Objective-based Design of Communication Processes in Factories

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Abstract

Production processes are characterized by an always increasing complexity: Against the background of individualized customers' demands, global production networks or reduced product lifecycles, the coordination necessity between companies and customers as well as contractors increases. To forward these external requirements into production facilities, efficient communication processes are necessary. Companies, however, are often only deficiently adjusted. The objective of a company should be to meet an adequate communication design.

Introduction

Companies act in a turbulent environment [1, 2]. Examples of change drivers include requirements like the integration of new product functions. Hereby, the complexity of production processes increases and internal communication processes become more important to handle the situation adequately. Furthermore, working processes are changing, e.g. because of a greater amount of teamwork or more complex job contents for employees in specific positions, so that communication must be a fundamental part of modern production facilities [3]. The advantages of communication processes are clearly documented: A positive effect on innovation rate [4] is demonstrated. Also, the implementation of change projects is enhanced [5, 6].

However, there are no methods which allow designing adequate communication processes in factories. A research project, which is funded by the German Research Foundation (DFG) – carried out by the Institute of Production Systems and Logistics (IFA) at the Leibniz University of Hanover in cooperation with the Chair of Industrial Building of the Technical University of Dresden – focuses on the development of a design model for communication processes in factories.

In this paper a methodology of an adequate communication design in factories will be presented. Therefore, the necessity of the consideration of communication processes is made clear.

Relevance of Communication Processes

The denotation of communication processes for production processes is reflected in various dimensions, some of which are presented in the following:

Changed work processes

The restructuring of work contents which is originated e.g. in context of globalization, engineering progress or postindustrial society, moves away from the hierarchical, segmented division of labor as was know during Fordism. In fact, it is nowadays characterized by flatter hierarchies and greater autonomy of the employees [7]. This results in different consequences for the work processes: The dimensions of how, who, what, when and why of the work content become part of the work process itself. The identification of quality potentials (e.g. by a Total Quality Management), increased worker competence (e.g. by Job Enrichment) as well as the adjustment of the production supply and demand (e.g. by a Kanban-supply) allow companies a continuous and active adjustment in times of changing requirements.

Communication processes as a basis for collective action

The individual employee expresses his professional estimation via communication processes. This occurs on the basis of situational perceptions and existing individual knowledge [8]. Particularly at the interface of operating processes, various perceptions are in competition with each other. The balancing of reasons in face-to-face communication is often the most efficient method. This helps to make decisions promptly and under the best possible use of the available know-how [9].

Communication as an integrated component of production systems

Today, routine tasks are more and more carried out by machines. Employees are increasingly engaged in problem-solving functions [13]. These are characterized by results that are unknown in advance or a high degree of constraints. This is precisely what makes communication processes so essential during production. Therefore, physical proximity of workers is essential in many respects:

- In order to bring about a decision in teams,
- In order to be able to react immediately to developments or
- In order to be able to assert influence on others.

The interpersonal communication in these areas is predominant over other forms of communication [11]. The content of the communication will be enriched with additional information and know-how of the individual. In addition, physical attendance helps avoid misunderstandings so that decisions can be made more easily [11].

The impact of areal organization on communication

The areal design of an industrial location biases a person in their communication behaviour. Especially in the past it was shown that the local distance correlates with the frequency of communication [4] (cf. Figure 1).

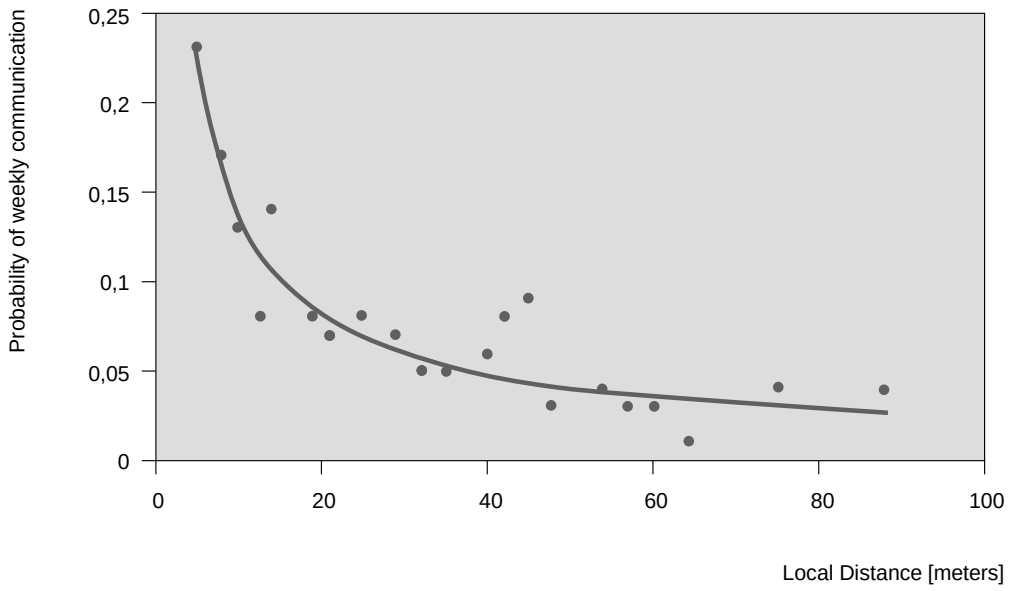

Figure 1 - Probability of technical communication depending on the distance between workplaces

The areal organization affects – even more than a company's organizational structure – what jiggles into the awareness of an individual. Physical presence facilitates the utilization of knowledge of other personnel. A person's perception selects information situationally – a fact that appears subjectively relevant [13]. Through physical presence an advantage of direct signal selection will be generated. Additional aspects that seem relevant can be selected in the course of the communication processes [14]. That is why the specific areal allocation and arrangement of interfaces can enhance the efficiency of communication in complex situations. At the same time, visual information can reduce the need of communication because the system status (e.g. order situation on the base on Kanban-cards) can directly be read out of the situation.

Target System of Communication Design in Factories

The origin of this consideration is the target system of logistics [15], which is used as the starting point for a transmission on communication processes in factories.

By the arrangement of efficient communication processes in a plant, it is assumed that there will be both a financial and organizational effort (e.g. through the spacious arrangement of communication places or the arrangement of meetings). A definite communication output rate is the result of the efforts (cf. Figure 2). The ambition is an adequate design of the communication performance. Therefore, two levers of adjustment are suitable. Firstly, the existing structures of the factory allow the lowering of the communication efforts while the output rate remains almost stable (figure section a). Although it will presumably be possible to achieve a higher level of communication performance even in existing factory structures, this means an increasing ratio of output-rate and effort. In order to achieve disproportionately high effort reductions, room design becomes necessary (figure section b): In the long run, a room (re)configuration is necessary to break up existing structures and to enhance the communication performance (e.g. by newly arranged communication areas in the production). At the same time, the utilization of room configuration allows a higher quality of communication processes and, thus, a higher level of output rate.

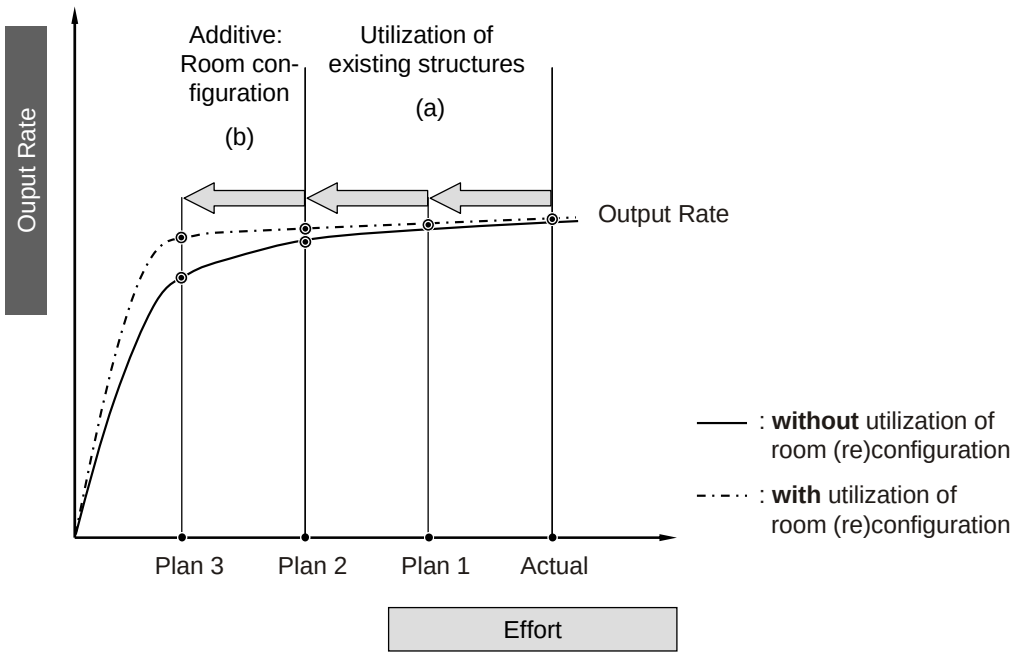

Figure 2 - Arrangements to gradual advancements of the ratio of output-rate and effort

There are two steps to determine how the ratio of output and effort of communication can be optimized. First of all, parameters are derived which describe the effort of communication as well as the output rate. In the second step, these parameters will be compared to so-called Description Features (DF) of communication. These allow a characterization of communication processes. Finally, specific design advices for communication are derived. The procedure is delineated in the following chapters.

Target System Operationalization

The target value ”communication output rate“ can be described by the parameter ”reliability“. A high communication output rate is guaranteed if the communication takes place between the right people at the right time. Further, the indicator ”degree of effectiveness“ can be consulted. The thereby described proportion of the communication content directly relating to the work task has to be increased to ensure a high communication output rate.

An operationalization of the target value ”communication effort “ is enabled by the indicator “number of processes“. In order to reduce the effort, the number of communication processes is to be minimized. Furthermore, the indicator ”process length“ is used. It refers to the constant minimization of the duration of the communication processes.

To arrange the communication processes in plants, adjusting levers have to be found. They go back to the DF.

Design of Communication on the Basis of Description Features

Examples of DF include quantitative variables such as the communication distance between two communicating people or qualitative variables such as the communication environment (with the characteristics e.g. loud or low), communication mode (e.g. face-to-face or media-bound) or the communication structure (relation of the communication flows to structural organization, e.g. horizontal or vertical communication flow).

The DF can be linked to the indicator and thus indirectly to the target value of communication (cf. Figure 3). One example is the indicator „reliability“, delineated below: In

order to ensure that the right people talk to each other at the right time, the communication distance between the parties as well as the communication mode will have a decisive influence. Furthermore, the place of those communicating in the structural organization of the factory (communication structure) is essential. The communication environment does, however, have only very little influence.

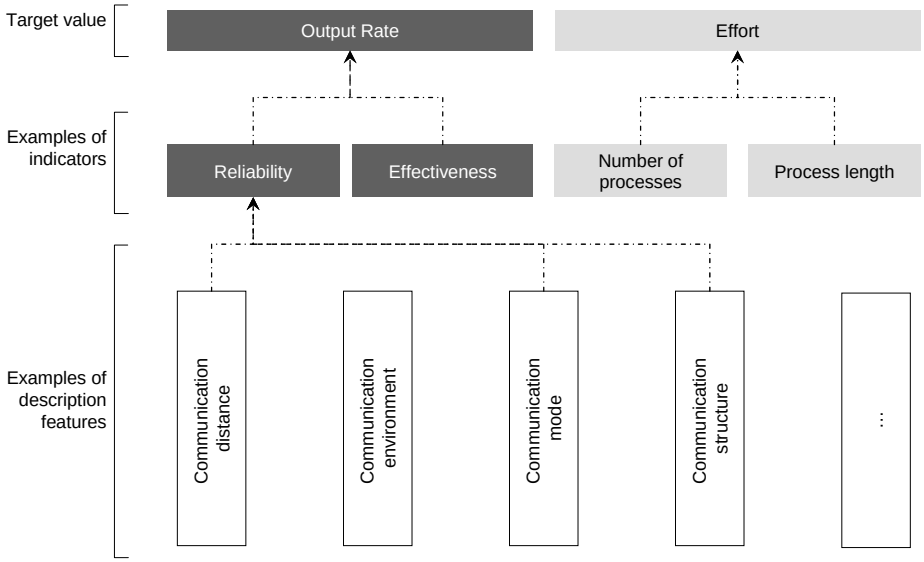

Figure 3 - Actuating variable of the target system of the communication design (e.g. reliability)

After the operationalization of the target system and the allocation of the DF to the indicators, design rules are finally to deduce. This allows the communication design in factories to be suitably implemented. The necessary steps will be outlined below.

Practical Example for the Suitable Design of the Communication Process

First of all, it needs to be investigated, if the production strategy pursued needs to be optimized in the future with regard to the intra-company communication processes. In favor of this, scenario management can be used to collect the required information [17-19]. If there is room for improvement, actuating variables have to be identified, which allow the desired improvement.

In a first step, an actual profile of communication processes in the factory can be derived on the basis of the DF. It is, therefore, investigated on how the communication processes usually take place during the processing of orders. As possible future trends are know through the scenarios, the assignment of the DF to the communication objectives reveal a target profile (cf. Figure 3).

In a second step, a comparison of actual and target profile can indicate the areas in which an adaptation is needed. Corresponding design rules for the factory can be derived.

The procedure will be made clear in this case study (cf. Figure 4). A manufacturer of individual goods in highly diversified one-off production. For few customers specific product variants are made. The formation of scenarios determines that in the future a fully customized production will be an essential criterion to remain competitive. Therefore, quick and effortless cooperation and coordination processes amongst the areas of development, manufacturing and quality management are necessary. This was formulated as an objective for the construction of a new factory.

In a first step, typical coordination processes between the regarded divisions have been described by an actual communication profile. The communication processes were

characterized by high communication distance, alternating communication environments, and a high proportion of media-based communication. Based on these results as well as the analysis of the scenarios, it was derived which communication objectives will become more important in the future. In the discussed case, an enhancement of reliability of communication processes has been particularly essential. The assignment of the DF to the target values of communication (cf. Figure 3) could reveal what a prospective target profile has to look like: The communication distance has to be reduced while the face-to-face-communication has to be invigorated. By comparison of the actual and target profile, areas of adaptation in the factory could be identified.

In the following stage of factory planning an intensive communication design was conducted in order to allow closing the identified gaps. Examples of solutions include the arrangement of direct and indirect areas close to each other by integrating offices into the factory on a balustrade. Beyond, designated “communication islands” were integrated in the manufacturing area to facilitate coordination processes. Finally, regular meetings were initialized.

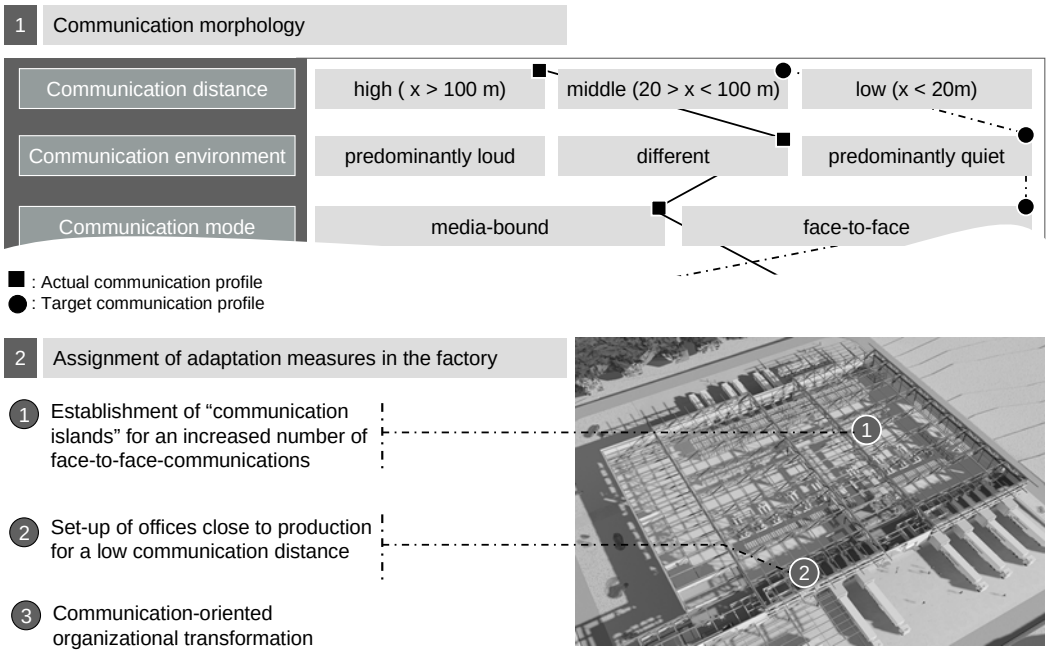

Figure 4 - Basis of communication design in factories

Summary and Outlook

In this paper the necessity of communication processes in factories is shown. A target system for the communication design was initially broad up. Characteristics of how communication can be described and finally designed in order to meet the given requirements were discussed. To assure the usability of the results, a comprehensive case study was described. It is planned to validate and adapt the results with companies in the future.

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Biography

Tobias Heinen holds a Master's degree (German: Diplom-Wirtschaftsingenieur) in Industrial Engineering. He studied at the universities of Halle-Wittenberg and Hannover in Germany and Port Elizabeth (South Africa). Currently, he is a research associate with the Institute of Production Systems and Logistics at the Leibniz University of Hannover in the area of factory planning where he is pursuing a PhD.

Prof. Dr.-Ing. habil. Peter Nyhuis heads the Institute of Production Systems and Logistics at the Leibniz Universität Hannover and is member of the management board of the Institute of Integrated Production Hannover. He studied mechanical engineering at the Leibniz Universität Hannover and, subsequently, worked as research associate at the Institute of Production Systems and Logistics. After receiving his doctorate in mechanical engineering he habilitated.