Guided and Interactive Factory Tours for Schools

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Abstract. School education today aims at improving the integration of school and professional life. A popular way to provide first hand experiences to students are guided factory tours. Companies are highly interested in establishing contacts to school classes, but guided tours to factories are subject to constraints on both sides. For schools, they require organizational effort, are not easy to integrate into educational routine, and are limited to the factories within reach. For companies, guided tours for school classes are restricted because of safety issues and because they disturb the working processes. Considering these restrictions, interactive guided factory tours are a valuable opportunity, as they enable school classes to actively take part in guided factory tours via internet. This paper discusses the technical, organizational, and pedagogical requirements of guided and interactive factory tours, presenting an interaction model, a role set, a technical solution, and best practices.

1 Introduction

In most countries educational policies today aim at improving the integration of school and professional life. The German federal government for example created the program *Schule – Wirtschaft/Arbeitsleben* (school – economy/professional life: http://www.swa-programm.de) with the goal to integrate school and economy. The main objective is to give the students inside views into professional life and the economy in general in order to facilitate the transition from school to vocational training and profession. Additionally, in the knowledge society it is of high importance to share not only explicit, but also the tacit knowledge appearing in the corporate settings. But in reality, the integration of school and professional life is achieved in isolated cases only. Partly this is due to the fact that integrating work life experiences into school lessons demands considerable efforts from the side of teachers, e.g. if she wants her class to visit a factory. As a consequence, the contacts between schools and companies are loose or even non-existent; school classes will visit companies twice a year at best.

In this paper we present the concept of *Guided and Interactive Factory Tour* (GIFT) that provides schools with a valuable new opportunity. Its basic idea is to enable school classes to actively take part in guided factory tours via internet. This can easily be integrated into everyday school life and instead of requiring effort from the teachers it may even reduce their workload. Learners, among other benefits, can choose their future careers based on such experiences. For companies GIFT is an in-

teresting opportunity as well. Instead of reaching only schools from the vicinity, they can provide guided tours to schools from everywhere. In this way the learning experience can be shared more effectively and efficiently. The technology behind GIFT is not brand new – mainly videoconferencing and wireless internet. But the constraints and requirements for a widespread use of this approach have not been thoroughly researched so far. This paper describes the needs of schools and companies regarding GIFT, outlines several related efforts, and formulates pedagogical and technical requirements. Furthermore, on the basis of the developments in the Remote Accessible Field Trips project (RAFT) project, an integrated pedagogical and technical solution for GIFT is proposed. Finally some future perspectives are outlined.

2 Need for Guided and Interactive Factory Tours

The integration of learning experiences with working life is a clear goal of present-day *school* education. For instance the conference of the state-ministers for education in Germany [1] declared that "economic education represents an indispensable part of general education and therefore must be embedded in the educational assignment of schools. Economic education should be realized within school lessons, in economy- or profession-related school projects or in cooperation with external partners as e.g. companies." With respect to economic education, guided tours through factories offer an excellent possibility to familiarize the students with working life, professions and economic issues in general. But in everyday school life guided tours through factories are difficult to realize due to organizational issues. The class must leave the school for a whole day accompanied by two teachers, thus disturbing the regular educational process in the school. The transport to the factory must be organized. The factory should be within reach, otherwise the costs for transport are too high and the students will be back too late. Due to these constraints guided tours to factories are only rarely arranged. For these constraints, GIFT offers solutions bringing benefits from the school point of view:

- Schools are not limited to the factories in their neighborhood anymore, instead they can choose companies and factories according to the pedagogical need,
- As GIFT might have a duration of about 90 minutes and the students do not have to leave the school, GIFT can easily be integrated into the everyday school routine,
- GIFT requires only a minimum of organizational effort from the teacher – an accompanying teacher and organization of transport are not necessary and there are no additional regulations to comply with.

Of course, GIFT should not replace real guided factory tours, because seeing, hearing and smelling a factory in reality definitely constitutes a richer experience than taking part via internet. But due to the constraints mentioned above, GIFT can become a valuable and feasible complement.

Most *companies* are highly motivated to establish contacts with schools. Cooperating with schools offers the possibility to get in contact with future customers and workers, to improve the public image of the company and to realize corporate social responsibility [2]. Guided tours through factories are valuable concerning all these goals. Companies can demonstrate the quality of the manufacturing processes to their

potential customers. They can display attractive workplaces and professions to possible future workers, who otherwise might not get in touch with this experience. By supporting the educational efforts of schools they can show their social responsibility. But guided factory tours for school classes are subject to several constraints. Managing a high number of guided tours can disturb the production process and may present a safety risk, especially if the visitors are school students who may be difficult to control. Furthermore, only schools within a driving distance of less than two hours will take part in guided factory tours, because in most cases the students have to get back to their school the same day. For both constraints mentioned above, GIFT offers solutions bringing benefits also from the company viewpoint:

- The production process is not disturbed by visiting school classes,
- Companies can offer guided tours to schools everywhere, instead of being restricted to schools in the surrounding area,
- Companies can exemplarily demonstrate their readiness for new developments and their social responsibility.

3 Related Projects

The idea of GIFT originated in the EU-funded *Remote Accessible Field Trip* (RAFT: http://www.raft-project.net) project that was carried out from 2002 to 2005. GIFT adopts the technological development of RAFT as well as parts of the pedagogical and organizational concepts, but obviates the drawbacks. Furthermore, based on the results of the RAFT evaluation, the feasibility of GIFT, as well as its pedagogical value and acceptance in schools are assured. In this section the RAFT concepts, the relevant achievements of the project and the evaluation results are shortly described to give an insight to the fundament GIFT is based on. Furthermore, some other related projects are described shortly.

Learners like to experience the real world and to be actively involved in live events directly or at least via technologies. Field trips enable active learning experience in real world context to improve effectiveness of education. To overcome various obstacles related to their organization (e.g. accessibility and safety issues) the RAFT project aimed at establishing real time collaboration between the field trip site and the classroom. In RAFT learning is considered as a social activity and various learning theories have been taken into account, including collaborative, cooperative, situated, peer assisted, and vicarious learning. Based on them several learning *scenarios* have been developed and a range of *roles* have been identified for pupils [3]. In essence, two basic processes are supported in RAFT: data collection and annotation [4], as well as real time communication between the field and the classroom.

In practice, the field site students take photos, annotate them (with voice annotation), send them to the classroom, answer the requests coming from the classroom, and (technically) support the videoconferences with experts. The classroom students analyze the data coming from the field (photos, audio annotations, and video); they research, ask questions and make further requests to the field site students (via audio or text messaging). Additionally they hold interviews with experts at the field trip site via videoconference. Three main scenarios have been identified to deploy the system:

outdoor field trips to landmarks, indoor field trips to areas with restricted access, and guided tours where companies, museums and other institutions can present themselves to remote students and other interested people.

Several RAFT achievements are highly relevant for realizing GIFT [5]:

- *Validated set of requirements:* During the RAFT project requirements for real-time collaboration applications that should be used in schools have been raised and validated during several tens of field trips performed throughout the project. The technical requirements for GIFT are based on this set of validated requirements.
- *Roles and best practices:* Roles and best practices have been derived and validated during the field trips and have been adapted for widespread use in schools.
- *Technical system:* The RAFT system was developed for the use in schools. It fulfills the requirements of widespread use in schools, is robust and easy to use, even for primary school students.
- *Field trip experiences:* The field trips have been performed and evaluated in various educational domains and subjects. Three of these field trips went to factories.

The feasibility and pedagogical value of the highly innovative RAFT approach have been proved by an evaluation study based on more than 30 field trips with more than 400 students [6]. This experience pool is the basis for specification of requirements and recommendations that should be considered by users in order to achieve a widespread use of the RAFT system.

Beside the RAFT project, only a few projects try to realize a concept similar to GIFT. One of them is BliK [7] that enables school classes to have a *videoconference* with partners from several companies that cooperate with this project. Students can talk to trainees and instructors of professions they are interested in. BliK provides teachers with detailed information for planning the videoconference, e.g. concerning roles during the videoconference. But this approach does not use wireless internet connection to offer the classes a guided tour via internet and its widespread use is hampered by the technical platform that is used. BliK rents videoconferencing devices to participating schools. Before participating in the videoconference, the teacher must get the device and ask the technicians in his school to install it. After the videoconference she must return the device. The organizational effort is high and BliK is restricted to areas where its infrastructure is available for renting the equipment.

Some companies offer *virtual guided tours* [8]. In comparison to GIFT their main disadvantage is the missing interactivity. The user can navigate round the factory, but there is no contact partner at the other side. Furthermore, virtual guided tours lack authenticity, because they do not show what is happening right now.

4 Requirements Analysis

While the basic idea and the advantages of GIFT are obvious, it is not trivial to successfully realize these tours. In comparison to movies or broadcasts, the unique selling proposition of GIFT is the possibility to interact with the guide at the factory. If the interaction succeeds, it can lead to an active and satisfying participation in the proceedings of the tour. Thus highest efforts have to be taken to induce and sustain a fruitful and satisfying interaction between the classroom and the factory staff. Fur-

thermore, if factory guided tours want to find a broad audience in schools, their pedagogical requirements, organizational and technical constraints must be considered. Finally, the organizational and technical constraints at the factory site must be taken into account as well.

In the RAFT project, students always were present at the field trip site and were actively cooperating with the classroom from there. Thus from the pedagogical point of view the collaboration of students at different sites was at the core of the RAFT project. But the fact that there are students at the field trip site who actively cooperate with students in the classroom implied some drawbacks that disabled the widespread use of RAFT despite its obvious pedagogical value:

- *High organizational efforts:* For preparing a RAFT fieldtrip, the teacher must check the technical feasibility at the field trip site, mainly assure the internet connection. Furthermore, as there is one group at the field trip site and the other group in the classroom, transport must be organized and the groups at both sides must be accompanied by a teacher. Therefore only technically experienced and dedicated teachers will be ready to run RAFT field trips regularly
- *Accurate preparation:* To realize satisfying collaboration during the field trip, the students must be properly prepared for the roles they will take over during the field trip and the field trip situation must be tested before. This again requires more skills and efforts from the teacher.
- *High price:* RAFT field trips require the use of expensive equipment for the field-trip site, as e.g. tablet PCs and 3G-cellphones. As schools will not afford to buy this equipment, it must be rented somewhere – requiring even more organizational effort and a RAFT infrastructure that is costly to maintain.
- *Questionable quality of transferred data:* Even with training, the students are not professionals and may even disregard requests from the classroom due to their fascination with the field trip site or the technique they work with.

GIFT in comparison is less ambitious. Instead of collaboration of students at different sites, the students participate remotely in proceedings at the factory site. This setting clearly avoids the drawbacks of RAFT:

- *Simple organization:* The teacher needs just to book the GIFT.
- *Minimum student preparation:* To ascertain widespread acceptance, the setup of GIFT will be as simple as possible for school classes.
- *Low costs:* As companies have an interest in a high acceptance of their GIFT, they will not charge excessive fees for schools.
- *High quality of data:* At the factory professional staff is involved.

In general, GIFT attempts to adopt the positive results of the RAFT project, like the validated technical requirements, the technical system as well as the roles and best practices, but avoids the drawbacks.

4.1 General Requirements

Considering GIFT, there are several requirements that are quite general – especially those related to videoconferencing, interaction, and authenticity. GIFT mainly consist of a *videoconference* with two conferencing sites, the guide at the factory and the students in the classroom. The use of videoconferencing in school education has been re-

searched in depth so that guidelines and best practices have been developed [9]. There are comprehensive and easy to read best practice guides for the use of videoconferencing in schools [10]. The research and the best practices assume that the participating partners are ready to invest in acquiring at least some expertise in videoconferencing, concerning both the correct use of technology (e.g. the microphone) and higher level best practices (e.g. aiming at establishing an equal interaction). But in the GIFT scenario this cannot be expected from the classroom side. To achieve widespread acceptance, the barriers for classes to attend GIFT should be as low as possible, both in terms of technology and in terms of preparation. The goal should be to deliver a satisfying experience to the students and the teachers, with only the minimum of previous training. Otherwise only teachers with expertise will embrace GIFT, while the others – especially older and technology-anxious teachers – renounce this offer. Thus the technology and the concepts of virtual guided factory tours must aim at delivering a satisfying interaction in a videoconferencing situation, where there is one highly experienced participant (the guide in the factory who should get explicit training) and a group of inexperienced participants (the students and the teacher). Given the asymmetric situation of the videoconferencing partners in GIFT, there are serious hindrances on the way to a satisfying interaction. As students and teachers are unfamiliar with videoconferencing, they may feel uncomfortable, dissatisfied and thus resile into a passive attitude. Furthermore, due to their experiences with common guided tours, the students may feel uncomfortable to interrupt the tour guide. This undesirable reluctance will even be increased by the unfamiliarity with videoconferencing. Finally, as observed during RAFT field trips, students often have a false impression of their role during interactive guided tours. Given their experiences e.g. with films shown in school lessons, they have to be taken out of their passive and merely receptive role.

The possibility to *interact* with the guide at the factory is the key idea of GIFT. Interaction must be engendered and sustained in an asymmetric videoconferencing situation, where one professional participant (the tour guide) faces a group of inexperienced participants (the students and the teacher). Thus a videoconferencing interaction model should be created, that allows the tour guide to continuously challenge interaction from the classroom and that lowers the interaction barriers for the classroom students. The desirable activities of the classroom students are asking questions and sending requests to the factory staff. These activities must clearly be supported and facilitated by the communication tools and by the setup of the interactive guided tour. Interactive guided tours require an accurate interaction design that ensures the active participation of the students. It is the tour guide who is responsible to take the lead (Fig.1). The students on the other hand will pick up the challenge and thus gain self confidence and experience in videoconferencing situations.

In common guided tours the participants have to some extend the possibility to control and steer their experience of the tour. They can look around for interesting items, they can take a close look at such items, and they can even abandon the guided tour for a few moments to investigate on their own. These possibilities are quite restricted by the web based data transfer. The view the students in the classroom get is determined by video delivered via the camera. Here the “stage direction” must provide possibilities to give the students at least partial control about what they see. GIFT should engender the *authenticity*, the feeling of “being there”. In common guided tours it implies that the participants see, hear, smell and feel their environ-

ment. Furthermore the environment stimulates emotions in them and they perceive how they move in the environment. Only seeing and hearing are directly supported by the web based communication; the tour guide should try to compensate the others.

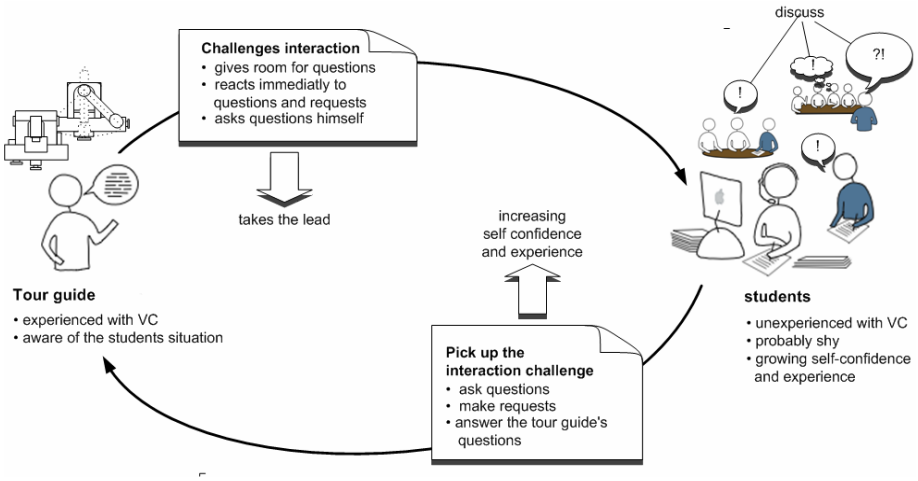

Fig. 1. Asymmetric videoconferencing situation during interactive guided factory tours.

4.2 School Requirements

For schools GIFT can constitute a feasible possibility to familiarize the students with the work and the production cycles in factories. To find widespread acceptance, it is necessary to take into account the requirements that schools have both at the pedagogical and technical level. GIFT must be connected to the relevant topics in *curricula*. While the specific possibilities of integration into curricula are dependent of the company and the products they manufacture, a connection to higher-level curriculum topics can in most cases be achieved. This will be demonstrated with two examples for the German secondary school curricula [11]:

- In classes 8 and 9 *occupational orientation* is a topic of paramount importance at all secondary schools. The topic is being discussed in social sciences, German and in the foreign languages. Occupational orientation offers a perfect starting point for a set of GIFT.
- In class 10 *humans and technology* is an interdisciplinary topic that is treated in social sciences, German, foreign languages, biology and art. GIFT can describe the relationship between humans and technology in factories, where the balancing of the relationship between human workers and technology is critical.

Furthermore in natural and social sciences virtual guided factory tours could take over an important role. During the factory tours, the students can see and experience what they have learned in theory before.

From the *organizational* point of view, to achieve widespread acceptance, GIFT should be simple to integrate into everyday school life – this is one of their main advantages in comparison to common factory tours that usually take a whole school day.

That means that GIFT should not be longer than 90 minutes (i.e. two school lessons) and classes should be able to participate with a minimum of standard equipment. Furthermore the planning for GIFT should be as simple as possible. Only simple steps should be required:

- The teacher signs up for a tour (via telephone or via e-mail),
- The teacher gets the relevant information (via e-mail),
- The teacher tests the applications a few days before the tour,
- The teacher connects to the guided tour 15 minutes before the tour starts.

Finally, GIFT should be for free or only a nominal fee per student should be charged. Otherwise teachers might run into difficulties justifying the need for the GIFT to the parents who have to pay for it, thus decreasing the number of teachers and students who are ready to participate.

The *technical* requirements for GIFT are derived from the technical requirements for the widespread use of the RAFT system [5]. Low technical barriers are an indispensable requirement for the widespread acceptance of GIFT. Most of the teachers who are interested from a pedagogical point of view (e.g. social science teachers) often do not dispose of high-level ICT competence. And even if they do, a demanding technical preparation of the factory tour would discourage them, given the high workload and the tight schedule teachers in general have. In detail, the system supporting GIFT should comply with the following requirements.

Reliable audio: Audio is the backbone of communication between the factory and the classroom. If the audio communication fails or deteriorates, the collaboration fails, leading to frustration and the feeling of being cut off in the classroom. Therefore reliable audio is even more important than having permanent video. GIFT is often employed in situations that make good audio quality difficult. In the factory there may be high level background noise, in classrooms often a microphone and loudspeakers are used. In common video conferencing systems this would lead to serious disturbances of communication on the field trip side, because the users there would get an echo.

Standard plugins: The need to install software constitutes a high barrier in schools, since most teachers do not have the right to install software on school computers – thus complicating the process of getting started. Installation is even a more serious problem at field trip sites. Here security issues are the main concern. Due to these problems, the application must be browser-based, using only standard plugins.

Avoiding firewall problems: Schools have very different and quite unpredictable firewall configurations. Requiring firewall changes would significantly reduce the number of schools who can participate, because the processes of network administration in schools are often complex and tedious. At the field trip site, the firewall issue is even more important, as companies can hardly be asked to adapt their firewalls for educational purposes.

Avoiding proxy problems: Schools often use proxy servers to handle the data transferred to and from the internet. Proxy servers hide the IP-addresses of clients – but for many videoconferencing solutions IP-addresses are necessary.

Platform independence: In schools, different platforms are used both on the client and the server side.

Acceptable performance: Schools often do not have the financial clout to buy up-to-date hardware and operating systems, therefore mediocre hardware and outdated operating systems have to be considered too.

Scalable bandwidth consumption: Schools often have to share a common DSL internet connection for all classes, thus a broadband connection cannot be guaranteed. Furthermore, the bandwidths at the field trip sites may be unreliable. Fixed bandwidth consumption would either make some field trip sites and some schools inaccessible, or would lead to low video quality, despite of the high bandwidth available.

4.3 Factory Requirements

The tour guide in the factory should be able to move freely while being in contact with the students and transferring video into the classroom. Therefore she needs wireless audio connection and a portable device with a camera connected. Additionally, to create authenticity it must be possible to show the tour guide to the students while she answers questions from the classroom. So two employees are the minimum required staff for running GIFT: the *tour guide* and a *technical assistant* who is responsible for the camera(s) and for the technique in general. But considering the costs of the tour, not more than two employees should be engaged. Given the need to move freely, the tour guide must connect to the internet wirelessly. But even if the factory disposes of a WLAN infrastructure, it often cannot be used for interactive guided tours due to data security restrictions. Therefore the applications should be scalable to either WLAN or 3G internet connection. A major obstacle may be objections by the worker council due to privacy issues of the factory employees. For example, in Germany, photographing or filming employees during their work requires the written consent of the worker. This is difficult to achieve in factories with hundreds of workers.

Due to image awareness most companies will not be ready to deliver mediocre *video quality* to the outside world. Furthermore for many procedures in factories, especially for the most interesting ones, detailed views are necessary to really get an impression, e.g. for robots in a car assembly line. Therefore high video quality is an important issue.

5 Solution

The aim of GIFT is to develop and adapt a suitable technical solution based on sound organizational and pedagogical concepts. Technical, pedagogical, and organizational developments are obviously interconnected with each other. The technical implementation has to take into account the pedagogical and organizational requests, while the corresponding developments must consider the technical constraints of GIFT.

The current research and development at Fraunhofer FIT focus on a prototype for GIFT that will be implemented at the Volkswagen factory and is being developed according to the requirements of the Volkswagen visitor center in Wolfsburg. This prototype based approach opens up the possibility of development in realistic settings. As the settings at the Volkswagen factory and the requirements of the visitor center are not unique, the results can be transferred to factories in other sectors of industry too. The Volkswagen factory in Wolfsburg is quite large, thus guided tours span several kilometers. Visitors can take a tour train for about 40 persons and they are not allowed to leave it during the sojourn in the factory. Beside the tour trains for common

visitors there are also individual tours offered to VIPs. Up to seven persons can use a tour car (VW Touran Cabrio) driven by the tour guide. During a 90 minute tour, about seven points of interest are visited and at some of those the tour guide and the visitors get off the car to take a closer look. The driving time between the points of interest is up to five minutes and is filled with more general information by the tour guide. Obviously the VIP tours are the model that GIFT should be based on.

5.1 Technical Solution

The technical solution for GIFT at the Volkswagen factory represents a further development of the RAFT system that was created to realize remote accessible field trips for schools. As the RAFT system was developed for widespread use in schools, it fulfills all the technical requirements of schools described above. The RAFT applications offer solutions for the accessibility and audio quality demands of schools and for the network access requirements in factories. The technical solution of the RAFT system has been described in detail in [5].

Simple accessibility: To meet the accessibility requirements of schools, the GIFT system uses the Flash Communication Server as a communication backbone. On the client side, only a browser with a Flash-plugin is needed. This ensures interoperability and platform independence. Since schools often do not have the latest Flash plugins installed on their computers, the development is based on Flash 6.0, the oldest Flash version providing the needed communication features. Audio- and video-streaming is done with port-80-tunneling. This avoids firewall problems with all but the most restrictive firewalls and the RAFT system is always accessible as long as streaming is not blocked completely. Because the Flash Communication Server does not need to know the IPs of the participating clients, problems with proxy servers are minimized. These settings ensure that at almost all schools the GIFT system is accessible without any special installation and without additional reconfiguration of firewalls, even in cases where outdated operating systems as e.g. Windows 98 are used. The drawback of using Flash is that the GIFT system currently can not be used on Pocket PCs, because their hardware or Flash-plugins do not provide sufficient performance to handle Flash-video streaming. So at the factory, tablet PCs or notebooks must be used, which are comparably bulky. These limitations will change with hardware of higher performance and better flash plugins for pocket PCs that will soon become available.

Reliable audio: During the RAFT project several technical problems have been identified that may obstruct or even disable audio communication between the factory and the classroom. One of them is deterioration of audio quality due to low bandwidth. The Flash plugin does not give audio priority over video. So with low bandwidth both video and audio qualities go down. As observed during the field trips, the deterioration of audio quality leads to severe disruptions of the communication, because then sentences arrive in fragments that are no longer understandable. Therefore to ensure acceptable audio quality, the GIFT system is scalable and adaptable to changing bandwidths; four levels of bandwidth consumption are implemented. If audio deteriorates, then users can switch to a lower bandwidth setting, assuring that audio quality is preserved. If the bandwidth is changed by one client, it automatically

adapts for all clients, ensuring that no client pushes video streams with too high bandwidth consumption.

Echo problems have to be avoided too. In the classroom typically loudspeakers and microphones are used for audio communication. This might lead to serious acoustic feedback problems for the tour guide at the factory. To avoid this, the GIFT system works with "speaking on demand". Only one user can speak, while others have the option to interrupt him. Of course speaking on demand has an impact on the free flow of communication, but given the possible disruptions as experienced during the RAFT project, speaking on demand is still preferable. The communication flow must be assured by other technical measures and by organizational and pedagogical concepts. Generally speaking, this communication protocol can become very efficient when users get used to it. Additionally, it might be supported by another communication channel – text chat.

Network solution: In the factory GIFT can be used either with WLAN or 3G internet connection. Thus it is up to the specific factory to make a choice considering WLAN infrastructure, data security issues and 3G coverage. To give an example, internet access can be delivered by 3G-WLAN-Routers, which are provided by cellphone companies. They offer the necessary flexibility and establish a high speed access to the internet. Fig. 2 shows a different network solution, using 3G cell phones for data transfer.

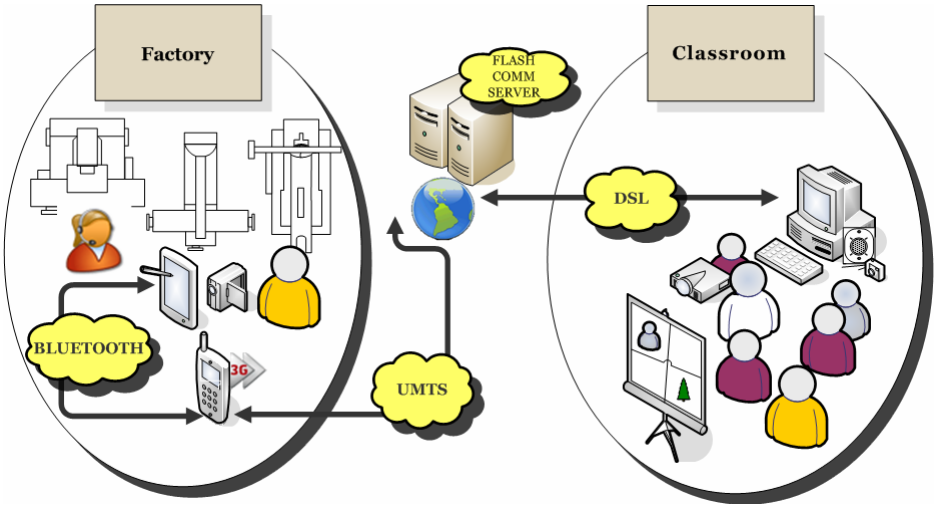

Fig. 2. 3G-based network connection for interactive guided factory tours.

5.2 Setup in Factory

The goal in the factory is to create an application that enables interaction and authenticity without hurting the technical constraints and without overstraining the capacities of the staff involved. Both the technical development and the best practices depend on the roles of the staff. Therefore the setup in the factory will be derived from their roles. As stated before, two roles at the factory will be involved in GIFT, the tour

guide and the technical assistant. The *tour guide* is responsible for the communication with the classroom. It is his duty to stimulate the interest and interaction with the classroom students. Furthermore she has to drive the tour car, at least in the envisaged prototype in the Volkswagen factory. While the tour guide can focus on the (audio-) communication with the classroom, the *technical assistant* has a wide range of tasks to solve. He must ensure the functionality of the equipment and the net-connection. Furthermore, he has to adjust the audio (volume, background noises vs. the voice of the tour guide) and the video (sharpness, general view vs. focusing on details or the tour guide) settings. In doing so he must try to provide the classroom students with a clear view of the proceedings in the factory, support the interaction (e.g. by immediately reacting to requests for detailed views) and create authenticity, e.g. by showing the location of the tour guide in the environment of the factory. All together the technical assistant could easily be overwhelmed by the tasks he has to solve. Therefore the technical and organizational setup should facilitate the tasks of the technical assistant as much as possible. The GIFT system will encompass the following audio and video recording facilities:

- *Audio:* A microphone for the explanations of the tour guide, a second microphone for the surround sound, that is highly important for creating authenticity. The activity of the microphones can be switched by the technical assistant. Both the tour guide and the technical assistant receive audio from the classroom via headset. To maintain the mobility of the staff, the headsets are connected via Bluetooth to the computer in the tour car.
- *Video:* A fixed camera for the front view and a turnable camera to show the view to the sides. Both these cameras are attached to the tour car, providing a steady view and simplifying the technical assistant's task. Furthermore a third camera is attached to a tablet PC allowing the technical assistant to leave the tour car, to walk to places of interest and show them in detail.

As described before, engendering and sustaining *interaction* and creating the feeling of *authenticity* is paramount to GIFT. To achieve both goals, a suitable tour setting has been developed. To give the classroom students the feeling of really participating in a guided tour, their "eye", the camera, is seated behind the driver. This creates authenticity by simulating the guided tour situation: The students "sit" in the car, seeing the car and the driver/tour guide while the car moves forward. Furthermore this setting offers clear advantages in regard to interaction.

While driving and explaining what the classroom students can see, the tour guide is always present to the classroom students. They see her explaining and can even have eye contact with her via the review mirror. From the interaction point of view this situation conveys the message to the classroom students that they may ask questions, but that looking at the surrounding factory and listening to the explanations of the tour guide are the principal expected activities.

The situation completely changes when the tour guide stops the vehicle and turns round to camera. It immediately becomes clear to the students that now they must definitely leave their passive situation and interact with the tour guide. The tour guide can enhance this situation change be requesting questions from the classroom or by asking some questions herself.

These two interaction situations should also be created when the tour guide and the technical assistant leave the car to show something, e.g. a machine in detail. First the

machine is displayed, while the tour guide explains, then the tour guide is shown in front of the machine, requesting activity from the side of the students just by changing the situation. Thus during the whole tour explanation phases and interaction phases alternate and can clearly be distinguished by the classroom students, giving them orientation and self-confidence in the unfamiliar videoconferencing situation.

Interaction should also be supported in explaining situations. The students may have urgent questions, but due to the situation they will feel awkward to put them forward, because this means disrupting the tour guide. To enable interaction here, technical support is deployed – the students can push a "question"-button. The tour guide is adverted by an audio signal – she can finish her sentence and then request the students to ask their questions.

In large factories there may be several driving periods from one point of interest to another. Due to the low speed these driving periods may last up to five minutes. Instead of trying to fill all the driving periods by providing explanations, they may partially be used to support interaction in a different way – the tour guide explains to the classroom that she now has to drive for several minutes and that she will switch off the sound in between. She advises the classroom students to use the time to discuss internally and to formulate questions that she will answer as soon as she comes back.

5.3 Setup in School

To enable widespread use, the setup in schools must be as simple as possible and should not require unusual organizational efforts and technical know-how. The *hardware requirements* are very basic:

- PC with broadband internet connection,
- video projector,
- headset (or microphone),
- loudspeakers,
- webcam is recommended.

The technical system should be tested several days before the factory tour. To facilitate the preparation, roles and best practices should be reduced to the minimum that is necessary to establish a satisfying interaction between the classroom and the factory staff. From the experiences of the RAFT project the following essential *roles* have been derived:

- *Interviewer* leads the interview with the tour guide, makes requests, and asks questions. Of course, other students may directly ask interposed questions, but the interviewer is mainly responsible for the communication. The interviewer should dispose of high communicative competences.
- *Technical assistant* cares about the technical quality of the transmission, e.g. adjusting the volume or the webcam. If there is a question from the classroom he notifies the tour guide via audio signal.
- *Requests gatherer* collects questions from all students and transfers them to the interviewer in a sequential order. Thus she relieves the interviewer from the organizational effort of deciding which question to ask first.

More detailed role sets have been put forward [12, 13, 5]. These role sets lead to the involvement of more students in the classroom and thus to richer interaction. They

may be offered to school classes, but their use is not imperative. As described before, mainly the tour guide in the company is responsible for engendering and sustaining satisfying interaction.

But nevertheless, some basic *best practices* should be followed by the interviewer. She should try to ask short and precise questions and she should inform the tour guide in case the class needs some time for internal discussion, as the tour guide may not be aware of this and may want to continue. Furthermore, she should command the courage to interrupt the tour guide, if the tour guide does not react to the "question" signal sent by the technical assistant. During the guided tour the teacher may take over the role of the requests gatherer or retreat to the role of a spectator. Therefore GIFT realizes the rare situation that the deployment of advanced technologies makes life easier for teachers instead of complicating their tasks.

6 Conclusion and Outlook

GIFT are a highly innovative concept for giving students inside views in professional life and the economy. They represent a solution to the needs and constraints of both companies and schools. Based on the experiences and the technology of the Remote Accessible Field Trips (RAFT), a validated set of requirements, a technical system, an interaction model, roles and best practices were developed. They enable school classes to take part in GIFT without effort and the tour guide in the factory can deliver an authentic and interactive guided tour experience. Given the experiences and the evaluation results of the RAFT project, the feasibility of GIFT and their pedagogical value are sure. As GIFT are easier to realize for schools and as their reach is not limited to factories in the vicinity, they can be a valuable complement to traditional guided factory tours in practice.

Due to the fact that there are no students at the factory site, GIFT is definitely more feasible and more widely applicable than RAFT. But having no students at the factory site may entail disadvantages from the pedagogical point of view: In RAFT field trips, having students at two sites cooperating induced a high level of responsibility and self determination concerning the learning process. The students were involved in the field trip planning and were responsible for the organization and communication at the runtime of the field trip. Thus having successfully achieved a RAFT field trip filled them with pride and self confidence. Furthermore, by establishing and maintaining efficient remote communication via video conference, in RAFT the students were able to greatly improve their communicative and organizational skills. Finally, seeing their peers at the field trip site provided the classroom students with a high level of authenticity. After the field trip the students were then able to exchange their experiences at the different sites, leading to further reflection of the field trip topics and the communicative experiences. By contrast in GIFT, the responsibility and self determination of the students is reduced, because in GIFT the tour guide at the factory takes the lead and is responsible for the tour proceedings. Having a professional tour guide in the factory, the communicative skills of the students are less challenged and less important for the success of the tour. That is the pedagogical price for the feasibility, the effortless organization and the broad reach of GIFT. It is not yet clear, whether the

less demanding setup of GIFT leads to lower acceptance rates among students. This will be evaluated during the prototype testing.

A prototype of the GIFT system is planned to be tested this autumn at the Volkswagen factory in Wolfsburg. The tests will be evaluated in regard to technical and organizational feasibility as well as student and teacher acceptance. If the tests are successful, Volkswagen visitor services will implement the system. In the near future improvements in 3G connection, in internet connection of schools, and in wearable computers will further enhance the feasibility and technical quality of GIFT. Then also other institutions (e.g. museums, historic sites) may adopt the GIFT concepts and technology.

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