UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*Siemens Energy Inc.*	**Date Submitted**	*3/6/2020*
Project Title	*Design of Autonomous Manufacturing Process within a Robotic CNC Cell* **(SIEM_CELL)**	**Planned Starting Semester**	Fall 2020

Personnel

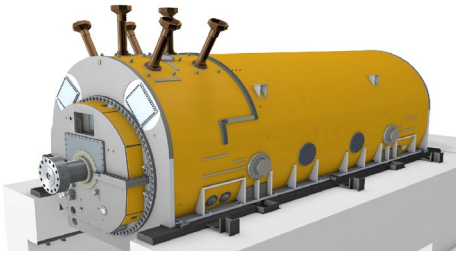
Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

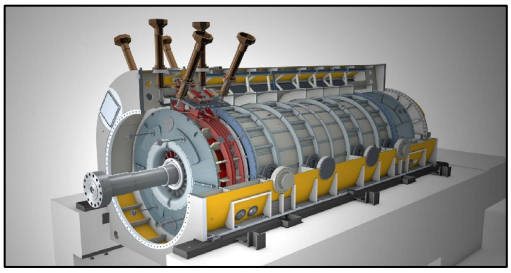
Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	5	Electrical	
Computer		Systems	
Other ( )			

Company and Project Overview:

The Siemens Charlotte Energy Hub is the company's worldwide hub for 60 Hz power generating equipment. Opened in 1969, the facility has manufactured and serviced generators and steam turbines for the power generation market for decades. In November 2011, the facility celebrated the opening of a new expansion, adding gas turbine production and service capabilities. The new Gas Turbine facility was designed based on LEAN manufacturing principles and certified for U.S. LEED Gold green building standards, making it the most advanced gas turbine production plant in operation. The expansion represents a $350 million total investment in Charlotte, adding 1,000 jobs. With its current workforce of 1,500 and more than one million square feet of space under roof, Siemens Energy in Charlotte has become the largest manufacturer in the city and the second largest among the 250+ Energy companies based in Charlotte.





The project is sponsored by the Siemens Generator Manufacturing department in Charlotte NC. The project is to develop a process to machine multiple different sized parts out of metal sheets to support Generator insourcing. The project will be to design fixturing, clamping systems (hydraulic, pneumatic, as necessary), and developing manufacturing process for autonomous machining utilizing Mazak Integrex e-1550V/10, Mazak Palletech, and a Kuka Robot.

Project Requirements:

Siemens has invested in a very sophisticated automation process for machining parts for its generator products. This work cell allows a material handle to deliver raw part blanks to the CNC center and later come back and retrieve machined parts. This work cell is shown in the photo below:

The Kuka robot (orange robot on the right) takes incoming raw material off of racks and places this into a fixture table. The raw part blank loaded into the table is transported, by the Mazak Palletech system (not visible), to the CNC machining center (black box on the left). Once machined, the Mazak system transports the finished products back to the Kuka robot where they are taken off the table and placed onto finished part racks then pushed out of the cell. To increase the utilization of the system, Siemens would like to design additional fixtures and tooling to allow parts that are currently manufactured externally, to be made at their Charlotte location.

This development would require the following:

1. Design of fixturing and process for the Kuka Robot to load raw materials and unload finished product. It is envisioned that the physical dimensions for the raw blank and the resultant machined parts would be the same. This would be accomplished by leaving the machined parts in the raw material frame by tabs that would be removed in a later manufacturing process. This task would include a raw material rack for a single type of rectangular, metal raw material blank and a manipulator for the end effector of the Kuka Robot.

Figure 1: Kuka Robot with fixturing and clamping example shown.

2. Design of clamping and fixturing (hydraulics, pneumatics, or manual clamps) for a Mazak Palletech table that the Kuka robot will transfer the part blank onto (and off of when unloading the machined part). This is an example of a base table that a fixture would be built on:

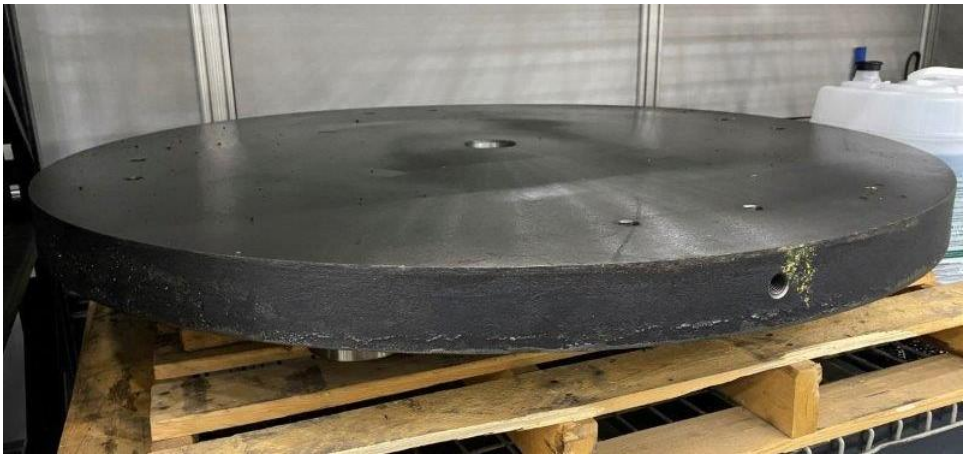
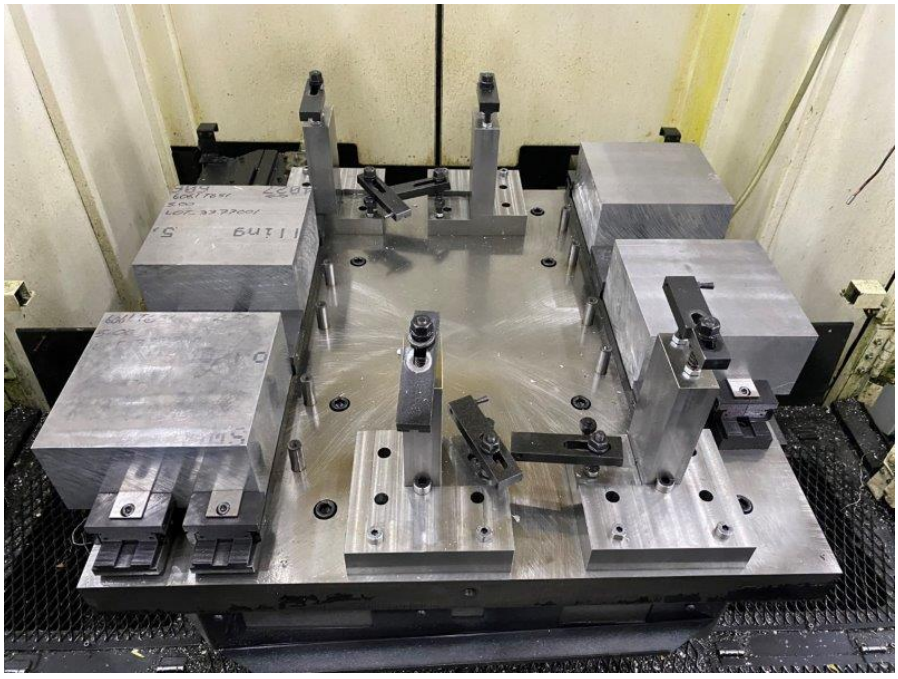


Figure 2: Mazak Palletech Table carrier

Below, is an example of a fixture built upon the Mazak table. The Mazak system would transport the blank part into the CNC center, the CNC center would machine the parts, then

the Mazak would transport the fixture back to the Kuka robot for unloading and placement onto a finished part rack.



This photo shows the Mazak transport table that transports part blanks from the Kuka robot to the Fanuc CNC machine.

1. Items 1 and 2 are the required parts of the project. It would be desirable if the team also

developed a method of autonomous deburr process / technique for the underside of the machined parts

2. There are additional design and development opportunities for programming of the Kuka, Mazak and Fanuc CNC if time permits. This is not a required part of the project, but Siemens would provide training if the team wanted to do this part of the solution.

Expected Deliverables/Results:

- Mechanical items:
    - Frame for holding rectangular blanks
    - Manipulator for Kuka robot to grasp part blanks and load into Mazak table fixture
    - Mazak table fixture for Palletech system
- Complete drawing package that can be given to a machine shop to be able to fabricate and assemble additional fixtures:
    - CAD drawings for every part
    - Bill of materials
    - Assembly instructions
    - Recommended maintenance procedures
    - Cost Estimates for fixture
- Analysis of fixturing and robotic clamping
    - FEA or other analysis to ensure proper clamping during machine and robot process to avoid safety incidents, damage to machine, or scrap.
    - Cost analysis of different clamping / fixturing process
    - Cost analysis of tooling options
- Verification testing of fixtures in operation in the CNC cell.

Disposition of Deliverables at the End of the Project:

Fixtures and report to be given to the Supporter after conclusion of the Expo. The display at Expo will consist of the parts designed and built by the team. The context of the operation of the cell will have to be conveyed by video as it is not possible to display the robot and CNC center at Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Mechanical design
- Capability to design for mechanical specifications including, weight, lifting, deflection, etc.
- CAD
- Ability to travel to Siemen's Charlotte location to gather design specification information and perform verification testing as required.