8.1 FACTORS AFFECTING THE DEVELOPMENT OF CNC MACHINE TOOLS

Many studies on the theory of construction of machine tools, performed either at universities or in production companies, deal with specific technical parameters of the designed machine tools and try to assessthe direction of further development. Those involved can erroneously assume that this is the main attribute of the marketability of a machine tool. Who determines the marketability of machine tools ? The designers of companies or development departments or perhaps makteting departments?

Who determines the marketability of a machine tool? The answer is unambiguous. The customer and his requirement for what is necessary for him. He is the one for whom the machine tool supplied in future has a value – so-called customer value. of For marketing departments it is an art to find and predict the future customer value. Development institutes, universities and centres of competence (further -cooperating institutes) can purposefully complete manufacturing companies from the field of machine tools in a way, which would make the predicted customer value fully acceptable to the customer.

Cooperating institutes, however, can never be those who will assess the orientation of the development in applied research. This is based on an idea that even the best machine tool with excellent technical and utility parameters is no good if it does not meet the requirements of the customer and is not marketable. From the fundamentals of the activity of cooperating institutes it cannot be expected that they themselves will offer the customer what they developed for commercial application. For this purpose they must have a reliable industrial partner and he must have a customer for whom he creates a value. In the opposite case all can be considered as only theoretical considerations, and this has nothing in common with applied research and development.

Customer value

Entrepreneurial success can be considered as the ability to predict the requirements of a customer and simultaneously to find ways how to create added values for customers either by themselves or with the help of cooperating institutes and companies. The customer anylyzes whether his requirements were fulfilled, if his needs were satisfied. The customer value is compared together with the utility values of the machine tool. Among utility values evalutaed by the customer can be:

- reliability of the function and operation of the machine;
- machining accuracy;
- multifunctionality;
- quality of the machined surface;
- product economy;
- environmental friendliness of operation;
- intelligence installed in the machine;
- labour productivity and effectiveness;
- automation of machine run.

The reliability of the function and operation of all machines is required without exception on the highest possible level. No customer wishes to repair his machine too often or have it set away. Machining accuracy is a criterion which reflects the quality of the design and type of the machine, activity of the operator, applied cutting operation and method of measurement of the final product.
Highest requirements are traditionally laid on grinding machines, drilling machines and at present also on machining and multifunctional centres. Multifunctionality is the domain of the present time and does not only mean machining with more applied technologies.

This means, as it has been stated above, converging of the values of the installed outputs of two basic machining operations, turning and milling. Surface quality in machining is in close relation with the achieved accuracy. These two attributes are usually closely related. The surface quality of components for aerospace industry is assessed differently from those for general industry. There is a boundary which cannot be exceeded by changing machining conditions since the design of the machine and the kinematic chain are absolutely inappropriate for the required surface quality. All customers will strictly consider the economy of operation. And it is quite obvious why. Ineconomic operation, based on e.g. an unnecessarily high installed

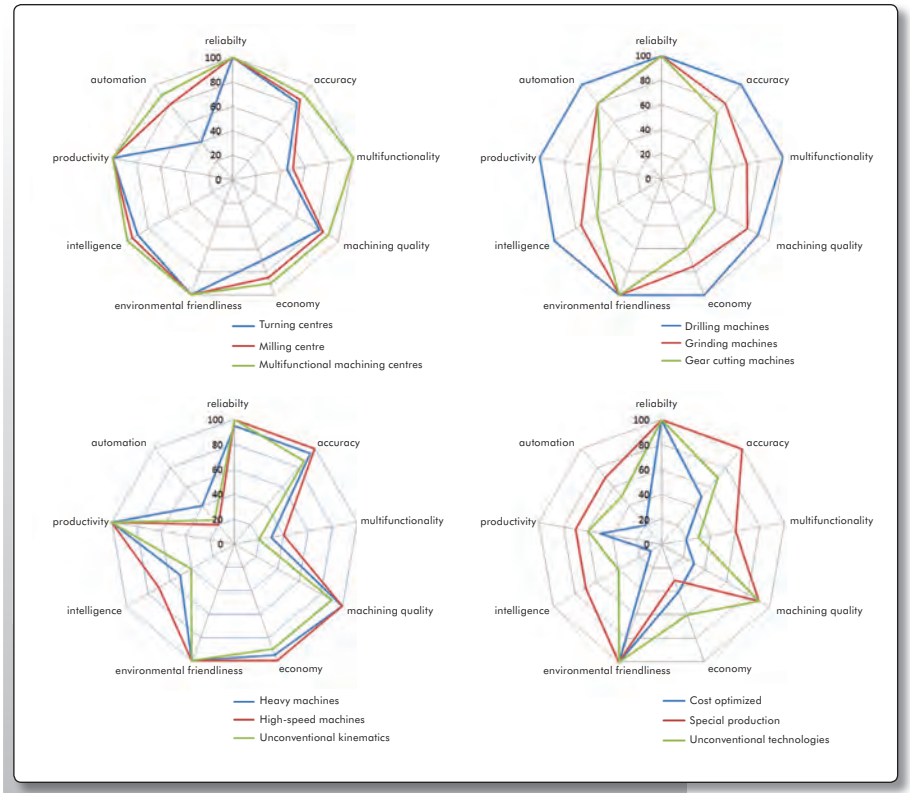

Fig. 8.1.1: Example of customers´ view on the utility properties of machine tools

output, decreases profitabilty and increases costs. Environmental friendliness is closely related with pollution of the environment of the machine tool. And this must not be confined only to the close neighbourhood of the machine. This can be a case of the protection of the operating staff against products created by the interaction between the cutting edge of the tool, the machined product and the process liquid. Intelligent systems of machine tools help the operating staff and techologists in the operating process to identify possible collisions and to specify optimum operating conditions of the machine tool. In addition they can make dealing with failures easier to the operating staff and service personnel of the manufacturing company.

The productivity achieved in installed machine tools is a combination of the following factors:

- mechanical properties of the machine tool;
- applied strategy of individual cutting operations;
- experience and accuracy of the operating staff.

The bad mechanical design of a machine tool cannot be compensated by good electronics. The potential use decreases of high-quality tools and consequently of the productivity of machining. Automation, namely of auxiliary functions, such as automatic exchange of tools and of the workpiece, plays a significant role in the entire process in the assessment of the customer value. Automation minimizes the idle time and leads to an increase of productivity. The above attributes are sometimes considered by the customer as utility properties of the machine tool. Obviously different customers have different views on the utility properties of the purchased machine tools. This is why the outlined and discussed properties of machine tools have to be considered only as an example. Fig. 8.1.1 gives the utility properties of machine tools in percent for various types of machine tools.

Added utility value of manufacturer

Besides monitoring amd searching for the utility value for a customer, the manufacturer can offer services which make the offered machine tool more attractive. The machine tool itself does not mean anything to most customers. The customer needs to deal with the task of machining of the given component, to obtain the machine tool as soon as possible and if possible for an acceptable price. The added utility of the manufacturer comprises:

- funding of the purchase of the machine tool;
- supply of the adjusted machine tool;
- above standard service;
- rapid supply;
- preferential training of the operating staff;
- testing of the customer´s workpieces prior to the purchase;
- participation in the development of the purchased machine tool;
- cooperative activities.

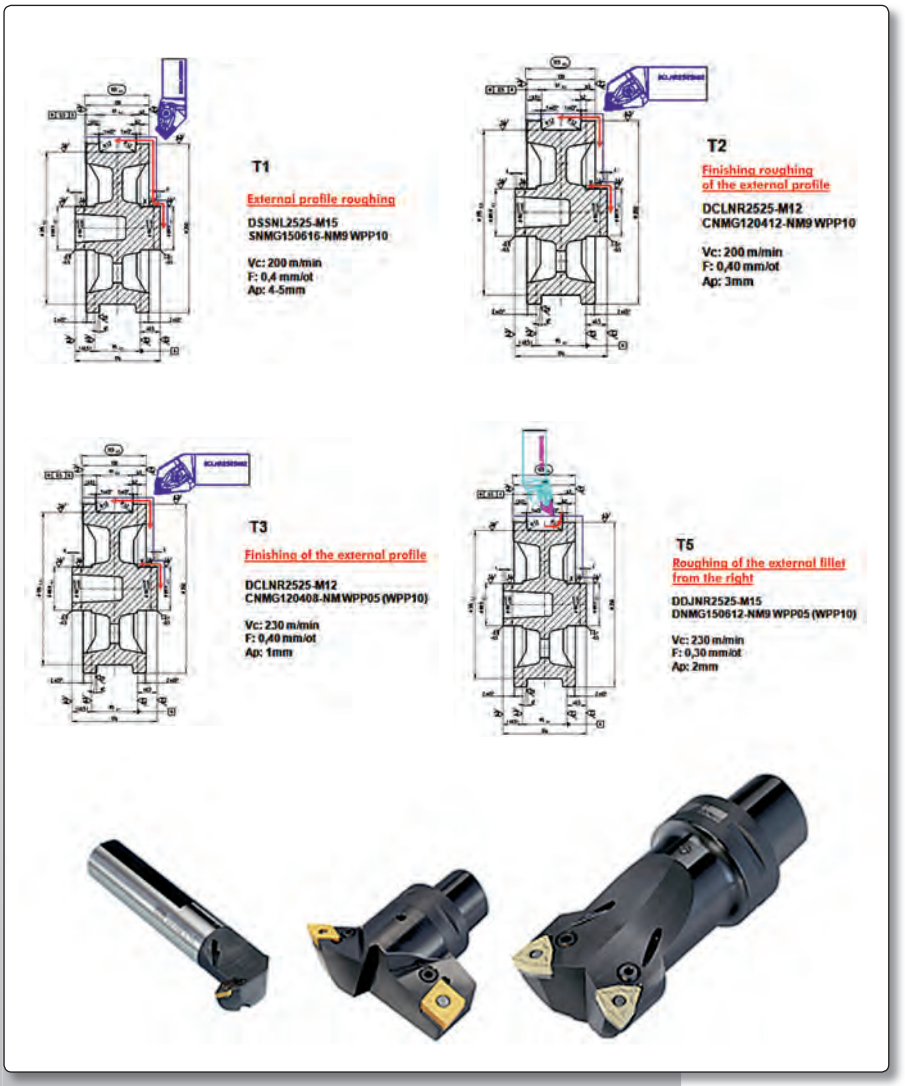

Fig. 8.1.2: Example of a technological study of the machining of a pulley wheel on a Tajmac-ZPS machibe tool [Walter]

Funding is carried out in a way that the customer, namely in case of complete industrial plants, obtains a special schedule of instalments or a bank credit can be arranged for him. The supply of "bare" machine tools with unadjusted technologies for the customers´ workpieces is slowly becoming history. The customer wants to be sure that his components can be machined on the purchased machine tool. Manufacturers create technological studies demonstrating the machining of the component, which they add to their offer – Fig. 8.1.2. Previously over-standard 24 hour week long service failure actions are now a current standard.

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The customer can receive a commission to machine a component unexpectedly. Consequently great requirements appear for the rapid supply of machine tools. However the manufacturer is in a similar situation, if he has not obtained an order for a machine tool for a long time. This is mainly due to the approval procedure at the customer´s company or searching for funds for the purchase. The order can then be sent very quickly but with a great time delay after business negotiations. The supplier considers this to be a quick delivery (often in fractions of months of the former delivery time) and to the customer this appears to be quite normal.

To invite the future operating staff in advance for training to the manufacturing company is at present a usual phenomenon, appreciated by the customer. Namely in the case of complex machines, before inquiring the machine tool at the manufacturer, the customer makes an agreement with the supplier on the test machining of his workpieces. Only after receiving the results the customer sends an official inquiry and the supplier only hopes, after investing a lot of effort, that the customer will really purchase the machine tool. Often maintenance personnel participate in the development of a future machine tool. The reason is quite obvious. They think of the future and want to minimize failures and simplify maintenace.

Currently the production capacities of manufacturers of machine tools are used for dealing with production activities of customers. In this way the customer can verify the quality and experience of the manufacturer. Together with the utility properties of the machine and added customer value this can lead to consider the supplier as an appropriate partner.

Orientation of development

To assess the numerical values of technical parameters or to describe accurately the utility properties of machine tools from the viewpont of the customer is nearly impossible. We must not forget, that they are a combination of the present state of knowledge in the world of technology and requirements of the customer objectified in the utility value. Every customer assesses the utility value of his machine tool differently. To predict or speculate that the manufacture

	Utility values (main and secondary)	Industrial sector: aeronautical	transportation	power engineering	extraction (petrochemical)	processing (universal)	Relevance
Related to the machining process	Multifunctionality and universality	■	■	■	■	■	low
		■	■	■	■	■	middle
		■		■			high
							extremely high
	Machining accuracy	■	■	■	■	■	low
		■	■	■	■	■	middle
		■					high
		■					extremely high
	Power for production machining	■	■	■	■	■	low
		■	■	■	■	■	middle
			■	■	■		high
			■	■	■		extremely high
	Reliability and stability of cut	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■	■	■	■	high
		■		■			extremely high
	Machining economy	■	■	■	■	■	low
		■	■	■	■	■	middle
						■	high
						■	extremely high
Related to the design of the machine tool	Possibility of reconfiguraton of the machine tool	■	■	■	■	■	low
			■			■	middle
						■	high
						■	extremely high
	Reliability of machine tool functions	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■	■	■		high
		■					extremely high
	Mechatronic principles	■	■	■	■	■	low
		■		■	■	■	middle
		■					high
							extremely high
Related to the operation and maintenance of the machine tool	Unmanned and automated systems	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■				high
		■					extremely high
	Safety of operating staff	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■	■	■	■	high
		■	■	■	■		extremely high
	Diagnostics and monitoring of the condition of the machine tool and of the cutting process	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■	■	■		high
		■					extremely high
	Virtual testing of the process of machining	■	■	■	■	■	low
		■	■	■	■		middle
		■		■			high
		■					extremely high
	Adaptivity of the cutting process	■	■	■	■	■	low
		■					middle
		■					high
							extremely high
	Power consumption of machine tool operation	■	■	■	■	■	low
		■	■	■	■	■	middle
		■	■	■			high
		■	■	■			extremely high

Tab. 8.1.1: Example of utility properties of machine tools perceived by the manupacturer with respect to the industrial sector