Welding Introduction

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Abstract

This module is meant to introduce students to the nomenclature of metal welding and to demonstrate some of the techniques using video clips. Welding processes are discussed along with weldability issues and welding effects such as heat effects in metals. It is meant to be useful for any student in manufacturing since acronyms in welding are many with the same process having several abbreviations.

Module Objectives

This module introduces the basic processes involved in the process of welding metals. Specific objectives include

- Introduction to the vocabulary of welding processes
- Observation of examples of welding
- Introducing the roles of flux and gas coverage during welding
- Introduction of the topics of weldability and heat affected zone and their influence on resultant properties of the material.

Student Learning Objectives: Students will be able to

- 1. Identify welding processes and their uses.
- 2. Observe or experience the welding process.
- 3. Explain the role of flux or gas coverage during welding characteristics.
- 4. Discuss weldability and factors governing weldability.
- 5. Define heat-affected zone and potential problems related thereto.

MatEd Core Competency covered:

17.B Describe techniques used for metals processing

Key words: weld, welding, flux, weldability, heat-affected zone

Type of Module/Mode of Presentation: classroom presentation/discussion; possible demonstration if available

Time Required: 15 to 30 minutes

Pre-requisite knowledge: None

Target Grade Levels: Advanced high school or community college technology students

Table of Contents

Abstract	1
Module objective and student learning objectives	1
Module data	1
MatEd course competencies covered	2
Equipment and supplies needed	2
Curriculum overview and instructor notes	2
Module procedures	4
Supporting materials	4
References	4
Evaluation packet	5

Equipment and supplies needed:

Internet connection for on-line videos and references Welding equipment for demonstration (optional)

Curriculum Overview and Notes to Instructor

Welding is a process where heat is applied to soften or melt a material surface, which then flows into a joint. A filler material is often added to fill the joint completely. Because metals at high temperature react with the atmosphere, some atmospheric protection is included as part of most welding processes, usually in the form of a flux or a protective gas.

References 1 - 4 provide background information on welding processes, types of welding, welding equipment, etc, while references 6 - 9 provide detail on specific types of welding with acronyms.

The "Weld" is often referred to as the complete part, application or system of parts that have been joined together. The weld material is made up of the filler material and some of the base material that is joined together.

Not all metals are weldable. For steels, those that alloy steels that can be hardened by heat treatment are generally the hardest to weld, whereas less hardenable plain carbon steels are easier to weld. Welding can also degrade the properties of steels, since welding changes the materials structure and properties in a region of the parent material around the weld called the "heat-affected zone" or HAZ. This can make the welded material in some cases weaker and in other cases making it more brittle. For aluminum welding, lower alloy materials are more easily welded. References 10 and 11 focus on the heat-affected zone and weldability. Some of these references are from Wikipedia and have been reviewed for accuracy by the author; they also have hot links to a number of other articles. These references may also be provided to the students for more background.

One interesting story related to welding of steels relates to the Liberty Ships used in

World War II. Steels used to construct the Liberty cargo ships suffered from catastrophic failures due the steel used. At welded joints, the ductile to brittle transition of these steels was not a problem at the temperature of the Gulf Coast where they were built, but in the North Atlantic and North Pacific, the water was cold enough that the steel became brittle and cracks formed. Legend indicates that welders were employed on these ships to follow cracks and to weld them to prevent failures. But not all succeeded and there were a number of cases where the ships actually cracked in half due to brittle failure. Several photos are available in textbooks and one article on this can be found at http://shippai.jst.go.jp/en/Detail?fn=2&id=CB1011020.

Module Procedure

If you have access to any of the standard welding techniques, the best way to begin this lesson is with a demonstration. If a demonstration is not available, use one of the video clips contained in the references.

- 1. (day before homework) Have the class look up the meanings of each of the key words.
- 2. Ask the class to define each key word. Discuss the answers. Have they ever welded? If so, what was it like? Can they discuss types of welding processes?
- 3. Show the attached diagram of a welded part with the regions labeled to emphasize the definitions.
- 4. Show a video clip or demonstrate a welding process.
- 5. Discuss stick welding and the role played by the flux. Ask what would happen if no flux were used.
- 6. Discuss inert gas techniques like TIG and MIG welding. Discuss how these techniques differ from stick welding.
- 7. Consider manual vs. semi-automatic welding processes. Review ref. 2 for background.
- 8. Discuss friction welding. Describe the process in general and ask the class how this can possibly cause welding. Let the discussion wander.
- 9. Show the video of friction welding as an example.
- 10. Introduce the question of weldability. Does it work for all materials? Explain that plain carbon steels and low alloy aluminum are easier to weld than hardenable steels and alloys. If the class has the background, discuss the question of hardenability of steels and relate this to weldability.
- 11. Introduce the concept of heat-affected zone. Explain grain growth with heating and the concept that strength decreases with increasing grain size. Relate this to hardenability—if the material is hardenable (i.e., as with the formation of martensite), discuss the potential of brittle behavior near the weld.
- 12. You can also tell the story of liberty ships during World War II, with the problem with the ductile-brittle transition at the temperature of the North Atlantic.

Supporting Diagram

The attached diagram may be used to illustrate the points made in the introductory parts of this module. Other supporting material is given in the reference section below.

Supporting videos and on-line references

- 1. General welding information: <u>http://www.theweldingsite.net/</u>
- Kobelco stainless steel welding—compares manual to semi-automatic welding. Poor quality low resolution video: http://www.kobelcowelding.com/welding_video.htm
- 3. Information and video on friction stir welding: http://www.ctc.com/learnaboutctc/FSW_proj.cfm
- 4. Welding tips and information: <u>http://www.millerwelds.com/resources/improving-your-skills/</u>
- 5. MIT Welding and Joining course: <u>http://ocw.mit.edu/OcwWeb/Materials-</u> <u>Science-and-Engineering/3-37Welding-and-Joining-ProcessesFall2002/Calendar/</u>
- 6. Shielded metal arc welding (SMAW or MMA or stick welding): http://en.wikipedia.org/wiki/Shielded_metal_arc_welding
- 7. Gas metal arc welding (GMAW or MIG or MAG process): http://en.wikipedia.org/wiki/Gas_metal_arc_welding
- 8. Gas tungsten arc welding (GTAW or TIG welding): http://en.wikipedia.org/wiki/Gas_tungsten_arc_welding
- 9. Friction welding FW): <u>http://en.wikipedia.org/wiki/Friction_welding</u>
- 10. Heat-affected zone: <u>http://en.wikipedia.org/wiki/Heat-affected_zone</u>
- 11. Discussion on weldability: <u>http://en.wikipedia.org/wiki/Weldability</u>
- 12. Liberty ships and brittle fracture: see, for example http://shippai.jst.go.jp/en/Detail?fn=2&id=CB1011020

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Evaluation Packet:

Student evaluation questions (discussion or quiz):

- 1. What is the role of the flux in the welding process?
- 2. How might inert gas welding be superior to stick welding?
- 3. What are the advantages of semi-automatic welding as opposed to manual welding processes?
- 4. How might friction welding provide a superior product?
- 5. What factors affect weldability?
- 6. How can the heat affected zone negatively affect materials properties?

Instructor evaluation questions:

- 1. At what grade level was this module used?
- 2. Was the level and rigor of the module what you expected? If not, how can it be improved?
- 3. If used, did the demonstrations or videos work as presented? Did they add to student learning? Please note any problems or suggestions.
- 4. Was the background material on welding sufficient for your background? Sufficient for your discussion with the students? Comments?
- 5. Did the discussion generate interest among the students? Explain.

6. Please provide your input on how this module can be improved, including comments or suggestions concerning the approach, focus and effectiveness of this activity in your context.

Course evaluation questions (for the students)

- 1. Was the demonstration clear and understandable?
- 2. Was the instructor's explanation comprehensive and thorough?
- 3. Was the instructor interested in your questions?
- 4. Was the instructor able to answer your questions?
- 5. Was the importance of materials testing made clear?
- 6. What was the most interesting thing that you learned?