WORKPLACE-BASED LEARNING—THE STUDENT VIEW

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Abstract *¾The Focus:HOPE Center for Advanced Technologies is the pilot for the Greenfield Coalition programs. This paper presents the Focus:HOPE mission, and describes the partnership between Focus:HOPE and the Greenfield Coalition in enabling workplace-based learning. We often describe the integration of experiential and classroom learning in the Greenfield programs as the Manufacturing Equivalent of the Teaching Hospital. This paper describes this experience from the eyes of a student in the program, and presents both the strengths and challenges of the approach. A typical day in the life of a candidate (student) is described, and the learning experience developed through involvement in three projects is presented: (1) The design of a Mobile Parts Hospital for the U.S. Department of Defense, (2) the design of a unique CNC machine to process metal matrix composite pistons, and (3) the design of a facility to assemble an engine subsystem for a General Motors vehicle.*

Index Terms ¾Experiential Education, Focus:HOPE, workplace-based learning.

EXPERIENTIAL EDUCATION

It is one thing to talk about experiential learning, another to understand the theoretical advantages of incorporating academic curriculum and integrating the acquisition of knowledge into actual production experience. It is truly another thing altogether to understand the impact this approach has on individual learning experience and life changing insights. The purpose of this paper is to flesh out theory with life experience in order to more fully appreciate the impact of this approach at Focus: HOPE's Center for Advanced Technologies (CAT).

Education is not an add-on to the manufacturing jobs of the Candidates at the Center for Advanced Technologies, but it is fully integrated in three parallel learning dimensions: (1) Learning within the work environment, (2) a mentor/coach relationship with faculty, and (3) technology enhanced learner-centered tools. The closest analogy is to a teaching hospital where the intern must fully integrate theory and practice, not in a virtual way, but in real life situations where decisions have immediate real life consequences.

Analogy becomes actuality at Focus: HOPE. Three projects demonstrate how and why Focus: HOPE was chosen to demonstrate its capabilities for research and development and agile manufacturing – the design of a Mobile Parts Hospital for the U.S. Department of Defense, the design of a unique CNC machine to process metal matrix composite pistons, and the design of a facility to assemble an engine subsystem for a General Motors vehicle.

FIGURE 1
CANDIDATES WORKING ON MOBILE PARTS HOSPITAL CONSULT WITH AN ENGINEER

Why was Focus: HOPE chosen to develop these three projects? All three required a fast and flexible organization which could make changes on the fly and had a culture which could look past existing paradigms of manufacturing engineering. Focus: HOPE is at the forefront of the agile revolution in manufacturing.

It was a natural fit – for me and the manufacturing culture of Focus: HOPE. Agility is the ability to thrive in a continuously changing, unpredictable environment. In manufacturing it means the ability to reconfigure the means of production –hardware and software— to focus on the changing needs and demands of the customer. And it means the willingness to abandon a comfort zone to learn new techniques to get the job done.

Focus: HOPE helped me abandon my comfort zone and look to the future. Like most youth, I wasn't sure what direction to take with my life. In early 1989 I took my girlfriend to the to receive food distributed by Focus:HOPE to young mothers, children and seniors. More than 27,000 people receive food at the Food Centers each month. But

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Focus:HOPE is not about handouts, but about opportunity. At the food center, a video tape about Focus: HOPE's Centers of Opportunity explained the Machinist Training Institute (MTI) program. My girl friend said that I should try and take the test to enter the school. I did, and I failed.

My basic math and reading skills were not up to the demands of the Machinist Training Institute, so I entered the 4 week Fast Track program to boost-up my Math, English and communication skills. After I completed Fast Track, I entered the Machinist Training Institute and two weeks before graduation, Focus: HOPE sent me and three other students to Cincinnati Milacron for training on a CNC lathe. After receiving a certificate in operation and programming of the CNC lathe, Father Cunningham and Eleanor Josaitis, the co-founders of Focus: HOPE told us that since we were now experts on this equipment, as well as Ambassadors of Focus:HOPE and the Center of Advanced Technologies, that we were fully capable of programming the lathe to machine pulleys for Focus: HOPE's first major contract. We didn't know Father Cunningham that well at that time but he was serious and he believed we could do it and we did.

Soon after, I accepted the challenge of helping to develop the C.A.T. program in November 1990 and officially enrolled at the CAT in 1996. I received my Associates of Science degree in Manufacturing Engineering Technology in 1999 and my Bachelor of Science degree in Engineering Technology in 2001. It was during this process I learned how to be agile as well as implement an agile manufacturing capability.

MOBILE PARTS HOSPITAL

The development of the Mobile Parts Hospital for the United States Army demonstrates how the three parallel learning dimensions at the heart of the Greenfield Coalition paradigm came together to develop these projects.

FIGURE 2
THE MOBILE PARTS HOSPITAL READY TO ROLL

The Mobile Parts Hospital (MPH) is a compact communication and manufacturing unit housed in a fifty-three foot trailer and is capable of being transported directly to the field of combat. It is designed for deployment to remote locations for emergency repair of non-operational equipment directly at the site.

The tractor trailer has three major sections – a vertical machining center equipped with a Cincinnati Arrow VMC500; a virtual manufacturing theater equipped with DVD/HDTV with a large flat screen display, and a communication center equipped with video conferencing, voice controlled video and satellite and cell phone data transfer capabilities. The third area of the trailer is also equipped with a DTM 2500+ Sinterstation for selective laser sintering of metals, plastics, ceramics and rubber-like materials.

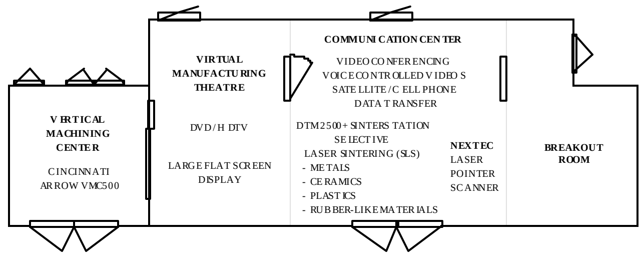

FIGURE 3
MPH LAYOUT

The MPH is capable of retrieving manufacturing data via satellite from an extensive solid model database of parts so that the facility can quickly and efficiently produce repair parts on demand.

In the event part data is unavailable, or there is a communications failure, the MPH is capable of gathering its own geometric data through the use of a 3-D laser scanning system. The scanned data can be sent to a computer aided design software package for conversion to manufacturing data, and then into the CNC machining center, or to the laser sintering machine for production.

The MPH will also be linked to three "Agile Manufacturing Cells" located strategically across the United States. These agile manufacturing cells will be small factories capable of engineering, producing and inspecting all types of parts. The capabilities range from machining and welding to heat treating and plating. The cells will be able to create multiple quantities of parts on demand with flexibility, efficiency and mobility.

The expectation is that this prototype for rapid manufacturing technology will spread across the military and eventually into other areas such as medical, heavy construction, oil drilling, and disaster relief applications.

METAL MATRIX COMPOSITE PISTON

I'm also proud to be part of the team who developed Focus: HOPE's first major R&D project in partnership with the National Automotive Center, General Motors Corporation, and The University of Michigan, to develop a prototype to machine Metal Matrix Composite (MMC) pistons in a single chucking and single machining application.

FIGURE 4
MPH Laser Scanner

The U.S. Army required a stronger, more efficient piston for use in the Army's HMMWV (Hummer) 6.2L engine to increase engine horsepower by 25% and reduce the Army's dependence on obsolete commercial components. Focus: HOPE's Center for Advanced Technologies was chosen to develop the prototype because of its experience in developing agile manufacturing technologies.

Focus: HOPE, working in concert with Cincinnati Machine, used a standard Series 1200 Vertical Machine and modified the machine with a special fixture and advanced software controls to allow all machining operations to be completed on the same fixture within 16 seconds compared to traditional machining steps which typically requires 15 separate steps

At the heart of the prototype is the fixture which grips the piston and moves the squeeze cast piston blank through the six stations running at 4,000 to 5,000 surface feet per minute. The first machining step, degating and rough finishing, required that the fixture would not shift, allow the same tool to machine the aluminum and silicon carbide, and mitigate the effects of pressure exerted by the holding fixture on the piston.

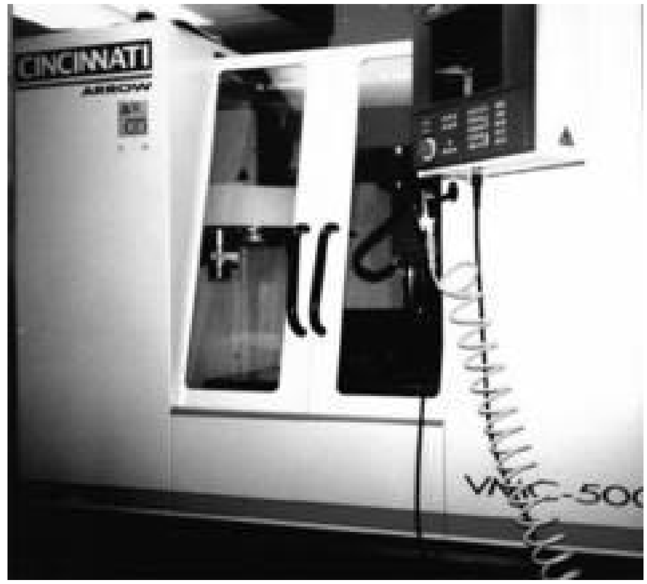

FIGURE 5
MPH Vertical Machining Center

After degating, the holding fixture moves to the second step to finish the outside diameter to specification. Running at 7,000 RPM instead of the 2,000 RPM utilized in current practice, resulted in reduced machining time, extended tool life, better finish and consistent distortion.

Steps 3,4, and 5, finishes and deburrs the ring grooves, rough bores the pin hole, finishes the boring of the oil groove diameter and chamfers the inside wall edge of the pin bore. Much work was done on the experimental tooling to address the challenges of cutting from soft aluminum to silicon carbide. The sixth and final finishing step to finish the pin bore has special requirements due to the extremely high finishing speeds of 15,000 – 20,000 rpm. No coolant is used during the machining process. High speed mitigates heat transfer with the additional benefit of helping to eliminate the typical machining mists found in standard production practices. In addition to requiring agile machine configuration and integration, this project also required the development of an advanced air handling system to eliminate air borne fibers present in metal matrix materials.

ENGINE SUBSYSTEM

When a major automobile manufacturer wanted a supplier for a water pump assembly for use in its premium luxury cars, it chose Focus: HOPE. The key factor to being able to be a Tier One supplier to this manufacturer was Focus: HOPE's ability to run a prototype and a pilot on the production line and make quick changes as necessary. Focus: HOPE manufactures 650 of these assemblies every day and is capable of producing up to 1,120 units per day.

These water pump assemblies have 29 separate components shipped to us by other suppliers. As a Tier One supplier, we are fully responsible to the manufacturer for the entire unit.

A DAY IN THE LIFE OF A CANDIDATE

I can think of no other place where a student would have the opportunity to work on and actively contribute to such advanced R&D projects while still studying for an advanced degree. I'm proud to be part of this innovative experiential learning program, but it does have a cost – and another opportunity to become agile in one's personal life. I'll describe a typical day for a CAT candidate.

I wake up at 4:30 a.m. in the morning every day, but take the luxury of hitting the snooze button until 5:00 a.m. Then, a quick shower, and if I am lucky, grab a piece of toast or fruit to eat on the way to work. I have to leave no later than 5:40 a.m. I must be at my workstation by 6:00 a.m. and no later.

Usually we have a meeting at 6:00 a.m. and it lasts until 7:00 a.m. Then we work on the production processes all day long until 2:30 p.m., then it's time to go to class. That's right after a long eight hour day, candidates must go to class for another three hours until 5:45 p.m. During this time, it is not always possible to stop for lunch or snacks. Usually the instructors let us eat in the classroom while they are teaching.

If everything goes according to plans, I may get home by 6:05 p.m. to be with my children. I am a married, and had six children when I started the CAT. So after spending some time with the children, and check their homework, it is about 7:30 p.m. Once the children are fed and their homework done, I can now do my homework. Usually I am done by 10:00 p.m., but often I must stay up until midnight studying before going to bed to prepare for the next day's schedule.

CONCLUSION

It's a difficult program, but also a tremendous opportunity to be part of an exciting new paradigm for engineering education. I'm learning state of the art techniques as well as how to be a leader and an agent for change – a renaissance engineer – ready to adapt to a fast-paced and fast changing industry. I'm ready for my real journey to begin once I have finished my studies at the Center for Advanced Technologies.

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