New Collaborative and Cooperative Just-in-Time Training Methods at the Workplace

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Abstract

Formalized methodologies for transfer of on the job knowledge between companies and their contractors have not been developed due to lack of semantic "interoperability" in the context of technical communication. Semantic interoperability in outsourcing processes targets one central issue: "Are the production processes and deliveries from the contractor in accordance with the company's requirements and specifications of quality?" This paper outlines flexible system solutions for just-in-time transfer of mechanical industry production process know-how at the workplace that requires detailed transfer of technical communication processes to small and medium sized companies. The solution utilize the strength, flexibility and speed of oral communication to avoid semantic interoperability issues related to technical communication, by mixing state of the art high quality video conferencing solutions and digital blackboard technology. The article includes a detailed description of how to interconnect the various audio-visual devices, and an outline of the Cyclic Corrective Action method. This system solution has recently been used to offer successful transfer of welding competence in Norway.

Keywords

Collaborative and cooperative learning, in-company training, video technology, e-learning, blended learning, outsourcing, video conferencing, semantic interoperability

Introduction

Industrial companies try to reinforce their competitiveness in the world market by transferring their internally developed know how and working processes to Small and Medium sized Enterprises (SME) that are recipients and contractors of outsourcing contracts within the global production flow. Lack of adequate quality assurance systems and guidelines for effective transfer of know how have led to unexpected failures, whereby it has been required to carry out numerous expensive repair procedures. Such problems occur often even though the regulated European manufacturing industry utilizes production standards, guidelines and diplomas that are identical! However, know-how and expertise associated with the new production technologies vary enormously throughout Europe when obtained on the job through the daily work. The culture dependent factors for strategic and successful change of organizations have been addressed by (Black 2002, Schneider 2000, Duarte 2001, Wlliams 1993, and Peper 1995).

Most citizens in Europe have got some competence about "down hill skiing" due to broadcasting of various championships on TV. However, only a limited amount of them have obtained the required practical knowledge on how to do it! Thus, the interpretation of the word "down hill skiing" depends on each person's competence and knowledge. Similar phenomena occur in mechanical industry fabrication processes where the descriptions used within welding specifications frequently describe technical items and relations that are

related to different technological levels and experiences. The lack of semantic interoperability in the communication process (Stav 2007b) is indeed one of the core problems within an outsourcing process, since the level of competence often differs from the knowledge level at the contractor site. As a result of this, the production processes and the deliveries from the contractor are not in accordance with the company's requirements and specifications of quality. The communication language used during the outsourcing process is often English. It includes both written and oral communication. However, the personnel and staff working in the company that receives the outsourcing usually require that material such as specifications, manuals, production procedures, etc. must be in their native language. This consequently requires the company, which outsource their production, to translate such written material. The translator may also have quite different knowledge levels when compared to the end user groups, and this may lead to using various textual contexts that may give the phrases different content for various end user groups.

Technical communication is usually based on drawings, data models or technical written specifications. The technical vocabulary is in many cases limited and lacks the required detailed specifications for in depth understanding of a problem. Consequently data models, drawings and other visual methods are used to identify the tasks and problem areas. Various categories of production process personnel, that may have different background and experiences, often use the same type of words, phrases and descriptions. Indeed, many technical phrases have been used over decades without any change and this may very well introduce new problems within the education itself. These problems are indeed related to all technical matters in the outsourcing process and if proper feedback and an open discussion is not taking place, may this lead to problems during the production process. Experiences from Norway indicate that formalized methodologies for the transfer of on the job knowledge have not been developed due to lack of semantic "interoperability" within the context of technical communication.

This paper reports the results obtained by combining digital blackboards, video conferencing and digital document cameras into one joint training environment, offering just-in-time access to competence and knowledge transfer between a company and its contractors. The pedagogical framework mixes i) blended learning methodologies, ii) e-learning solutions, and iii) learning design methods where theoretical and practical training may follow each other closely on a just-in-time basis according to an industrial production process flow approach.

Blended learning solutions and inter- and intra-company training delivery

It is expected that learners participate in skill development programs while working in the industry. For this reason, the training delivery method must take into account limitations in terms of time and location. It should further be noticed that in a professional environment learners could benefit from each other's knowledge and skills, as much as through the interaction with an instructor. Thus, the social part of education becomes an increasingly important factor.

The mainstream concept of asynchronous distance education usually involves networked self-paced learning under the guidance of an instructor. Existing asynchronous solutions have disadvantages in terms of the instructor-learner communication, and the learner-learner collaboration. Both of these are important in education that is heavily based on the social aspect of classroom teaching and face-to-face training. The latter greatly benefits students, who can learn from each other. On the other hand, classroom based instruction lacks flexibility, which is often necessary for learners that face time and location limitations.

Video conferencing introduces a new concept of curricula design that combines traditional and new approaches (Stav 2007c) to achieve the best level of flexibility, as well as a distance-learning arena offering social interplay in education. Blended learning refers to a pedagogical approach that includes the following components:

- Instruction and/or guidance by using high quality videoconferencing in combination with digital blackboards and document cameras. This solution uses advantage of video communications technology developments for real time face-to-face communication in distance teaching settings.
- Hands-on practical training, possibly at the contractor site, where groups of staff may work together regularly during a production process.
- Self paced collaborative online learning by utilizing short, targeted industrial streaming video clips.

Blended learning training methods allow the control of training related costs, both in terms of travel expenses and in terms of time off work. The latter includes the disruption to the work schedule pre and after training related travel, as well as the disruption to the lives of professionals as it usually takes a few days to get into the normal work rhythm. The increased face-time and the limited use of self-paced learning in the context of a wider skill development strategy is a step forward from traditional distance teaching, which is not applicable in industrial processes and which suffers from a reputation of lower quality as compared to in-class instruction. It allows training to take place intra- and inter-company, often across borders, in the context of a global economy

Visual communication technology for just-in-time transfer of knowledge

Perceptual modality is a key consideration in learning design. It relates to the delivery method under which a learner best comprehends and absorbs knowledge. Individuals may learn more effectively through visual presentations, audio presentations, through reading texts in a self-paced manner, or combinations of the above. In a manufacturing environment where training revolves around specific processes and tasks typically demonstrated by an expert in real-life conditions, visual presentations provide a vivid means for know-how transfer (Knudsen 2002). Pictures, images and video help learners understand concepts and implementation steps better than oral explanations. Literature has not always succeeded in providing explicit or decisive conclusions with relation to the impact that multimedia technology has on learning. Until recently (Samaras, 2006) it failed to recognize a broader range of parameters like the knowledge level of the learner, the intrinsic cognitive load, support from the multimedia learning environment and cognitive processes encouraged of learners by the environment. However, training offered in combination with job and industrial production activities, is one of the best available training methods since it is planned, organized, and conducted at the employee's worksite. Such training will generally be the primary method used for broadening employee skills and increasing productivity.

An outsourcing process will usually involve transfer of various types of technical information and know-how to different user groups at the workplace. Formalized methodologies for transfer of on the job knowledge between companies and their contractors have not been developed due to lack of semantic “interoperability” in the context of technical communication. Semantic interoperability in outsourcing processes targets one central issue: “Are the production processes and deliveries from the contractor in accordance with the company’s requirements and specifications of quality?”

Oral communication is fast, effective, and may lead to quick results without too high risks for misunderstandings or misinterpretations since issues related to the semantic interoperability within technical communication may be addressed immediately during the ongoing discussion. Unfortunately, oral communication traditionally takes place face-to-face. Oral communication processes may be offered efficiently at distance by mixing state of the art high quality videoconferencing solutions with digital blackboards (Stav 2007a). In such a setting two video streams are transferred in parallel, one containing the instructor, and the second one the presentation the instructor make up at the digital blackboard.

The company must interconnect a digital blackboard, a projector, a videoconferencing system with 1-2 microphones, a document camera, and a PC in order to offer real time transfer of production and design knowledge from company to contractor. The contractor needs one videoconferencing system with 1-2

microphones, and two monitors or projectors. The video conferencing systems are interconnected through the IP network. It is not required to use a firewall between the video systems.

The video conferencing system, the digital blackboard and the document camera must be installed in such a way that they display efficiently all kind of technical drawings, i.e. figures that may contain a lot of details. In order to handle that, it is necessary to use a solution that easily enlarges details of the drawings and the figures. Figure 1 displays the most convenient way of installing the videoconferencing system, the digital blackboard and the document camera at the company site. At the contractor site, the personnel will be sitting in front of two monitors and a camera.

It is very tricky for a videoconferencing system to record with sufficient quality the teacher standing besides the Smatboard, and at the same time the surface of the Smartboard. The basic problem is that the surface is very bright and reflects a lot of the light from the projector, whereby the quality of the video picture is significantly reduced. Thus, the camera must be positioned in such a way that the surface of the Smartboard only covers at maximum 15-20% of the monitor view and in such a way that the noise from the reflected light doesn't disturb the camera. The appropriate solution is shown in the pictures on the left hand side in Figure 1 and Figure 2.

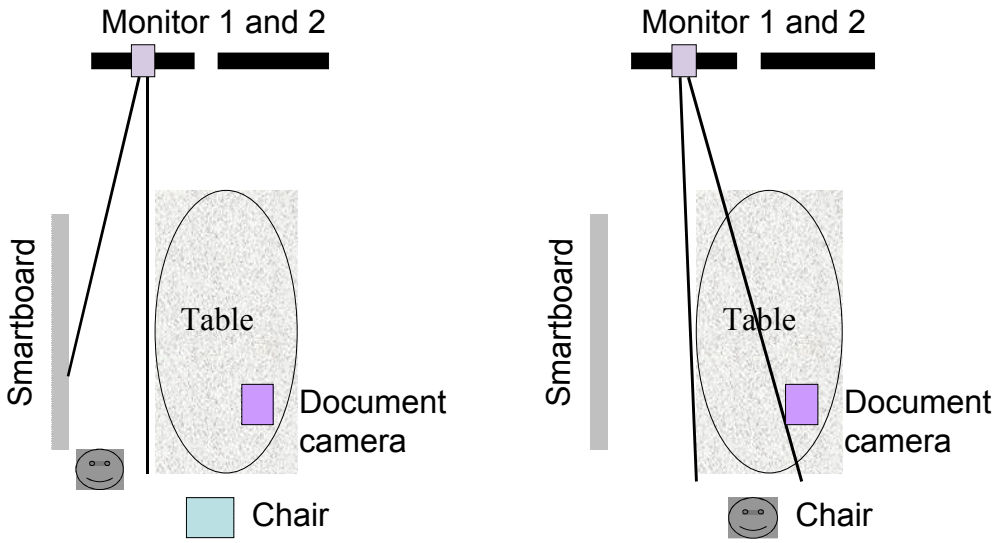

Figure 1: The teacher may either stand in front of the Smartboard (picture to the left), or sit down beside the document camera.(picture to the right). It is recommended that the distance from the camera (on top a 28"-29" monitor) to the teacher is 3.0-3.5 meters in order to maintain eye contact.

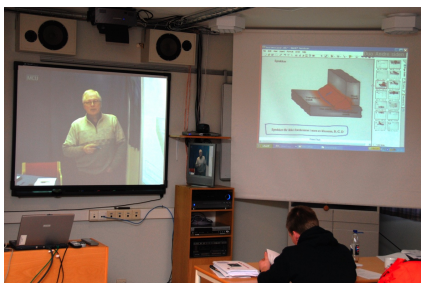

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Figure 2: State of the art use of videoconferencing and digital blackboards for just-in-time transfer of competence and know-how in Norway in 2007. The picture to the left displays how the instructor uses a Smartboard to mediate details in a welding production process drawing. The students are shown on his left monitor, while the drawing is displayed on the right one. The picture to the right demonstrates how it looks at the student site. The teacher is on the left screen, while the right screen displays the drawing.
Monitor 1 displays the picture of the students (far end site), while monitor 2 displays the picture of the teacher. If two parallel real time video streams are transferred (the teacher and his/she's presentation), monitor 2 displays the presentation and a small picture of the teacher in one of the corners. The presentation may be the Smartboard, the PC or the document camera. The teacher may use this configuration to talk and discuss with the students across large distances.

Figure 3 displays the basic chart for how to interconnect the various devices. It is important to avoid using a S-video cable from the document camera to the video conferencing system, since this will reduce the quality of the video picture. It is much better to use VGA cables. The instructor may, by using this system solution, manage to scan and import a picture (to the digital blackboard) from a drawing on the document camera within a period of 3-5 seconds, whereby it become time efficient. The system solution offers flexibility in such a way that the document camera may transfer the picture directly through the videoconferencing system. This is important, in order to maintain the just-in-time aspect of transferring competence and knowledge within a short notice from the company to the contractor. The teacher switches between the PC and the document camera by pressing the button on the switch.

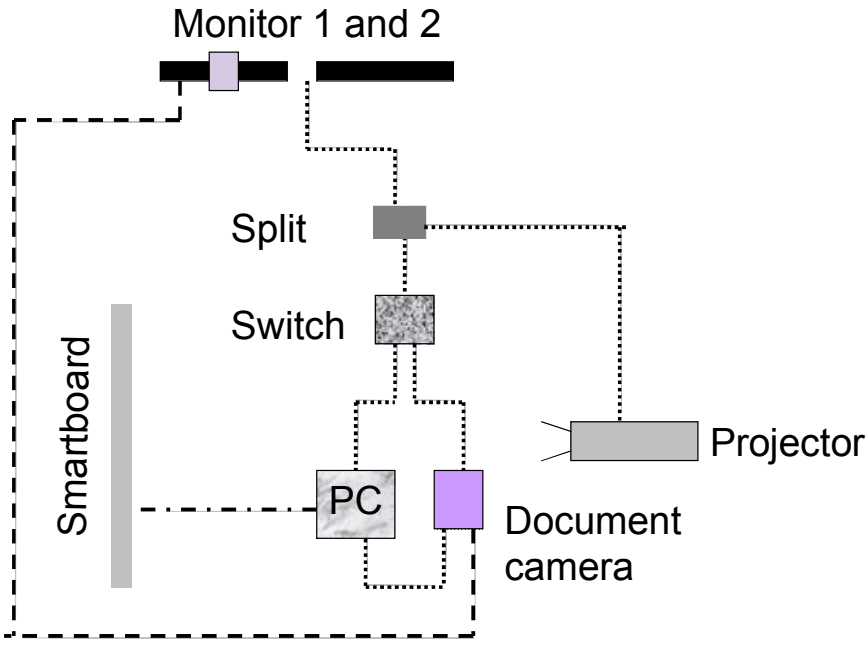

Figure 3: Interconnection of the various devices. Dotted line: VGA cable, Dashed-dotted line: USB cable, and Dashed line: S-video cable.

The Cyclic Corrective Action Method

The outsourcing process involves transferring or sharing management control and/or decision-making of a business function to an outside supplier, which involves a degree of two-way information exchange,

coordination and trust between the outsourcer and its client. Such a relationship between economic entities is qualitatively different than traditional relationships between buyer and seller of services. The involved economic entities in an "outsourcing" relationship dynamically integrate and share management control of the labor process rather than enter in contracting relationships where both entities remain separate in the coordination of the production of goods and services. Many companies outsource manufacturing and engineering. Some of the major advantages that today's organizations can expect to obtain through outsourcing include the ability to purchase intellectual capital, to focus on core competencies, to better anticipate future costs, or to reduce the costs. Overall outsourcing is viewed by many organizations as a strong business tactic that ultimately is a superior economical approach to developing products and services.

Unlike other typical skills upgrading processes utilizing on-site training and partly e-learning methodologies, the user groups may consist of all types of personnel within the organization, i.e. from the top management to shop floor level in mechanical industry. It is challenging to clearly identify only one or two groups of the staff. This yields special user requirements for the transfer of competence and knowledge. Unlike traditional and comprehensive training scenarios where the students move from item a through to z, the knowledge transfer within an outsourcing process may be very simple, concrete and limited. It may still be very complicated and difficult to perform. Some of the key issues and challenges are:

- The partners in the outsourcing process both believe that they are competent and have the required competence, e.g. formal issues like the required number of diplomas and engineering degrees.
- All partners believe that they have the knowledge for the outsourcing of the product or services.
- The partners in the outsourcing process may communicate at different levels such as for instance the management level, the financial level, and the technical level.
- The communication language used during the outsourcing process is often English. It includes both written and oral communication. However, the personnel and staff working in the company that receives the outsourcing usually require that material such as specifications, manuals, production procedures, etc. must be in their native language, whereby the knowledge level of the translator towards highly specialized production processes become critical.

Each level may include personnel from upper or middle management. Furthermore, the company cultures may create invisible barriers for open communication, thus hiding problem areas for each other. The companies involved are often at various production levels (technical, organisational, production, etc.) whereby these levels may lead to hidden agendas for obtaining effective communication. The communication through possible foreign languages may cause translation problems, or problems related to the semantic interoperability of the words used in the communication between the involved companies. Thus, the knowledge transfer itself may consequently be a delicate matter because none of the involved participants may accept that there is a need for knowledge transfer before the practical work actually starts!

The cyclic corrective action method improves and enhances the online cooperation and collaboration between international organizations. The new method help identifying the gap between formal knowledge, and the required competence! This is done my combining real time video and face-to-face communication across large distances, by addressing the following four issues in a cyclic and repeating way:

- Tools and services analyzing the ongoing real time communication process between the company and the contractor
- This is followed up with a non-conformance analysis targeting the semantic interoperability issues in technical communication
- The next step is to carry out a mapping of the required competence and existing formal knowledge, according to the needs of the company as well as the staff and their career planning
- The final step initiates corrective actions that help improving the outsourcing by using the above analysis. This includes just-in-time transfer of competence, knowledge and training elements that help closing the competence and knowledge gap.

Discussion and conclusion

This article discusses the knowledge transfer during an outsourcing process. Unlike traditional training the knowledge and competence transfer may face challenges related to semantic interoperability problems, as well as cultural dependent behavior. Lack of semantic interoperability in the communication process is one of the core problems within an outsourcing process. As a result of this, the production processes and the deliveries from the contractor are not in accordance with the company's requirements and specifications of quality. Many topics addressed during an outsourcing process depend on the industrial application and the methods used in the production process. The standard courses that are used in traditional education will not solve and close the knowledge and competence gap, since they don't handle the role of semantic interoperability. Short training sessions utilizing visual communication and collaboration tools like video conferencing in combination with digital blackboards, and industrial video streaming services, offer a flexible solution that may be developed instantly during the outsourcing job that it is necessary to carry out. The training framework offers, organizes, delivers, and deploys effective production technology transfer processes that are closely connected to outsourced production processes. The training may be transferred in a flexible way on a just-in-time basis. The selected learning design structure the training elements into small, standalone pieces that may be adapted to the various steps in the production process.

The gap between competence and formal knowledge may easily introduce production problems in the outsourcing process. Unlike traditional training the knowledge and competence transfer may face challenges related to semantic interoperability problems. Lack of semantic interoperability in the communication process is one of the core problems within an outsourcing process. As a result of this, the production processes and the deliveries from the contractor (the receiver of the outsourced production) are not in accordance with the company's requirements and specifications of quality. Several topics addressed during an outsourcing process depend on the industrial application and the methods used in the production process. The standard courses that are used in traditional education will not solve and close the gap between formal knowledge and required competence, since they don't handle issues related to semantic interoperability. Short training sessions utilizing visual communication and collaboration tools like video conferencing in combination with digital blackboards, and industrial video streaming services, offer a flexible solution that are developed instantly during the outsourcing job that it is necessary to carry out.

The recently developed Cyclic Corrective Action (CCA) method improves and enhances the online cooperation and collaboration between international companies and Small and Medium Sized Enterprises. Digital blackboards and high quality videoconferencing, in combination with new training methods that address just-in-time transfer of training elements, help closing the gap between formal knowledge, and the required competence in an industrial production process that has been partly outsourced. CCA includes 4 main elements: the communication process, non-conformance analysis, mapping of required competence, and corrective actions addressing training at the workplace. The new training methodologies offer the regulated European manufacturing industry a new market for trans-national on the job know-how competence transfer where effective, possibly remotely located in-company skills upgrading processes and mentoring/tutoring solutions constitute critical business activities within successful production frameworks.

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