Chapter 6
Employee Training Programs for Small- and Medium-Sized Manufacturing Enterprises

Angelina Iakovets, Michal Balog, and Stella Hrehova

6.1 Preparing of Employees

6.1.1 Introducing

The development of engineering and technology always requires retraining of the workforce, therefore, to investigate the effectiveness of teaching methods and organize training courses for employees is the task of all enterprises and schools. The research had shown that a lot of secondary and high schools actively apply and implement the latest technology and equipment for the training and education of students. On another hand, schools cannot prepare students for real specific conditions of every enterprise, therefore, the graduate will be instructed again, according to the specifics of the enterprise. One cannot reject the fact that a pretrained student, especially a young one, will easily and quickly perceive information than a adult and unprepared one. That is why it is important to turn to the modern trends of personnel education and training.

In a recent study by BambooHR, the importance of onboarding was clear. Losing a newly hired employee costs nearly two times the employee's annual salary in wasted hiring and rehiring activity.

Effective onboarding is not just the responsibility of HR, managers must also take an active role. Survey respondents said they wanted more time with their hiring managers during onboarding and identified some common ways companies could improve in their new hire processes [1].

A. Iakovets (✉) · M. Balog · S. Hrehova
Faculty of Manufacturing Technologies with the Seat in Presov, Technical University of Košice, Prešov, Slovakia
e-mail: angelina.iakovets@tuke.sk

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One of the main directions of every manufacturing enterprise is not only the implementation of the newest technologies but also reducing the production cycle as well. The main tools for reducing production time and time losses are:

- improvement of technology
- the use of more productive equipment, tools, and technological equipment
- automation of production processes and the use of flexible integrated processes
- specialization and cooperation of production
- organization of in-line production
- flexibility (multifunctionality) of staff
- trainee programs for stuff
- controlling the processes and machines
- many other factors affecting the duration of the production cycle.

6.1.2 Staff Training Approaches

Each manufacturing enterprise has its own special technology and equipment, which accordingly directly affects the type of work performed. Thanks to such features, the training of personnel for a certain type of work is often carried out directly at the enterprise or the training centers of the enterprise.

Small- and medium-sized enterprises often cannot afford to develop preparatory course programs and open training centers. Despite the size of the enterprise, it is important not to stop the production process, therefore it is essential to develop training courses for personnel rationally to ensure a reduction of production downtime associated with this.

A lot of managers and scientists continuously study trainee programs for manufacturing enterprises. Dr. G.S. David Sam Jayakumar and a group of scientists in their research say that all tests confirm that: “strategic goals and mission of the organization are to continuously improve the training and development system” [2]. This idea is especially relevant since it is very important to motivate employees to develop and be adapted to all technical innovations.

Referring to existing research and forecasts of specialists in this industry, it is obvious that most of them see the future for new technologies that will be widely used for staff training. Personalized learning will boom in 2020, thanks to the ability of artificial intelligence and machine learning to assess a learner’s needs and offer customized learning content, predicted Celeste Martinell, vice president of customer success at BenchPrep. A Chicago-based company, BenchPrep works with large training and credentialing organizations to improve the employee learning experience [3].

Also, Martinell said: “There are a number of companies that are employing recent graduates, paying them salaries and providing benefits to train them in the latest technologies, development or data science skill sets, and then staffing them at their client sites. They also provide ongoing professional coaching for them so that their

clients are confident they are receiving a high-quality employee, albeit a contract employee. It's an innovative model that removes a lot of the friction in the education and training space" [3]. According to the quotes presented, it becomes obvious that specialists understand that using the latest types of training is more suitable for the young generation, recently graduated from institutes.

Employees have to be trained in new technology in automated manufacturing facilities. They always won't have the time for classroom training due to their regular work.

"Myautomation solutions's" representative Lavanya, says that augmented reality (AR) and virtual reality (VR) technologies are improving training programs in plant facilities and bridging the skills gap with more efficient training for the incoming workforce—training new workers at 30–40% more efficiently and reducing assembly time. Also, advancements in AR for creating and documenting work procedures for training have shown a 37% reduction in time spent training and a 75% reduction in time required to document work instructions [4].

Introducing such technologies into the learning process, it is noteworthy that the equipment is expensive and requires a specialist for creating and maintaining such systems. Not every small- and medium-sized enterprise that does not have enough financial resources for such investments and also has a small group of permanent staff will not be able to implement such a technology. It is also worth considering that such enterprises often take students and temporary employees during the seasonal growth of orders, and then the speed and quality of training of such personnel is especially important.

6.2 Solutions for Small- and Medium-Sized Enterprises

6.2.1 Selecting Criteria for Employees Preparing

Due to the fact that technology is rapidly developing, knowledge very quickly lose relevance, therefore, it is important to maintain the level of knowledge required in the labor market. Since the whole world is in crisis due to the coronavirus pandemic, this factor should also be taken into account.

To justify the need for personnel training courses, one should turn to the existing problems:

- loss of knowledge due to quarantine compliance
- a decrease in the relevance of acquired knowledge due to unemployment
- lack of practical implementation of the knowledge gained due to lack of work experience in a certain working position.

For the experiment, two medium-sized enterprises were selected. Both have similar features:

- number of permanent production employees up to 50 people

– mass production, which depends on the season
– in the season of a large number of orders hires temporary staff
– the age group of production workers 25–70 years
– 1–2 employees are engaged in training and preparation
– working day lasts 8 h (30 min for lunch)
– a large range of products that constantly changing.

Geographically, the proposed studies were conducted on the territory of the Slovak Republic, so further statistical data are from the study area.

In order to choose the appropriate method of training, it is important to determine the target group of trainees.

The purpose of each state is to eliminate unemployment, therefore, training and advanced training of the unemployed. Due to the fact that both enterprises take temporary employees, it means that most of them will be from the group of unemployed.

Among all EU countries—Slovakia is in the 12th place among 24 countries (Fig. 6.1). This is a pretty good result, but do not forget that the statistics were made in February 2020. Now the situation has changed because of the virus, so unemployment will increase and the state will not be able to provide financial support for small enterprises, that were closed due to quarantine. Due to this fact, it becomes apparent that these enterprises will not be able to pay for training for their employees or even hire new highly qualified employees due to lack of financial resources.

From Fig. 6.2, it can be seen that the overall unemployment rate is 5.05% and this indicator fluctuates significantly, this is especially evident in the period starting from January 2020, when the COVID-19 began [7]. To pick up the appropriate way of training it is necessary to study a target group of future workers of the studied enterprises (see Table 6.1).

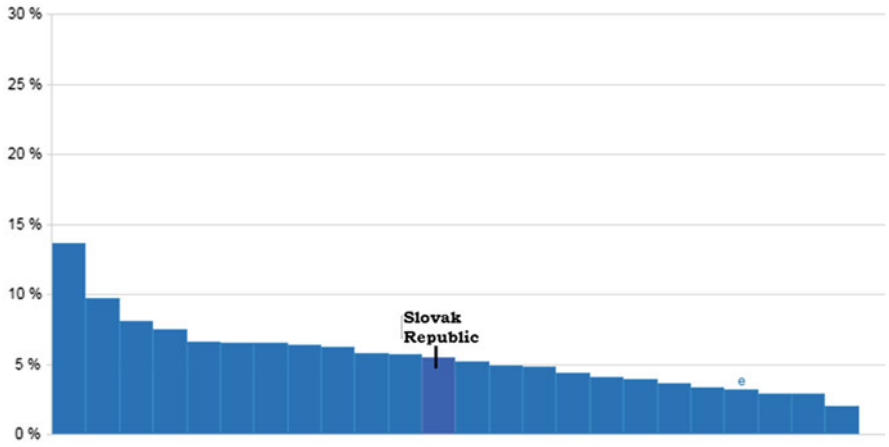

Fig. 6.1 Unemployment of EU countries 2020 year [5]

March	168865	▲	+108	5,05%

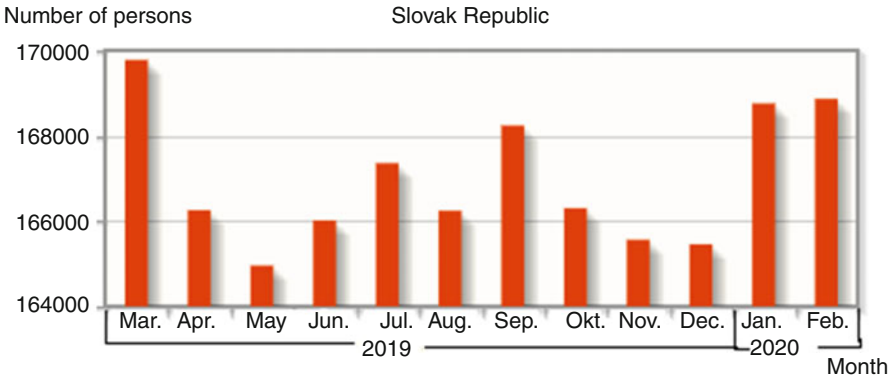

Fig. 6.2 Unemployed of Slovak Republic [6]

Table 6.1 Age structure of employed population in Slovakia [8]

People pending employment	Age groups					
	Less than 25 years		25–54 years		55 years and more	
	Less than 20 year	5024	25–29 years	18,912	55–59 years	21,042
			30–34 years	19,678		
			35–39 years	20,555		
	20–24 years	16,389	40–44 years	20,626	60 years and more	10,646
			45–49 years	19,131		
			50–54 years	18,864		
Total amount	21,413		117,766		31,688	

Table 6.1 shows that the largest number of unemployed people are in the age group of 25–54 years. Such people have long graduated from institutes and schools, therefore, they need initial training to begin to perform official duties. Since the group members have a difference in age up to 24 years, it is worth considering the level of their erudition and technical readiness when developing training programs. Programs using virtual and augmented reality for such a group of people will be difficult to perceive.

According to Gregory's theories, for most people, it is more convenient to perceive visualized information in the form of pictures, videos, as well as visual demonstrations [9]. The research of Kevin Larson of Microsoft and Rosalind Picard at MIT showed that text information is more difficult to perceive if it is not accompanied by graphic images because not everyone can focus on the text to the right extent [9]. These facts should be taken into account for design effective solutions, for investigated enterprises.

6.2.2 Practical Side of Research

Both enterprises carry out production and non-production operations. The speed of production operations primarily depends on the machine where employees make only servicing.

Nonmanufacturing operations of both enterprises include product assembly, visual inspection, technical control, revision or elimination of product defects, and packaging.

Training at both enterprises was conducted on the basis of technical documentation and drawings, where the workshop master was a trainer and showed on his example what and how to do. This approach took a lot of time for additional consultations of the employee, also it was impossible to clearly standardize processes and accurately calculate the lead time.

In order to maintain the established level of product quality and provide qualitative training seasonal staff as well as create comfortable conditions for permanent staff, it was proposed to create the appropriate type of instructions.

Based on the research of scientists [3, 4, 9] and current trends [3], the criteria for the educational material were determined:

- minimum text
- visualization of actions
- the ability to have training materials at hand
- ease of use
- with the possibility of modernization

In 2020, the most modern and relevant method of training is argument (AR) and virtual reality (VR) simulating the work processes. Such types of training are widely used by a huge volume of big corporations from all economic fields [10, 11]. According to literature resources, the price of implementation of AR or VR assembling courses will take 3–6 months, where the price of developing in Western Europe is from $80 to $150 per hour, and Eastern Europe from $25 to $100 per hour [10] (Fig. 6.3).

Such characteristics of VR application will cost $15,854 [12] but it should be noted that studied enterprises have a lot of products, which are constantly changing and adding new components will be expensive. AR assembling program will be cheapest and easier because it requires a mobile phone or tablet and a 3D model of the product. As written by Bocevska a Kotevski: “Marker based augmented reality technologies represent quite useful tools that can be used for creation of interactive visualizations of 3D CAD models. The advantages of this type of application are the opportunities to display a 3D CAD model in a real world scene, while enabling the user to interact with it in the manner of translation, rotation and scaling of the overlaid model by the simple usage of a printed marker placed in the camera viewing field. Presented visual graphics enable viewers to comprehend the core concept and features behind the design of the assembly, even if they are not from a technical background. Besides, this paper presents the possibilities to use augmented

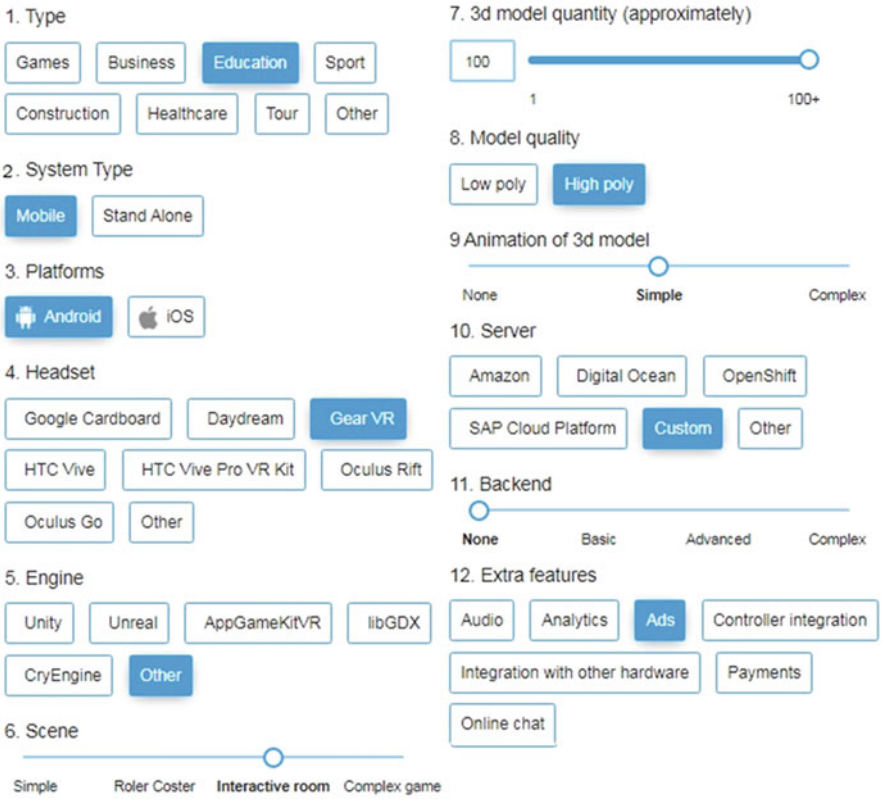

Fig. 6.3 Online calculator [12]

reality technologies in CAD assembly design supplemented with animations i.e. the possibilities to view the virtual object and its constituent parts in the real world using a marker based AR system. Such product animations also provide better overview of the final product, its performance and overall efficiency" [13].

This type of technology is very useful but it requires visual contact with object or marker and source of software as mobile phones or AR glasses—that is why it will be uncomfortable for persons with poor eyesight. If we are talking about AR glasses, it should be maintained that their workability is very poor.

In order not to demotivate the staff by setting standards, a modernization was carried out in two stages:

The first step was the introduction of photo instructions with accompanying text, where, the master explained according to the instructions and on a practical example how do this kind of job.

At the second stage, the average time of the operation was calculated. At the second stage, there was calculated the average time of each operation.

EWH [hours] = Working hours − lunch-preparing time − time for natural needs − consultations

Effective working hours (EWH) of employees were calculated in this way:

EWH = 8 – 0.5 – 0.5 – 0.5 – 1.5 = 5 h

All times for EWH were taken for a new employee and permanent staff.

Where the consultation time included the training time, time for consultations linked with work process, and the waiting time for a mater to fix the defect of the product components.

According to this calculation, multimedia instructions were made with time limits. Where time limits were equal to the average operation time for one process. Each employee in one process performed an average of five operations (exceptions occurred when a defective component appeared).

For example, an operation lasts 1 min—this means that the video animation will loop and last a minute, after which it will switch to the next operation and this will continue until the employee stops the program.

To reduce the downtime associated with training, consultation, and photo-fixing of defects, it was proposed to integrate mobile devices to combine these processes. For convenience, a tablet with a 7-in. display diagonal was chosen, which was a tool for creating instructions and as a result, became its carrier, and was also used for photo-fixing defects [14, 15].

The device's camera, a GIF Maker-GIF Editor application [16], and PowerPoint application [16] were used to create video instructions. Thanks to the simple management interface of multimedia instruction, there were no problems with switching between animations and stopping the instruction. The instruction's program window had only four buttons: wreck, back, stop, exit. GIF pictures provided an easy perception of the workflow, and comments on images replaced additional consultations. Also, the worker was able to carry out photo-fixing of defects. Testing showed reducing of downtime from 1.5 h to 30 min and waiting time from 30 to 10 min. There was a decrease in low-quality products, the pace of assembly work improved due to the fact that the instruction was always in front of the employee and the number of errors associated with negligence also reduced.

Price of such a solution was 120 euros per worker (100 euros for tablet and 20 euros for holder). Instructions design did not require special skills from the instructor and it took one week to create the instructions for an entire current product range. Another advantage of mobile devices is that the main applications for installation workers do not consume much memory and do not require a high-

performance processor, which means that the price of such devices will start from 100 euros/device.

The third stage of budget modernization of small and medium enterprises will be the use of a mobile application, where the basis for such solutions is already provided at the second stage of modernization.

The benefits of training can be summarized as:

- improves the morale of employees
- less control
- fewer accidents
- odds of promotion
- productivity increase

Functions and opportunities of mobile devices are limitless. On the third stage of modernization – permanent staff will be able to use more options of mobile devices. For example, scanning processed components (for checking how many parts were used), collect data about processes, and to get feedback from employees, reporting, and so on.

So-called mobile learning is the best ground for small- and medium-sized enterprises because it will help to provide other components of Industry 4.0. As experts in this field say: m-learning is the next step in e-learning and the future in employee training [17].

6.3 Conclusions

The main advantages of managing the plant using mobile devices are better monitoring of the workload of employees, improving the accuracy of the information, real-time shipping and order tracking, quality assurance and control, data mobilization, faster data collection, and processing. During the investigation of the problem, appsFreedom magazine found in electronic form that a regular production company prints 10,000 papers a year for one employee, which in money terms is $80 a year for one employee [18]. Properly selected programs and equipment will reduce time losses, optimize the management process, and in general, increase the level of the company in the market compared to competing companies in the market. Perspectives of implementation of mobile devices in the learning process:

- self-guided learning on worker's own schedule
- online learning when workers don't have desktop computers
- pre-training (the "flipped" model of instruction)
- post-training and spaced practice
- field-based skill demonstrations and evaluations
- on-the-job performance support
- training for employees who work remotely
- quick, nearly instant updates for employees

The use of mobile devices can reduce the time of reports, training, as well as informing employees. The phased modernization of small- and medium-sized enterprises is very important since such enterprises are very valuable to their employees and do not always have the finances for large investments in the latest technologies.

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