Integrating Academic and Experiential Learning

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INTRODUCTION

This paper is one of a series of four developed for the ASEE conference in June, 1998. As it is not the first component of this group's effort, I will not repeat my colleagues' introduction to the nature of the NSF sponsored Greenfield Coalition at Focus:HOPE's Center for Advanced Technologies (CAT). Instead, the center point of this paper will be our efforts to understand, map, appreciate, and measure the learning that is required for revenue production and the learning that is required for academic credit. This effort is a critical component of the mandate that the National Science Foundation has given us. It assumes that the reader accepts, at least for a moment, the premise that engineering is a practiced based profession whose purpose is to contribute to the tangible form of some planned item.

PEDAGOGY

It is sound educational theory that when a broad theoretical concept is learned in tandem with a rich specific context, the acquired knowledge is more readily transferable.[1] The next time a related, different specific context is encountered, the transition of the old knowledge to the new context is both easier and faster than acquiring brand-new knowledge. An example of this is the manufacturing engineer who has learned, say, design of cutting tools in both theory and practice. When the need to design stamping tools is confronted, the necessary theory and skills can be attained more quickly through relationships of common facets of machining and stamping.

It has also been well established that the maximum transfer of knowledge occurs when learning is as close to the real-world application as possible. Learning in-context also implies, however, that we evaluate knowledge and subsequent performance competency through means which are consistent with the context, the depth and the rigor we are seeking. Attempts at evaluating candidates (student) performance by applying traditional means from university practice has fallen short of assessment needs. In order to bring manufacturing education and practice into the same space-time continuum, other potential assessment models have had to be examined.

ARCHITECTURAL SKETCH

The Greenfield Coalition is in the midst of an effort to create a system that will permit two entirely different operational systems (Industry and Academia) to work toward a common goal. Both want to produce a competent and employable manufacturing engineer / technologist. One will not dominate the other because both have essential roles in our society.   Our intention here is to present where we are in our endeavors to build a bridge between the two systems and hope that others will challenge and contribute.   Since we are not at all sure of what the final product will ultimately look like, we are trying several approaches.

In one approach we use directed study for current Candidates (students at the CAT) pursuing current degrees. It is a known and do-able approach and the Candidates cannot wait for the development of the “silver bullet”. It has the advantage of giving the industry folks practice in viewing the manufacturing function from an academic frame of reference.   It also gives a faculty member a perspective regarding the variables, complexities and judgments required in a manufacturing context. This proves valuable to all of us as we grow as a Coalition and learn to speak each other’s languages and appreciate each other’s values.

In another approach, we are conducting a job task analysis in order to set the foundation of a larger structure.[2]   Job task analysis is known within industry and industrial training as a mechanism to clarify the skills and knowledge needed to perform a job. We are expanding the format of a typical task analysis so that it may assist us in both the development of competency statements and serve as a bridge between “training” and “education”.   The job assignments are analyzed for duty and task identification and sequence. However, in our approach, once the functional priorities are established, the analysis proceeds to identify a meaningful set of manufacturing competencies.   These competencies set the stage for the identification of learning opportunities that can be ranked using a Quality Function Deployment (QFD) system. This cross referencing and ranking of the curricular topics and job tasks permits some opportunities to remain as “training”, others as “education” and still others as feasible “linkages” forming realistic bridges between the two worlds.   An example follows.

Figure 1. Expanded Job Task Analysis

Rotation Level 3	**Job Assignment: Defense Project Leader**	
Job Duties & tasks	***Performance Competencies***	***Learning Opportunities with QFD***
DUTY 2 --PREPARE AND SUBMIT BIDS FOR ASSIGNED RFQ’s	Manage multiple projects.	Project Management 9
Task 1 Determine the part processing methods available	Generate potential process plans.	Machine selection 9 Process Planning 9 Capability studies 9
Task 2. Evaluate and select suppliers	Determine cost-benefit. Negotiate pricing.	Cost-benefit analysis 3 Fundamentals of negotiation 3
Task 3. Determine the most cost effective process plan	Search technical resources to answer specific questions. Seek out qualified individuals for answers.	Information search skills 3 Read Military specifications 9 Communication & 1 interpersonal skill 3
Task 4. Submit a written detailed process plan to Management	Use computer software. Generate a process plan. Defend judgments.	Computer literacy 9 Decision making 3
Task 5. Quote the new part according to customer specifications	Produce a competitive bid.	Presentation skills 3 Assertiveness training 1

A series of job rotations at increasing levels of functional judgment and requiring increasing academic attainment will broaden the educational and experiential base of the Candidate.

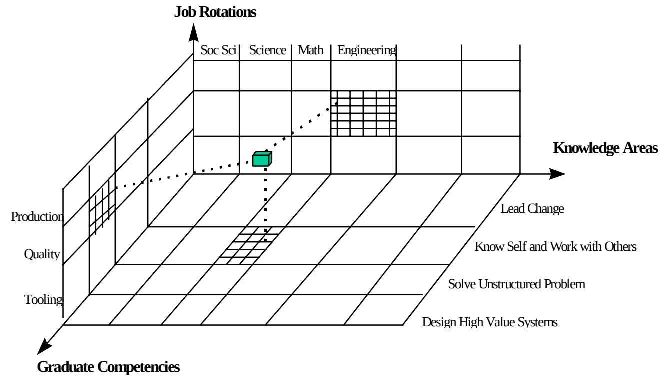
With this Job-Module Map we can obtain a thorough articulation of one manufacturing facility cross referenced to three manufacturing degree programs (AAS, BSET,BSE). We are clear that the CAT is only one manufacturing setting that is mapped, but our point of view is that if we know where the holes are, we have a good beginning. Through this, we will be able to identify where experiences at various levels throughout the CAT manufacturing enterprise are related to the degree pursuit as well as build a portfolio of job performance and work product for future employers.

CHALLENGES

We have a multitude of challenges to face as we pursue this avenue. One is the shear magnitude of mapping an entire manufacturing facility and implementing a system of rotating the workforce without devastating the revenue producing side of the house.. At the time of the writing of this paper, we have identified about fifty candidate job positions at five levels of the organization and across eleven functional areas. Another challenge, is in the administrative discontinuities that arise. A job typically does not translate into a full course credit worthiness. How do we record the patterns that emerge and transcribe them in a meaningful way to internal and external customers like ABET and other universities? Still another challenge, and by no means a trivial one, is to gain consensus from the partners regarding the amount of credit and the location of the credit count within the academic degree program. This issue has generated much discussion and will no doubt continue to do so. We cannot report the solution at this juncture, but we are confident that as QFD exercises are conducted in a team atmosphere there will be real clues that emerge. Even more challenges are faced with the development of highly flexible educational delivery systems in smaller, modular arrangements that can be matched to the relevant manufacturing function at the time when the Candidate is assigned. The Greenfield Coalition has significantly upgraded its ability to produce quality Computer Based Instruction which will contribute to addressing this challenge. Web based deliveries, videoconferencing, and other learning technologies will all be utilized in this paradigm.

The Coalition is also working on developing statements that articulate the knowledge competencies we will expect of the graduates from this paradigm . We began this articulation of the competencies of a manufacturing engineer/ technologist at the beginning of our formation and there are plans to revisit and update those against what we currently understand. This effort is also open to using a QFD process to map the competencies against the job tasks. This third axis mapping will offer additional support and/or challenges to the Job-Module map described earlier. The development of competency based statements of our engineer/technologist is likely to provide a powerful validation tool and a level of accountability not normally experienced in either operational system.

Figure 2 3-Dimensional Matrix from QFD



BENCHMARKING

In our efforts to define a structure that will permit the integration and recognition of practical as well as theoretical knowledge, it was determined that we would benefit from a benchmarking study of existing ways to grant credit for experienced based learning outside of the traditional laboratory or classroom. Five types of models were explored.

<u>Benchmark #1 Medical School -- Apprenticeship</u>

This model employs the learning methodology of coaching-mentoring by an expert. It is a known and time honored model. It is also extremely time and labor intensive as well as highly subjective. It generally is time based rather than competency based which leaves room for crucial gaps in knowledge. Nonetheless, we used the rotational aspects of this model in our own structure.

<u>Benchmark #2 Directed Study</u>

In this model, the Academic Dean of the CAT works with the individual university faculty to identify the appropriate application of the subject content. Ideally, they will locate something within the factory environment that can be used to address the course content and intended competency achievement. It embeds an extracted portion of a daily activity within an academic framework. Negotiation with the faculty member forms the basis and format for the credit allocation. As indicated earlier, we use this approach currently

<u>Benchmark #3 Job Task Analysis</u>

This model uses an industry standard- job task analysis as the starting point for identifying the academic material that is relevant to a specific manufacturing function. The job assignments are analyzed for duty and task identification and sequence. Skills and knowledge required for job performance is noted and, generally a training plan is completed for each individual in the position. As a QS9000 certified, Tier One supplier to the automotive industry training plans are a requirement at the CAT. This approach was incorporated into our model

<u>Benchmark #4 Knowledge Performance Competency</u>

This is a known educational model wherein the performance based competencies of the program are established and the curricular components are worked backwards from there. In this approach the performance competencies are the recognized markers of success. It is a cohesive model that derives the subject content from the competency goal. It requires measurable statements of behavior or tangible evidence of the knowledge base as evidence of the competency. This approach is also incorporated into our model.

Benchmark #5 Student Teaching, Coop, Internship

The Student Teaching model permits practice of the profession as part of the education. Student teaching, or variations such as Co-op, and non-medical student Internship is normally at the end of the academic degree path but within the Bachelor level rather than at a Graduate level like medicine. It is far more limited than the medical model and generally carries not more than 20 credits and lasts for about a semester within the degree program.

GLEANINGS

After examining all of these models we felt that we needed to define some boundary conditions for our own efforts to weave together the utilization of the actual manufacturing facility at Focus:HOPE CAT and the requirements for a fully rigorous academic program.

1. The manufacturing facility cannot feasibly be operated on an academic calendar. Human resources cannot be assigned where and when an academic need emerges. Likewise, the academic credit grantors cannot accept manufacturing action without substantiation to protect their academic integrity. Job duties and work products, in some cases, may need to be expanded to provide sufficient documentation for the academic community.
2. Flexible delivery systems that accommodate manufacturing shift times and topical relevancy are a must.
3. We must be committed to the credit becoming visible and sustainable at an institutional level. The allocation of credit must be institutionally agreed to by all the partners and recognized at their universities.
4. Administrative discontinuities are not trivial but are solvable. Documentation is essential
5. The description of both academic content and manufacturing function must be at a level of detail much finer than normally addressed in order to permit integrative opportunities to become feasible.
6. Practice during and throughout the program is the requirement. Practice after, or at the end of the academic program is not a viable integrative option.

SUMMARY

We use every tool we can find to work on the mandate of the NSF to integrate experiential and academic learning. We have taken pieces from medicine, education, industry, and training and combined them in what promises to be a practical and intelligent approach. As our partnership matures, as we learn from each other, as we hammer out consensus, the design of these tools and the final form of the system will no doubt change. We have set ourselves a goal… to show employers of our graduates a return on their investment in half the normal amount of time. The incorporation of experiential learning into the academic program in a viable and useful manner will take us a good deal of the distance toward that goal. Anecdotal evidence to date with interviewers of the Bachelor degree candidates indicates that these people are highly desirable. Interviewer feedback is extremely positive and we anticipate the growth of an “alumni” population that are ambassadors of this new paradigm.

REFERENCES

[1] Knowles, Malcolm S. , “The Making of an Adult Educator” 1989 Jossey-Bass Inc., Publishers
[2] Norton, Robert E., DACUM Facilitator Training, 1997 Center on Education and Training, College of Education, The Ohio State University

BIOGRAPHICAL INFORMATION

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