Integrating Companies in a Sustainable Apprenticeship System

Project 2017-1-DE02-KA202-004174

Intellectual Output 3

Train-the-Trainer Manual

Technical Development / Pattern Making

Authors: ISC Germany and ICSAS-Team

Version: Final

Erasmus+

This project has been funded with support from the European Commission.

Contents

1. Introduction

1.1. Aims of the ICSAS Project

The aims of the Erasmus+ project «Integrating Companies in a Sustainable Apprenticeship System» are to

- show ways how the existing Vocational Education and Training (VET) systems to train skilled workers for footwear manufacturing in Romania and Portugal can evolve towards work-based learning (WBL), and improve the sector-specific tutor training in Spain and Germany
- develop a sector qualification framework and the referencing of national qualifications for Germany, Portugal, Romania and Spain.

1.2. Eleven Manuals to Guide In-Company Tutors

In dual training schemes, the work-place specific know-how is imparted by skilled workers from the respective departments. As outlined in the ICSAS project application, the project consortium has committed to issuing eleven manuals, the purpose of which is to prepare designated in-company tutors in WBL for their role and provide support for the work-based learning phases of the apprenticeship. The tasks of a tutor are to

- demonstrate the operations which the apprentices are expected to learn to perform
- introduce the apprentices to each new task and supervise them during their first approaches
- accompany them as their skills are becoming more and more advanced
- guide them towards an independent performance of the task

Furthermore, each company enrolled in work-based learning shall appoint a Head of Training who is responsible for

- drawing up an individual training schedule for each apprentice (how long each apprentice will be trained at each learning station and in which order an apprentice will run through the departments – not all apprentices can start, for example, in cutting)
- assessing and documenting the learning progress of each student at each learning station

The manuals are not meant to replace a textbook. They are meant to provide support to the trainers to plan the work-based learning activities with the trainees. The workplace trainers are invited to gather more information from other sources.

1.3. Take Your Apprentices on a Guided Tour

Before you start the hands-on training in a specific department, please make sure that the apprentices have been given a tour of the entire company including all departments.

For example, the apprentices should be introduced to the types of products the company manufactures and their intended use, the different customer segments, the distribution channels etc. They should be allowed insight into the product creation and manufacturing processes, i.e. product design, pattern making, purchasing department, production planning, and all production departments to warehouse and logistics.

Point out the details of a typical shoe model which the company produces (see Fig. 1). Your trainees will better understand the complexity of the product “shoe”.

Fig. 1: Views of shoe parts as shown here can be very helpful for the trainee to understand the complexity of a shoe.

2. Technical Development of Shoes

The tangible results of a footwear designer's creative work are – at least this is still the case for the vast majority of SMEs in the footwear industry – sketches on paper or on deep draw copies of lasts. Only few SMEs in the brown shoe sector use digital tools for the design process. The situation is utterly different in the universe of athletic footwear, where workshare in global teams and speed of the development process are even more important and easier to achieve in a totally digitised process.

Deep draw copies allow for upper but not for bottom design. Designers usually select the upper material to be used. To create the respective shoes bottoms, most designers produce sketches. Alternatively, shoe bottoms can be entirely sourced from suppliers.

Fig. 2: Last and deep draw copies (in the background). Credit: ISC

Fair enough, now we have an idea of what the future shoe will look like. But how to turn a sketch into a physical product?

In most companies, the creative designers produce sketches on paper or on plastic shells. Then the footwear developers come into play: They will break down the ideas into manufacturable components that can finally be assembled to a shoe. The development process is called pattern making. It includes the digitalisation of the shoe model as well as the development of all necessary technical specifications for production.

Fig. 3: Design sketch of a men's shoe on a deep draw copy (a plastic shell). Credit: ISC / Schuhkurier

Technical development addresses questions such as: How to break down a product sketch into producible parts in the correct dimensions and with all the necessary allowances and reductions? How to create all necessary patterns and tools (cutting dies, matrices, etc) to produce the parts for a 3D object (the shoe) from 2D sheet materials (leather, textiles)? Which type of seams, reinforcement materials, linings, what type of manufacturing know-how and which operations in the production are required to translate the sketch into a product?

This document describes the organisation of the technical development in one of the companies which is part of the ICSAS consortium. This is one possibility to structure the development process – other companies may well have different internal organisation and operations.

In our example, the technical development is a division of labour between the following three departments:

- Upper Development / Pattern Making
- Bottom Part Department
- Upper Coordination

We will be focussing on the development of prototypes in size 4 ½. The important topic of grading will not be treated in this document as it would go beyond scope (the piloting phase has a duration of only one year and its main focus is on enabling the trainees to acquire skills and know-how on the production floor).

2.1. Upper Development / Upper Pattern Making

The department “Upper Pattern Making” produces the technical patterns for upper manufacturing. Their task is to break down upper design sketches into producible parts and manufacturing specifications. The footwear developers of this department collaborate closely with the designers.

Before coming to this department, the trainees should have completed the programme in the production departments (cutting and stitching) and should possess a sound theoretical background in footwear materials and construction methods. The aim of their stay in this department is to understand the development process and learn to detail various upper models of low complexity. It would be too time-consuming and difficult for the developers in the department to train them on models of the current collection because first these could be too complex, and second, their details are still being discussed with the designers.

Making a Last Shell Copy

The first thing a developer does upon receipt of a design on paper or on a plastic shell is to create a basic pattern. In order to do so, the first step is to make a last shell copy. The aim is to flatten the 3D last surface to 2D because later on in production, the shoe parts will be cut from 2D sheet materials. There are two common methods to pull the shell surface: by making a tape copy or a slotted forme.

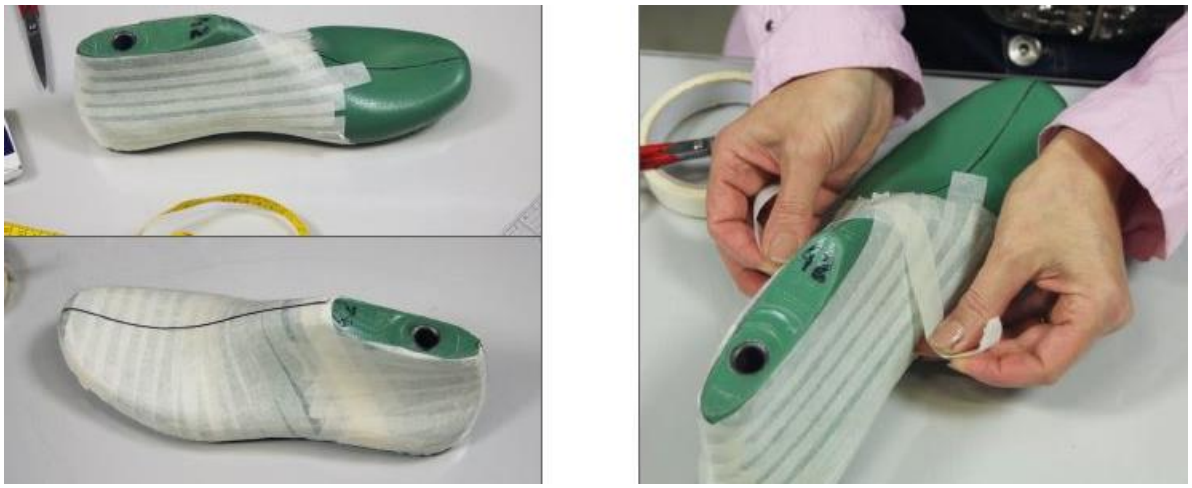

Fig. 4: Making a tape copy. Credit: ISC

Fig. 5: Another method to flatten the last surface from 3D to 2D is producing a slotted forme. Credit: ISC

The lateral and medial last copies are placed flat on the desk. Their outline shapes are transferred onto cardboard. The cardboard models are digitised. These scans can be uploaded in the CAD system to be further processed (e.g. adding allowances and reductions according to the desired construction method as well as type of seams and other joints).

Fig. 6: The lateral and medial last copies are transferred onto cardboard. Credit: Gabor

The outlines of the scans can be printed again. In these so-called “plots” the designers can specify further details of the models.

Manual Pattern Making / Pattern Development Using a CAD System

Although the use of CAD systems is standard in pattern making, learning how to make patterns by hand helps the trainees to understand the process.

Therefore, they will elaborate a basic pattern and the respective patterns for all upper leather, lining leather and interlining parts, including all necessary allowances and reductions (lasting allowance, folding edge, open edge, butt seam, French binding, closing seam etc.), marking slots and run-in points (to mark the height of folded edges) as well as centre and medial markings.

Fig. 7: Basic model which is used for training purposes at Gabor. Credit: Gabor

All patterns of a shoe model must be marked correctly (upper leather UL 1, 2, 3, interlining IL 1, 2, 3 or lining LI 1, 2, 3, etc.), checked and put in an envelope to be transferred as a work order to prototype production.

The apprentices practice pattern making by hand on various styles.

The third important learning field in this department is how to use a CAD system for pattern making. The apprentices learn how to create a model in the system and to enter the model number. There is a scheme to be followed for encoding model numbers: Season – line – group – model – version. Proficient users of the system can grasp the information contained directly from this code.

Another learning objective in this department is that the apprentices are able to retrieve last outlines in the CAD system and plot them for the designers to detail their ideas. When these plots come back from the designers, the need to be scanned again to be re-entered into the CAD system. Crosshair pointers, precisely aligned, ensure the exact same position of the newly scanned drawings.

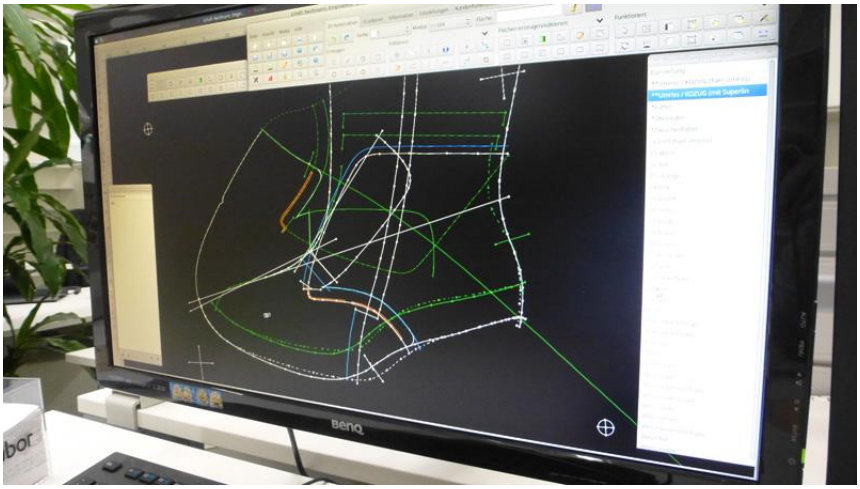

Fig. 8: Basic model in the CAD system. Credit: Gabor

In the CAD system the re-scanned plot must be uploaded in order to digitise the base lines (which the designer drafted on the plot) by setting so-called “splines” (by mouse clicks). The base lines need to be complemented by the processing instructions, e.g. by defining seam types etc.

The Pattern Making Department should have a folder with internal specifications to provide a common base for the daily work. The apprentices should be allowed access to this folder.

In the CAD system, all patterns for upper leather, lining and interlining parts are created, exactly as in manual pattern making. There is a colour code for the different lines, for example white and green for base lines, cyan for allowances (e.g. for folded or beaded edges), red for lining parts and yellow for interlining parts.

In the following, the surface areas are created. Medial side and centre are marked with notches, as well as bar points, the different seam types, folding edges, run-in points, partitions (e.g. on the tongue), marking slots (for stability reasons; the slots need to be disrupted depending on the overall length).

Finally, lift-off points are defined at critical points (e.g. sharp angles, corners) where the leather risks to tear during the cutting process. These lift-off points command the leather cutting table to lift the oscillating knife in order to change cutting direction.

Printing Patterns on a Cutting Table

In the next step all patterns are “nested”, i.e. the cutting layout is created, and the patterns are cut from cardboard on a cutting table which is reserved for the pattern making department. Once cut, they must be checked again and marked. For serial production, there will be cutting patterns, marking patterns as well as patterns for the production of cutting dies and matrices.

Fig. 9: Pattern printing. Credit: Gabor

Thanks to an export function of the CAD system, a line drawing of the model can be created and printed. This serves as a cover page for the envelope carrying all patterns of the model which is handed over to production. The model data are communicated to the production planning department to calculate material and time requirements for all operations.

If – during prototype production – questions occur (mostly from cutting or stitching room), the Pattern Making Department clarifies these issues and makes the necessary adaptions.

2.2. Bottom Parts Development

In parallel to the uppers, the bottom parts must be developed for production. Some companies develop all or at least some of the bottom components themselves, others source them from suppliers.

The tasks of the Bottom Parts Development department are

- develop and detail all bottom components (insoles, sock liners, inlay soles, outsoles, heels, heel covers, heel top pieces, wedges)
- place orders for components, check deliveries against orders, release materials

Trainees coming to this department should have completed their training in the production departments cutting, lasting and assembly and possess a sound knowledge on materials.

Introduction to the Software Systems in Use

A key competence which the trainees should acquire in this department is to get familiar with the software systems used.

Therefore, the trainees learn how to construct bottom components in the CAD system and how to add drawings and specifications for production; they follow through the ordering processes with the different suppliers.

When the designer hands over the idea sketches for outsoles and heels, and the developers will create corresponding 3D models in the CAD system to be able to print out 3D prototypes to visualise the new outsole/heel together with the last and to make further decisions.

The trainees will assist throughout the entire process.

Copy of the Last Bottom

To copy the last bottom (i.e. to create a 2D pattern), a tape copy of the last bottom is made. The tape copy is cut around the feather edge and transferred onto cardboard. The cardboard outline is then scanned, and the scan uploaded to the CAD system.

Insoles

The trainees have become familiar with insoles during their training in the pre-lasting and lasting departments. Within the scope of their theoretical instruction, they learned that the insole is the backbone of many different makes. In the Bottom Parts Development department, they can put their theoretical knowledge about insoles and insole materials into practise.

They learn how to construct insoles on the CAD system and how to generate the production specifications. They follow the process when the technician places insole orders and learn how to check incoming insole deliveries as well as how to release insoles for prototype and serial production.

Sockliners

During their training in the cutting department, the trainees learn how to produce sockliners.

In the Bottom Parts Development, the trainees get to know all the different sockliner materials (samples help to get an impression of their look & feel) and sockliner variants.

Sockliners are developed in the CAD system. The apprentices follow through the complete process from sockliner construction to order placements for sockliner cutting dies at the respective supplier. They are encouraged to place orders themselves (with the trainer supervising the ordering process). On delivery of the cutting dies, the trainees learn how to check and release them for production.

Removable Insoles

The apprentices get to know the whole range of removable insole variants. The learn how to construct removable insoles in the CAD system and how to generate the production specifications. As for insoles and sockliner cutting dies, they learn how to place orders at the supplier and how to release removable insoles for production.

Outsoles

The apprentices deepen their theoretical knowledge about soling materials (characteristics, specific requirements in terms of bonding preparation and bonding process).

They learn to distinguish different outsole types and how to create inside and outside sole edge patterns. They are present when designer and bottom parts technician review outsole prototypes (produced on a 3D printer) and eventually make changes. After the review meetings, they learn how outsole orders are placed with the supplier, how incoming soles are checked and how the bottoming technician releases new soles for production.

Heels

The apprentices learn to distinguish different heel types and how inside and outside heel edge patterns are constructed. They learn how heel covers are produced and how to cover heels. They learn how the technician places heel orders, how the incoming heels are checked and how heels are released for production.

During their entire stay in the department, the trainees have the following responsibilities:

- Hand over upper samples and bottom parts to the assembly department
- Restock packaging materials
- Take deliveries to the central warehouse

2.3. Upper Coordination

The Upper Coordination Department is the interface between design / upper development and production. All proceedings are closely coordinated with the Bottom Parts Development as well. As a rule, several upper models can have an identical common bottom.

In some companies, the upper coordination tasks are part of Upper Coordination or simply of the development department as a whole (in the latter case, usually one developer is responsible for upper and a second developer for bottom parts).

The Upper Coordination Department defines the inside of the shoe which is more or less invisible: lining, elastics, reinforcements, toe puffs, but also where to place markings (EU regulation: pictograms to define material types of upper, lining, sockliner and outsole) etc.

The department further elaborates CAD drawings created by the Upper Development Department. The files already contain the most relevant specifications (such as upper materials, colours, upper leather patterns). The Upper Coordination completes further details necessary for production, e.g. defining buckles, seams, type and placement of reinforcement materials, toe puff, dimensions, etc.

If, for example, a new buckle for a prototype does not exist yet as a CAD file, the CAD department is instructed to create a CAD drawing of the buckle and save it in the CAD dataset of the respective shoe model.

Many companies work with internal standards and manufacturing specifications, e.g. the number of stitches per cm for each seam type. The Upper Coordination Department ensures that these internal standards are applied to each model.

Trials to Define Materials

An important decision taken in this department is the determination of the most appropriate interlining material. Its characteristics must match the characteristics of the upper leather (e.g. embossed or not). The department also decides on the thickness of straps (when creating the splitting instructions), and how materials shall be skived, e.g. for lap seams (skiving = thinning out material edges to avoid double material layers which could lead to pressure points and therefore cause discomfort).

In order to determine the most appropriate interlining material, samples are produced: upper leather and possible interlining material samples are ironed together. Sometimes the upper leather needs to be split, and therefore the ideal thickness needs to be identified by making trials with different thicknesses. The trials are assessed in order to determine the ideal interlining for the respective shoe model, or the ideal thickness.

For applications such as studs, the ideal stud length must be defined (it has to match the material thickness of upper leather and reinforcing material together).

For all decisions, a variety of factors must be considered, such as the shoe type (casual / pump), specifics (e.g. heel height, how to attach decorative elements) as well as cost (material consumption, complexity and duration of each production operation).

Any potential difficulties in prototype production of the uppers (e.g. how to attach decorative elements) are reported back to Upper Coordination; their task is then to develop alternatives.

3. Assessment / Feedback Template

3.1. Introduction to Feedback Sheet

Unlike learning in formal environments as in classrooms or workshops, learning outcomes (LO) from work-based learning (WBL) in a learning station (LS) depend strongly on the actual equipment of the production line and the models and makes, which a shoe factory manufactures. If the shoe models produced do not require certain work tasks of a whole sphere (in stitching or assembly, for example), then it is simply not possible to acquire skills in this production line related to this method.

A systematic and transparent communication on concrete LOs acquired via WBL by a learner/apprentice between tutors, supporting the learner in the various departments, and the head of training, being responsible for the entire training programme, is of great importance in WBL.

With the intend to provide a concise and handy communication tool, we recommend using the matrices as shown below: They allow tracking the achievements of each trainee in each department in a quick and easy way. The matrices do not refer to any formal assessment; they simply state the degree of autonomy each trainee was able to reach within the given timeframe in each Sphere of Activity.

The matrices list the main work tasks (in bold) and the performance that can be acquired in each department. The work tasks refer to the acquired skills; to indicate that they include key competencies and knowledge the underlying elements for some of the work task are listed.

How to use the matrices: In order to give feedback on the learning progress of each trainee, please tick off the level of autonomy the learner has reached for each work task (choosing between needs assistance / needs instruction / needs supervision / completely independent).

If the work task in the matrix was not part of the training, you can leave it out or erase the work task; if additional work tasks were trained, please feel free to continue the list of work tasks according to your training goals.

In the end, the matrices will document what each learner has been able to acquire and which level of autonomy she/he has reached. And again, although this has already been said: Please bear in mind that you may have to adapt the matrices according to the processes and to the operations in your department.

Sphere of Activity: Technical Development

Work task:	Upper Pattern Making

Making a last copy;

Creating a basic model and making all patterns for upper production manually;

Creating a basic model and developing all upper patterns in the CAD system;

Digitising last copies;

Scanning plots;

Printing cardboard patterns for the production of all upper parts on the cutting table and labelling them correctly;

Asking for support if needed.

Evaluation

Needs assistance	Needs instruction	Needs supervision	Completely independent
☐	☐	☐	☐

Place, Date Signature

Work task:	Bottom Parts Development

[Please set up the criteria in this section in line with your evaluation needs according to the example given above]

Evaluation

Needs assistance	Needs instruction	Needs supervision	Completely independent
☐	☐	☐	☐

Place, Date Signature

Work task:	Upper Coordination Department
[Please set up the criteria in this section in line with your evaluation needs according to the example given above]	

Evaluation

Needs assistance	Needs instruction	Needs supervision	Completely independent
☐	☐	☐	☐

Place, Date Signature

Final evaluation (in this department)

Technical development, including all work tasks above

Evaluation

Needs further training	Can perform all work tasks (almost) independently
☐	☐

Place, Date Signature

4. List of Figures