

GMACW Steel Fabrication Council – Academic Pathway for Fitters

The GMACW Steel Fabrication Council has identified training for fitters as its most urgent workforce need. Traditionally, fitters have been recruited from the ranks of incumbent workers and trained to become fitters. The committee sees a need to supplement this traditional process with targeted training to create a larger pipeline of entry-level fitters. Fitters do require a fundamental knowledge of welding to be effective; however, it is not necessary for fitters to have extensive work experience or education in welding. Thus, the following short-term training program includes some basic welding but focuses on other, more specific occupational skills.

Short-term Training

In order to fill the gap and begin addressing the Steel Fabricators Council’s needs in the short-term, we recommend developing a non-credit certificate program designed for incumbent workers. On December 14, 2016, the committee met with ASU Mid-South to begin a deeper dive into the learning activities, outcomes, and assessments needed to implement the following high-level recommendations.

The exact length of this program will be determined during the curriculum design process undertaken by Mid-South and the fitter committee, although early discussions indicate that it will probably be approximately one academic year (nine months). The duration of this training will depend on the complexity and depth of the learning outcomes associated with the competencies below. However, best practices indicate that short-term training provide measurable skill gains in the shortest amount of time possible. For that reason, we recommend modularizing curriculum so that participants can complete portions of the training in 10 to 15 week chunks. This type of program may be eligible for funding through the Workforce Innovation and Opportunity Act as Customized Job Training or similar program.

For participants to be successful in the short-term certificate program, they must come with the following core competencies (see fitter competency list below for definitions):

Basic blueprint reading	Basic welding	Safety and quality practices	Applied math
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These prerequisites can be met in several ways—through previous work experience (as measured by challenge exams or portfolio assessment) or through coursework. Mid-South has courses and Prior Learning Assessment policies to measure students’ readiness.

The fitter committee has identified the following topics for inclusion in the short-term program:

- Use of common fitter tools¹
- Crane operation and rigging
- Advanced blueprint reading
- Proper fitup, layout, and measurement techniques

¹ Fitter committee and the lead instructor at Mid-South is currently developing the full list of tools to include in this module.

As this training will most likely be offered to incumbent workers, a flexible schedule that allows for full-time workers to succeed is essential. One way to accommodate this is through a flipped classroom, in which students are required to complete their “book work” outside of class so that the instructor can focus on hands-on practice and instruction during class time. Another option is to provide open lab hours so that participants can take as much (or as little) time as they need to master certain skills.

Ideally, the modules developed for the short term training will also become the core courses required for the associate’s degree program or a fitter concentration in an existing degree program. This way, curriculum developed in the immediate future can be repurposed rather than reinvented.

In order to begin moving forward, Mid-South’s lead instructor has met with the fitter committee to begin attaching learning activities to the list of essential fitter tools, and is also reviewing Mid-South’s existing curriculum for alignment to the competencies discussed here. Instructors and subject matter experts will continue to work together to review these recommendations, develop learning outcomes, and assign contact hours to each major topic.

Long Term Training

The following two-year curriculum reflects recommendations made by the council as well as a review of ASU Mid-South’s existing courses, the Fabricators and Manufacturers Association (FMA) Fundamentals of Metal Fabrication Certification, the SME code, and post-secondary programs in fabrication and materials joining. The curriculum is mapped so that students earn stackable credentials each term, including a short-term welding certificate. Ideally, this program will align with the short-term fitter training so that students will also receive a Fitter Certificate of Proficiency before beginning the second year of the AAS degree. Specific AWS, API, and ASME codes have not been identified at this time; TPMA recommends that the council identify those codes that are most commonly used in the Greater Memphis region to be incorporated into the appropriate course learning outcomes. Course descriptions are provided on the following page.

Year 1 – Fall	Year 1 – Spring	Year 2 – Fall	Year 2 - Spring
BUSN 1201 Career Preparation	MATH 1104 Applied Technical Math	ENGL 1113 English Composition 1	MACH 1063 Inspection and Testing
TECH 1003 Intro to Blueprint Reading	WELD #### (New course) Materials Joining Fundamentals and Lab	MATH #### (New Course) Advanced Applied Math (Trigonometry)	WELD #### (New Course) Jig and Fixture Design for Fitters
TECH 1013 Shop Essentials	WELD #### (New Course) Fitter Tools	Weld #### (New Course) Advanced Fitter Tools	WELD #### (New Course) Advanced Fabrication Lab
TECH 1303 Industrial Safety	MACH 1023 Intro to Metallurgy	Industry or Technical Elective	Internship
Weld 1053 Fundamentals of Welding			
Weld 1113 or 1123 or 1133 or 1143			
Outcomes: <ul style="list-style-type: none"> • 16 Credits • AWS D1.1 in one process • Certificate of Proficiency in one welding process (FCAW, SMAW, GMAW, or GTAW) 	Outcomes: <ul style="list-style-type: none"> • 14 Credits • FMA Fundamentals of Metal Fabrication Certification • Technical Certificate Steel Fabrication (Fitting) - NEW 	Outcomes: <ul style="list-style-type: none"> • 16 credits • Additional AWS Certifications (based on elective chosen) 	Outcomes: <ul style="list-style-type: none"> • 16 credits • 250 hours work experience • AAS Fitters Concentration • Additional API or ASME certifications (TBD)
Existing Course / Required for Welding Certificate	Existing Course / Required for AAS	Proposed Course – Responds to Fitter Committee recommendations and/or FMA Core Topics	Existing Course with alignment to council recommendations and/or FMA Core Topics

Course Descriptions

All course descriptions are from the ASU Mid-South Course Catalog unless otherwise indicated.

Year 1 – Fall

BUSN 1201: Career Preparation (1 credit) This course provides information on career planning and decision-making, job search preparation, and professionalism skills for employees. Students will learn to explore and evaluate career options, write a professional resume, prepare for an interview, and communicate effectively with potential employers and co-workers.

TECH 1003: Intro to Blueprint Reading (3 credit) This course is designed to provide students with knowledge and skills needed to read and interpret drawings, symbols and systems schematics and to develop drawings and sketches of components, parts and pieces into usable, working prints. The student will develop drawings and sketches of repairs and alterations and learn to utilize blueprints, graphs and charts to obtain or provide needed information.

TECH 1013: Shop Essentials (3 credits) This course introduces the student to basic safety practices, fire safety, measurements through the use of Micrometer and tapes, conversion of metric and English measures, shop practices, common shop paper work and basic hand tools common to various industrial trades. Students must complete lab exercises where they demonstrate competency in identifying basic safety practices, fire classes, material and proper fire control methods. Students will perform and read measurements through the use of Micrometer and tapes and demonstrate a working knowledge of conversion tables of metric and English. In addition, they will be introduced to common shop practices, common shop paper work practices and identify and appropriately use basic hand tools through practical applications.

TECH 1303: Industrial Safety (3 credits) This course covers the rationale for industry safety, safety regulations, and key safety movements. Hazardous materials handling, lock out-tag out, as well as OSHA regulations are introduced. Students must successfully complete lab exercises to demonstrate practical applications in the topics in the course.

WELD 1053: Fundamentals of Welding (3 credits) This course introduces students to safety, application, technique, process essential variables, quality control, and inspection of common welding processes used in industry. The student will experience each welding process through instructor-led demonstrations and hands-on welding applications. Students who successfully complete this course will be able to make decisions regarding process selection and control common to non-essential welding personnel in an entry-level technical capacity.

WELD 1113, 1123, 1133, and 1143 (3 credits each) This course provides entry-level technical training to SENSE Level I/ NCCER Level II in the FCAW, GMAW, GTAW, or SMAW process. Students will receive instruction in process safety, equipment, filler metal selection, terminology, power sources, equipment and operational mechanics pertaining to wire feed processes.

Year 1 – Spring

MATH 1104 Applied Technical Mathematics (4 credits) This course is a college-level mathematics course covering mathematical topics as they relate to technical skills and knowledge designed for AAS degrees. However, the course does not apply to transfer associate degrees or baccalaureate degrees unless specifically approved by the transfer institution. Specific emphasis is given to ratio and proportion, percentages, plan geometry, exponents, scientific notation, reading and constructing graphs, and solving quadratic equations in application problems.

WELD ####: Materials Joining Fundamentals with lab (4 credits) Fundamentals of materials joining theory, principles and application. Includes basics of interatomic and interfacial bonding, process characteristics and classification, arc physics and metal transfer, energy and power sources, heat flow, distortion and residual stress, joint design and weld symbols, inspection and quality, safety and health, economics and process selection.²

WELD ####: Fitter Tools (3 credits) In this course, students will become familiar with the most common tools used by fitters and be able to demonstrate the appropriate use of those tools in a controlled environment. Students will use hand tools, learn how to operate a crane, learn proper rigging, and more. (Course in development as of December 14, 2016.)

MACH 1023: Intro to Metallurgy (3 credits) This course will prepare students to apply the three metal identification methods and explain what characteristics they exhibit about a metal; discuss three metal properties and observable attributes; and understand the mechanical testing methods used to measure the response of metals to mechanical forces.³

Year 1 – Summer

No courses required; however, if students need developmental courses prior to completing the required English course, they should take it during this term.

Year 2 – Fall

ENGL 1113: English Composition 1 (3 credits) English Comp I gives attention to critical reading and thinking skills applicable to all college courses. The course stresses writing as a process and uses the essay as the vehicle while stressing invention, drafting, revising, and rewriting. This course utilizes computers and requires keyboarding skills of 20 wpm or better.

MATH ####: Advanced Applied Math – Trigonometry (3 credits) This course covers common trigonometric functions as they apply to the steel fabrication industry. (New/recommended course)

WELD ####: Advanced Fitter Tools (4 credits) This course provides students with an opportunity to use common fitter tools in a variety of environments and builds upon the skills developed in Fitter Tools (above).

Industrial or Technical Elective (3 or 4 credits) Students on the fitter pathway may choose any course from the industrial trades; we recommend that instructors/advisors and/or employers provide guidance regarding which courses will most benefit the student when seeking employment.

Year 2 - Spring

MACH 1063: Inspection & Testing (3 credits) This course introduces the fundamental methods and instruments used to effectively inspect parts in the shop. Students will use the caliper, micrometer, and CMM to perform calibration and more advanced inspection methods. Students must demonstrate competency in core course objectives through practical applications.

² Course description from: http://catalog.letu.edu/preview_program.php?catoid=6&poid=1193

³ Course is not listed in ASU Mid-South's current course catalog but has been offered previously. Course description based on Core Topics for FMA Certification.

WELD ###: Jig and Fixture Design for Fitters (3 credits) Focuses on the design and application of work-holding devices and clamping methods used in steel fabrication. Cutting theory, economic processes and continuous quality improvement principles are applied in the analysis of problems.⁴

WELD ###: Advanced Fabrication Lab (4 or more credits) This course provides students on the fitter track ample opportunity to combine discreet skills (such as jig and fixture design, job planning, and basic welding processes) in a controlled environment. Students will practice manipulating and assembling structural steel, steel plates and pipes, etc. Students will gain practical experience with proper fitup techniques, precision measurement and tolerancing. Students also gain the opportunity to practice metal working skills such as bending and shaping steel, including rolling, forming, etc. Students will learn to read and apply Weld Procedure Standards (WPS). Safety, Personal Protective Equipment (PPE), hand tools, and welding inspection will be included. Students will become familiar with the function(s), usage, and application(s) of the following equipment: Shears, Press Brakes, Water Jets, Punches, Lasers.⁵

Internship (3 credits) Students will work with a local steel fabricator as a fitter helper for a total of 250 hours over 10-15 weeks. Interns will observe and assist in a variety of fabrication situations.⁶

⁴ Adapted from <http://www.triton.edu/collegcatalog/ent-260--jig-amp-fixture-design.htm>

⁵ Course description based on Fitter Committee recommendations and Core Topics for FMA Certification.

⁶ Course description based on Fitter Committee recommendations

Fitter Competency List

The following competency list is based upon the Advanced Manufacturing Competency Model (<http://www.careeronestop.org/competencymodel/competency-models/advanced-manufacturing.aspx>) and the recommendations of the Steel Fabrication Council Fitter's Committee. When a definition is not included below, please refer to the original competency model for definitions. (Note: Color Coding corresponds to Advanced Manufacturing Competency Model categories.)

Competency Model Category	Competency	Definition
Occupation Specific Requirements	Steel fabrication terminology	Understand the terminology and nomenclature used in metal fabrication, including processes and materials/tools related to joining, forming, and shaping steel.
	Jig and fixture design	Demonstrate the ability to identify the need for and specifications of jigs and fixtures in a fabrication environment; design drawings and/or molds to use in creation of jigs and fixtures.
	Advanced fabrication	Determine process and materials required; develop fabrication methodology; create and communicate welder and inspector requirements; operate or oversee operation of welders, machines, etc.
Industry-Sector Technical Competencies	Blueprint reading	Identify the three basic elements of a blueprint, section views, tolerances, dimensions; Interpret the blueprint for use in manufacturing processes.
	Measurement/tolerance	Calculate dimensions or tolerances, using instruments such as micrometers or Vernier calipers. Demonstrate knowledge of the differences and similarities of semiprecision and precision measurement.
	Use of measurement tools	Demonstrate ability to use calipers, rules, protractors, and other precision measurement tools within prescribed tolerances
	Machine operation	Demonstrate safe set up and operation of machines (including mills, lathes, drill presses, and other common machines used in a fabrication setting); read work orders and drawings required
	Press brake operation	Set up and operate Press Brake; read and follow work orders, drawings as required
	Basic welding	Be familiar with common welding practices including SMAW, GMAW, FCAW, GTAW, and thermal cutting processes; read and interpret weld symbols and simple prints; use PPE and follow safety procedures when operating welding equipment
Industry-Wide Technical Competencies	Manufacturing Process Design and Development	

	Production	
	Maintenance, Installation, and Repair	
	Supply Chain Logistics	
	Quality Assurance / Continuous Improvement	
	Sustainable & Green Manufacturing	
	Health, Safety, Security & Environment	
Workplace Competencies	Business Fundamentals	
	Teamwork	
	Adaptability / Flexibility	
	Marketing and Customer Focus	
	Planning and Organizing	
	Problem Solving and Decision Making	
	Working with Tools and Technology	
	Checking, Examining, and Recording	
	Sustainable Practices	
Academic Competencies	Science	
	Basic Computer Skills	
	Mathematics	<p>Know and apply mathematical principles:</p> <ul style="list-style-type: none"> • Number Systems and Relationships - whole numbers, decimals, fractions, alternate base systems (e.g. binary, octal, and hexadecimal numbers) • Arithmetic – arithmetic operations on numbers, percentages, square root, exponentiation, and logarithmic functions Plane and Solid Geometry – distance, perimeter, area, and volume, spatial coordinates, visualization, spatial reasoning, and geometric modeling • Measurement – measurement of length, mass, time, systems of measurement, units, and conversion between systems (e.g. from English to metric) • Estimation -- estimate sizes, distances, and quantities; or determine time, costs, resources, or materials needed to perform a work activity • Mathematical Notation - the language of mathematics to express mathematical ideas

		<ul style="list-style-type: none"> • Mathematical Reasoning and Problem Solving – inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results • Elementary Statistics and Laws of Probability – mean, median, and standard deviation • Algebra and Functions – equations, patterns, and functions (From Competency Model Clearinghouse)
	Reading	
	Writing	
	Communication - Listening and Speaking	
	Critical & Analytic Thinking	
	Information Literacy	
Personal Effectiveness Competencies	Interpersonal Skills	
	Integrity	
	Professionalism	
	Initiative	
	Dependability and Reliability	
	Lifelong Learning	