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Design of student curricula, trainings and courses connected to WPS - MAG 135 and MMA 111 on a Fronius Virtual Welding Training System

Good practice example
Industrial and Trade School Slavonski Brod



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System developed in IOS

Integrated interactive training of welding trainees has been carried out in the Industrial and Trade School Slavonski Brod, Croatia since 2010. Integrated because it connects virtual and real welding, and interactive because the interaction of 3 elements - virtual welding, real welding and aerobic training yields a system that has several advantages over the classical training system for welders:

1. Training becomes cheaper,
2. Training is more modern and more acceptable to younger generations
3. Training is more dynamic, and can be shortened,
4. This training can also be used with experienced welders to correct their welding technique,
5. By including the aerobic training, the level of welder's psychophysical abilities is raised and also the quality of welding.





Good practice examples

Example 1

1. Integrated interactive training using MAG 135 process: 3-layer welding of a fillet joint
 - training on the Fronius simulator - 40% (training + simulation),
 - training on the real machine Transsteel 3500 Synergic Fronius - 60%

Example 2

2. Integrated interactive training using MMA 111 process: 1-layer welding of a fillet joint
 - training on the Fronius simulator - 50% (training + simulation)
 - training on the real machine Transpocket 180 - 50%





Good practice example 1

Training using MAG (135) welding process

TRAINING CONCEPT:

1. Trainer designs a WPS for the trainees to practice 3-layer welding of a fillet T- joint, steel sheets, in PB position.
2. Training is carried out in pairs.
3. Foreseen training duration is 20 school hours.
4. The first part of the training is carried out on the Fronius simulator. The foreseen training duration is 40% (8 h)
5. The second part is real welding on Transsteel 3500 Synergic Fronius. The foreseen training duration is 60% (12 h)
6. Visual inspection of the coupon/test piece

WELDCHANCE		WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)				TRAINING - IOS					
Produced by: IOS		Client: WELDCHANCE		Ref. stand: EN ISO 15614-1		Date: / /					
Project: WELDCHANCE		Client: WELDCHANCE		Ref. Standard: IOS-SI. Brod		Rev: / /					
Location: SI. Brod		Client: WELDCHANCE		Exam body: IOS-SI. Brod		Date: / /					
Mesto: SI. Brod		Client: WELDCHANCE		Exam body: IOS-SI. Brod		Date: / /					
Welding process Postupak zavarivanja	1	135	2	3							
Shielding gas type Uzeta zastitna plina		EN ISO 14175-8:21 (Ar 85%, CO ₂ 15%)									
Welding (Yes/No) Zavarivanje(Da/Ne)	No	max: mm			max: mm						
Purging gas type Vazduh plina za ociscenje											
Welding position Polozaj zavarivanja	PB										
Joint type Uzeta spoja	FILLET JOINT (KUTNI)										
Joint preparation Priprema spoja	OXY FLAME/MACHINING										
Cleaning method Postupak ociscenje	GRINDING, BRUSHING										
Backing Podlozka	NONE										
Single/beadable Jednoslojno/dvoslojno	SINGLE "1"										
Back gouging Zadivljivanje											
Flux designation Oznaka praška za zavarivanje											
Flux handling Rukovanje praškom za zavarivanje											
Tungsten electrode Volfrumova elektroda											
Torch angle Kut gorionika	8 - 12°/45°										
Stand off distance Udaljenost	8-15										
Nozzle diameter(s) Prečnik mlaznice	17-22										
Tack welding procedure Prilazna specifikacija zavarivanja											
Identification of parent metal Identifikacija osnovnog metala											
Part Dio	Name/grade Ime/razred	Standard	Group Gruppa	Delivery conditional Stanje isporuke	Thickness range Raspon debljine mm	Diameter range Raspon promjera mm					
I	S355J2+N	EN 10025-2	1,2		10,00						
II	S355J2+N	EN 10025-2	1,2								
Identification of filler metal Identifikacija dodatnog metala											
Index Indeks	Trade name Trgovacko ime	Classification/ Klasifikacija	Group Gruppa	Filler handling Rukovanje dodatnim materijalom							
1	MG-2 (Oerlikon)	EN ISO 14341-A:G3Si1									
Welding parameters: Parametri zavarivanja											
Pass no. Broj prolaza	Index Indeks	Dist. Prilaznik	Welding process Postupak zavarivanja	Wire feed speed Brzina žice	Current Jačina struje, A	Voltage Napon, V	Current/polarity Strujni polarnost	Welding speed Brzina zavarivanja, mm/min	Run-out length Dužina držača i elektrode, mm	Gas flow Protok, l/min	Heat input Ulaz topline, kJ/mm
1	1	1,20	135 P	8,90	215 - 220	27 - 28	DC(D)	390 - 395		12-18	0,9 - 1,8
2,3	1	1,20	135 P	8,90	215 - 220	27 - 28	DC(D)	390 - 400		12-18	0,8 - 0,9
Remarks Primjedbe								Signature Datum/potpis			
Transfer mode pulsating current								Approved Odobreno			



Good practice example 2

Training using MMA (111) welding process

TRAINING CONCEPT:

1. Trainer designs a WPS for the trainees to practice 1-layer welding of a fillet T- joint, steel sheets, in PB position.
2. Training is carried out in pairs.
3. Foreseen training duration is 24 school hours.
4. The first part of the training is carried out on the Fronius simulator. The foreseen training duration is 50% (12 h)
5. The second part is real welding on Transpocket 180 - Fronius. The foreseen training duration is 50% (12 h)
6. Visual inspection of the coupon/test piece

WELDCHANCE		WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)				TRAINING - IOS				
Produced by: IOS		Client: WELDCHANCE		Ref. stand: EN ISO 15614-1		Date: / /				
Project: WELDCHANCE		Exam body: IOS-SI. Brod		Exam body: Isp. Ispito		Rev: / /				
Location: SI. Brod										
Welding process Postupak zavarivanja	111	2	3							
Shielding gas type Vrsta zaštitnog plina										
Wearing (Yes/No) Nijanje(Da/Ne)	max. mm			max. mm		max. mm				
Purging gas type Vrsta plina za čišćenje				litmin						
Welding positions Položaji zavarivanja	PB									
Joint type Vrsta spoja	FILLET JOINT (KUTNI)									
Joint preparation Priprema spoja	OXY FLAME MACHINING									
Cleaning method Dobijanje čistosti	BRUSHING									
Backing Podnica	-									
Single/double electrode Jednostruko/dvustruko	SINGLE "T"									
Back gauging Začebanje										
Flux designation Oznaka praška za zavarivanje										
Flux handling Rukovanje praškom zavarivanja										
Tungsten electrode Volframova elektroda	mm									
Torch angle Kut priporoka										
Stand off distance Ledenost	mm									
Nozzle diameter(s) Promjer mlaznice	mm									
Task, welding procedure Promjena specifikacije zavarivanja	Rev: / /									
Identification of parent metal Identifikacija osnovnog metala										
Part Dio	Material grade Ime kvaliteta	Standard	Group Grupa	Delivery conditional Stanje isporuke	Thickness range Raspon debljine mm	Diameter range Raspon promjera mm				
I			1		10,00					
II			1		10,00					
III										
Identification of filler metal Identifikacija dodatnog metala										
Index Indeks	Trade name Trgovачko ime	Classification/ Identifikacija	Group Grupa	Filler handling Rukovanje dodatnim materijalom						
1	UTP 614 KB	B Basic, E 7018 EN ISO 286 A E 42 J B 32 H 10								
2										
Welding parameters: Parametri zavarivanja										
Process Isp. prioka	Index Indeks	Welding process Postupak zavarivanja	Wire feed speed Brzina žice	Current Jakost struje, A	Voltage Napon, V	Current polarity Smjer napajanja	Welding speed Brzina zavarivanja, mm/min	Run-out length Dužina depozita i elektrode, mm	Gas Plin, litmin	Heat input Udal. toplina, kJ/mm
1	3,2	111	133	MACHINE	DC(+)					
Remarks Primjedbe								Disinfectant Dezinficiranje		
								Apparatus Ostalo		



Training preparation on Fronius VWTS

1. Trainer enters the WPS into the simulator.
2. At the same time, trainer enters his know-how and skills of the real welding in practice.

The goal is to train the trainees based on the trainer's skills.

There is no difference between the travelling/leading of the burner on the simulator and its travelling/leading in real welding.





Virtual Welding Training System Fronius

TRAINING SEQUENCE:

Who is the trainer?

- Virtual trainer called „Ghost” ensures best help possible in mastering the welding technique
- Colours of the „Ghost” (red, yellow or green) and the sound of welding show the current condition and provide for the necessary correction of the welding technique.

What is practiced?

- Welding speed - level 1
- Welding speed + stick out (MAG) / arc length (MMA) – level 2
- Welding speed + stick out (MAG) / arc length (MMA) + tilt angle of the burner (MAG) / electrode (MMA) – level 3



Training sequence:

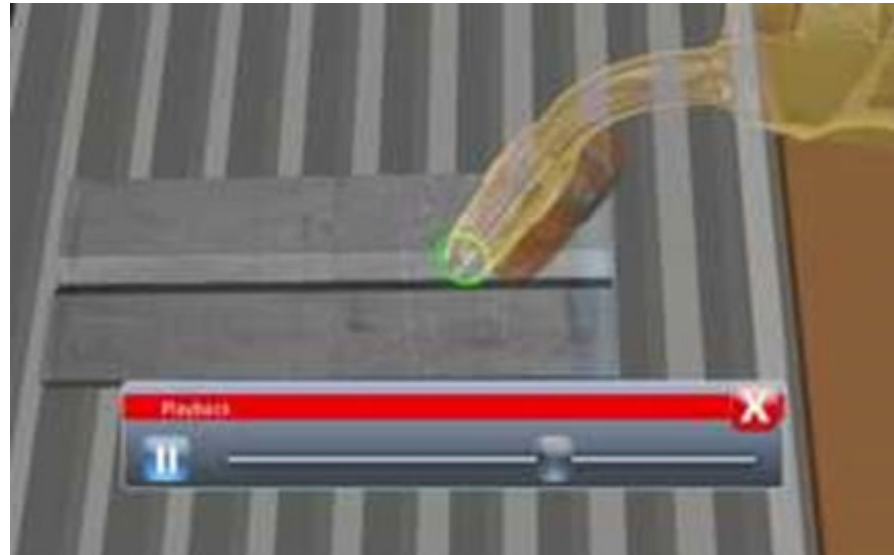
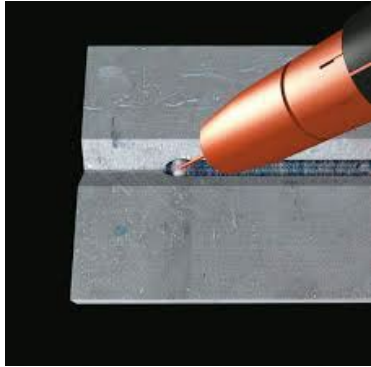
A virtual teacher (“Ghost”) gives the best help possible

Simulation sequence:

Training in a “real” welding situation (with no help from the Ghost)



Virtual Welding Training System Fronius



SIMULATION SEQUENCE

When?

Upon completion of the entire training
Training without the Ghost in real training situations

What is practiced?

Weld formation
Setting the welding parametres

Who is keeping track of the trainee's progress?

A video analysis provides feedback



Virtual Welding Training System Fronius

RESULTS

Objective and transparent evaluation of results

- Comparing training results
- Objective scoring system

Ranking list

- The list is generated automatically and simplifies the evaluation

Playback function

- Each weld is recorded and can be played back and analysed

Trainee motivation

- Trainees compare results and motivate each other
- Group dynamics is improved





Training on the Fronius virtual simulator MAG 135

Threshold is 60% - to pass each level minimum of 600 points is necessary.

Training with the „Ghost”

Step/level 1: welding speed is trained (600 points to pass)

Step/level 2: welding speed + stick out are trained (600+600=1200 points to pass)

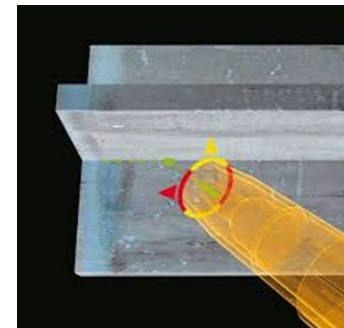
Step/level 3: welding speed+ stick out + tilt angle of the burner are trained (600 + 600 + 600 = 1800 points to pass)

Moving to the next level is only possible after a passing score has been reached on the previous level.

The training is finished after the trainee has successfully completed the level 6 times out of 10 tries on all 3 levels.

Simulation without the „Ghost”

The trainee has passed if he has 6 successfully executed welds out of 10 tries. If the trainee fails, he goes back to the training and the circle continues.





Real welding - MAG 135

EXPECTED RESULT - MAG 135

The expected result is achieved when the trainee executes 5 consecutive successful welds visually inspected according to HRN EN ISO 9606-1.





Training on Fronius virtual simulator MMA 111

Threshold is 60% - to pass each level minimum of 600 points is necessary.

Training with the „Ghost”

Step/level 1: welding speed is trained (600 points to pass)

Step/level 2: welding speed + arc length are trained (600+600=1200 points to pass)

Step/level : welding speed + arc length + tilt angle of the electrode are trained (600 + 600 + 600 = 1800 points to pass)

Moving to the next level is only possible after a passing score has been reached on the previous level.

The training is finished after the trainee has successfully completed the level 6 times out of 10 tries on all 3 levels.

Simulation without the „Ghost”

The trainee has passed if he has 6 successfully executed welds out of 10 tries. If the trainee fails, he goes back to the training and the circle continues.





Real welding - MMA 111

EXPECTED RESULT - MMA 111

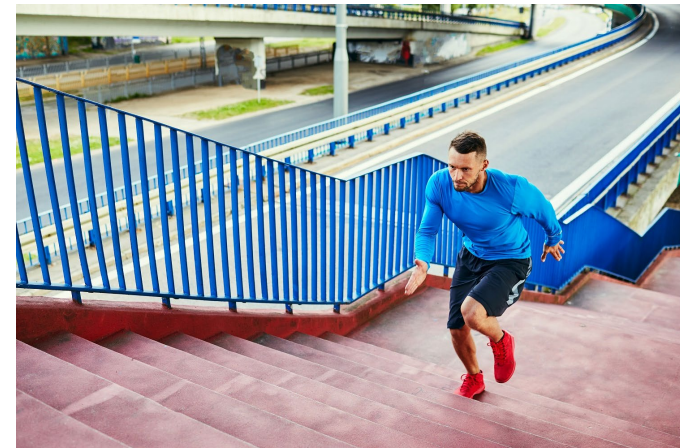
The expected result is achieved when the trainee executes 5 consecutive successful welds visually inspected according to HRN EN ISO 9606-1.





AEROBIC TRAINING

Aerobic training is conducted parallel to the welding training. By continuously training, welders acquire physical predisposition to work in forced positions, and through physical predisposition they also raise their level of confidence and psychological stability, which is very important for continuous work and good results regarding the quality of welded joints.





SYSTEM RESULTS

By collecting data throughout 12 years of work in integrated interactive training of this type, the following results were obtained:

1. On average, welding simulator training ends 20% (MAG) and 15% (MMA) ahead of schedule.
2. With the practiced welding technique on the simulator, the expected results in real welding are achieved faster, which accelerates the training by another 20%.
3. The hourly rate intended for MAG welding of fillet welds according to IAB-089r5-14 amounts to 180 hours of training. The integrated interactive training anticipates 40% of the work on the simulator and 60% for real welding. This means 72 hours of work on the simulator and 108 hours of work on the real welding device.
4. The hourly rate intended for MMA welding of fillet welds according to IAB-089r5-14 amounts to 140 hours of training.

The integrated interactive training anticipates 50% of the work on the simulator and 50% for real welding. This means 70 hours of work on the simulator and 70 hours of work on the real welding device.



SYSTEM RESULTS

Taking into account points 1, 2 and 3 (MAG), the time savings on the simulator would be 14 hours and on the welding machine 22 hours, which means that the course could be completed in 144 hours, which represents significant savings in welder training.

Taking into account points 1, 2 and 4 (MMA), the time savings on the simulator would be 11 hours and on the welding machine 14 hours, which means that the course could be completed in 115 hours, which represents significant savings in welder training.