BINGHAMTON UNIVERSITY
STATE UNIVERSITY OF NEW YORK

Thomas J. Watson
School of Engineering
and Applied Science

Watson Capstone Projects
Project Proposal Form

Computer, Electrical, and Mechanical Engineering
2015-2016 Version

*Please complete the following to submit a project proposal for a multidisciplinary senior capstone project team. In order to be guaranteed consideration, submission should be received by **August 15st**. You will be notified when this form is received, and then again in early September to indicate whether or not the project has been approved.*

Please submit this form via email to watson.capstone@binghamton.edu, with an updated filename and email subject line.

1. **Project Title**
   Center for Technology and Innovation (CT&I) Spindle Drill Controller

2. **Organization Name and Address**
   IEEE Binghamton Section

3. **Contact Names, Phone, Email Address**

   a. **Sponsor Management Representative:**
   Daniel Sniezek
   desniezek@yahoo.com

   b. **Sponsor Technical Representative:**
   Tommy Lam
   tlam14@binghamton.edu

   c. **CT&I Engineering Advisor:**
   Arthur Law
   (607) 725-9306
   alaw@stny.rr.com

4. Project Description

CT&I has acquired an Electro Scientific Industries (ESI), Inc., Spindle Drill that is used for drilling holes with very high accuracy in Printed Circuit Boards (PCBs). The Spindle Drill can move in the X-Y direction and commanded to select and mount different size drill bits. This proposed project is a two year project to develop a Spindle Drill Controller to control the Spindle Drill (Year 1) and then to develop visitor interactive demonstrations/games using the Spindle Drill suitable for use in a museum setting (Year 2).

5. Project Requirements

These are the project design objectives and describe what the device/program shall do as well as other items such as operating environment, standards, etc. Use the word "shall" for hard requirements that must be met and the word "should" for requirements that are desirable but not absolutely necessary (stretch goals).

Requirements should be unambiguous, verifiable (testable), goal-oriented (desired goal, not how to achieve it), and realistic. Some areas to be considered are performance, functionality, economics, energy, environment (impact on earth resources), health and safety, reliability, maintainability, manufacturability, operationality (e.g. temperature, humidity), and usability. Please be as specific as possible. The project team will develop these requirements into a formal project requirements specification.

Pictures of the spindle drill is provided in the PowerPoint presentation embedded at the end of this proposal.

The spindle drill consists of:

1. DC Servo motors that move the drill in the X-Y direction over an area of approximately 20 x 20 inches.
2. Control of the drill in the Z direction through a magnetic solenoid.
3. Pneumatic control of the drill to select and insert a drill bit.
4. Control of fluid that is used to cool the drill. Whether the cooling fluid is required will depend on the kinds of demonstrations/games implemented.

This project is anticipated to be a two year project. The objective of Year 1 of the project (the subject of this proposal) is investigation, discovery, and demonstration on how to control the Spindle Drill.

1. Characterize and learn how to control the spindle drill
2. Create a simplified spindle controller that shall demonstrate:

a. Control the XYZ movement of the spindle drill

b. Control of the spindle drill drilling functions

The objective of Year 2 (the subject of next year's proposal) of the project is development of a computer based Spindle Drill Controller and creation of visitor interactive demonstrations/games:

1. Create a computer based controller that is demonstrates increased capability and accuracy in the control of the XYZ movement of the spindle drill and drilling capabilities

2. Create a generalized control interface in software to make the development of demonstrations and games easier

3. Creation of demonstrations & games suitable for visitor interaction

The total project is divided into the following steps. At each step there will be a team discussion between WCP Team, CT&I, and Triple Cities Makerspace. At each step we will define the specific goals, technical challenges, specific requirements, and division of requirements between the WCP Team, CT&I, Triple Cities Makerspace.

Step 1 (Year 1): Investigation of the Spindle Drill

The WCP Team shall determine the required signals to operate the Spindle Drill. Operation of the Spindle Drill includes:

a. Movement of the Spindle Drill in the X-Y direction. Determine how fast and how accurate the Spindle Drill can be moved.

b. Movement of the Spindle Drill in the Z direction. Determine vertical limits and accuracy of the Spindle Drill.

c. Determine how limit sensors operate. The limit sensors limit the movement of the drill in the X-Y direction.

d. How to command the Spindle Drill to select and insert a drill bit.

e. Control of drilling operation

f. Determine the need for and operation of the cooling fluid

Results of the investigation and discovery shall be documented in a Theory of Operation document.

Step 2 (Year 1): Simplified Controller

The purpose of Step 2 is to demonstrate that the WCP Team has an understanding of how the Spindle Drill operates. Based on the results of Step 1 the WCP Team shall build a simplified controller that will move the Spindle Drill in the X-Y direction and up/down direction. The movement of the Spindle Drill shall be within the operational limits and be constrained by the limit sensors. The controller shall be able to control the drilling capability and bit selection of the Spindle Drill. The controller can be an integrated device or it can be multiple devices that each demonstrates control of one or subset of the Spindle Drill functions.

Step 3 (Year 2): Computer Based Spindle Drill Controller

The WCP Team shall build a computer based controller to operate the Spindle Drill. The computer based controller shall allow for more complex motions of the Spindle Drill. The Spindle Drill Controller is divided into two parts.

a. Develop computer software and electronics that shall control the Spindle Drill.

b. Develop a user interface that shall allow a visitor to control the Spindle Drill. The nature of the user interface can take many forms. Listed below are the types of input and use.

    a. Joystick input to drive the spindle in the X-Y direction.

    b. On a display allow the user to select “command blocks” that are linked together which command the Spindle Drill in the specified sequence of operations.

    c. Input text such as a name. The Spindle Drill will then drill or carve the text into metal or wood.

    d. Control of the Spindle Drill based on the output of an Xbox Kinect motion sensor

There shall be a clear divide between the software and electronics that drive the Spindle Drill and the user interface software so that multiple user interfaces can be implemented.

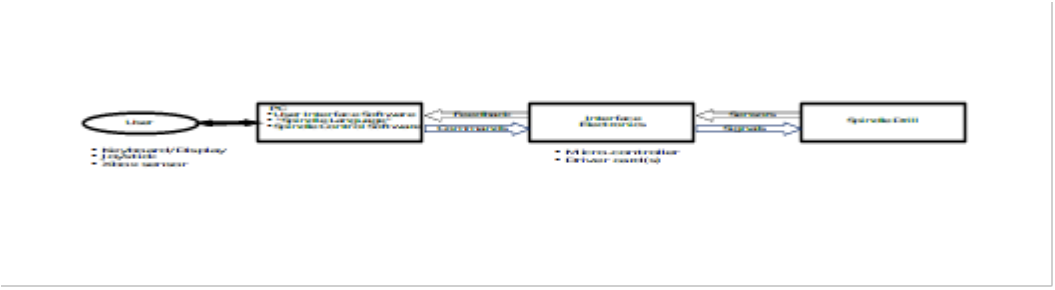
Step 4 (Year 2): Demonstrations/Games

The WCP Team shall propose demonstrations/games that shall be implemented on the Spindle Drill under the control of the computer controller. The selection of the demonstrations/games to be implemented shall be jointly made by the WCP Team, CT&I, and Triple Cities Makerspace. Examples of demonstrations/games are:

1. Etch-a-Sketch
2. Have the spindle drill push a ball through a maze
3. Carve simplified 3-D figures in wood or plastic
4. Drill/carve letters onto a slab of wood based on input by the visitor

6. Project Graphic

Please include a system diagram, flow chart, or mechanical layout drawing.



System Diagram Of The Final Year 2 Computer Based Spindle Drill Controller

7. Budget

Please provide the students' total budget amount for the project, along with estimates for any large ticket items as well as an amount for small items, prototyping, rework, and consumables (typically $50 to $100 per student). This budget may be refined during the project startup phase.

Our normal practice is for the students to make all purchases for their projects and be reimbursed by the university; we then invoice you at the end of the project. Please indicate if you desire an alternate arrangement.

It is anticipated that a budget of approximately $500 is sufficient to purchase the components and supplies for the Year 1 project. The components and supplies will be used to probe and experiment with the Spindle Drill and create the demonstration controller:

1. Prototyping boards
2. Wires
3. Connectors

4. Discrete components
5. Printed Circuit boards
6. Micro-controller such as an Arduino or chipKit

8. Deliverables and Meetings

Please be as specific as possible, especially considering user manuals and installation guides as project appropriate. Describe your expected meeting schedule and locations.

The resulting project system will be delivered to you, if you like, or the non-profit "client" organization, if applicable.

Deliverables for Year 1 project:

1. Theory of Spindle Drill operation
2. Simplified controller including all schematics, documentation, and (if applicable) software

Periodic meetings will be held at the Center for Technology & Innovation at 321 Water St, Binghamton NY. Meetings shall be weekly at the start of the project and transition to bi-weekly at a mutually agreed point in the project.

9. Recommended Team Composition (3-5 students)

Please indicate the desired number of students from each discipline. Note that occasionally Biomedical Engineering, Computer Science, or Systems Engineering students are also available.

Mechanical Engr: 1 Electrical Engr: 1-2 Computer Engr: 1-2

10. Citizenship Requirements (if any)

No requirement

11. Team Members (optional)

Indicate the names, emails, and major of student(s) (if any) that you request to be on your team. It is not guaranteed that these students will be on the team as their skills may be needed elsewhere.

Typically this field is left blank unless this project is student-initiated or a continuation of a working relationship you have with a student.

12. PowerPoint Presentation

This PowerPoint Presentation has pictures of the spindle drill.

Spindle Drill Project.pptx