ADJUSTMENT OF WELDING PRACTICAL FOR ONLINE DELIVERY

ADAPTACIJA LABORATORIJSKE VJEZBE IZ ZAVARIVANJE ZA ONLINE NASTAVU

Štefanija Klarić[1], Andrew Ward[1], Sara Havrlišan[2]

[1] Charles Darwin University
[2] Sveučilište Slavonski Brod

Ključne riječi: *online nastava, laboratorijska vježba iz zavarivanja, GMAW, AS/NZS 1554.1*

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Sažetak: Upoznavanje studenata sa osnovama procesa zavarivanja (uključujući sigurnost na radu, uobičajene postupke zavarivanja i relevantne Au norme iz područja zavarivanja) jedan je od ishoda na predmetu Proizvodni postupci. Ovaj predmet dio je smjera Strojarstvo na preddiplomskom studiju na Charles Darwin University. U ovom radu opisane su prilagodbe u izvođenju laboratorijske vježbe iz zavarivanja za studente koji nisu mogli sudjelovati u kontaktnoj nastavi zbog COVID-19 restrikcija.

Abstract: Introducing students to welding process basics (including welding safety, common welding processes and relevant Australian Standards related to welding) is one of the outcomes of Manufacturing unit. This unit is part of Mechanical Stream of Undergraduate Engineering Course at Charles Darwin University. This paper describes adjustments made to delivery of the welding laboratory practical for students that were not able to participate in face-to-face welding session due to COVID-19 traveling restrictions.

1 INTRODUCTION

Manufacturing is special elective subject in Mechanical Engineering stream of Associate Degree of Engineering, Bachelor of Engineering Science and Bachelor of Engineering Honours courses at Charles Darwin University. These subject covers principle of manufacturing processes including joining and assembly processes. As a part of the subject, three laboratory practicals are foreseen: CNC, Casting and Welding Practical. Subject is offered to internal students studying on Casuarina Campus in Darwin and external students studying online. Prior 2020, laboratory practicals were part of intensive and external students would come on Campus to do them in laboratories, however from 2020 this practice had to be replaced with online version of the same activity. This paper covers activities related to developing and conducting online version of the welding practical in Manufacturing subject.

2 RESPONSE TO PANDEMIC IN HIGHER EDUCATION

Although developments and introduction of technologies were increasingly present in education in last decades, COVID brought new challenges for the whole sector. Common overall response across higher education was introduction of online delivery accompanied with necessary adjustments of curriculum, delivery and communication practices. Critical reviews of new practices and tools, educators and students' attitude, engagement and motivation levels as well as plans for post-COVID transition are presently topics of extensive research in the higher education area [1- 9].

Due to hands-on nature of the area as well as the need for development of problem-solving skills, for engineering education and other STEM areas transition to complete online delivery brought own discipline specific challenges [10, 11]. Having in mind requirement for acquiring practical STEM knowledge, special attention was given to adjustment of laboratory work with different approaches like:

- Intensive laboratory experiences [12]
- Remote laboratories [13, 14]
- Simulations [15]
- Hybrid, blended or completely online (synchronous or asynchronous) presentation of laboratory exercises [16, 17].

As mentioned in [11], one of the key goals during the transition to online delivery in engineering education is the active learning and engagement of students with the content. In this paper adjustment of welding laboratory practical to full online delivery is presented.

3 ADJUSTING THE PRACTICAL TO ONLINE DELIVERY

Lab practical description

The purpose of this laboratory practical is to demonstrate Welding Procedure Specification for GMAW welding process and application of standards in welding, particularly AS/NZS 1554.1:2014 Structural steel welding, Part 1: Welding of steel structures. The practical includes:

- Welding safety and GMAW theory briefing;
- Introduction to welding equipment including safe use;
- Parameters settings for GMAW;
- Common welding defects;
- Requirements and documents for Welding Procedure Specification.

In laboratory conditions students would observe the demonstration of GMAW parameter setup, welding process and weld measurements and visual inspection. Additionally, students will have the opportunity to use welding equipment under supervision and weld under different settings to note the influence of welding parameters and welding skill to obtain appropriate and consistent weld quality.

Based on observations and measurements technical report is required that includes all information necessary for WPS, reviewing welding done in this practical and comparing it to the AS/NZS 1554.1 standard with estimation of heat input and calculation of the carbon equivalent (CE). Emphasis is also given to process safety requirements.

Adjustment for online delivery

Online version of the described laboratory practical comprised intro videos, slides and questioners (theory background) about: weld safety, welding standards and inspection, welding terminology and basics of GMAW process (Figure 1). Trough CDU Library students were also provided access to relevant Australian Standards.

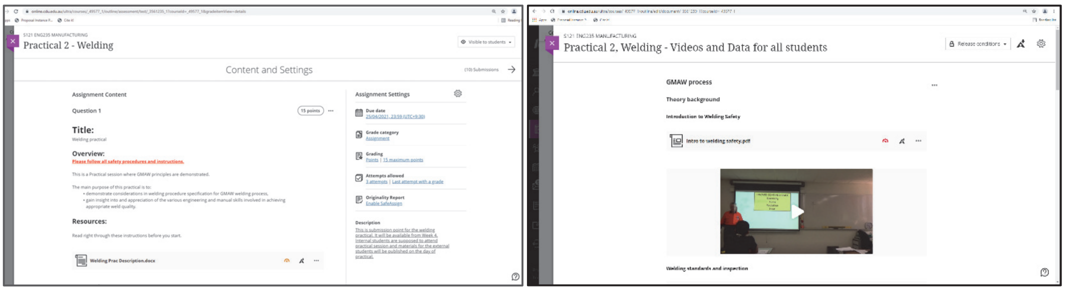

Figure 1. Practical setup and theory background on online site of ENG235 Manufacturing

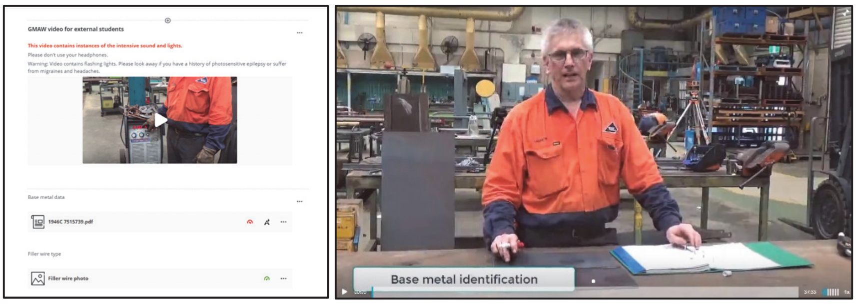

Figure 2. Base metal identification

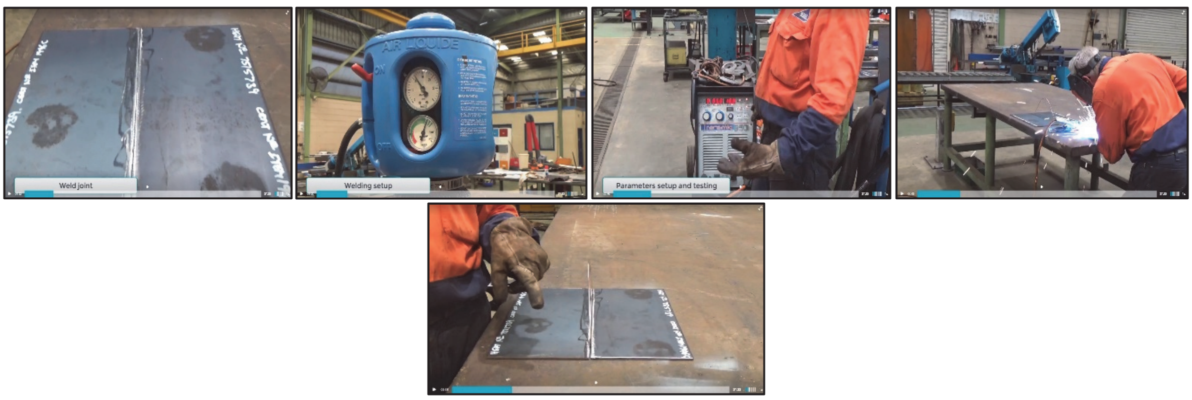

Figure 3. Weld and parameters setup

Apart from attempts to perform the welding, students studying online have the same task as if they were doing the practical in the workshop: to engage with provided content and provide the above described report.

In order to be able to do that practical part of this exercise provided base metal and filler wire data as well as detailed video of the welding process starting with the base metal identification (Figure 2).

Then, demonstration of weld groove preparation, setup of welding parameters and weld joint was explained and demonstrated (Figure 3).

Recordings of the GMAW of the test plate were accompanied with details required for calculation of heat input according to AS/NZS 1554.1 as well as advices on achieving a good weld quality (Figure 4).

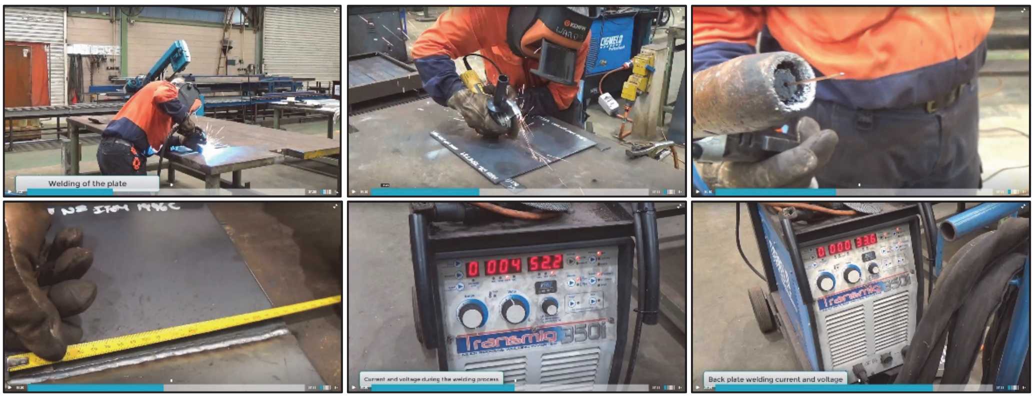

Figure 4. Welding of the test plate

Finally, demonstration of weld visual inspection and application of different tools for measurement of weld geometry is provided (Figure 5).

Figure 5. Weld inspection

4 DISCUSSION

As described, materials for the online delivery of this practicals are prepared for asynchronous delivery. This allowed external students to access the materials, engage with relevant practices and standards, do the work in their own time and achieve the intended learning outcomes.

In order to provide additional support and instructions on how to proceed and engage with provided materials Q&A online session was offered to students.

However, this approach (as reported by [16, 17] as well) didn't allow real hands-on experience: possibility for additional inquiries in the workshop regarding safety, equipment, procedures or welding practices or students testing of their own welding skills.

5 CONCLUSION

Adaption of welding practical to asynchronous online delivery was presented in this paper. Presented approach allowed addressing the intended learning outcomes with maintaining the accessibility to learning for all students. Although videos and descriptions cannot replace hands-on experience, they provided content and allowed students to engage with welding practice.

Additionally, developed online resources could be used in a future as an additional support for the practicals, as student could use them to introduce themselves to real workshop conditions before coming to welding practical.

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