18
Shaping of Working Conditions Using ICT Technology

Dariusz Michalak, Magdalena Rozmus, and Teodor Winkler

18.1
Working Environment

Working conditions and the environment include occupational safety and health and general working conditions. Working conditions refer to the working environment and to the non-pay aspects of an employee's terms and conditions of employment. They cover such matters as the organization of work and work activities; training, skills, and employability; health, safety, and well-being; and working time and work–life balance (Eurofound, 2011). Although safety and health are concepts that are clear to all, general working conditions are vague and may mean different things depending on the country or person in question. They may be defined as the factor determining the situation in which the worker lives, and are commonly considered to include hours of work, work organization, job content, and welfare services (Clerc, 1985, p. 15; Flanagan, 2006, p. 9).

Computer-aided shaping of technical and organizational aspects of the working environment are discussed in this chapter. From an engineer's point of view, these aspects of the shaping of the working environment are vital elements that enable losses to be reduced. *Working environment* can be defined as a set of factors that influence a course of working processes in an organization. This set of factors can be divided into natural environmental factors, and technical and organizational conditions. The natural environmental factors, also called the working environment in the scientific or specialist literature, include three groups of factors: physical, chemical, and biological. Physical factors that occur in a working process include microclimate, radiation, dust, air composition, and industrial poisons. Biological factors include bacteria, viruses, and molds. Technical and organizational conditions include a set of factors that result from design and technological features of technical means, from solutions of workspace, from group work organization, and from working methods. Work environment is a very broad problem and can be considered globally, relating to broadly understood workspace, and locally. relating to a particular workstation. The workstation of a given worker consists of a configuration of technical means (machines, tools) in a workspace that is surrounded by a work environment. In a systems approach, a workstation is a

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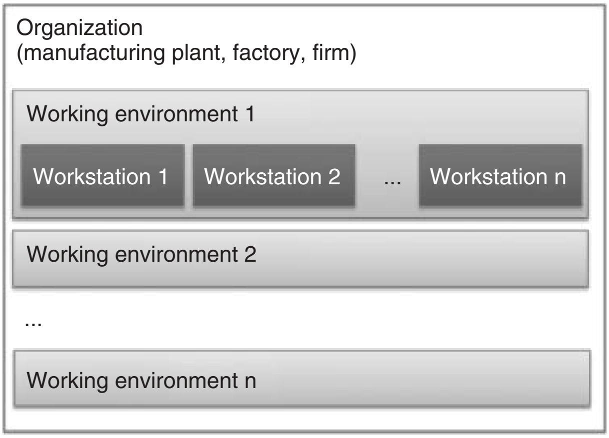

Figure 18.1 Working environment and workstation – overall scheme.

system in which a person, in a given space and environment, uses technical means to conduct activities in order to produce value (Koradecka, 1999, p. 859). Global and local approaches to workstation and working environment are presented in Figure 18.1.

As can be seen in Figure 18.1, several workstations can be located in one working environment, and the working environment can be heterogeneous even within one organization/plant. Factors that directly shape conditions in particular workstations and shape the way in which particular activities are carried out are elements that characterize particular working environments. Depending on the work that is carried out in a given working environment, it can be classified as static, if basic environmental parameters do not change, and dynamic, if the working environment can change. These changes can appear in an organized way, based, for example, on a job procedure, or in an accidental way, caused by hazards that are present at a given workstation. Conditions within the future working environment should be taken into consideration during the design of machines that are planned to be used in this environment and should be taken into consideration in defining requirements for workers who will use these machines. Tasks that are planned to be conducted in a given work environment directly influence the requirements of psycho-physical predispositions and qualifications of workers. Work done to install a longwall mining system is an example of changing of the workspace in a dynamic way. Changing of the workspace during subsequent stages of the installation process is presented in Figure 18.2.

The workspace determines, for example, what tools can be used or how machine units can be moved during an assembly process. It rapidly becomes smaller and this fact must be taken into consideration during machine design. Proper design of machine units (their size and weight) or development of proper organization solutions, for example, proper assembly sequence, are solutions for this problem (Winkler *et al.*, 2000, pp. 22–26).

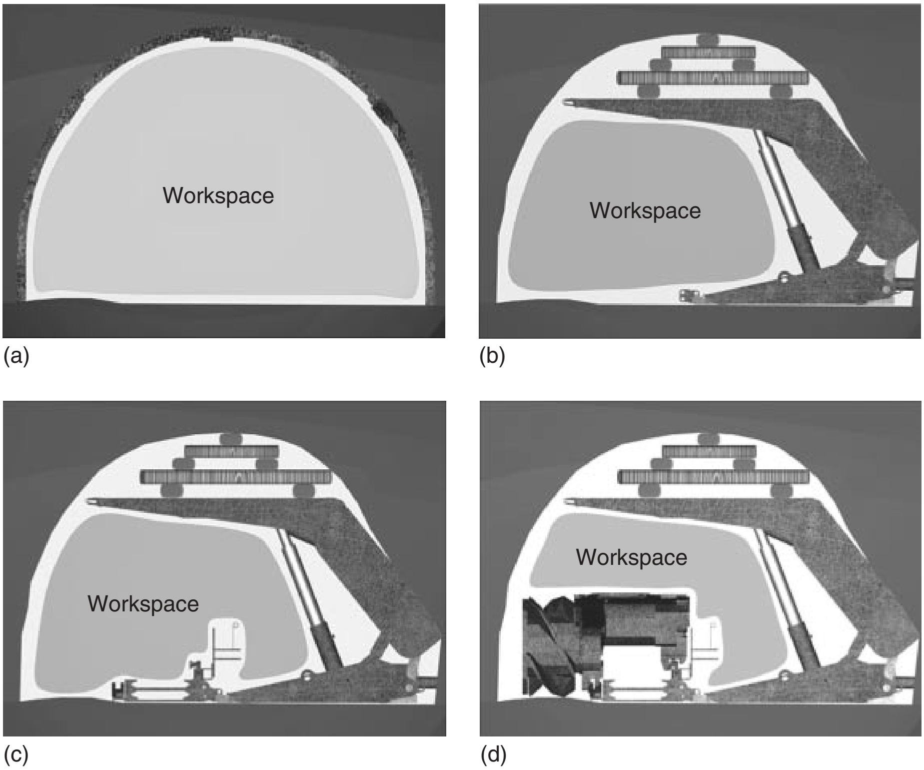

Figure 18.2 Installation of a longwall mining system: (a) initial roadway; (b) workspace after installation of a hydraulic roof support; (c) workspace after installation of a face conveyor; (d) workspace after installation of a longwall shearer.

18.2 Information and Communication Technologies

The term information and communication technologies information and communication technology (ICTs) includes a broad range of all technologies that enable the processing and sending of information. It also includes all communication media (the Internet, wireless networks, bluetooth, fixed-line telephony, mobile telephony, satellites, technologies for sending images, and sound, radio, television, etc.) and media for the recording of information (portable memory devices, hard disks, portable hard disks, CD/DVD, and tapes), and devices for the processing of data (personal computers, servers, clusters of computers, networks, etc.). ICTs also include a wide range of computer applications and complex IT systems for the processing and transfer of data. Nowadays this definition can be extended to systems that are used for the design of manufacturing systems and monitoring of existing ones. Design with the use of the concurrent engineering method (Chlebus, 2011, p. 75) is an excellent example of the application of ICT solutions. It is based on parallelization of tasks and requires the application of sophisticated tools for exchanging data between design teams. ICTs are widely used in each of the above-mentioned aspects of shaping of working conditions.

18.3
Computer-Aided Shaping of Working Conditions

Design of the working environment focuses on creating proper relationships between all elements of the environment. The network of relationships between single elements of a working environment can be very complicated, hence applying special information tools can be necessary in order to make proper decisions. Application of information technologies in design is nowadays very sophisticated. Engineering tasks can be automated and integrated to a high degree owing to the continuous development of computer tools. Shaping of the working environment with consideration of reducing losses can be focused on the design of workstations which are safe and optimized for use.

Application of computer tools gives the possibility not only of meeting mandatory requirements specified in standards for particular working environments (e.g., instructions about shaping machine operators' workspace), but also of optimizing objects which are designed with consideration of safety, ergonomics of use, and economic aspects. Computer-aided design enables the engineer to simulate all of the main interactions between humans and the working environment that is being designed. In particular, it is possible to simulate carrying out maintenance and operational activities, including potential hazards and identification of methods for reducing or eliminating those hazards. Computer programs that are available now permit not only basic analyses of geometric relations but also much more advanced analyses, which include, among others, simulations of human body behavior (VTT Technical Research Centre of Finland, 2011). In the Figure 18.3, the workstation and working environment previously shown in the Figure 18.1 is presented in a more detailed way–for a typical organization.

The workstations are selected in a way that enables the engineer to present a wide range of factors and requirements that shape working environment within one organization. The office workplace will be organized differently for a call center office worker and for a designer. For office work that includes considerably more creative work, a single workstation office or an office with not more than three workstations is much better from an ergonomic point of view. An office with many workstations is not conducive to such work; on the contrary, it hinders it. A set of factors characteristic for workstations can be identified for each of working environments shown in Figure 18.3.

A typical office workstation in an office with many workstations is presented in Figure 18.4. Factors that characterize such a working environment are described in Table 18.1, including computer simulation methods that can be used for analysis and optimization of a given hazard. Examples of computer tools that can be used for those analyses are included in the table.

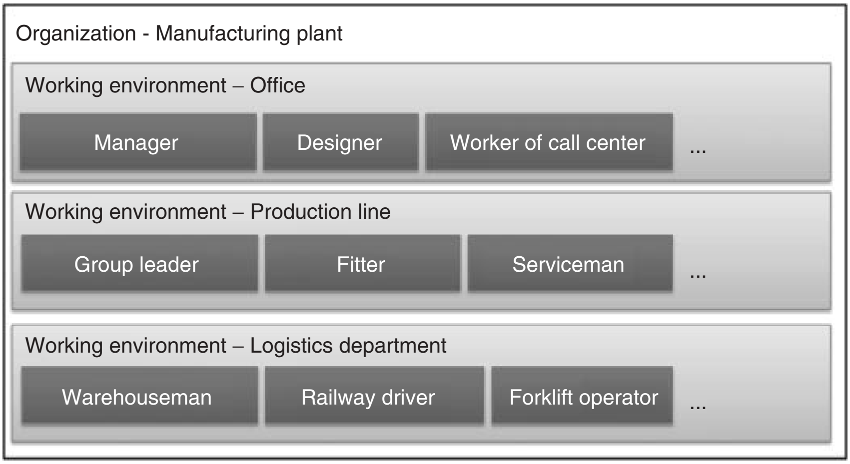

Figure 18.3 Examples working environments in a typical manufacturing plant.

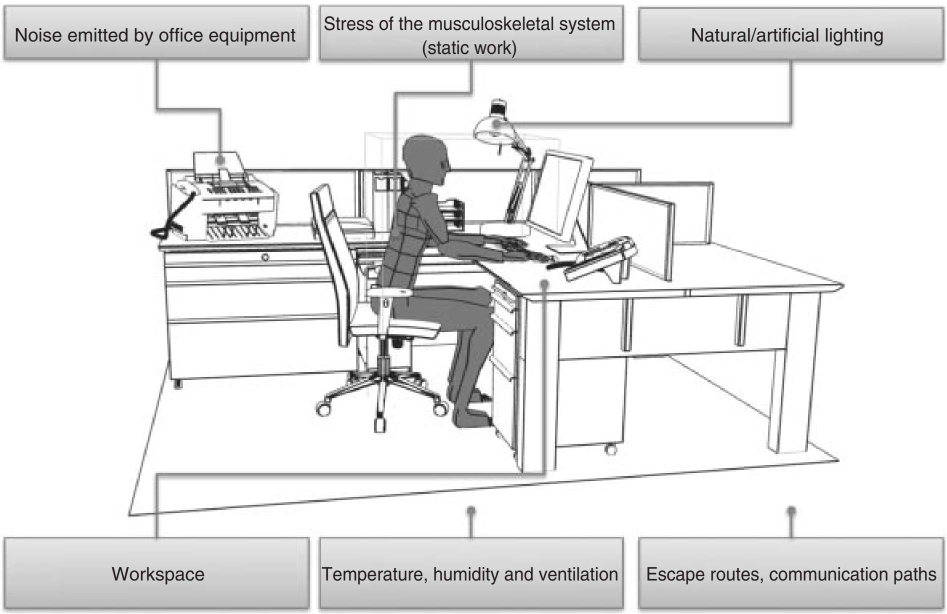

Figure 18.4 Factors that characterize the working environment of office work.

Factors characteristic for the discussed working environment, listed in Table 18.1, are subjected to computer modeling, simulation, and analysis. The creation of a proper model, that by definition is a simplified representation of phenomena and relationships existing in the real world, is a key factor to obtaining simulation results that are correct (consistent with potential real-world study findings). The subject is broadly discussed in Chapter 19, The Virtual Working Environment.

Table 18.1 Shaping of working conditions in the working environment of an office.

Main factors that can occur on a workstation	Description	Types of analyses	Exemplary software tools
Stress of the musculo-skeletal system (static work)	Long-term work in a sitting position is arduous. As a consequence, unfavorable spine stress (increased tension between spinal discs), static load on trunk and back muscles, that can cause curvature of spine, appear. Disorders in blood circulation in the area of the thighs can be caused by a too high seat or not properly shaped front edge of the seat	Ergonomic assessment of working posture Analysis of field of view and range of motion of limbs	JACK, RAMSIS, 3D Static Strength Prediction Program (3DSSPP), DELMIA Ergonomics Analysis
Workspace	Analysis of required workspace is conducted along with analysis of other factors present at the workplace such as optimal working posture and necessary escape routes	Simulation of workspace necessary for all equipment required for a given workstation Analysis of optimal arrangement of workspace with consideration of work planned for the workspace, for example, creative work, client service, reception desk	Any CAD system
Escape routes and communication paths	Detailed analyses including possible scenarios of quick escape in case of danger	Simulation of behavior of people in a workspace, with use of agent-based software solution that permits simulation of these behaviors in a global mode (assembly shop, building floor, whole building)	Pathfinder 2011 – agent-based emergency egress simulation FDS + Evac – evacuation simulation module for fire dynamics simulator (FDS)
Exposure to environmental factors: ● Natural/artificial lighting ● Temperature, humidity, and ventilation ● Noise emitted by office equipment	In the case of office work, other environmental factors include those which are regulated by standards: ● Intensive eyesight burden in poor lighting conditions can cause or increase tiring ● Noise in office rooms emitted by office equipment does not exceed the volume that causes damage to hearing, but it has a disturbing character ● Assessment of ventilation or temperature as comfortable is based on subjective judgment of workers, but a designer must comply with relevant standards and regulations	Requirements included in norms and other regulations dealing with a particular type of work are usually used due to lack of computer solutions that allow objective assessment of these factors	Computer programs that use databases with requirements for a given type of workstation

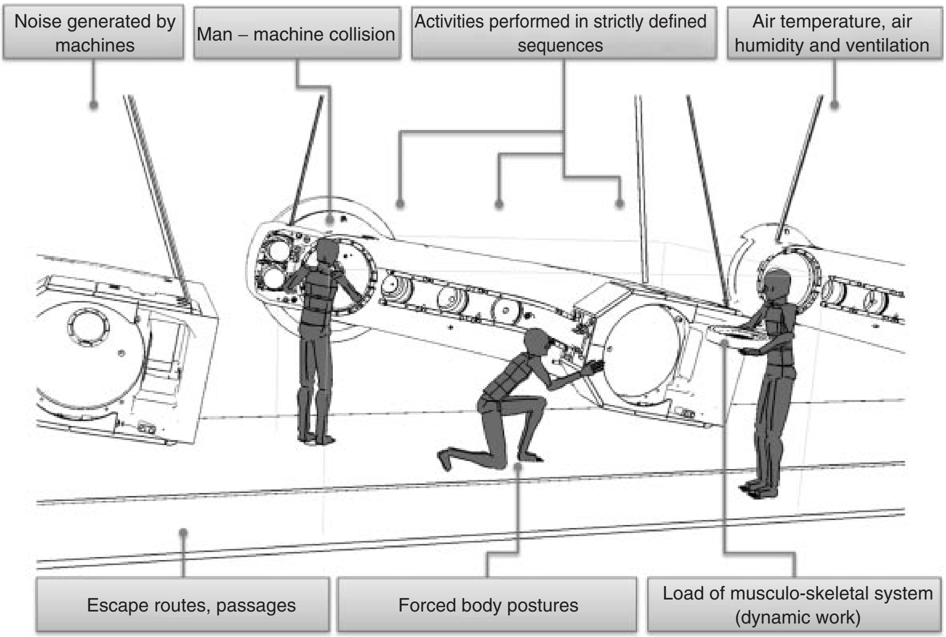

Figure 18.5 Factors that characterize working environment of a production line.

A manufacturing line is another example of a working environment. Many factors influence not only safety but also the optimization of a technological process that is carried out in a given working environment. Identification and assessment of risk are a significant source of information about environmental factors that must be taken into consideration during the design process. Risk assessment enables the engineer to identify factors that are significant because of the frequency and consequences of their appearance. From a risk analysis we also gain information about risk factors that must be taken into consideration in design, for example, if there is a hazard that requires the application of personal protection equipment or if the hazard must be taken into consideration in the design of a workstation. Factors that can appear in the working environment of a production line are presented in Figure 18.5.

Industry standards such as the Lifting Equation from the National Institute for Occupational Safety and Health (NIOSH), the Stover Snook tables, and the Rapid Upper Limb Assessment (RULA) are used to identify any potential body injuries during physical work and are included in computer programs that are nowadays used to aid designers. Advanced computer solutions that are intended to aid the shaping of work conditions are nowadays available in the engineering applications market. These applications operate as standalone programs or are integrated with a computer-aided design (CAD) environment as plug-ins. Integration with CAD systems is done in many ways. A given application can be directly incorporated in the main application by integration of user interfaces and smooth, unnoticeable to a user, transfer of data between parent system and subsystem that does specific functions. Integration of many systems in one computer environment is significantly important when multi-criteria analyses of the working environment are necessary. A production line is an example of such a complex object of analysis (Wang *et al.*, 2011, pp. 765–775). Factors that should be taken into consideration in shaping workplace are presented in Table 18.2.

Workstations located in a production line are an example of an object of multi-criteria optimization aimed at the best usage of available resources. The use of a computer-aided process of simulation of a production line is illustrated in Figure 18.6.

Particular components of the production line are analyzed separately but as a component of the whole system. Selection of proper simulation methods and proper modeling of interactions existing in the workplace are necessary. Too simple a model will not be useful to represent interactions in a realistic way; too complex a model will cause a longer analysis time and can be a source of errors. Computer-aided analysis of a production line working environment is not only focused on material elements of the environment. it can also be focused on a broadly understood work organization, which is discussed in the next section.

A self-propelled transport machine operator workstation is another characteristic example of a working environment. There are many standards and guidelines dealing with this kind of machine. An list of factors that are characteristic of this workstation are presented in Figure 18.7.

Environmental factors that are presented in Figure 18.7 can be shaped with the use of computer tools, as shown in Table 18.3.

Examples of computer-aided shaping of working conditions, presented above, can be described as user-centered design (UCD), and hence is a design in which

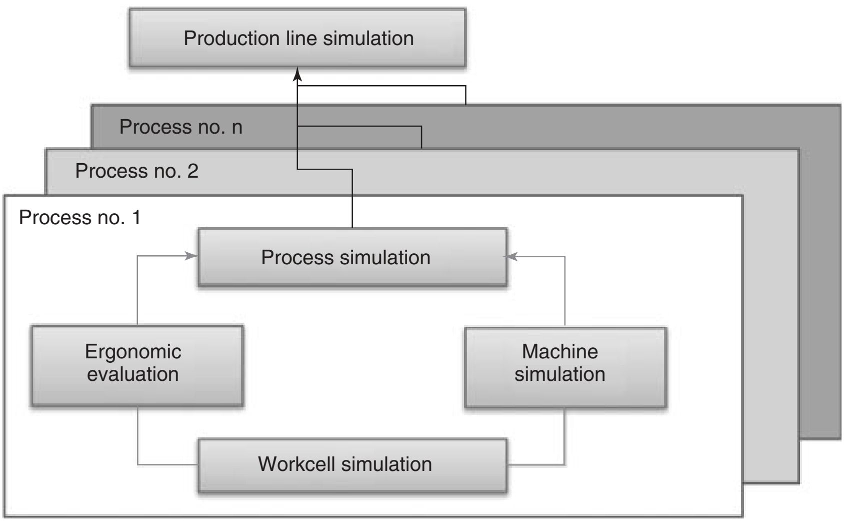

Figure 18.6 Computer-aided production line simulation.

Table 18.2 Shaping of working conditions in the working environment of a production line.

Basic factors which can occur at the workplace	Description	Types of analyses used	Exemplary software tools
Load of musculo-skeletal system (dynamic work)	It is work associated with considerable physical activity, which, depending on measured energy expenditure, can be classified as light, hard, and very hard. Workplaces at which work is determined as dynamic are subject to analysis regarding identification of problematic manual activities and then their optimization. Moreover, due to series of requirements and recommendations regarding maximum effort at the workplace, identified problems are then subjected to further analyses. Reducing the workload at a given workplace can be realized, for example, by use of additional equipment (manipulation means) or suitable shaping of the workspace	Analysis of field of view and ranges of limbs. Analysis of posture during work Workplace can be assessed according to industry standards such as NIOSH, Snook, Ciriello, and RULA to identify any potential body injuries	JACK, RAMSIS, DELMIA Ergonomics Analysis, Energy Expenditure Prediction Program
Noise generated by machines	In a work environment where many machines operate in one hall, the permissible noise level can be exceeded Acoustic screens, shields, and personal protections are used to reduce the noise level in the work environment	Computer modeling of the acoustic field in the work environment, determination of the range of impact of identified sound sources	SoundPLAN
Man–machine collision	Avoiding man–machine collisions is realized by ensuring there are suitable safety zones, which prevent incidents such as hitting or catching by movable machine components Identification of dangerous zones and suitable shaping of work environment are tasks for the designer	Modeling of kinematic chains of machine components to identify workspace Simulation of human presence in the immediate vicinity of machines, analysis of collision occurrence to determine zones in which work can be safely realized	Any CAD system with integrated module for ergonomic analyses

Table 18.2 (*continued*)

Basic factors which can occur at the workplace	Description	Types of analyses used	Exemplary software tools
Activities performed in strictly defined sequences	Optimization of work in conditions of an assembly line requires the development of optimal method for realization of operational activities	Task analysis Optimization of sequence of activities on the basis of recording of real activities Simulation of realization of sequence of operational activities with use of a parametric human body model	CAPTIVJACK – task analysis toolkit, DELMIA Ergonomics Analysis
Air temperature, air humidity, and ventilation	Developing heating, ventilation, and air conditioning systems takes into account factors such as room temperature, humidity, and expected occupancy, and also heat loss through doors, windows, and walls. Understanding of air flows in a building, vehicle, or any other environment is a key to creating the best design of a ventilation and comfort system	Analysis of temperature distribution by computational fluid dynamics method	ANSYS Fluent, ANSYS CFX
Emergency routes, passages	The need to ensure quick evacuation from the workplace in an emergency situation requires making detailed analyses including different possible scenarios of the situation	Simulation of the behavior of people who are in the workspace with use of agent-based software solution, which allows the simulation of such behaviors in a global context (hall, floor, and building)	Pathfinder 2011 – agent-based emergency egress Simulation FDS + Evac – evacuation simulation module for fire dynamics simulator (FDS)

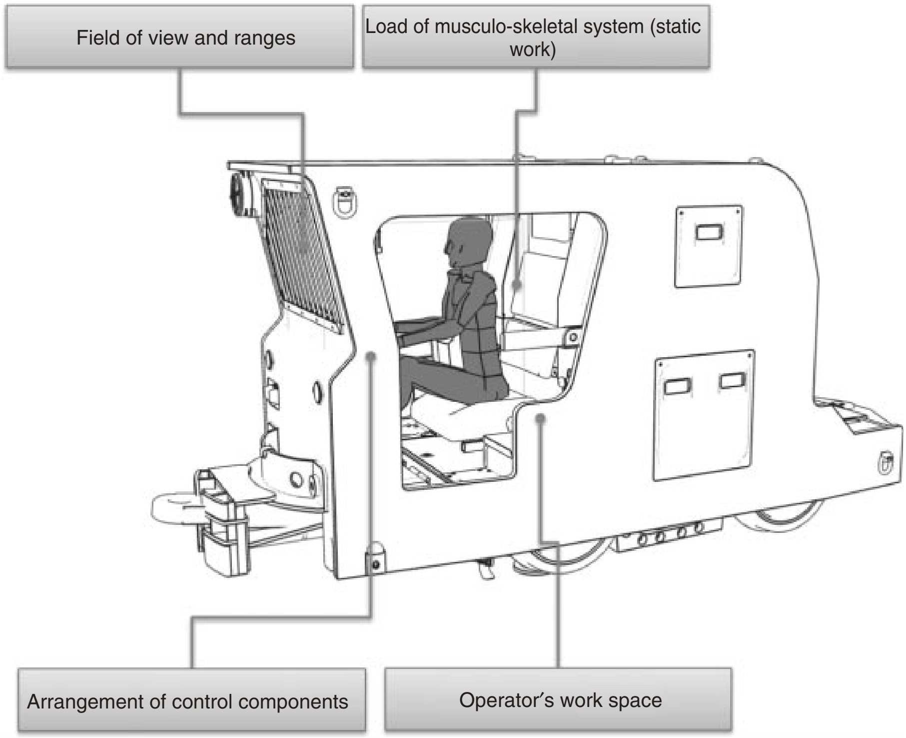

Figure 18.7 Factors characteristic of a machine operator's working environment.

the human factor is of crucial importance. Taking into consideration all mandatory human-related requirements in the product development process is not always possible in high-risk industries, for example, the chemical industry and mining industry. Large and sophisticated chemical installations do not require continuous operation by a human. They are operated (e.g., by adjusting valves) when necessary and are inspected periodically, which is taken into consideration during the design of the installation. Hence an operation or maintenance worker's comfort is not of the greatest importance during the design of the chemical installation. Design is focused on the proper course of the chemical process. This can result in an arrangement of components does not meet optimum ergonomic conditions, for example, valves or other elements of installation. Human factors should not be neglected; on the contrary, problems that can occur during interactions between humans and a given installation should be identified. It enables the engineer to identify necessary additional equipment such as ladders or platforms and also (organizational aspects) to develop proper operating and maintenance procedures and training materials. Part of a chemical installation with hard-to-reach control elements circled is presented in Figure 18.8.

A workstation located in an underground mine is an example of a working environment in which the natural environment is a factor that influences the

Table 18.3 Shaping of working conditions in a self-propelled machine operator's workstation.

Basic factors which can occur at the workplace	Description	Types of analyses used	Exemplary software tools
Field of view and ranges	Ensuring proper visibility and ranges of limbs at the place occupied by the operator is a key element in shaping the work environment for operators of self-propelled machines	Analysis of field of view and ranges of limbs	JACK, RAMSIS Industrial Vehicles
Load of musculo-skeletal system (static work)	A sitting posture maintained for a long time during work can become inconvenient. Unfavorable load of spine (increase of pressure of discs) and static load of muscles of trunk and back, which favors the formation of incorrect curvatures of the spine, are the consequences of immobilization. Circulator disturbances, which result from a too high seat or improperly shaped edge of the seat, can also occur in the thighs	Ergonomic assessment of posture during work	RAMSIS Industrial Vehicles, 3D Static Strength Prediction Program (3DSSPP), DELMIA Ergonomics Analysis
Operator's workspace	Owing to spatial limitations, the workspace of a machine operator is the subject of many analyses regarding optimization of the arrangement of control components or simulation of activities performed by the operator	Motion capture analyses of actions performed by the operator Simulation of basic operational activities performed during a ride	iPi Desktop Motion Capture VICON
Arrangement of control components	Arrangement of control components depends on their destination. Analysis of the optimum arrangement of control devices should be made with respect to not only ergonomic aspects but also functional aspects	Arrangement of models of control components in virtual workspace	RAMSIS Industrial Vehicles, RAMSIS Bus and Truck

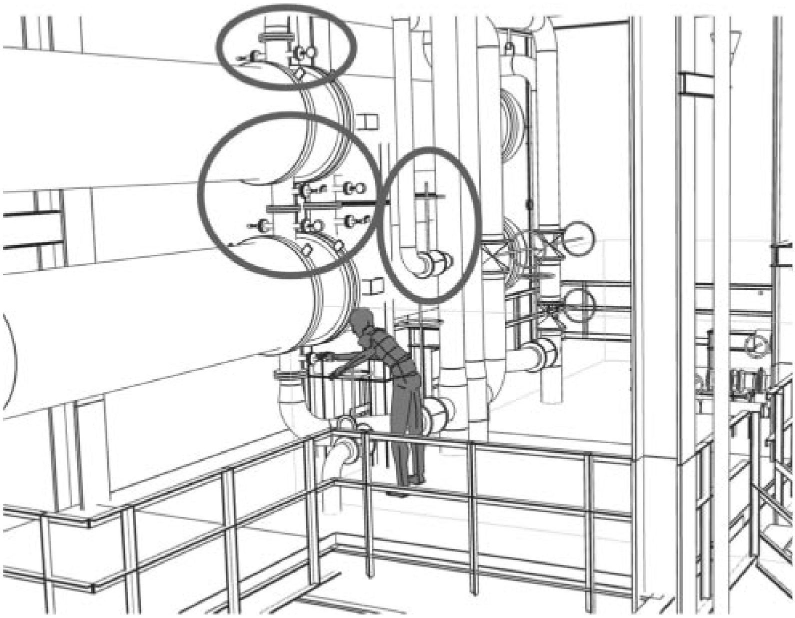

Figure 18.8 Working environment of a chemical installation with hard-to-reach control elements circled.

design of each component of a longwall mining system, in spite of the fact that coal excavation is the main goal. Limited space and the probability of occurrence of events such as methane explosions, ejection of rocks, mine bump, water flow, and high temperatures are factors that must be taken into consideration in the design of machines. Meeting requirements that deal with the natural environment is necessary, hence taking into consideration ergonomic factors during the shaping of the working environment can be done to a limited extent. Shaping of the working environment is moved to the next stage of a machine life-cycle, that is, to work organization. Detailed procedures that describe operation and maintenance activities are developed. This enables the engineer to develop optimum working methods that include all working environment factors. The working environment in which mining machines are operated (on the left) or maintained (on the right) is illustrated in Figure 18.9.

A place in which repairs are carried out is regarded as dangerous; therefore, workers who do machine operation activities cannot be present there. The workplace should not be dangerous to workers after meeting requirements that are included in properly developed maintenance instructions. Dissemination of these requirements is done not only through proper instructions but also via the training process. Hazards that cannot be eliminated or reduced during workplace design can be reduced by dissemination of proper knowledge including requirements from relevant standards and safe work practice, during training.

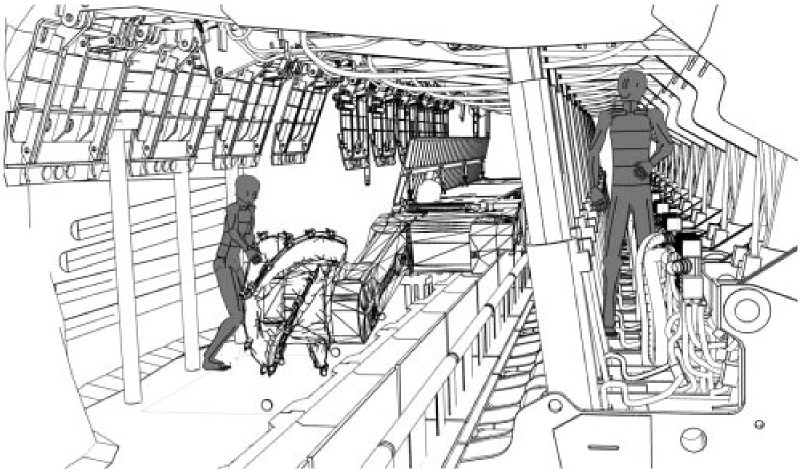

Figure 18.9 Workstation in a coal mine.

Risk factor identification is a significant source of information on environmental factors for complex mechanical systems. Risk assessment enables the engineer to identify factors present in a given workstation that are of high importance due to their frequency of occurrence and the seriousness of the result. From risk analysis we also gain information about risk factors that should be taken into consideration during design, for example, whether it is possible to reduce a given hazard by proper machine design, by using proper personal protection equipment, or by proper work organization.

Application of advanced computer tools for solving problems that can occur in man–machine interactions is necessary owing to the complexity of each of the working environments discussed above. Application of virtual prototyping methodology for analysis of the working environment is an optimum solution. In this methodology, scenarios of machine use are used. Virtual prototyping methodology is described in a more detailed way in Chapter 21.

18.4 Shaping of Work Organization Using ICT

Effective functioning of every company depends on processes being run within that company. In the case of a production company, these processes include, among others, the broadly understood production process and maintenance processes. Each of the processes can cause losses. Both processes influence each other (discussed below), so their poor cooperation also causes losses.

A production process is based on machine operation. It also includes manufacturing management in order to meet customer needs concerning quantity, quality, and delivery time (on-time delivery), material resources management, and human resources management, and other.

Machine operation is the use of a machine in accordance with its purpose. It causes wear and tear, leading to the gradual deterioration of the machine. As a consequence, failures or a decline in the performance (effectiveness, accuracy, and energy usage) of the machine occur. To avoid these consequences, proper maintenance of the machine must be conducted. Maintenance (Kans, 2008, p. 33) includes any activity carried out on a machine in order to ensure that the machine continues to perform its intended functions or to repair the machine. These activities are of technical, administrative, and managerial types. They are conducted during the life-cycle of a machine and include repairs (including overhauls), inspections, cleaning, adjusting, lubricating, machine conditions diagnostics and monitoring, maintenance tasks management, material resources (spare parts, consumables, tools, and devices) management, maintenance staff management, and other.

A production process must be operated in a cost-effective way (including the best use of production capacity) and in a way that guarantees customer satisfaction. Maintenance processes must be conducted in a way that minimizes costs, increases asset life, and eliminates production stoppages. Important factors are tasks management and material and human resources management, and other.

Properly conducted production process and maintenance processes (Figure 18.10):

- Enable expectations of current customers to be met; failing to meet a customer's satisfaction can cause costs (penalties) for not meeting contract provisions. Also, loss of a customer is possible – nowadays it is easy to find an alternative company (manufacturer).
- Enable new customers to be gained – being considered a reliable manufacturer attracts potential customers.
- Reduce the probability of unnecessary and unjustified costs of operation and maintenance activities.

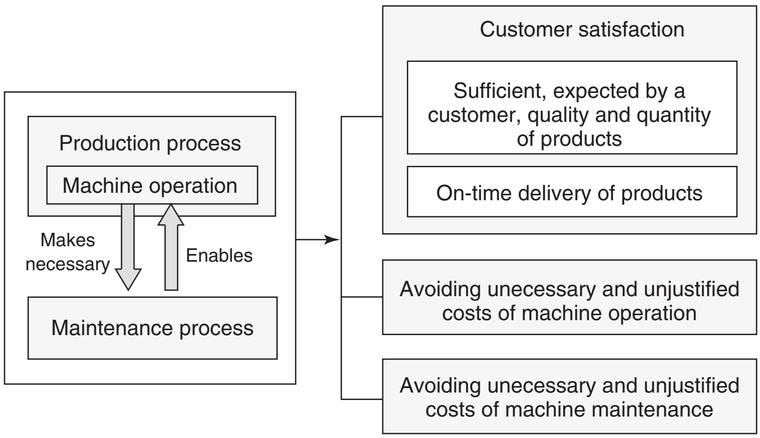

Figure 18.10 Results of properly conducted machine operation and maintenance.

Both production tasks and maintenance tasks require access to a machine and they cause planned or unplanned shutdowns of a machine. Therefore, the production process and maintenance process must be planned and conducted in such a way that:

- maintenance activities do not disturb the fulfillment of production plans
- production plans take into consideration necessary maintenance activities.

Maintenance tasks are conducted according to a maintenance schedule. Production tasks are conducted according to production schedule which is developed on the basis of a production plan. The production plan is based on forecast and actual customer orders (Figure 18.11). For both types of tasks, required resources must be available in the right place and at the right time, otherwise it will be impossible to keep to the schedule.

The production capacity must be considered during the development of production schedules. On the basis of the schedules, operation of machines is conducted. Maintenance of machines is conducted to make them work in the proper way and, as a consequence, is one of the crucial factors to achieve fulfillment of the production plans and to meet customer needs.

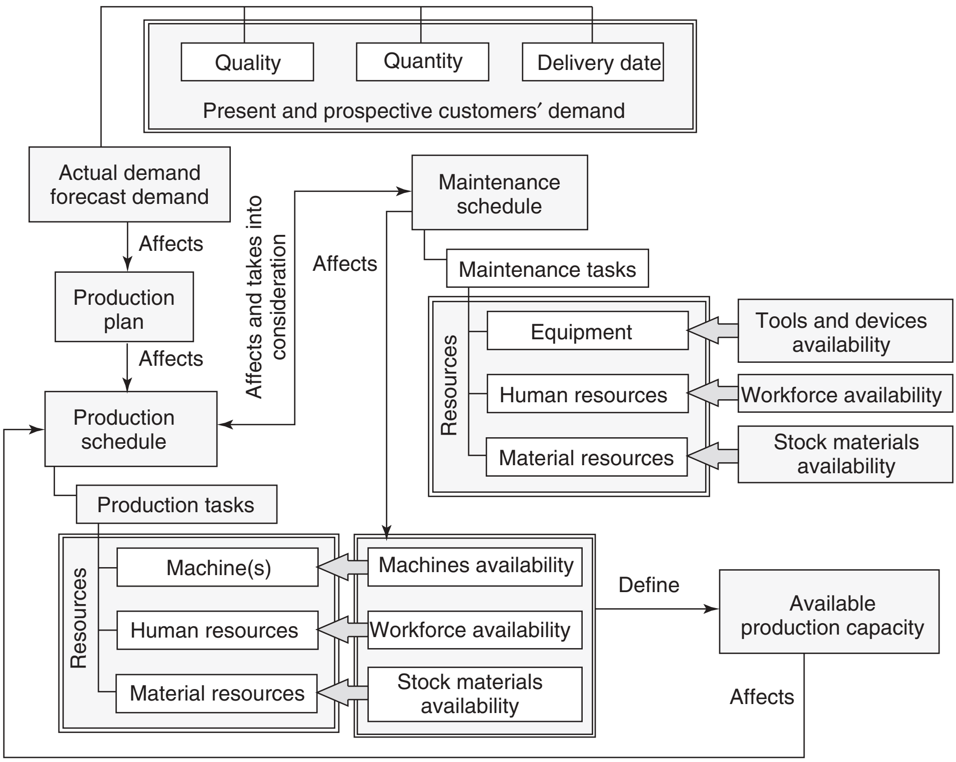

Figure 18.11 Interrelations between production process and maintenance process.

To calculate production capacity correctly and to maintain the required production capacity for a given period of time, quick and easy access to adequate information on machine maintenance and operational tasks and necessary resources is essential. This access includes creating, browsing, and processing information. Therefore, a proper computer information system should be used to prevent losses. The production process is supported by an Enterprise Resources Planning (ERP) system (Lech, 2003, pp. 12–15). Maintenance processes can be supported by an ERP system or by a Computer Maintenance Management system - CMMs (Loska, 2004, pp. 132–144). In these systems, all data are stored in one database which is available via a computer network (local or Internet). Therefore, there are no redundant or inconsistent data in a company and data used by any system user are up-to-date.

The above discussion shows that both production workforce and maintenance workforce availability are factors that determine the production capacity for a given period of time. The following interrelations can also be distinguished:

- The production schedule directly influences production workforce availability – work schedules of individual employees are developed with regard to the required production capacity.
- The production schedules indirectly influences maintenance workforce availability – work schedules of individual employees are developed with regard to maintenance tasks, which are planned with regard to production schedules.

The interrelation between workforce availability and meeting production schedule is presented in Figure 18.12.

Analysis of production workforce and maintenance workforce availability and making any changes to it (to meet production capacity needs) must be done with regard to (Figure 18.13):

- Employees' work schedules – they reflect their presence at work.
- Employees' competence – it reflects the ability to conduct particular tasks in the correct way.

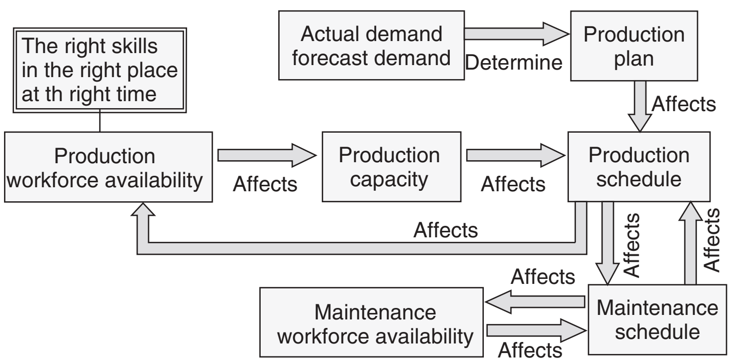

Figure 18.12 Workforce availability as a factor in meeting production schedule.

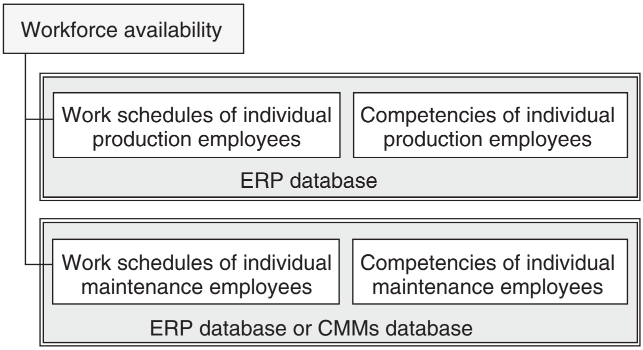

Figure 18.13 Elements of workforce availability.

To organize work (production and maintenance tasks) in an efficient way, it is extremely important to base it on an up-to-date set of all the necessary workforce data, which are easily usable. Complete, compliant, accessible digital records of company's workforce are stored in a computer information system. In addition to data such as personal details, contact details, wage details, and many others, the records include the following data that are important for work organization:

- Organization assignment – details about employees' positions in the organization, their work locations, and details of their employment.
- Work schedule – employees' planned working time, including planned start time (or range of start times), breaks (morning, lunch, afternoon, or as required), and planned finishing time, planned presence, and absence.
- Competencies (a cluster of skills, capabilities, knowledge, abilities enable a person to act effectively in a job or situation), educational background, training, certificates, and diplomas.

ERP systems and CMMs systems allow the easy use of the workforce data. System users quickly gain a clear overview of each worker's records. There are also many browsing options which enable all of relevant information and documents to be rapidly retrieved.

To maintain the required workforce availability, it is necessary to manage employees' working hours and also to manage workforce competencies. ERP systems and CMMs systems enable employees' work schedules to be created and changed. They also support training management and recruitment to develop competencies necessary for manufacturing and maintenance processes.

Another key factor necessary to accomplish production schedules is material resources availability. Material resources management is also supported by ERP systems and CMMs systems (Figure 18.14).

Functions that allow effective management of stock levels with regard to production schedules and maintenance schedules but also with regard to unexpected situations are embedded in ERP systems and functions that allow effective management of stock levels with regard maintenance schedules but also with regard

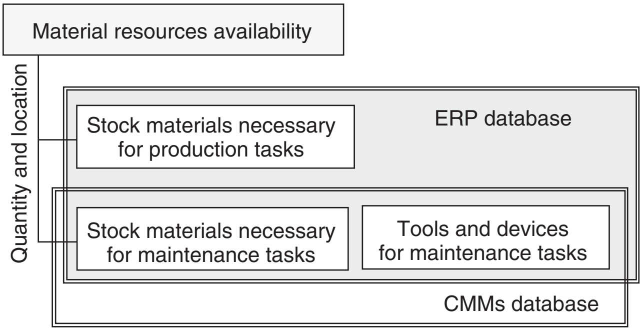

Figure 18.14 Elements of material resources availability.

to unexpected situations are embedded in ERP systems and CMMs systems. In particular, it is possible to define the safety stock level (Persona *et al.*, 2007, p. 148), which is the minimum level of inventory that a company should keep to avoid not meeting schedules (caused by, e.g., late delivery by a supplier) and to be able to react to unplanned events (e.g., emergency repairs) (WebFinance, Inc., 2011). Hence safety stock inventory is held as a buffer against mismatch between forecast and actual consumption or demand between expected and actual delivery times, and unforeseen emergencies. The systems allow automatic comparison of personnel needs with the availability of various competencies.

ERP systems and CMMs systems permit the tracking of the availability (including quantity and location) of particular tools and devices necessary for maintenance tasks.

Activities that must be done and all necessary resources can be defined for production and maintenance tasks. Descriptions which include a specification of all resources that must be provided for individual activities can be created. ERP systems and CMMs systems allow all resources to be requested in advance, so it is possible to avoid shortages of needed resources. As a consequence, a task can be completed according to a production or maintenance schedule and meeting the production plan is possible.

ERP systems and CMMs systems databases should include all data necessary for tasks and resources management. The data must be up-to-date and accessible at any time and place, and the selection of relevant, required data must be easy and quick. Interrelations between these factors and loss prevention are presented in Figure 18.15.

ERP systems and CMMs systems can be used by geographically dispersed users. Particular system modules are developed also in a version intended to be used on portable devices such as a PDA (portable digital assistant) through a WiFi connection. Therefore, all necessary data are available in real time to all users, no matter where they are located. Also, creation of data can be done at any time and at any place. This enables data to be maintained up-to-date and as a consequence

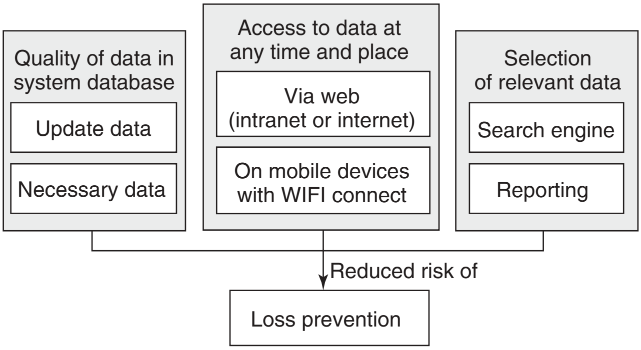

Figure 18.15 Data factor in loss prevention.

losses caused by decisions based on invalid data or by delayed decisions because of lack access to the system can be avoided.

A very useful functionality of ERP systems and CMMs systems is search engines and reporting. They both allow a quick overview and analysis of data in order to obtain necessary information.

Work organization can be effectively supported by the use of computer tools. Of course, no computer program is sufficient to succeed in work organization that prevents losses. Population of the database with all required and accurate data and the proper use of computer programs are necessary.

18.5 Conclusion

Processes in a company when operated in a poor way can cause losses. There are at least two factors that influence these processes and their results:

- the working environment
- work organization.

The working environment influences workers' efficiency and safety. When shaped in a poor way, the working environment can hinder the carrying out of activities using best practice and safe methods. As a consequence, activities last longer, can cause damage to a machine and other objects near the machine, and can cause accidents and occupational disease. To avoid such consequences or to reduce them as much as possible, it is necessary to analyze the working environment and activities carried out there. Many methods and computer applications have been addressed to such analyses. Properly conducted analyses allow the identification of what is hazardous for workers in a given working environment and what can be improved and how.

In a manufacturing company, production and maintenance are the two main processes, and they interact with each other. The production process includes the use of machines, which leads to a need to conduct maintenance tasks to permit proper performance of these machines. Both processes must be operated in a way that enables the expectations of customers to be met and at the same time unnecessary and unjustified costs to be avoided. Work organization in these processes includes:

- planning and scheduling of maintenance and production tasks
- resource management to provide the right resources at the right time and place.

Both groups of activities are based on information. Therefore, a poor company information system hinders effective work organization and causes losses.

The information system must enable its users to gain quick and easy access to all necessary information. Information must also be available any place because maintenance and production process participants are geographically dispersed and carry out their tasks in different conditions.

A wide range of information solutions that effectively support organizations is nowadays commercially available. For production processes an ERP system can be applied and for maintenance processes a ERP systems and CMMs systems can be applied. The systems provide immediate access to relevant information through browsing, processing, and producing data. User-friendly interfaces and tools such as search engines and reporting make it easy. The systems can be used on both personal computers and portable computers.

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