

## **Manufacturing Engineering Technology Program Addition of a Sustainability Option**

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### **Abstract**

The Chemical Engineering Technology (ChET) program at Austin Peay State University (APSU) has been suspended after an extensive 3-year effort to convert the program to online delivery. Opportunities have been identified to capture the process technology subject matter for deployment in another program that could benefit from the online availability. One of these promising opportunities involves the existing Engineering Technology program at APSU via the addition of a Sustainability option within its Manufacturing Engineering Technology Concentration (B.S. in ENGT). A proposal for a new Sustainability option built upon the captured ChET body of knowledge is currently being prepared. Much of the original ChET subject matter is already commonly included in the ENGT curriculum. The unique material from the ChET program is primarily associated with energy production and consumption, other industrial inputs and the Health, Safety & Environmental concerns in the manufacturing industries. With some additional course work, this unique ChET material will be expanded to meet the requirements of a new Sustainability option. The full paper will provide details for this new Sustainability option inside Manufacturing Engineering Technology..

### **Keywords**

Sustainability, Online, Manufacturing

### **Chemical Engineering Technology – Unusual Opportunity**

The Chemical Engineering Program (ChET) at Austin Peay State University was started in the Fall semester of 2009 to meet the needs of the growing polysilicon processing industry in Tennessee. This new ChET program was situated in a geographic region that does NOT contain a significant number of employment opportunities in the traditional Chemical Process Industries. However the excitement associated with the “clean” nature of Solar Photovoltaic energy was unavoidable. Although exciting, it was recognized that the polysilicon processing industry was not sufficiently large enough to support an on-going ChET program over the long-term. Therefore it was decided that the ChET curriculum at APSU should leverage this focus on solar energy with an expansion into other forms of renewable energy. Luckily the ChET faculty members had extensive experience in the traditional fossil fuels and several alternative energy technologies. Likewise the Health, Safety and Environment (HSE) subject matter was emphasized in the ChET program recognizing the importance of these subjects in all energy industries. Similar to HSE, Quality Control and Improvement has always been a fundamental focus area for Chemical Engineering Technology programs.

Unfortunately the major employer of ChET graduates announced a massive layoff in January 2013 and proceeded to completely withdraw from Tennessee (over the following 3 years). This devastating event motivated the ChET faculty to find another mode of delivery for the subject matter that they had worked so hard to develop. Therefore they undertook an extensive effort to completely convert the entire ChET curriculum to online delivery. With a few false starts and some repeated efforts, several key learnings were captured and a workable methodology was finally adopted for the conversion effort. The accepted methodology enacted to transition the traditional “live” lecture content to an online format involved audio and video additions to the normal static lecture slides. Typical in-class problem solving sessions were captured, converted to short recitations and delivered as stand-alone movies. In the process of performing these online conversions, it was recognized that connections between lecture material and lab exercises were easily lost and it became necessary to enhance the recitation effort to include lab discussions. During the intervening 3 years, all of the above subject matter areas were dissected, analyzed and re-synthesized into an asynchronous, online delivery system for the ChET program at APSU. All of the course material was delivered in consistent formats acceptable in the university Course Management System. C. Little et al.<sup>1, 2, 3, 4, 5</sup> describe this conversion methodology in detail in the references listed below.

However the ChET program at APSU was unable to overcome the lack of process technology employment in its region after the exit of its major employer; even the online program did not attract an adequate number of students to continue. The loss of the ChET program was definitely disappointing for the ChET faculty but it was hoped that the key learnings and work product from the online conversion effort could be captured and used in another university program. APSU also has a Manufacturing Engineering Technology program that shares many similarities with the erstwhile Chemical Engineering Technology program. Upon review of the similarities and other areas where the programs could synergistically combine, it was determined that energy (production, consumption and efficiency), industrial Health, Safety and Environment considerations and Manufacturing Excellence were common, significantly important and worthy of a more serious investigation.

### **Sustainability Programs – Scope and Focus**

While the Engineering Technology programs at APSU were undergoing such enormous change, a new “discipline” was forming that encompasses many of these same subject matter areas in addition with other pertinent fields of study. Sustainability was taking form as a broad, but ill-defined, discipline of study. Several APSU faculty members recognized that the industrial (manufacturing) sector was not adequately served in Tennessee by the emerging Sustainability efforts. Furthermore it was noted that the Sustainability needs of the manufacturing sector were centered around those same subject matter areas described above as synergistically common to the Chemical and Manufacturing Engineering Technology programs. Many manufacturers are focused on lowering cost through efficient operations that are rooted in sustainability practices. These practices have contributed to the emergence of a manufacturing renaissance in the United States within the last decade. Considering these impacts, it was hoped that the work product from the ChET online conversion effort could become useful again in that it provides a course-by-course, lecture-by-lecture, slide-by-slide analysis of much of the needed subject matter. In this dissected form, the subject matter can be modified, augmented and re-combined to fit a new purpose. The related course material from similar Manufacturing Engineering Technology

courses will serve to complement the ChET material and transition the ChET curriculum from a 2-year program serving a subset of the Chemical Process Industries to a full 4-year program serving the entire manufacturing sector. Furthermore the Manufacturing Engineering Technology material will elevate the Math and Science rigor of the Sustainability discipline far beyond its current status. It should be noted that Sustainability faculty members should be motivated to reduce the energy intensity of “Sustainability” courses by delivering an ever-increasing amount of course content in an asynchronous, online delivery mode thereby minimizing travel (and parking space searches) to/from campus. The online course material from the ChET program is an excellent starting point for this purpose.

### Plan for New Option – Manufacturing Sustainability

With emphasis on the Manufacturing sector, it is appropriate to use the Manufacturing Engineering Technology lower-division preparation curriculum for this new Manufacturing Sustainability option. Upon review, it was obvious that the Math and Physics preparation was excellent but additional preparation would be necessary in the other natural sciences (Chemistry, Biology, Geology, Geography and Agriculture). Many successful manufacturers not only focus on energy reduction as part of their sustainability effort, but they also put significant importance on responsible environmental and social practices as an indispensable part of the company’s values. These efforts include focusing on ergonomics with more specific and complete concern about employees’ physical and mental stressors encountered in the workplace that may strain proper work-life balance. These practices have historically been taught outside the traditional engineering technology departments. Rather than propose new courses in the Engineering Technology departments, it was decided to find appropriate existing courses for the majority of the natural science subject matter and supplement Engineering Technology courses with that remaining subject matter that is unique to Sustainability considerations. The following table briefly describes the existing Manufacturing Engineering Technology preparation courses.

Existing Manufacturing Engineering Technology Preparation Courses	Remarks
Math Preparation	Descriptive Statistics, College Algebra, Trigonometry and Applied Calculus
Physics Preparation	Entire Algebra/Trig-based Physics sequence
Material Science	potential for incremental Chemistry preparation
Statics and Strength of Materials	could introduce sustainable building materials
Engineering Economics	could supplement with Project Management Basics
Problem Solving in Engineering Technology	could introduce dynamic behavior
Thermodynamics	potential for incremental Chemistry preparation
Production/Operations Management	will include Production Quality Control and Improvement and Manufacturing Excellence material

The following table contains descriptions of those upper-division courses that are specific to Manufacturing Sustainability. Many of these courses are already available in Engineering

Technology or other departments on campus. The manufacturing focus is evident in these courses but the breadth of the Sustainability discipline is also addressed.

“New” Manufacturing Sustainability Courses	Remarks
Health & Safety in the Manufacturing Industries	shared with other Engineering Technology concentrations
Fossil & Sustainable Energy	significant physical science content – CO2 emissions, supporting campus Sustainability effort
Product Stewardship and Control	significant Chemistry and Biology content
Systems Dynamics Modeling	physical models, of course, but will also include social systems
Environmental & Social Justice	similar course already available
Land and Soil Conservation	similar course already available in Agriculture
Industrial Energy Efficiency Improvement	shared with other Engineering Technology concentrations
Water & Earth Systems	similar course already available in Geography
Environmental Considerations in the Manufacturing Sector	shared with other Engineering Technology concentrations
Energy Efficiency Improvements for Buildings	outgrowth of and supporting campus Sustainability effort
Modeling Environmental Systems	extension of Systems Dynamics Modeling
Modeling Climate Systems	extension of Systems Dynamics Modeling

### Future Work – developing a proposal

The completion of the above work has encouraged the authors to recruit allies and support for an undergraduate Manufacturing Sustainability program at Austin Peay State University. Like most universities, APSU is very interested in Sustainability efforts for improvement in campus operations and its impact on the surrounding community. The distinguishing benefit of the Sustainability discipline is its wide approach to issues and its ability to address multiple concerns within one solution. The Manufacturing sector is NOT isolated in its communities and regions and therefore cannot independently function within itself. The lessons of the Sustainability discipline are extremely valuable but the Sustainability efforts must be focused for the Manufacturing sector.

Additional work is necessary for the Manufacturing Sustainability concentration to gain greater definition. After sufficient granularity has been developed, the authors will approach several potential industrial partners throughout the Manufacturing sector for potential interest, support and suggestions. It is hoped that a number of new Industrial Advisory Board members will be identified by the above efforts.

Lastly the authors will develop a complete proposal to the academic decision-makers at Austin Peay State University. That future proposal will include sections addressing Student Learning Outcomes in service of ABET-ETAC accreditation and potential endorsement by an organization of Sustainability Professionals.

## References

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## Chester Little

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