Department Chair's Guide to Developing an Integrated Systems Project Based Curriculum

Industry Needed Competencies

A department chair must consider and balance many details in determining competencies that are specified in a technical curriculum. Today, manufacturing operations require technical graduates to be able to see and understand these operations as a system consisting of many sub-systems.

The operation, troubleshooting and repair of these plant systems, then requires that graduates be trained in and accomplished in a "Systems" oriented educational process. To accomplish this and insure that curriculum is properly vetted, the department chair needs to form a close and collaborative relationship with industries served in order to determine and develop the educational response to industry's needs.

These plant systems often consist of multiple and differing technologies which require that a technician have knowledge of and be able to perform a broad range of tasks and skill sets. The "systematic" performance of these tasks and skills becomes the objectives of their work and of the educational process. For this reason they have been called Performance Based Objectives (PBOs). There are a large number of work objectives that occur in the workplace and therefore a large number of objectives that need to be taught. Detailed evaluation of these PBOs becomes an excessively administrative burden; thus, accomplishment and assessment of PBOs needs to occur in a project based method where PBOs are integrated into several student projects.

Performance within these "milestone" curriculum projects becomes the evaluative system that validates the achievement of the overall competencies. Completed student project rubrics also could be used by students to create multi-media E-Portfolios that would support job placement. Establishing milestone projects made up of several technologies allows the department chair to develop curriculum competencies using an integrated systems approach. Additionally, asking students to come up with multiple solutions to project problems stretches their perspectives and causes them to realize that there are often multiple ways to solve a problem. This process also encourages teamwork and critical thinking, a much needed set of skills in industry.

A similar collaboration occurring through the Multi-State Advanced Manufacturing Consortium (M-SAMC) has produced 20 industry vetted courses, containing PBOs that can further assist the department chair in curriculum development. These are available through the Resource tab on the national M-S AMC Web Site. (Factors involved in construction of these PBOs can be seen in Appendix 1.

To facilitate the development of project based learning and the use of performance based objectives, a list of considerations is presented that might be summarily contained in a range of projects. These projects can then be assessed through use of rubrics made up of elements of the list below.

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Appendix 1: Assessment Elements

When used appropriately, the following items can be used to generate a grading rubric for assessing students' projects. See Appendix 2 for an example.

Skills Demonstrable

- What tasks/skills are required to do the job?
- How and where should skill be demonstrated?
  - Student observation of a demonstration of the skill required? (Instructor demo, online demo)
  - Student participated or assisted in demonstrating the skill?
  - Student demonstrated the skills unassisted?
  - Student can teach the skill to someone else?

Knowledge Element

- What does the student have to know in theory and in practice to do the task or demonstrate the skill?

Attitude

- What attitude about safety, cleanliness, co-workers, and equipment should prevail about this task?
- What elements of problem solving need to be taught and demonstrated with regard to this task?
- What goals need to be set in the task to enable the operator to self-regulate?
- Teach and measure the proper strategies such as time management, productivity, problem solving, troubleshooting in order to obtain a powerful performance of this task.
- Teach and measure the student's ability to self-evaluate and determine if the task met their pre-set goals.

Use of Tools

- What tools/equipment/books/resources/online access/instructor information does the student need to be able to use?
- Teach and measure the ability to use required resources efficiently for this task.

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Related Safety

- What safety measures will industry require for specific task/job with regard to the operator (i.e. Personal Protective Equipment)?
- What safety measures will industry require for specific task/job with regard to the nearby co-workers?

Communication

- What terminology must the student know to communicate effectively with others? (i.e. Operation, Technician, Supervision)

Teamwork

- What collaboration skills must the student know to work effectively with others? (i.e. Operation, Technician, Supervision)

Critical Thinking

- What critical thinking skills must the student know to work effectively and troubleshoot systems?

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Appendix 2: Sample Rubric

The following rubrics are samples pulled from a comprehensive final project made up of two parts, Troubleshooting and Machining.

TROUBLE-SHOOTING PLAN	***PTS***	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/ Developing***	***(D) Limited***	***(E) Major Improvement Required***
Using schematics prints and test equipment to troubleshoot a system	*25*	*Accurately identified 100% of the components*		*Needed some prompting to identify the components*		*Unable to identify 50% of the components*
Establish plan for Fault #1-Elec	*10*	*Selected the most efficient troubleshooting path to identify the problem*		*Needed some prompting to select the most efficient process*		*Not able to identify the failure components*
Establish plan for Fault #2-Mech	*10*	*Selected the most efficient troubleshooting path to identify the problem*		*Needed some prompting to select the most efficient process*		*Not able to identify the failure components*
Establish plan for Fault #3-Fluid Power	*10*	*Selected the most efficient troubleshooting path to identify the problem*		*Needed some prompting to select the most efficient process*		*Not able to identify the failure components*
Establish plan for Fault #4 - Communication-Data	*10*	*Selected the most efficient troubleshooting path to identify the problem*		*Needed some prompting to select the most efficient process*		*Not able to identify the failure components*
Safety	***PTS***	***(A) Highly Proficient***	***(B) Competent***	***Partially Competent/ Developing***	***(D) Limited***	***(E) Major Improvement Required***
Safe Work Practices	*25*	*Used appropriate PPE; practiced common safety practices*		*Most safety practices used*		*Demonstrated unsafe working practices*

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Safety Attitude	*25*	*Work practices demonstrated safety consciousness in all procedures; looked out for safety of others*		*Most of the time worked safely and showed some concern for safety of others*		*Dangerous worker; did not look out for safety of others*
Electrical safety practices	*25*	*Used appropriate control energy and safety procedures*				*Dangerous worker around electrical*
Troubleshooting Skills	***PTS***	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/ Developing***	***(D) Limited***	***(E) Major Improvement Required***
Applied sequence of diagnosing problem	*20*	*Followed their identified sequence*		*Skipped or added some non-valued added steps or required prompting or out of sequence*		*Did not follow sequence*
Efficient use of time	*15*	*Finished tasks on or ahead of time*		*Barely finished task in allocated time*		*Did not complete task*
Accurately diagnosed root cause problem	*25*	*Correctly diagnosed problem*		*With assistance was able to diagnose problem*		*Did not find the problem*
Attention to detail	*15*	*Every aspect followed through in detail*	*Some areas skipped in terms of detail*	*Good, but incomplete*	*Poor and incomplete understanding*	*Substantial lack of effort made*
Accuracy of Repair Plan	*25*	*Problems/Faults/Remediation accurately documented*		*Skipped or missed some problems/ Faults/ Remediation*		*Substantial problems/Faults/Remediation not documented*

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Tool Use	PTS	(A) Highly Proficient	(B) Competent	(C) Partially Competent/ Developing	(D) Limited	(E) Major Improvement Required
Use of Diagnostic Tools	25	Correctly and efficient use of diagnostic tools in an appropriate manner		Somewhat efficiently; mishandled one or more of the tools		Had to have assistance in connecting the meter to device; or showed disrespect for the tools
Work Habits	**PTS**	**(A) Highly Proficient**	**(B) Competent**	**(C) Partially Competent/ Developing**	**(D) Limited**	**(E) Major Improvement Required**
Work Attitude	15	Alert to finding and correcting problem		Honestly attempted to find and correct problems		Showed frustration in finding and correctly problem
Work Procedure	25	Always followed standard procedures; demonstrated planning and organization skills in correcting the problem		Complied with standard procedures; Showed some plan and organization in working		Did not follow standard procedures; Disorganized and slipshod methods;
Professionalism	20	Work showed pride in accomplishment		Tried hard and shows promise		Work lacks praiseworthy factors
Self-confidence	15	Appeared comfortable and posed when performing tasks		Fairly self-confident; occasionally disconnected		Hesitant, timid, uncertainty
Knowledge of job	25	Has an exceptionally thorough knowledge of the job		Has good knowledge but needed coaching		Has inadequate knowledge of job

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SKETCHING	PTS	*(A) Highly Proficient*	*(B) Competent*	*(C) Partially Competent/ Developing*	*(D) Limited*	*(E) Major Improvement Required*
Completeness of sketch	25	All features and details are represented in at least an isometric view		Major features and details are provided; but some missing		Too many features missing to be able to produce the task
Clarity of sketch	20	Legible; no ambiguity in the design		Some assumptions need to be made in order to produce the part		Too many assumptions need to be made; part could not be produced from the sketch
MATERIALS AND PROCESSES	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/ Developing***	***(D) Limited***	***(E) Major Improvement Required***
Selection of materials for bill of materials	10	Appropriate materials for load, safety, cost		Needed assistance or prompting to select materials		Unable to select appropriate materials
Selection of fasteners for component	25	Appropriate fasteners for load, safety, cost		Needed assistance or prompting to select fasteners		Unable to select appropriate fasteners
Selection of tools	10	Appropriate drills and taps		Needed assistance or prompting		Unable to select appropriate tools
Resource utilization	25	Used appropriate resources for selecting materials, selecting fasteners, and tools		Needed assistance or prompting		Unable to use resources

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LAYOUT AND FABRICATION	PTS	*(A) Highly Proficient*	*(B) Competent*	*(C) Partially Competent/Developing*	*(D) Limited*	*(E) Major Improvement Required*
Accuracy of layout	10	Correct measurements; marked center points of holes; accurately cut parts		Need prompting to do correctly		Unable to layout
Use of fasteners for component	25	Appropriate installation of fasteners for load, safety, cost		Needed assistance or prompting to install fasteners		Unable to install fasteners or incorrect fasteners used
Use of tools	10	Appropriate operation of drills press, taps, wrenches, etc.		Needed assistance or prompting		Unable to use tools
Assembly	25	Assembly was easily put together; holes appropriately located		had to alter to assemble; rework required		Was impossible--could not be assembled
PRODUCT EVALUATION	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
Safe product	10	Product was deburred so could be handled safely		Minor deburring problems; but overall safe		Ouch
Durability, reliability and load appropriate	25	Appropriate materials, fasteners and design made the product durable for use in an industrial environment		Minor design issues could have improved the durability		Not at all durable
Function	25	Product met the needs of the problem presented		Will basically work		Will not serve the needs of the problem

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WORK HABITS	PTS	*(A) Highly Proficient*	*(B) Competent*	*(C) Partially Competent/Developing*	*(D) Limited*	*(E) Major Improvement Required*
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Work Procedure	25	Always followed standard procedures; demonstrated planning and organization skills in correcting the problem		Complied with standard procedures; Showed some plan and organization in working		Did not follow standard procedures; Disorganized and slipshod methods;
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Self-confidence	15	Appeared comfortable and posed when performing tasks		Fairly self-confident; occasionally disconnected		Hesitant, timid, uncertainty
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