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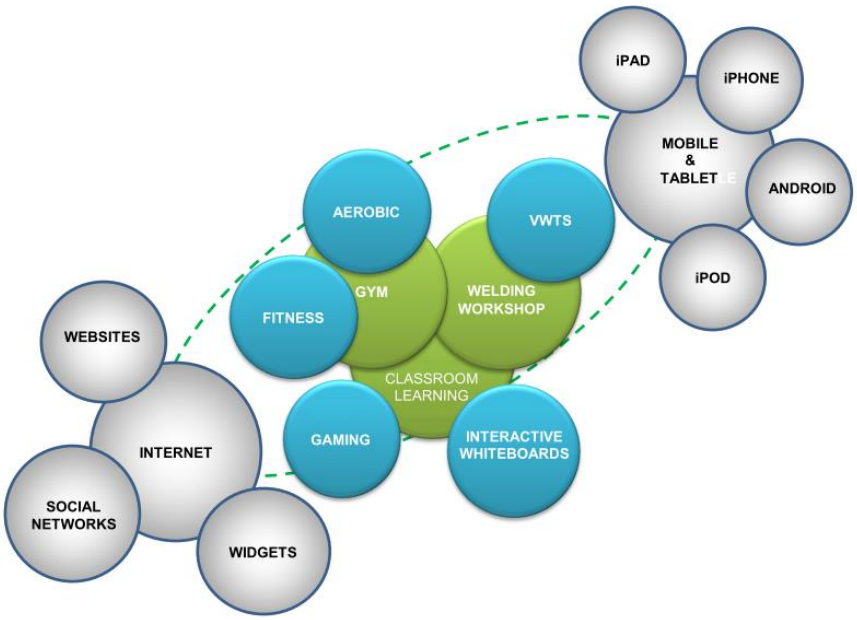


Research proposal for introduction of new methodology, teaching materials and VWTS into education and training of welding trainees and professionals

Slavonski Brod – Porto Salvo – Oberhausen – Basel – Wels - Zagreb

Introduction

S-K-S system

A two-year research helped come about an interactive training system for welders called S-K-S (Skills-Knowledge-Stability), conceived on modern educational technologies, starting from the man: student - welder and professional - welder.

SKILLS stand for acquisition of skills, i.e. mastering of welding techniques.

KNOWLEDGE stands for knowledge acquisition, i.e. mastering of welding technology.

STABILITY in the welding line of work represents the capability of frequent repetition of quality welds under demanded technology using the demanded technique in the demanded period of time on one's own or under supervision.

Capability system for beginners

CAPABILITY is an integrated education programme (learning and techniques) that precedes the S-K-S system and is of the same internal structure. It consists of teaching material, knowledge sources (media) that enable a two-way communication, assignment system that encourages the student, and instrument activities with the help of which the programme realisation is evaluated. The goal is to acquire basic capabilities to work as a professional in welding.

Teaching materials lean on the document IAB-089r4-10 Draft1 June 2010, IIW-IAB Section: "Minimum Requirements for the Education, Training and Qualification of International Welder".

Knowledge sources are partly traditional, and mainly modern, associated with Internet use, web pages with e-learning materials and welding sites. Facebook was chosen as means for communication because of its wide spectrum of possibilities for communication and immense popularity within the student population, but also because all students have mobile phones, and Facebook use is free of charge. Coordination of all activities is run via mentorship.

Assignment or activity system consists of a theoretical, practical and psychophysical part.

Theoretical system of assignments is of thematic character, and it is solved by the students in cooperation with their mentor and presented to other students in the classroom or with the help of media.

Practical assignments are divided into two types: virtual (40%) and real (60%). Virtual assignments are set by the mentor by designing the curriculum and determining the minimum threshold required for stepping to a higher level. Real assignments are defined according to the already mentioned IIW-IAB Guidelines.

Role of the psychophysical training is to raise the welder's efficiency in such a way to enable them to very specifically repeat certain moves many times in specific body positions, and to have a steady hand while doing that. In addition, this type of training helps the welder achieve stability – to be able to transfer the accomplishments from skills and knowledge training in interaction with conditioning to his work place, i.e. to optimise their work and achieve the results systematically, and not by chance. Evaluation instruments for programme realisation are: achieving of minimum goals for all types of assignments, self-control of learning results, grading of presentations based on readership rating, independent scoring on the virtual simulator and reaching of corresponding levels, as well as grading of practical assignments through methods used in evaluation of welders (e.g. EN ISO 5817). The other link in the evaluation system is grading of teachers by the students, and the third link is the feedback on employment of students and satisfaction of employers with their efficiency.

S-K-S system for professionals

Professional welders very rarely renew their knowledge and welding technique during their working life. While they work, they mostly live in a closed circle: work – attestation – work – attestation.... And one loses the technique without the renewal of knowledge and training. To constantly weld does not guarantee top-of-the-line welding technique.

Defects in welding usually come from the badly chosen welding technology or the badly chosen welding technique. If the technology is left to the welding specialists (IWE; IWS or IWT), the poor performance (technique) is, then, left to the welders.

The research has shown that welders regain their technique through training, which automatically reduces the percentage of defects.

S-K-S system for professionals is based on:

- training of welders on virtual simulator (100%) at least once a year, regardless of attestation,

- renewal of knowledge from the field of welding technology once a year,

- constant care of psychophysical condition of welders by introducing the conditioning and psychological preparation through organized professional or recreational programmes.

InteractivWeld - Research

1. Skills – VWTS (P1 – Mirta Szügyi)

Goal: to prove that through the project we can recommend:

- *For beginners: Interactive training 40% VWTS + 60% classical training,*
- *For professionals: 100% VWTS for correction of the welding technique in a specific time period.*

Research curricula for students (trainees)

Welding procedure: MAG – 135

Following trainings were conceived for the research purposes:

1. training 1 - fillet weld in PB position - 1st layer
   - without weaving
2. training 2 - fillet weld in PF position - 1st layer
   - with weaving
3. training 3 - fillet weld in PF position – 2nd layer
   - with weaving
4. training 4 - fillet weld in PD position - 1st layer
   - without weaving
5. training 5 - single V butt weld in PA position - 1st layer
   - without weaving
6. training 6 - single V butt weld in PF position - 1st layer
   - without weaving
7. training 7 - single V butt weld in PF position - 2nd layer
   - with weaving
8. training 8 - single V butt weld in PE position - 1st layer
   - without weaving

PB position should be welded in leading hand direction, the position PF neutral (90°) or slightly leading (80° - 85°).

The first layer of the V seam in the welding position PA should be welded neutral or slightly leading.

The V seam in the welding position PF should also be welded neutral or slightly leading.

Each of the trainings consists of 4 steps:

1. step: practising handling the welding gun for the purpose of correct welding speed,

2. step: practising handling the welding gun for the purpose of correct welding speed, taking into consideration the stick-out,

3. step: practising handling the welding gun for the purpose of correct welding speed, taking into consideration the stick-out and inclination angle of the welding gun

4. step: practising welding process through invariable and ideal welding parameters.

Working principle is such that you cannot move to the next step until you have achieved the minimum test score set in the curriculum (60%).

Curriculum is carried out by two groups of students in the Welding practicum of the Industrial and Trade School Slavonski Brod.

Research for the MAG welding process is done by the 2nd year students divided into 2 groups.

The first group of students are going to carry out the Interactive training - training on the virtual simulator, and then later on move to the real welding machines.

The other group is comprised of the 2nd year students whose assignment is to do the trainings on real welding machines according to the exact same concept as the Interactive training.

Welding procedure: MMA – 111

Following trainings were conceived for the research purposes:

1. training 1 - fillet weld in PB position - 1st layer
   - without weaving
2. training 2 - fillet weld in PF position - 1st layer
3. training 3 - fillet weld in PF position – 2nd layer
   - with weaving
4. training 4 - fillet weld in PD position - 1st layer
   - without weaving
5. training 5 - single V butt weld in PA position - 1st layer

- without weaving

6. training 6 - single V butt weld in PF position - 1st layer
   - without weaving
7. training 7 - single V butt weld in PF position - 2nd layer
   - with weaving
8. training 8 - single V butt weld in PE position - 1st layer
   - without weaving
9. training 9 - fillet weld, tube to plate in PB position - 1st layer
   - without weaving

Each of the trainings consists of 4 steps:

1. step: practise igniting the rod electrode at the correct tilt angle and following the specified ignition sequence – ignition attempt:4; threshold: 50%,

2. step: practise the manipulation of the road electrode at the right speed in the right position, threshold: 60%

3. step: practise the correct welding speed, arc length and correct manipulation of electrode holder at the appropriate angle, threshold: 60%

4. step: practise with fixed and ideal welding parameters, threshold: 60%

Working principle is such that you cannot move to the next step until you have achieved the minimum test score set in the curriculum.

Curriculum is carried out by two groups of students in the Welding practicum of the Industrial and Trade School Slavonski Brod.

Research for the MMA welding process is done by the 1st year students divided into 2 groups.

The first group of students are going to carry out the Interactive training - training on the virtual simulator, and then later on move to the real welding machines.

The other group is comprised of the 1st year students whose assignment is to do the trainings on real welding machines according to the exact same concept as the Interactive training.

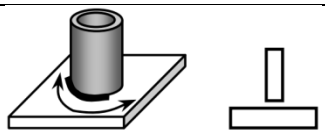
The 1st and 2nd year students studying for metalworker, as well as 2nd year female students will do the trainings on the virtual simulator and on the real welding machines at available times not later than 15/8/2014.

Welding model samples

Both groups of students will be working on identical models of single V butt weld and fillet weld in order for us to be able to compare the research results.

Table 1. Basic information on the samples

WELDING MODEL SAMPLES – MEASUREMENTS [mm]					
	Single V butt weld		Fillet weld		
	t	l	a	t	l
RW	8	300	4	8	300
VW	10	250	4	10	250
RW – REAL WELDING			VW – VIRTUAL WELDING		

No.	Type of weld	Recommended material thickness [mm]	Welding position	Sketch	Remarks
1	Fillet weld, tube to plate	t > 8 (t=10 mm) D = 100 mm Wall thickness = 8 mm	PB		1st layer - without weaving

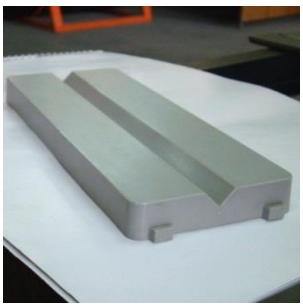


Figure 1. Sample of the single V butt weld model on the Fronius VWTS

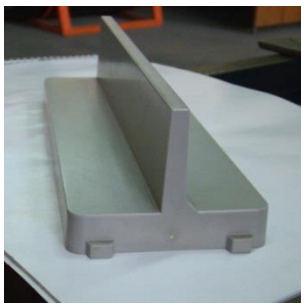


Figure 2. Sample of the fillet weld model on the Fronius VWTS

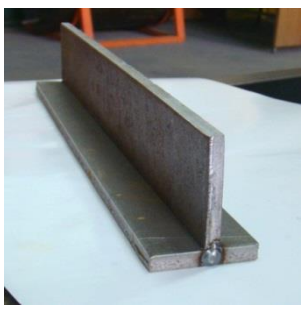


Figure 3. Sample of the single V butt weld model on the real welding machine

Figure 4. Sample of the fillet weld model on the real welding machine

Welding machines

Part of the research pertaining to real welding at IOŠ, Slavonski Brod will be carried out on 4 OrigoTM Mig 410 ESAB machines.

Part of the research pertaining to virtual welding will be carried out on Fronius Virtual Welding machine.

Filler metal

Filler metal – MMA

Basic covered electrode for high quality weld joints. Diameter = 3.2 mm.

Filler metal – MAG

Filler metal G3Si1 is non copper plated wire electrode used for MAG welding in connection with the inert gas group M21.
Diameter = 1.2 mm.

Shielding gas - MAG

Inert gas – mixture M21

Monitoring and evaluation

Monitoring and evaluation of trainees' welding competence - training on VWTS:

- monitoring and evaluation of results of the achieved welding speed, stick-out and inclination angle of the burner
- monitoring and evaluation of results achieved after the carrying out of simulation concepts
- monitoring and evaluation of the final result after the carrying out of the training

Monitoring and evaluation of trainees' welding competence - training on real welding machines:

Monitoring and evaluation of the student's practical work through 4 elements:

- insufficient penetration

- porosity
- undercuts
- a = measure (FW)

Practical assignments will be marked according to the standard EN ISO 5817.

Test criterion ISO 5817

Group B 5 Points

Group D 4 Points

Group C 3 Points

N e Not passed

The research will be conducted by 5 teachers divided into two teams. First team's assignment is to assist the students while executing welded joints on the ESAB welding machines and assigning the samples with corresponding numbers. Second team's assignment is to evaluate the samples.

Students' accomplishments will be estimated with the help of visual method.

Research curricula for professional welders

Trainings for professional are carried out for the purpose of correction of their welding technique.

The trainings are done exclusively on the VWTS (training share 100%).

The training concept on the VWTS is designed according to the company needs - Tailor Made (procedures, welded joint type, welding positions).

Time frame for the trainings in the Companies ĐĐ TEP, Slav. Brod and KMK, Zagreb is from 10/2/2014 until 15/8/2014.

Training concept on the VWTS

Training concept on the VWTS encompasses:

- initial testing of candidates on the VWTS – simulation concept (3D weld) at the level of 65%
- training of candidates on the VWTS - training concept for welds in different positions at the level of 65%
- Final testing of candidates on the VWTS – simulation concept (3D weld) at the level of 65%

Monitoring and evaluation

The monitoring and evaluation of welder's competence achieved through the training on the VWTS will be realized by:

- monitoring and evaluation of results achieved by initial testing
- monitoring and evaluation of results achieved by training
- monitoring and evaluation of results achieved by final testing
- monitoring of the training influence in real working conditions until first weld defects emerge

Additional ways of monitoring and marking will be arranged according to the needs and demands of individual companies. They will be further explained in the addendum to this document.

2. Knowledge (P1 – Željko Habek)

Goal: To research the possibility of developing a modern pedagogical-methodological and communicational education model applicable in lifelong education of welders.

Demands

1. Teaching materials lean on the document IAB-089r4-10 Draft1 June 2010, IIW-IAB Section: "Minimum Requirements for the Education, Training and Qualification of International Welder". (Welding technology).
2. Mandatory mastering of welding vocabulary in the native and one foreign language (e.g. English).
3. Mandatory mastering of the technical drawings reading.
4. Mandatory computer literacy and mobile internet usage.
5. Lifelong education.

Concept

The new concept of welding technology learning:

- For beginners: 50% formal learning + 50% informal learning,
- For professionals: 20% formal learning + 80% informal learning. In the future 100% informal learning.
- Formal learning: modules type
- 3 Forms of Informal Learning: On-Demand, Social and Embedded[1]
- New Disciplines
- New Tools and Technology

[1] Josh Bersin „Mobile and Informal Learning: Trends for 2012", Linkedin

- Learning Culture

New Devices Transforming Learning

- Mobile phone and Tablets,
- Video (You Tube)
- Platform: Android
- Games
- Consumerization: Employees expect the consumer experience they have at home at work

Research

1. Survey among students and professional welders:
- Via Facebook on https://www.facebook.com/interactivweld
- At IOS (P1)
  At Končar MK (P6) and ĐĐ TEP (silent partner)
  Goal of the survey: research into the usage of mobile phones/tablets and social networks in everyday life

2. Research into the possibility of applying the learning concept for welding technology:
- In 1.M grade (28 students) IOS (P1) from 10/2/2014 until 13/6/2014
- On professionals at Končar MK (P6) (10 professionals) and ĐĐ TEP (silent partner) (10 professionals) from 1/3/2014 until 15/8/2014

Questionnaire

1. Do you use a mobile phone or a tablet in your everyday life? (answer with YES or NO)

2. How many hours a day do you spend on your mobile phone/tablet?

3. Does your mobile phone / tablet have an Android platform? (answer with YES or NO)

4. You use your mobile phone / tablet for: (rate the following according to importance, 1 being the most and 4 the least important)
   __Games
   __social networks (Facebook, Twitter…)
   __ making calls
   __ texting

5. If you had to give something up, what would it be? (circle the letter in front of your answer)

a) mobile phone	a) coffee with friends
b) mobile phone	b) going out
c) mobile phone	c) computer
d) mobile phone	d) new trainers
e) mobile phone	e) girlfriend/ boyfriend

6. Do you use your mobile phone / tablet for? (rate the options according to frequency, 1 being the most and 5 the least frequent)
   __ surfing the Internet
   __ using e-learning materials
   __ watching educational videos (YouTube…)
   __ reading educational/ professional literature
   __ visiting learning sites

7. Have you tried to replace your literature with mobile internet by visiting one of the following: (answer with YES or NO; if the answer is YES, please rate by importance, one being the most and 6 the least important)
   __ Wikipedia
   __ Blogs and forums
   __ Communities practice
   __ Facebook
   __ Linkedin
   __ Twitter

8. In your vocational education, do you use any of the following? (if your answer is YES, name them)
   - applications (Welding Dictionary, Welding Calculator, …)
   - games (Weldplay, …)
   - online training (www.e-weldingandfabrication.com, …)

9. What is the best method of learning for you?
   - traditional – teacher, board, OHP, PowerPoint, …
   - mobile – using the mobile phone
   - combination traditional-mobile

10. What kind of communication with your trainer / mentor suits you best?
    - face to face
    - via professional or educational forums

- via social networks
- other …….

11. What kind of communication with your colleagues suits you best?
    - face to face
    - via professional or educational forums
    - via social networks
    - other …….

3. Stability (P1 – Goran Adelsberger)

The basic goal of this system is raising the welder's fitness - physical performance and effectiveness.

The ultimate training result is to render the welder capable to repeat a precisely determined set of moves multiple times in different specific body positions while having a steady and stable hand.

Analysis

- ❖ movement and work place screening
  - working positions
  - working techniques
  - welder's specific locomotive and functional needs
  - working conditions and environment
- ❖ health state measuring
- ❖ initial state measuring
  - determining the age groups
  - motor abilities/functions
  - functional abilities
  - survey on motor knowledge, skills and abilities

Research programme

The training is conceived so that:

- ❖ It gradually increases the intensity and volume from the actual, initial state to the maximum state allowed for a specific individual or a homogenised group
- ❖ Correction of the programme is done by analysing the results of measured transitory states
- ❖ People are taught self-control, determining their own work intensity according to their own abilities. In such a way, every individual is enabled to exercise

safely and positively health-wise and to monitor one's own progress, which additionally raises the confidence and motivation.

- The aspiration is to do the training without the additional costly equipment and space. So that one can train in the work place or at home.
- The influence on locomotive and functional body system is balanced so that a harmonious ability development occurs, with emphasis on those abilities specific for welders.

Choice of Exercises

It is necessary to choose the exercises that will ensure the progress and have influence on:

- Locomotive system by increasing
- Cognitive – conative system
- Cardiovascular system
- Mental relaxation

Research

The research will be carried out at:

- IOS (P1) from 13/1/2014 until 30/5/2014
- KMK (P6) and DDTEP (silent partner) from 10/2/2014. until 12/7/2014

Revision

Revise/reassess the training programme according to research results from 2/6/2014 until 8/8/2014.