CACHE News
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NSF Sustainable Manufacturing Modules

Mahmoud El-Halwagi and Debalina Sengupta

The Sustainable Manufacturing Advances in Research and Technology (SMART) project funded by the National Science Foundation aims to bridge the gap between academic knowledge discovery and industrial technology innovation for sustainable manufacturing. The SMART project involves a multidisciplinary team which has created an interdisciplinary and international Research Coordination Network (RCN) through the joint effort among a number of leading academic laboratories, centers, non-government organizations, and major manufacturing industries. Meeting the educational goals of the SMART CN has been achieved through creation and coordination among member universities and developing online modules specific to sustainable manufacturing through self-study.

The presentation will provide an overview of this educational component of the project with emphasis on the dissemination of modules supported by computer tools for incorporation into the engineering curriculum. These modules include topics like life cycle assessment, green design, and engineering, green chemistry, process intensification, process integration, optimization, and process safety among the core module elements. Test-use data, classroom use experience and general student feedback will be shared. These can be adopted by chemical, mechanical, civil, environmental, and other engineering disciplines. Extensive case studies demonstrating these concepts are also provided for classroom teaching, homework assignments and term projects. The modules already available through the CACHE website have been reviewed by corporate sustainability teams, as well as academic instructors.

Module Name	Developer/Affiliation	Module Content
Life Cycle Assessment for Sustainable Manufacturing	Debalina Sengupta, Texas A&M University	Core Topic: provides overview of life cycle assessment methodology as outlined in the ISO standards, Emphasize the utility for the LCA methods for manufacturing sustainability Assessment Tools: Case study for a chemical production process choice for methanol, assignment set Supporting Documents: spreadsheet tool demonstrating case study Learning Outcomes: Understand the role of process engineers in providing effective inventory data for LCA, conduct screening level LCA studies for sustainable manufacturing.

Sustainability Metrics and Sustainability Footprint Method	Debalina Sengupta, Texas A&M University	Core Topic: Provides overview of methods to compute sustainability metrics. It also gives a method compute overall sustainability by aggregating metrics. Assessment Tools: Two case studies are presented on automotive shredder residue treatment method and on automobile fender formulation. Supporting Documents: spreadsheet tool demonstrating case study Learning Outcomes: Understand the metrics used for measuring sustainability, compute these metrics, and then use the sustainability footprint method to decide on best option.
Sustainable Process Design	Jeffrey R. Seay, Assistant Professor, University of Kentucky	Core Topic: Introduces the concept of green chemistry for green design of processes, gives three methods for assessing "greener" processes: The WAR Algorithm for computing the potential environmental impact (PEI) of a process, Life Cycle Assessment for assessing environmental and other impacts, and inherently safe process design. Assessment Tools: Case study for assessing sustainability of acrolein production, assignment set for pre-test on sustainability and five guided inquiry activities. Supporting Documents: Aspen Plus design files for acrolein production Learning Outcomes: Learn the theory for green chemistry, green engineering, and sustainability assessment methods.
Sustainability Root Cause Analysis (SRCA)	Helen H. Lou, Professor, Lamar University	Core Topic: Demonstrates Sustainability Root Cause Analysis (SRCA) as a tool to determine the bottlenecks for a system's progress towards sustainability. The framework is built on the combination of Pareto chart and the Fishbone diagram, in conjunction with a set of sustainability metrics (economics, environmental and safety). Assessment Tools: Three case studies with assignment set on steam reforming of methane, polygeneration, and LNG process Supporting Documents: ASPEN Plus design files for the case studies Learning Outcomes: Learn how to combine quality assessment method of Root Cause Analysis (RCA) and sustainability metrics to determine a sustainable manufacturing process.