BACK SLIDES

TEST SPECIFICATION

- Testing:
  - Program to calibrate hardware
  - Implementation program
- Not testing:
  - Any physical hardware
- Major areas to test:
  - Conversion of G Code to Arduino specific language
  - Timeliness of commands

DELIVERABLES

- Calibration program
- Program to interface with 3D printer
  - Send data to allow hardware to produce 3D object.
- Specification on how to control device and printer

DELIVERABLES – INTERFACING PROGRAM

- Model slicing software
  - Utilize open-source software stacks
    - RepRap CAM stack
- User interface
  - User may select file
  - User may begin, pause, or cancel print
  - User will see status of printer at all times

SOFTWARE DESIGN

- C++
- Utilizing RepRap CAM stack
  - Input G Code
    - Conversion using dictionary-style comparison
  - Output commands to Arduino board it can understand
- Control of heat plate via temperature sensor

HARDWARE SPECIFICATION

- Desktop or laptop containing:
  - At least one (1) USB port
  - Modern operating system
    - Windows XP or above, OS X, updated Linux distro
- USB cable that is Type A male on one and Type Micro-A male on other end
- temperature sensor

INPUT / OUTPUT SPECIFICATION

- Model input in .STL format
  - Easier to slice with functions
- Data sent to Arduino DUE to control 3D printer.
- Dynamic feed of status of printer and status of temperature sensor

DECISION ANALYSIS

- GUI – Easier for people without technical backgrounds to use
- Live output – Makes it easier for people to see and correct errors
- RepRap – Lots of pre-existing tools for 3D printers
- .STL files – Most common type of 3D model files to print.

CONSTRAINTS & CONSIDERATIONS

- Must be able to operate on specific hardware
- The hardware can only be accessible to authorized users
- Dangerous hardware – user should not be able to manually control it
- Can only take in .STL files

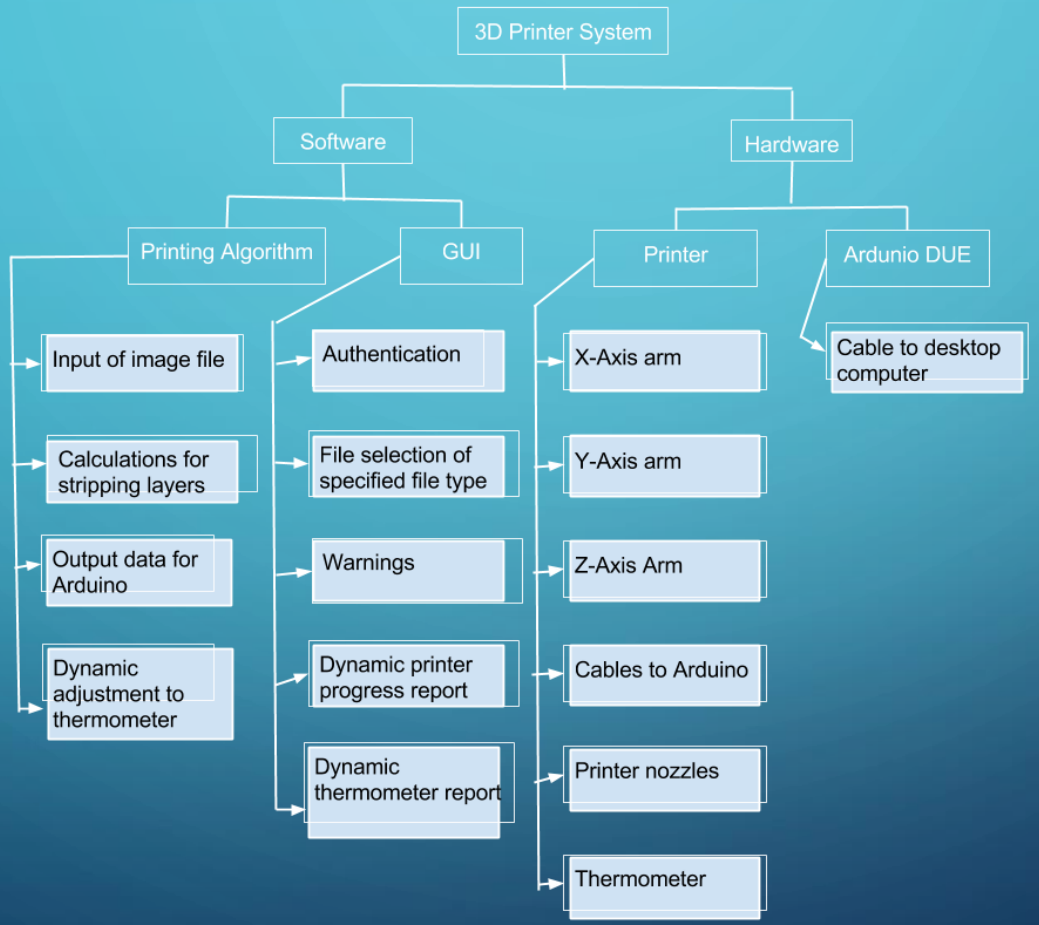
COST ESTIMATE

- From our side… no cost. We are just doing software.
- Resource we need: Desktop computer with appropriate connections.
- Hardware…
  - Extruder $99
  - Heat bed + Power components $99

USER INTERFACE SPECIFICATION

- Buttons for:
  - Uploading STL file
  - Starting, pausing, stopping printing
- Window with dynamic feedback
  - What printer is doing
  - Temperature of heat plate
  - Error messages

FUNCTIONAL DECOMPOSITION DIAGRAM



CURRENT PROJECT STATUS

- Work on implementing calibration program
- Understand RepRap CAM software stack
  - Understand methodology of implementation; calibration program must be done first
- Lots of research done on implementation – working on full implementation for next semester

MARKET SURVEY

- New field in computing
  - Still not established
  - Resources spread thinly
- Strong selling point – able to produce items cheaply.
- Wide variety of applications

TEAM MEMBER CONTRIBUTIONS

- Piriya – Main C++ coder; understanding of technical implementation
- Arielle – Documentation, website, requirements; will be working on GUI
- Albert – Understanding of RepRap software stack; other research to assist in full implementation.
- Wanting – Understanding of software stacks and will also assist in full implementation

PROJECT MILESTONES & SCHEDULE

- September 23 – Provided code for 3D printer
- October 22 – Printer moved into senior design lab
- November 3 – Able to obtain local administrative access to computer to begin work
- November 13 – Website launched

TECHNOLOGY PLATFORMS

- Windows machine
  - C++ interface
- USB cable to Arduino DUE.
- temperature sensor to Arduino DUE.

BACK SLIDES

EE/CPRE/SE 491 SENIOR DESIGN
3D PRINTER – SOFTWARE
TEAM MAY14-07

ARIELLE CZALBOWSKI
PIRIYA KRISTOFER HALL
ALBERT KURNIAWAN
WANTING ZHAO

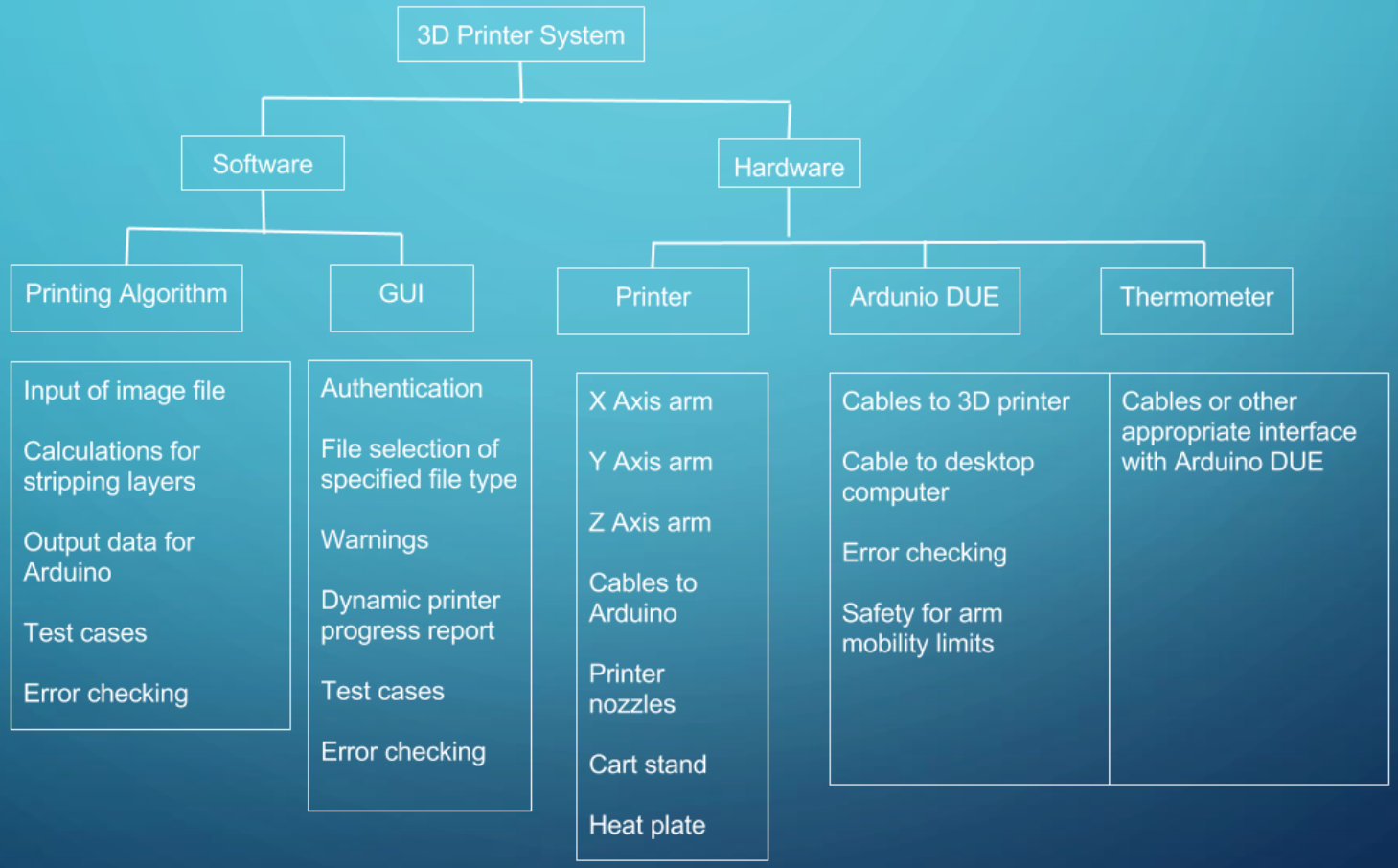
ADVISOR: DR. THOMAS DANIELS

TEAM MAY14-07

PROBLEM STATEMENT

- Create 3D printer that will input model file and output plastic model item through 3D printer.
- Need to ensure that 3D printer's software will be able to communicate effectively with hardware.
- Goal is to produce object that will be meet quality standards and be printed to specification.

WORK BREAKDOWN STRUCTURE



SOFTWARE SPECIFICATION

- Calibration program:
  - Run specified time in set patterns
- 3D Printing program:
  - Prepare printer for print job
  - Take .STL file as input and output information into Arduino DUE
  - Allow user full control over print job via GUI
  - Output plastic model of model file
  - Adjust print based on temperature sensor's temperature

MAJOR FUNCTIONAL REQUIREMENTS

- The product shall determine a path that the printer nozzle can take in order to print the 3D object.
- The product shall only accept one model file at a time.
- The product shall not allow the user to manually move the printer via commands excepting maintenance and calibration.
- The product shall only print when the heat plate is hot enough for the print job to be successful without significant error.

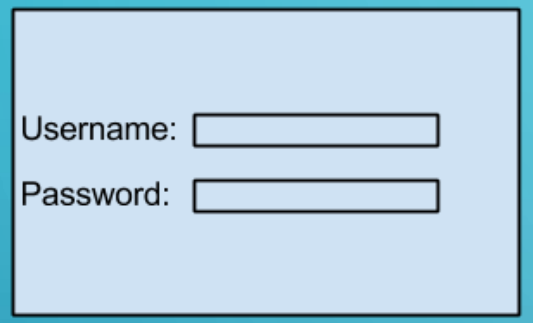
MAJOR NONFUNCTIONAL REQUIREMENTS

- The product shall take no more than 10 seconds to complete the path finding algorithm per layer and send it to the Arduino DUE.
- The product shall not allow a model file over 1 GB.
- The product shall only allow Iowa State University students and faculty access to printing, and therefore will always require authentication.
- The product shall always clearly warn users of the safety concerns of utilizing the 3D printer.

RISKS

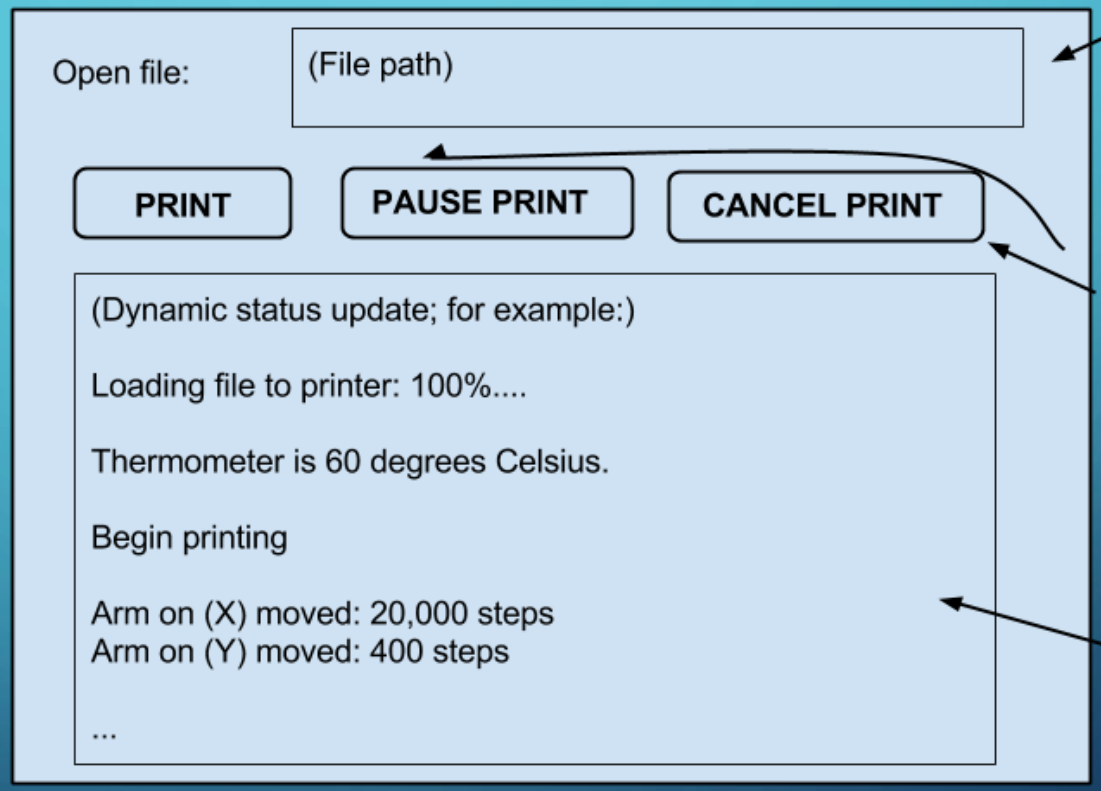
- Due to having two teams, progress could be halted in the event of a communication breakdown – Have weekly meetings
- The 3D printer hardware is very expensive, so if it becomes unusable, we cannot replace it – Be very careful!
- The full capabilities and limitations of the hardware are currently unknown – Do work to figure out what hardware is capable of.
- Communication breakdown between any of the components of the 3D printer could ruin the print job – Implement failsafes into software.

USER INTERFACE (CONCEPT)



Login Screen

requires authentication -- for ISU students and faculty only!



Main Screen

Allows user to open print file & see whole file to ensure it's the right one

User can start or stop print on command

Keeps user constantly informed of printer status

TEST PLAN

- Plan to test printer incrementally
- First – Test printer's accuracy with calibration program
- Second – Test printer's path with a marker
- Third – Test with actual plastic

- Program should follow deconstruction of .STL file to produce model

PROTOTYPE IMPLEMENTATIONS

- Have been working on calibration program
- Have looked into RepRap CAM software stack
  - Shows how to deconstruct .STL file
  - Methods for feeding information to 3D printer
- Allows for conversion from G Code to Arduino-friendly language

```
N3 T0*57
N4 G92 E0*67
N5 G28*22
N6 G1 F1500.0*82
N7 G1 X2.0 Y2.0 F3000.0*85
N8 G1 X3.0 Y3.0*33
```

NEXT STEPS

- Completion of calibration program
- Implement RepRap CAM software stack for model slicing
- Integrate temperature sensor and heat plate into program
- Implement user interface

TIMELINE

- September – Setup of system; code provided
- October – Configuration of system; printer moved
- November – System planning; administrative access gained; website launched
- December – System programming
- January – Work on GUI, finish calibration, work on system
- February – Finish GUI, finish basic printing algorithm
- March – Attach GUI to system, do advance printing tests, add temperature sensor support
- April – Testing of all system components

QUESTIONS?