

Global Demands of non-european Markets for the Design of User-Interfaces

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Keywords: Benutzerakzeptanz, Benutzerschnittstelle, Farbkodierung, Befragung, Werkzeugmaschinen

1. Introduction

One of the byproducts of increasing globalization is the intensified communication and economic exchange between countries. This is facilitated through modern forms of transportation and telecommunication which make it possible to bridge large distances in relatively short periods of time. Thus, interaction between very different cultures has become a common occurrence. Yet, the different rituals, practices and rules of communication, nonetheless still seem foreign and strange for those newly confronted by them. For Europeans, the Far East is particularly challenging in this regard.

On the other hand, economic access, low incomes, the desire to catch-up to western levels of consumption, the advantageous conditions for establishing firms, and the large population levels, make the far eastern regions especially attractive production sites and sales markets. Whether to sell products or produce components inexpensively, many investors from industrial nations are interested in the Far East. However, in order to be successful, detailed knowledge of the needs, similarities, differences, and technical possibilities of these areas is necessary. It is essential to possess a well-developed customer orientation for success on these markets. The goal of the project INTOPS¹ is to contribute to the knowledge of potential Asian markets by investigating which requirements "new markets" potentially pose for the design of machine controls in comparison with the USA.

¹ Global demands of non-European markets for the design of user interfaces. Project funded by the German minister for Research and Technology.

2. Human Machine Communication

In essence, machine operator interfaces are a form of communication, and one which has become an important topic of research due to the increasingly complex and rich functional spectrum found in today's machines (see Zühlke, 1996). In Germany, under the rubric Human Machine Communication, it is intensively studied in colleges and universities. The focus of the research is developing user-oriented operating systems, that is operating systems adapted to the abilities and tasks of the users, in order to facilitate and optimize operation. To achieve this it is necessary to define a generally understandable coding scheme for information so that the information transmitted by the machine lets the operator know what the current status of the process is. This coding scheme is compiled in so-called style-guides in which the terminology, design attributes of the coding scheme, the way the information is grouped, etc. are all laid down. These style-guides were first created for Germany and then with the introduction of CE guidelines were extended for European use. In defining the terminology it was found that, in part as a result of the differing languages, foreign cultures place different requirements on the information coding scheme. Also, as we know, communication does not take place entirely at the level of speech.

As made clear by many news reports recently, problems in understanding often emerge particularly in communications with far eastern discussion partners due to differing intercultural forms of communication. Communicating non-verbally through body language and gestures is determined by the cultural and social framework, which in turn, influences how information will be interpreted. For this reason it is important to examine how various cultural influences on communication effect the human-machine interaction and to see to what extent machine operating systems can be designed that take the idiosyncrasies of different cultures into account (see *Figure 1*).

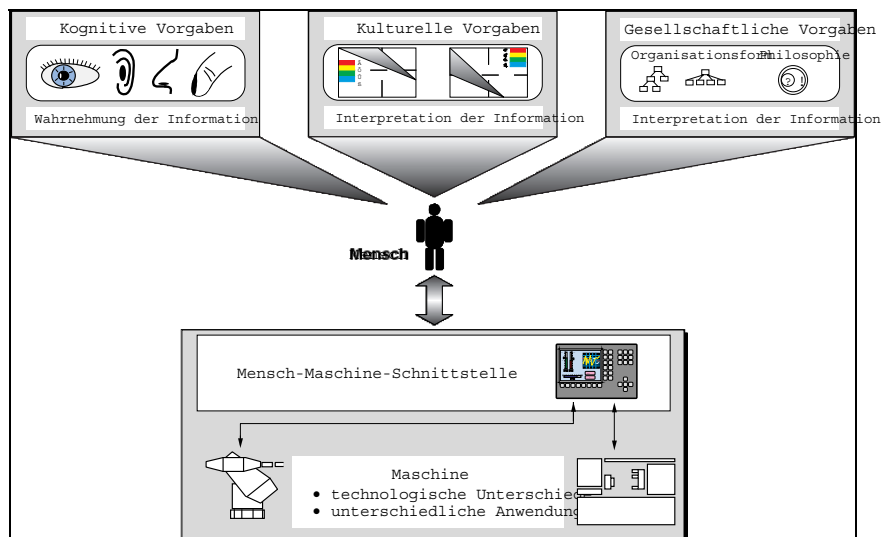


Figure 1: Characteristic elements influencing the interpretation of perceived information by operating machines (Romberg, 1997)

3. Investigated Nations

This project investigated this issue in 5 countries rated as important export markets for German machines and process lines². The countries in the study were found to have the following characteristics:

- The USA are currently the strongest sales market for German machines outside Europe and has displayed consistently high sales figures over a period of several years.
- China is especially important as a future market, given its enormous potential in terms of population, resources, etc. and its development in the last 4 years (since 93/94). The sales volume in China for machine tools has reached that of the US. and an end to growth is not yet in sight. Difficulties lie, however, in China's very different culture compared to that of Germany.
- South Korea has developed quickly in the past several years up to the point of being almost comparable to highly advanced industrial nations. The strongly expanding economy with a growing product spectrum demands equipment which, as the statistics show, to a growing extent are bought in Germany.
- India is an important potential market with high levels of resources; large increases in sales volumes are also evident. The new more capitalistically oriented government is encouraging import by decreasing tariffs and simplifying regulations. Particularly relevant for the study are the obvious cultural differences to Germany.
- Indonesia has ambitious goals for its future and has the reputation for being very positively inclined to Germany. It is characterized by a large growth potential and high levels of training thereby representing an important market for German exports despite current drops in orders.

Four to five industrial sites were chosen in the selected countries from the following sectors: automobile producer, automobile supplier, plastics or synthetic manufacturer or company with a product reflecting national priorities. The differing company types broadened the scope of machines that could be observed, but limiting the diversity of company types allowed comparisons across countries. Within the companies a range of interviewees - management, machine operators, maintenance people - were questioned to acquire a range of interaction with the machine operating system. The interviews were conducted using a standardized set of questions on qualification structures, work organization, thought processes, training procedures, machine purchase practices, experience and problems with technology to allow comparability, but with open-ended answers to enable flexibility according to company situation and interview partner. A variety of survey methods for the identification and evaluation of the meanings of color and symbols were also carried out.

² Statistical data on the import and export of machine building products in these countries were gathered from publications of the German Machine Tool and German Machine and Process Line Associations (see VDMA 1995).

4. Results

4.1 Major Results

The results of the study (see Romberg, 1997) confirmed that an orientation to the needs of the customer is extremely important in order to have success on these markets. One particularly significant finding was that each individual market, perhaps even each individual customer, makes differing demands on the product. However, there is broad-based agreement on certain, especially elementary, requirements for the machine. Therefore one outcome of the study was the development of a "needs pyramid". The needs of the lower levels of the pyramid have to be fulfilled to reach the next level.

- The first level, and thus the primary need, is to achieve *process ability* and meet elementary company prerequisites (climate, energy source).
- At the second level the need for continuing *process reliability* has to be satisfied (service, parts).
- The third level involves the need for completely dependable basic functions - in other words, *basic functionality*.
- The concerns of the fourth level is to satisfy all of the needs involving *special functions*.
- The fifth level is the need for free *configurability* on the part of the customer.

4.2 Life Cycle oriented Optimization of Machine Operation

German machines were criticized due to their complexity and difficulty to repair. Complexity is defined as a large number and interdependence of operating functions, which the semi-skilled machine operator does not utilize. Difficulty in repair means that the machine can only be serviced by specialized technicians. In one of the companies that was visited, in which German products are manufactured under license, the products in some areas were also criticized for being difficult to assemble. These are weaknesses which damage the good reputation of German products and erode customer satisfaction. To achieve and keep customer satisfaction, it is necessary to satisfy all of those coming into contact with the product throughout its life cycle, from the assembler, the maintenance department, the operator, etc.

4.3 Modularization

To improve the design of the machine controls, proposals can be made in the areas of modularization of functionality, information coding and the design of operating sequences. Given their broad functional range, German machines have the reputation of having a high performance potential and therefore a wide utilization spectrum. In many countries, however, the machine operator do not have the types of training, nor is work organized in the plants in such a way, as to allow the use of these diverse functions. Therefore, for many machine operators, the performance capability of the machines turns into simply intransparent complexity. In order to come to terms with

this complexity, without limiting the performance capacity of the machine, a modularization of the machine and especially the operating system, is recommended. In this way, the machine producer can coordinate the control possibilities and the functionality of the machine to the qualification level of the operators and the product spectrum of the company. This modularization also allows the machine producer to respond flexibly to customer wishes and only to sell the components and functions that are really needed. The potential for configurability, however, makes it possible to adapt the performance ability of the machine to the increasing experience of the machine operators and the growing needs of the company. If the modular functions are made up of operable units, then the needs of the customer will be optimally met.

4.4 Color and Icon coded Information

The findings in the area of information coding should be viewed with some caution given the small sample size for such a broad range of cultures. Therefore the results should be understood as representing tendencies derived from the statements of the surveyed respondents. However, the assumption that there are different requirements in the various markets in terms of information coding was confirmed.

With regard to the use of colors for information coding, red and green appear to be understood worldwide for production purposes (see Norm DIN EN 60073) the same way they are in Europe. The study could not prove, that foreign cultures relate a different meaning to a color. Hence, it shows that the meaning of a color depends very significantly of its context. This can also be stated for European cultures. For instance the color *red* can mean love, power, threat or alarm. One explanation for this is that under all conditions the same emotional excitement is generated. Based on these results it can be assumed that the state of excitement for technical important conditions is the same for Asians as for Europeans. For positive, normal conditions like e.g. "machine is operating according to plan" the colors green or blue were assigned. In Europe the color yellow is used for coding the condition "warning" as an interstate between normal operation and alarm. In India, Indonesia and the USA everybody interviewed agreed to that. However China and Korea do not differentiate that precisely between the operating status. All people interviewed used for statement e.g. "the machine is operating then the condition is *normal* or the machine is stopped then the condition is *alarm*" the according colors green and red (see *Figure 2*).

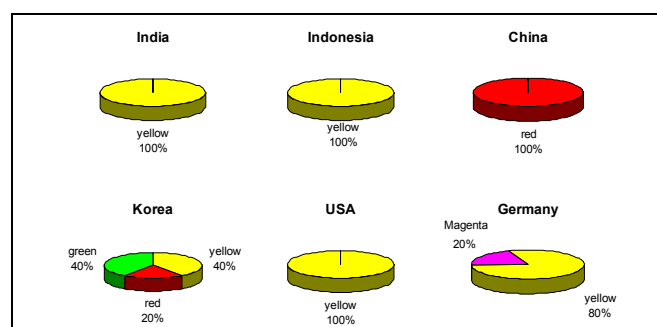


Figure 2: Colors assigned to the operation condition "Caution" for each country

Furthermore, groupings of information, control elements and compatibilities of place, direction, and grouping also seem to be transferable from Europe into Asia.

Symbols are, however, in contrast to widespread opinion, not independent of cultural context. It was repeatedly demonstrated that symbols could not communicate information independent of language. The tests showed that standardized symbols (see e.g. Norm DIN 30600) with widespread acceptance in Germany are not understood or are misunderstood in other parts of the world. Abstract symbols and abbreviations on little used control elements caused the most confusion; pictorial symbols were recognized more often but tend to be linked to particular cultural contexts (see *Figure 3*). Thus, it is important that symbols used in technology do not contradict a specific cultural meaning, as for example in the coding of hand signs. In order to assure clarity, it is recommended that a symbol be accompanied by an explanation in the appropriate language. Currently, it appears that using symbols to replace translating labels in the language of the country is not possible. In most cases, the interview partners expressed the preference that manuals and control system labels be offered in their national language.

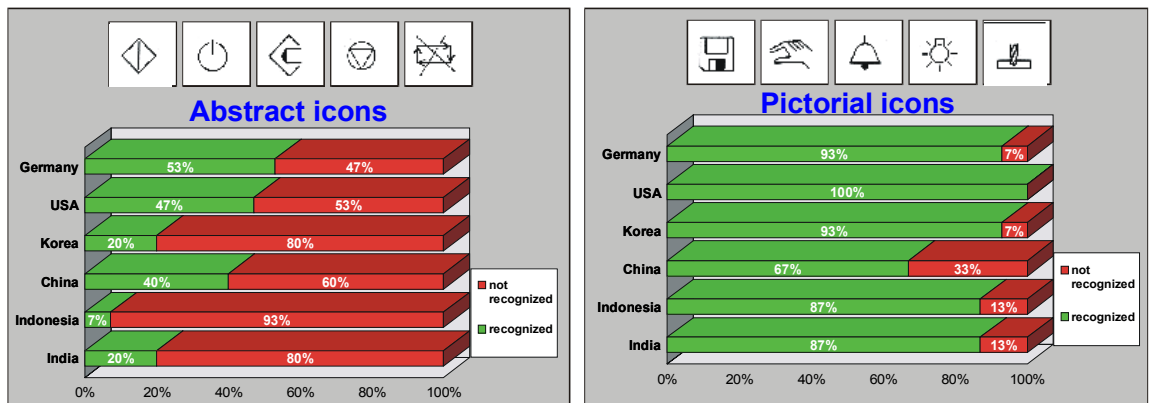


Figure 3: Recognizability of abstract and pictorial icons

4.5 Training and Work Organization

Another aspect of the project was an investigation of how existing training practices and work organization influence contact with and use of modern technologies. In addition to the practice of using memorization as a pedagogical method, another characteristic of training in other parts of the world is the lack of skilled workers in the German sense. Without such workers, companies use semi-skilled or unskilled workers to operate production lines. The resulting deficits in technical knowledge are compensated through specialized further training programs in the company or in schools. Often developing basic craft skills are simply not included in such programs. Many aspects of machine operation or maintenance tasks are closed off to machine operators with this kind of training.

5. Conclusion

This study led to the conclusion that, in order to meet the needs of future machine users worldwide, producers of machine tools have to design interfaces that are easier in terms of user orientation, but not in the reduction of functions or operating options. These findings are particularly relevant given possible new definitions of the qualification requirements of CNC machine users in the future. The following strategies are proposed as ways to better understand the future needs of users:

- Think Global - Act Local; Information that German developers lack regarding foreign cultures can be obtained through close cooperations between customers and producers in the form of subsidiaries or joint ventures that operate locally.
- Use of networks; German machine producers should build up and maintain personal networks with Asian customers. Asians are used to comprehensive service and close cooperation between partners; tightly knit groups and relationships play a large role in the private sphere as well as in business.

The solutions offered in this project in response to the conditions found in the countries and companies visited should contribute to European development potential and open new market opportunities for machine producers in these very important export markets.

6. References

- Krauß, L. (1997). Charakterisierung von Designelementen zur Gestaltung von Bedienoberflächen unter Berücksichtigung des fernöstlichen Kulturkreises. Diplomarbeit, Kaiserslautern: Universität, Maschinenbau und Verfahrenstechnik.
- Norm DIN EN 60073 01.1994: Codierung von Anzeigegeräten und Bedienteilen durch Farben und ergänzende Mittel (*Coding of indicating devices and actuators by colors and supplementary means*): Deutsche Fassung der IEC 73
- Norm DIN 30600 Teil 2 07.76: Bildzeichen: Übersicht (*Pictograms : Overview*)
- Romberg, M. (1997). u.a.: *Anforderungen außereuropäischer Märkte an die Gestaltung der Maschinenbedienung (Global demands of non-European markets for the design of user interfaces)*: INTOPS. Projektabschlußbericht, Kaiserslautern: Universität, Maschinenbau und Verfahrenstechnik.
- VDMA (Hrsg.) (1995). *Statistisches Jahrbuch für den Maschinenbau (Statistical yearbook for mechanical engineering)*. Frankfurt: Maschinenbau Verlag GmbH.
- Zühlke, D. (Hrsg.) (1996); VDI/VDE-Gesellschaft Mess- und Automatisierungstechnik (GMA) (Veranst.): *Menschengerechte Bedienung technischer Geräte (Operation of technical devices suitable for human)*: VDI-Berichte: 1303 (1. Fachtagung "Menschengerechte Bedienung technischer Geräte" Kaiserslautern 1996 - 09 - 17/18). Düsseldorf: VDI.
- Zühlke, D. (Hrsg.) (1998). *Anforderungen außereuropäischer Märkte an die Gestaltung der Maschinenbedienung (INTOPS)*: VDI-Fortschr.-Ber. VDI Reihe 2 Nr. 485. Düsseldorf: VDI.