to use globalized markets for sourcing. Figure 29 shows that standard tool parts are the largest part of global sourcing. It seems that while Eastern European and Chinese/ South East Asian toolmakers have a stronger focus on selling their tools in other regions then their Northern American and Western European counterparts, they also go further when it comes to buying parts in other regions (below). Furthermore it can be seen that while standard tool parts are commonly sourced globally, service are still mostly procured locally.

The graphs on the opposite page depict advantages and disadvantages perceived by toolmakers when sourcing globally. While North American, Western and Eastern European toolmakers mostly see an advantage in price, Chinese/ South East Asian toolmakers source globally because of quality, reliability, reputation, warranty conditions and, surprisingly, delivery time.

Fig. 29: Global sourcing by type (toolmakers)

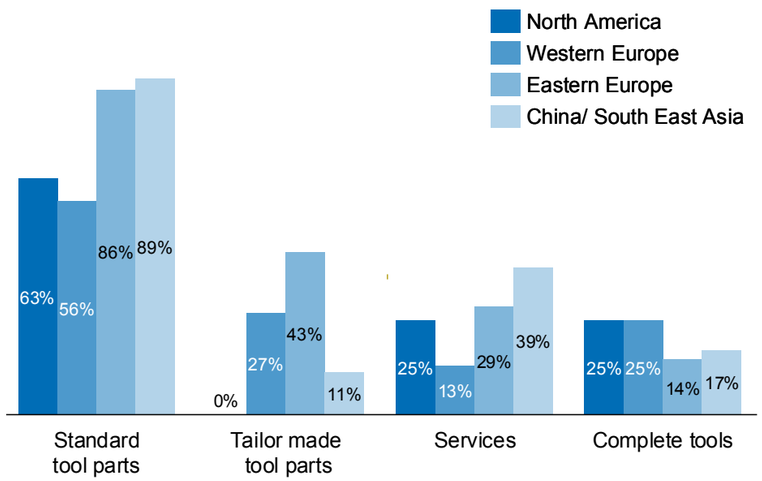


Fig. 30: Global sourcing by region (toolmakers)

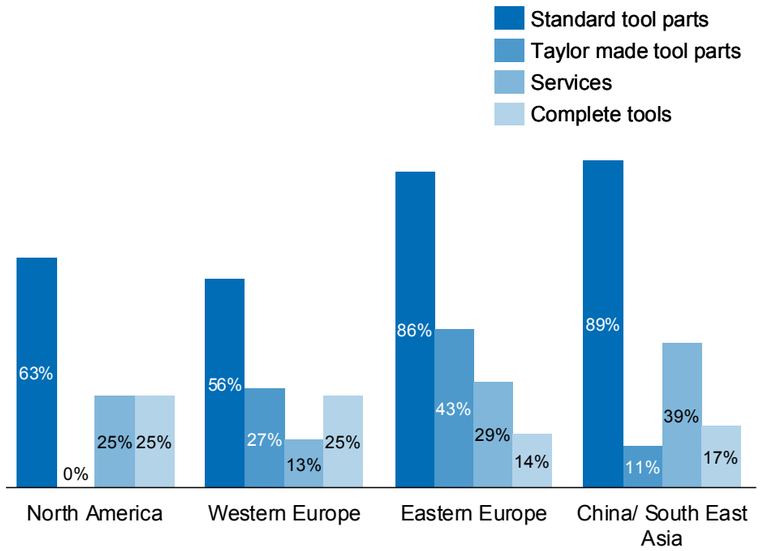
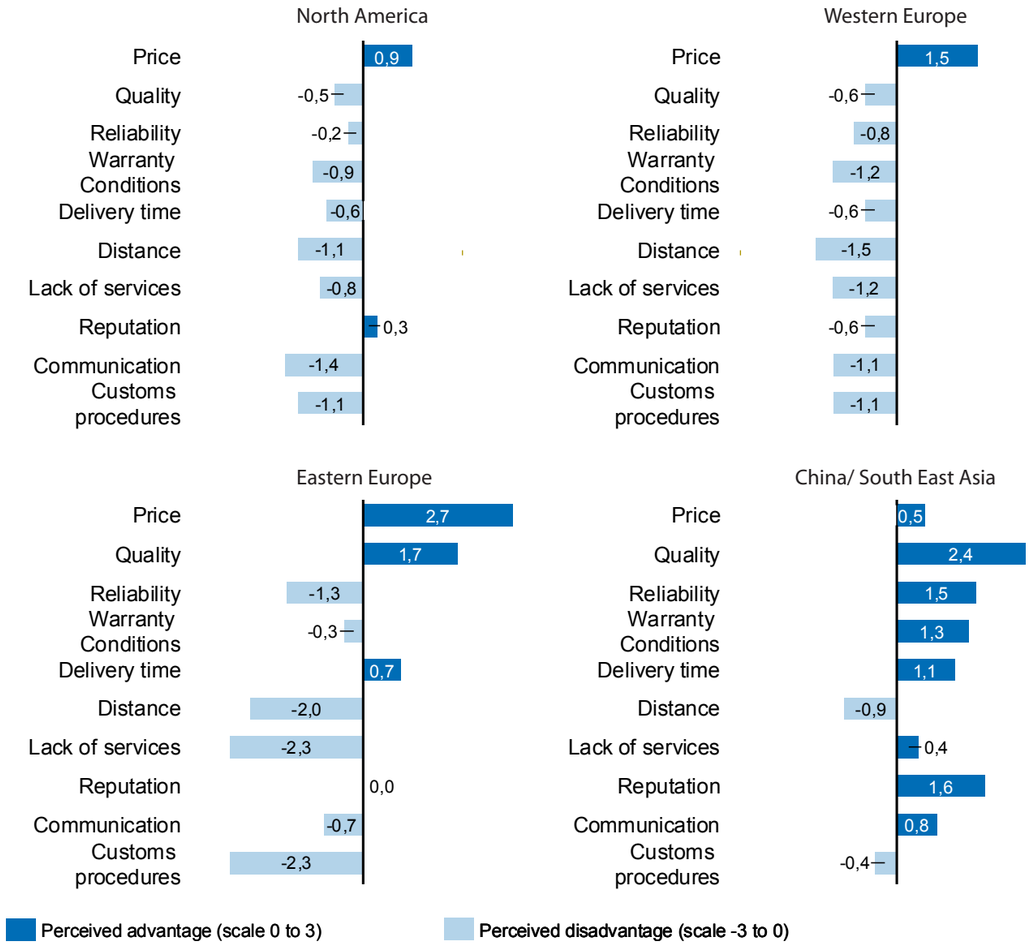


Fig. 31: Perceived advantages and disadvantages of global sourcing (toolmakers)



Price is currently the only advantage seen by toolmakers worldwide when sourcing globally

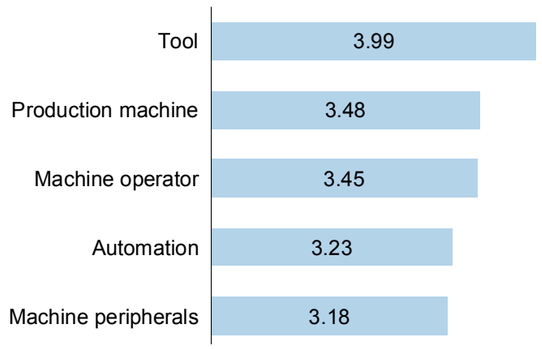
Tool malfunctions

Interruptions of the production process

As anticipated, the main cause for malfunctions in the production process turned out to be the tool itself, followed by the production machine and the machine operator (Fig. 32). This outcome confirmed our assumption that there is a relevant need to improve the cooperation between toolmakers and their customers. As each tool is more or less a prototype, only close cooperation can lead to the desired results.

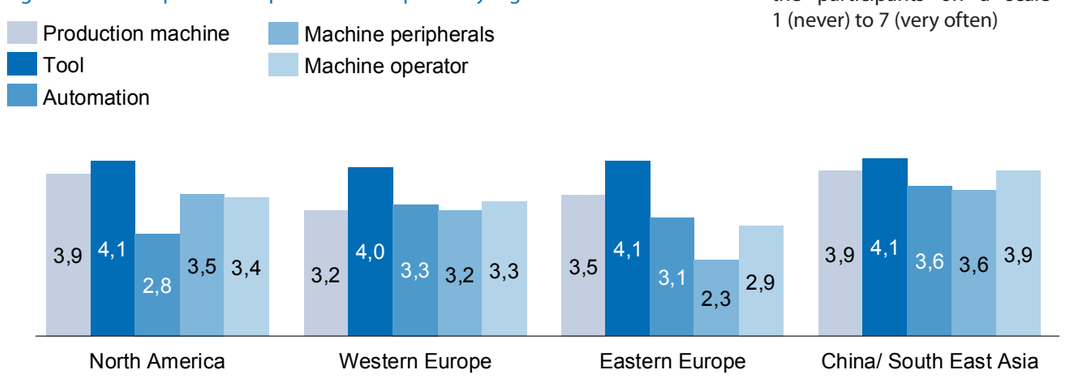
When differentiating between the four major regions analysed in the study it can be seen that apart from the tool, the production machine and - especially in China/ South East Asia - the machine operator are frequently the cause for an interruption of the production process (Fig. 33).

Fig. 32: Causes of production process interruptions



Note (Fig. 32 - Fig. 34):
Average value of answers given by the participants on a scale from 1 (never) to 7 (very often)

Fig. 33: Causes of production process interruptions by region



The tool is the major cause of malfunctions during the production process

In the study a distinction was made between simple and complex tools, the latter being defined as having more than eight cavities and/ or dimensions greater than 500mm by 500mm and/ or a weight of more than 1000kg.

As expected, customers using complex tools identified the tool more frequently as the most important cause for production process interruptions then parts producers using simple tools.

Furthermore the results showed, that complex tools malfunction more frequently thus the need for preventive or condition oriented maintenance is higher (Fig. 35).

Fig. 34: Causes of production process interruptions by tool complexity

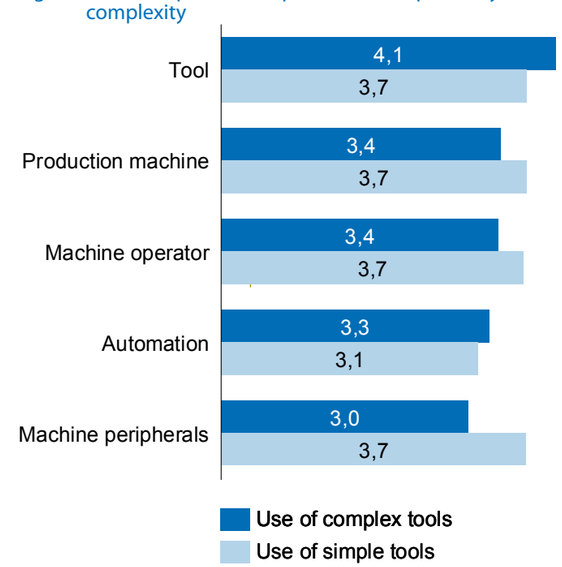
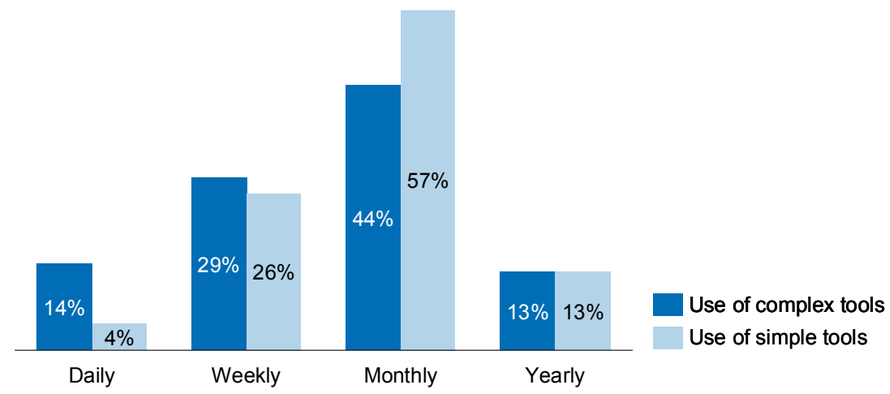


Fig. 35: Frequency of tool malfunctions by tool complexity



Complex tools malfunction more frequently than simple tools

Causes of tool malfunctions

Fig. 36: Frequency of possible causes for tool malfunctions

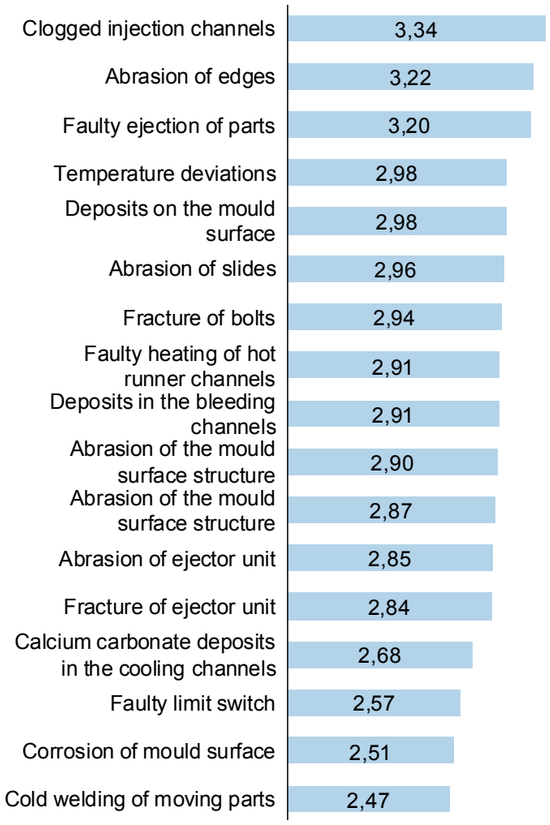
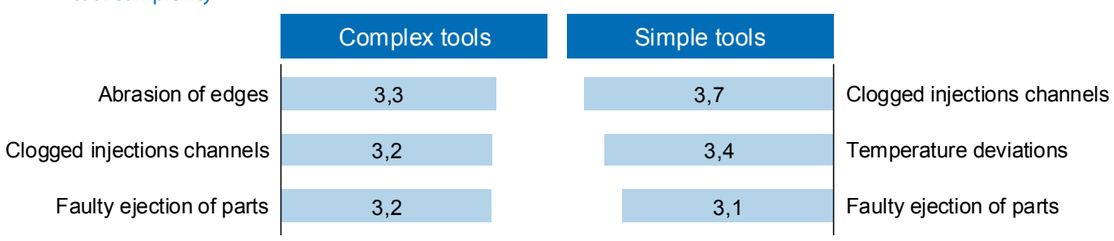


Figure 36 shows possible causes of a tool malfunction. It becomes clear that while some causes are more frequent then others, every one of them needs to be addressed by the customer in order to have a functioning production process. For the toolmaker this creates the opportunity of offering value adding services resolving these issues.

Analogous to the evaluation above, the complexity of a tool was taken into account yielding different results for the most common tool malfunctions (Fig. 37)

Note: Average value of answers given by the participants on a scale from 1 (rarely) to 7 (always)

Fig. 37: Frequency of possible causes for tool malfunctions by tool complexity



Costs of production process interruptions

Fig. 38: Cost of a typical production process interruption as percentage of the tool price

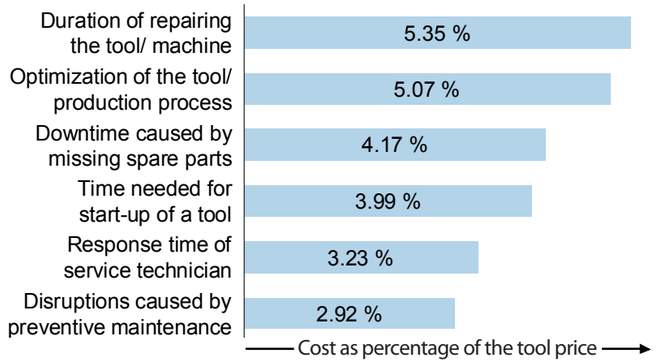
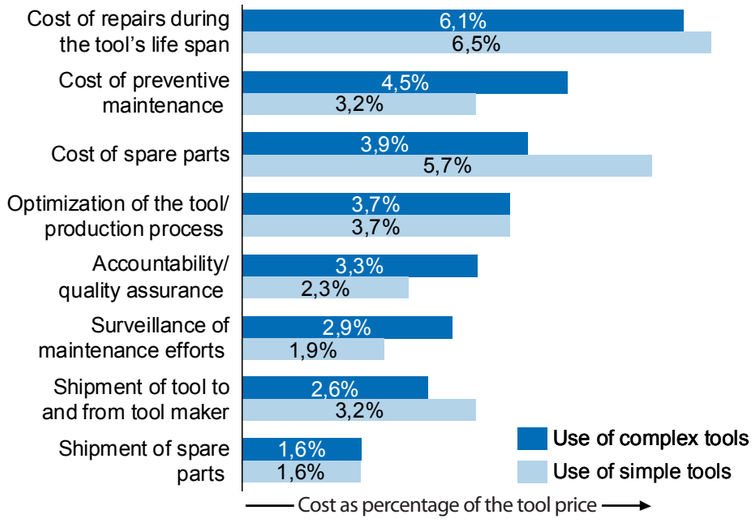


Fig. 39: Cost of services during a tool's lifespan by tool complexity as percentage of the tool price



In order to get a clear picture of the economic consequences of tool related malfunctions, parts producers were asked to estimate the costs they incurred by different types of interruptions of the production process (Fig. 38). To achieve a high level of comparability among various types of production processes, the cost of an interruption was to be specified in percent of a given tool's purchase price.

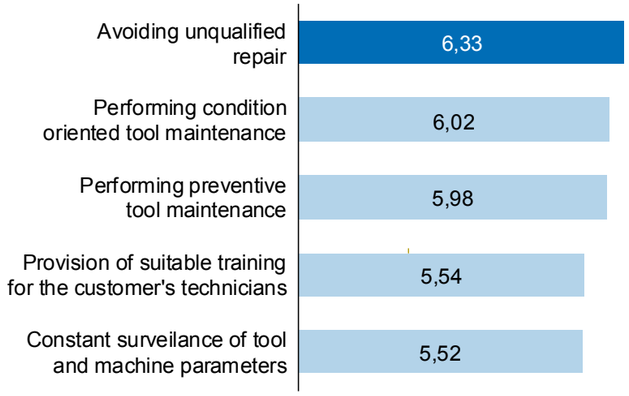
The results show that the most costly interruption of the production process is the time needed for repairing a broken tool. It can be concluded that services aiming at the reduction of tool downtime, e.g. a faster tool repair process, have great potential for providing added value to the customer. The interpretation of process data collected by smart tools offers the possibility to improve a tools optimization process, again reducing downtime of the tool.

Next to cost for repair, complex tools encounter high costs for preventive maintenance, while simple tools face high costs for spare parts (Fig. 39)

Tool breakdowns lead to the longest and thus most costly production process interruptions

Tool repair

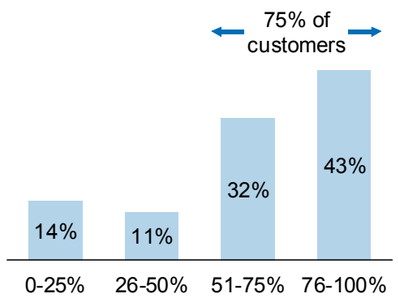
Fig. 40: Measures to avoid tool break downs



Even though avoiding unqualified repair is deemed the most important measure to reduce tool break downs most maintenance and repair is not performed by the toolmaker (Fig. 40).

Figure 41 shows that indeed a large part of the required maintenance work is performed by the customer himself. Three quarters of the customers state that they conduct more then 50 percent of the maintenance with their own capacities.

Fig. 41: Percentage of maintenance conducted by customer with own capacities



Unqualified tool repair often is the cause of future tool break downs

Reaction time

While the majority of toolmakers is obligated to assist the customer within 24 hours of a malfunction only 28 percent of toolmakers can always fulfil this requirement (Fig. 42).

Fig. 42: Required reaction time vs. fulfilment of requirement

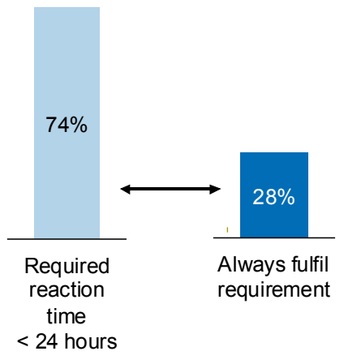
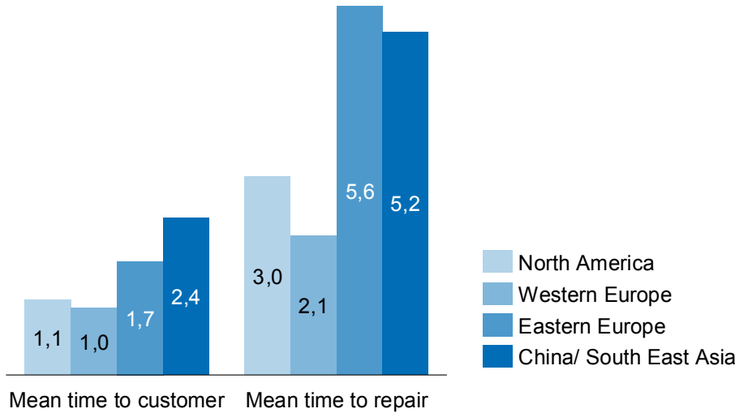


Fig. 43: Mean time to customer vs. mean time to repair



Parts producers in Asia and Eastern Europe have to wait the longest for receiving assistance in case of a tool malfunction (Fig. 43).

Most toolmakers are not always able to fulfil guaranteed reaction time requirements in case of tool malfunctions

Tool-related services

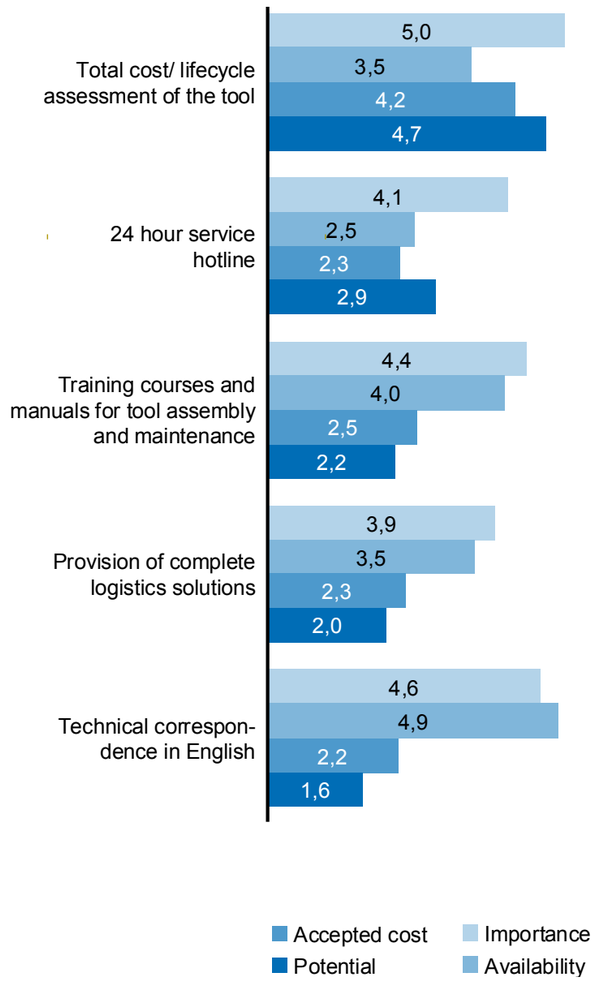
General services

When choosing appropriate tool related services for the service portfolio, a toolmaker has to take into account not only if a service is needed by his customers, but also evaluate the willingness to pay for it. In order to give guidelines to this selection, we asked the participating parts producers to evaluate a selection of services that were listed in the questionnaire. The services were divided into six categories:

- General services
- Documentation and standards
- Preventive maintenance
- Data and diagnostics
- Support for the production process

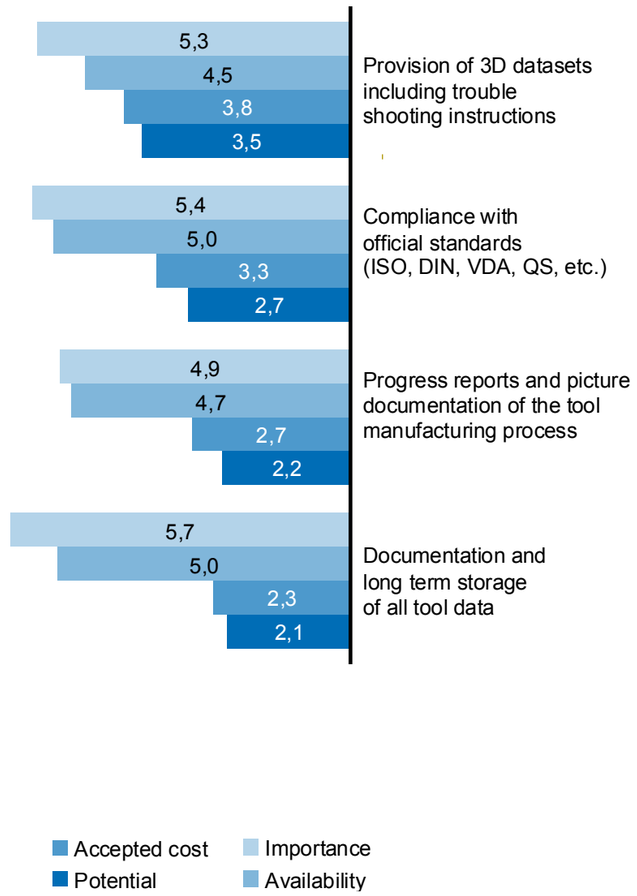
Participants were asked to rate each service according to the importance for their production process, the current availability of the service as well as their willingness to pay for it. For the evaluation of the economic potential of each service we developed the following model. The model was based on the assumption that importance and acceptable cost of a service increase its economic potential while a high availability of the service on the market reduces its potential.

Fig. 44: Evaluation of general services



Documentation and standards

Fig. 45: Evaluation of services regarding documentation and compliance with standards



The ranking according to importance was to be done on a scale from one to seven (in), one being the lowest value and seven the highest.

Importance $I = (\sum i_n) / N$

where $i_n \in \{0, 1, \ldots, 7\}$,
$n \in \{0, 1, \ldots, N\}$
N = number of answers

The participants were to mark whether a service was offered (an) to them by their toolmaker, another supplier or not offered by third parties. To fit the one-to-seven scale, the results were multiplied by seven.

Availability $A = (\sum a_n) / N * 7$

where $a_n \in \{0, 1\}$,
$n \in \{0, 1, \ldots, N\}$

The accepted cost was to be specified in percent of a tool's purchase price, which was classified in five classes: 0 percent, 0-2 percent, 3-5 percent, 6-10 percent and more then 10 percent of the tool price. As the economic evaluation was not an absolute one but rather compared the individual services with each other, an arbitrary value for each class was chosen in order to fit into the one to seven scale.

Accepted Cost $C = (\sum c_n) / N * 2$

where $c_n \in \{0, 1, 4, 8, 12\}$,
$n \in \{0, 1, \ldots, N\}$

Preventive maintenance

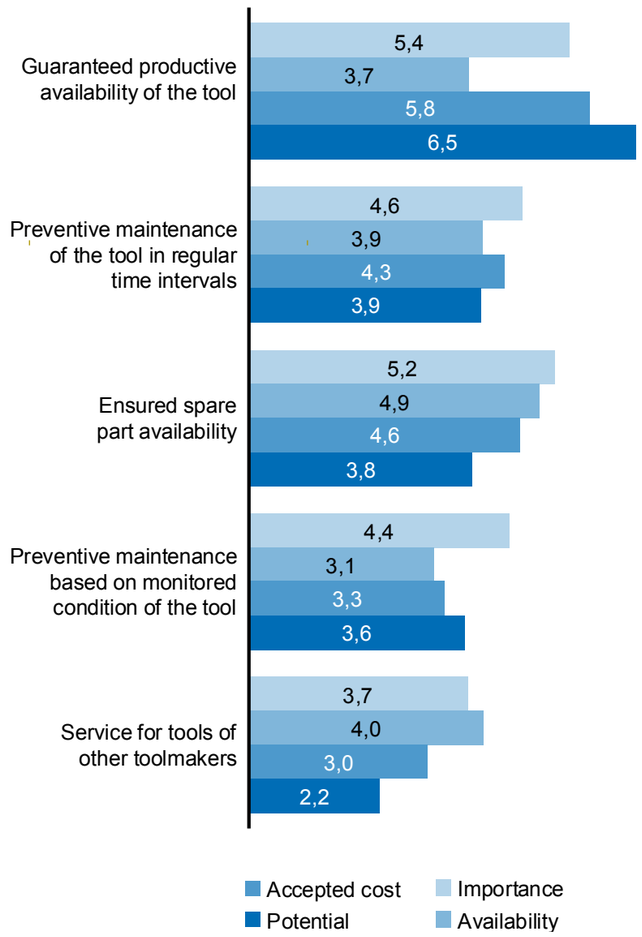
The relative economic potential of each service compared to each other was derived by multiplying the Importance by Accepted Cost and dividing by the Availability. The result was scaled by 7 / 9.

Potential P = (I * C / A) * 7 / 9

where I = Importance
C = Accepted Cost
A = Availability

In a nutshell, the highest potential was received for the services "guaranteed productive availability of the tool", "optimization of the production process based on real time data", as well as "preventive maintenance of the tool in regular time intervals". Clearly some services which are generally deemed very important by both customers and toolmakers did not score very high in the indicator for economic potential. This is due to the fact that the customers either expect the toolmaker to deliver these services at a very small fee, if any, or because they are readily available on the marked.

Fig. 46: Evaluation of preventive maintenance services



Data and diagnostics/ Support of the production process

Fig. 47: Evaluation of data and diagnostics services

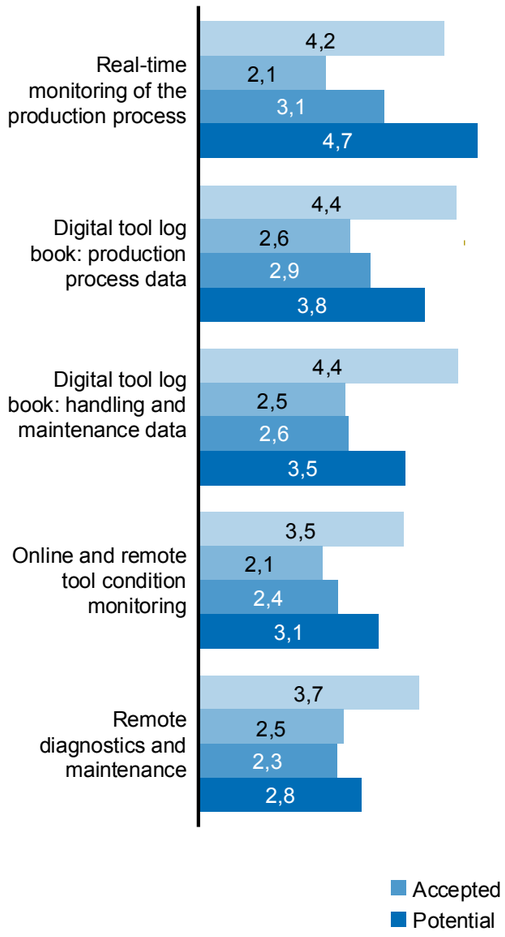
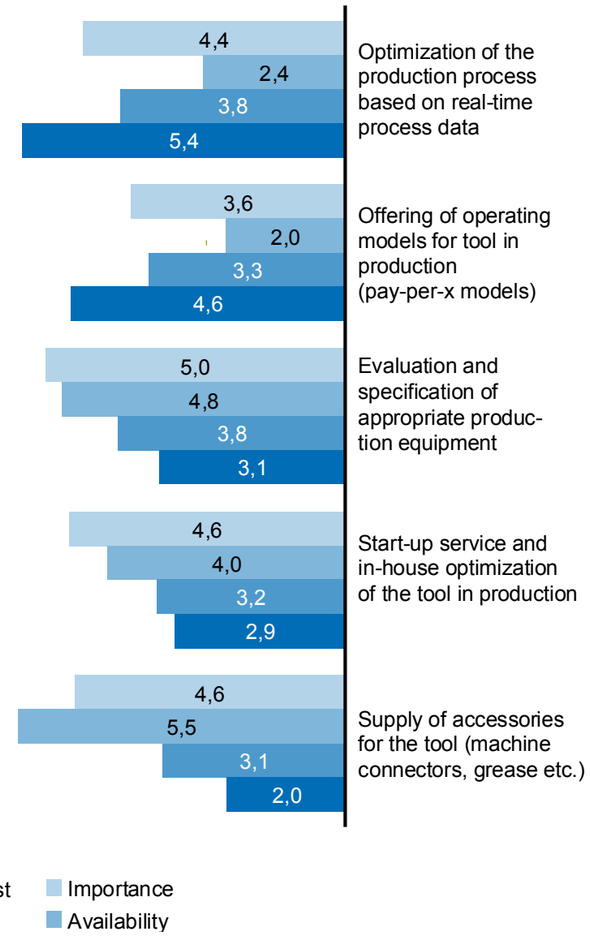


Fig. 48: Evaluation of production process support services



The economic potential of a service is determined by its availability on the market and the value generated for the customer

Revenue through service provision

In order to be able to offer some of the higher potential services such as guaranteeing productive availability, it will become crucial for the toolmaker to know how his tools are performing at any given moment and no matter where on the planet the tool is being used. So-called smart tools, capable of providing the toolmaker with data from the production process will become the technological enabler for achieving this. The study results show that in general, most parts producers do not object sharing process data with their toolmaker as long as it improves the performance of the tool (Fig. 49).

Fig. 49: Customers' willingness to give access to production process data

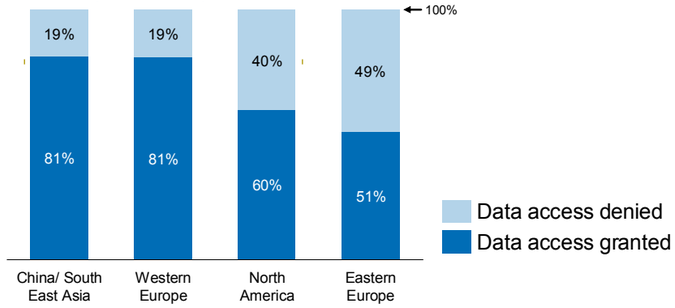
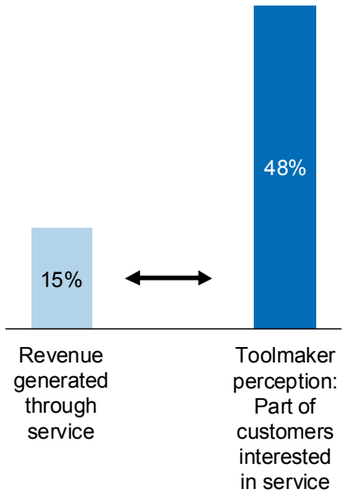
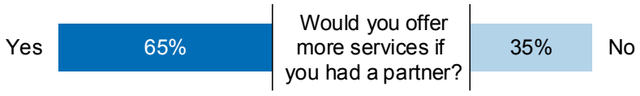


Fig. 50: Revenue generated through services vs. demand for services



While recognizing that customers need and demand services, toolmakers still focus mainly on their products for generating revenues (Fig. 50). One reason for the lack of service provision is the challenge of finding an appropriate service partner. The majority of toolmakers perceives cooperation as a key to offering better services (Fig. 51).

Fig. 51: Service partners

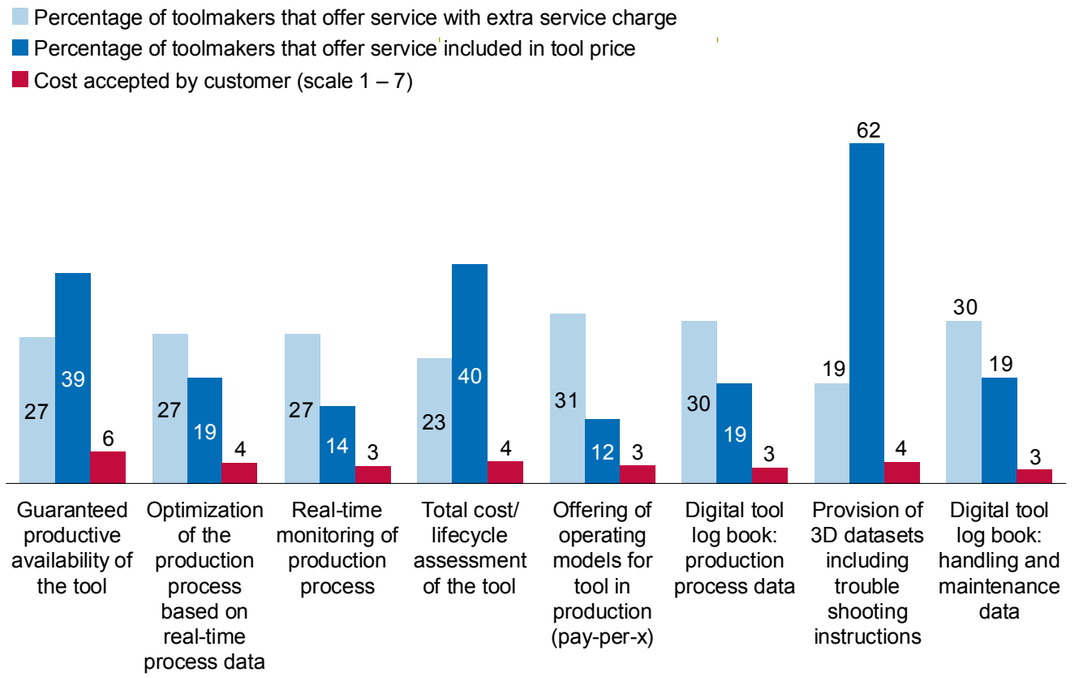


While recognizing that customers demand service, toolmakers still focus mainly on their products for generating revenues

Opportunities for generating additional income

The evaluation of the toolmaker survey showed, that pricing policies regarding services offered are not optimal. Figure 52 shows the pricing policies of toolmakers for high potential services as well as the customers' willingness to pay for these services (scale from 1 to 7 with 7 being the highest). The results indicate, that even when customers would accept a relatively high additional cost for a given service, toolmakers are hesitant to charge extra.

Fig. 52: Service charges vs. customers' willingness to pay



Toolmakers largely do not take advantage of the customers' willingness-to-pay for certain services

Conclusion and outlook

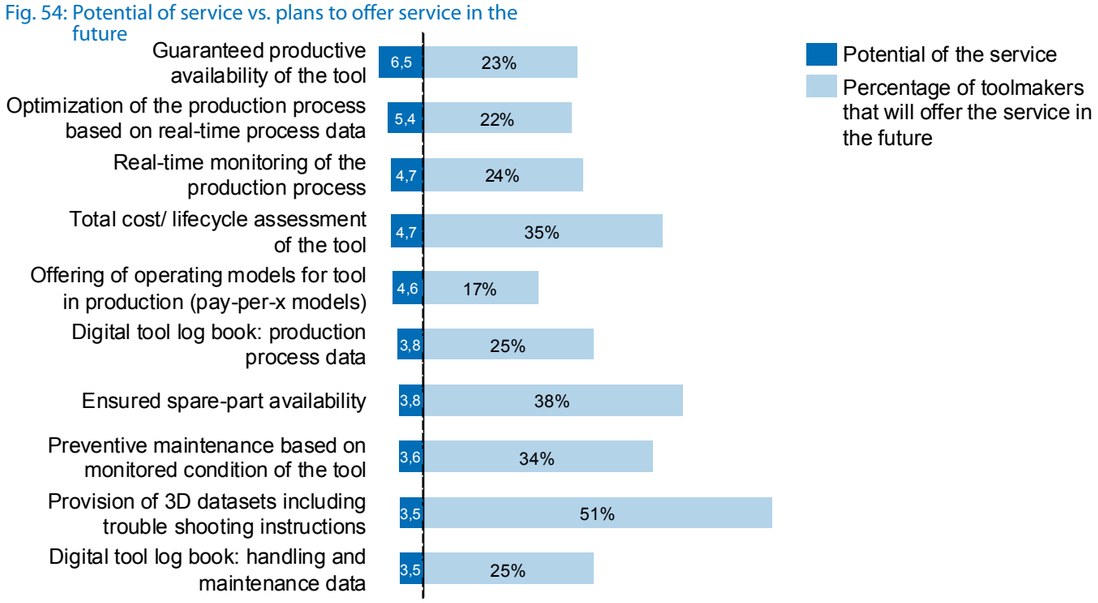
Developments in service provision

Most toolmakers currently focus on day to day business instead of planning ahead. As Figure 53 shows, only few toolmakers actively pursue solutions to the questions they will face regarding services in tomorrow's tool industry. However, improving their skills to find innovative solutions to customer needs will be the key to success in the future.

Fig. 53: Development of service strategies

Figure 54 compares high potential services with the percentage of toolmakers that is planning to offer the service in the future. It sticks out that less then a quarter of the participating toolmakers think about offering the top three services in the future.

Fig. 54: Potential of service vs. plans to offer service in the future



Only a small part of toolmakers is planning to offer high potential services in the future

The future of toolmaking

Today's toolmakers face the challenge to maintain their competitive position in a changing globalized market. Focusing on cost cutting or differentiation through high quality tools is no longer sufficient to meet this challenge. Especially toolmakers in established markets of Northern America as well as Western Europe will start to experience stronger competition from their Chinese/ South East Asian and Eastern European counterparts. The results show that while key markets for parts production might still be in Western Europe and Northern America, tool procurement has become a global business. As distance becomes less and less important the decision is not from where to buy a tool, but from whom. Currently this decision is still based on the tool's quality, reliability and price, often giving an edge to highly experienced toolmakers in the established markets. The transfer of knowledge and experience, however, will not cease until the playing fields in the major markets are leveled. In the near future, technological capacities, knowledge and productivity in developing markets, especially in China and South/ East Asia, will match or even surpass those in the western world. By then, the only means for differentiation left will be the maximization of customer value.

A possible key to success will be offering the tool in combination with value adding services.

These so-called industrial product-service-systems bind the toolmaker closely to his customers and generate additional income along the lifecycle of the tool. In order to be able to provide value adding services together with the tool, toolmakers have to adapt new business models, which focus on four major topics

- service provision
- cooperation with partners
- customer integration
- strategies for identifying relevant customer needs

Currently each of these four topics is being addressed insufficiently by toolmakers on the whole. Especially smaller toolmakers that do not have the capacities to offer adequate services on a global level will have to adjust their business models accordingly. Only through close cooperation with other toolmakers as well as their customers will they be able to strengthen their position in the vast competition of the globalized markets.

Acknowledgments

FP7 - Project TIPSS

The study was performed as part of the European Commission co-funded project TIPSS (Tools for Innovative Product-Service-Systems for Global Tool and Die Networks) within the Seventh Framework Programme (FP7).

Information on TIPSS:
All activities along the value-adding chain can be supported by an internet-based platform to coordinate all forms of forwards and backwards collaboration. At the same time, the platform accesses the data collected by the smart tools at the customers' production facilities. Smart tools are injection moulds equipped with stateof-the-art sensor technology that deliver realtime data from the production process. The online analysis of the gathered data enables an optimized mix of both condition-based and preventive maintenance services, which directly leads to an increase of the overall operational availability of the production cell. In order to best monitor the production process, algorithms and methods for the interpretation of the gathered data are developed within TIPSS, which allow the simulation of different scenarios forecasting the tool's further behavior in operation. This simulation makes the TIPSS solution for injection moulds speak of „smart tools" and not just of „intelligent tools". That is to say that, based on those forecasts, errors or downtimes can be interpreted in real-time by the toolmaker, thus minimizing the time to respond and the repair time, according to the service level that has been agreed upon with the customer.
See also www.tipss-fp7.eu

Contact

We hope that the results of the study will be useful for a broad audiance. Should you have any questions regarding the study or wish to receive advise on how to use the study results to improve the competitive position of your company, please do not hesitate to contact us. Combining our research activities with industry projects has always been a reasonable way for us to ensure the practical relevance of our research. Many years of successful industry projects have shown that exchanging ideas between industry and academia generally leads to a win-win situation for all parties envolved.

Contact us to learn more about our industry related research projects.

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