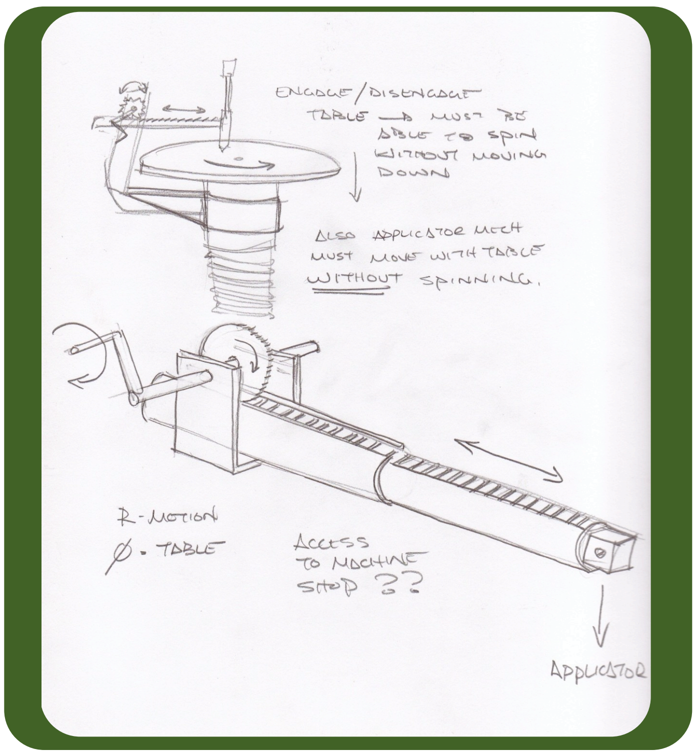
A DIGITAL LOGBOOK FOR COLLABORATION AND CONCEPTUAL DESIGN



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Overview

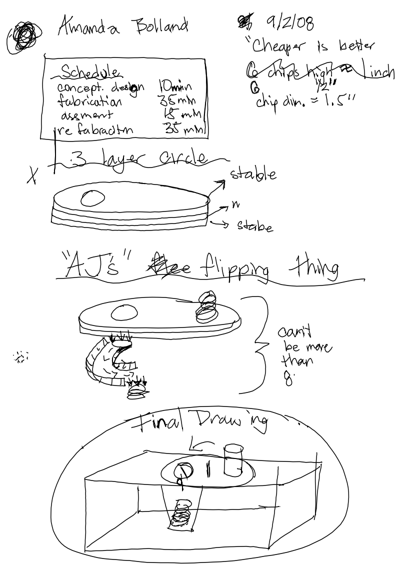
Outlined in this report is the work to date on the project, expenditures, and a projected timeline through the completion of the project.

Work to date

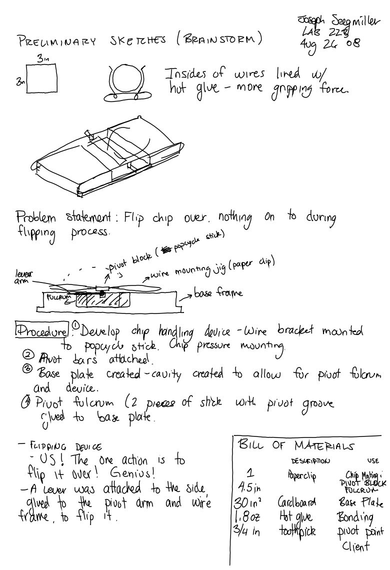
The project team has successfully established and deployed the digital logbook system for use in the sophomore mechanical engineering design course, which was designated as the primary audience. The Pulse Smartpen from Livescribe was selected as the hardware of choice because of the low cost and the software development opportunities made available through its API. Unfortunately the development and initial release of the selected pen computer was delayed, postponing the acquisition of twenty pens until the end of June. Despite the nearly two month delay, the use of the pens as a design logbook tool was piloted by a senior level mechanical engineering design team that is developing a slurry pump system for an equipment manufacturer in the waste water treatment industry. The pilot project provided valuable feedback in the areas of uploading and sharing the digital information captured. Through this pilot, an initial online repository was created on the Livescribe website to hold and organize the data. This approach allows for access to the synchronized drawing and audio entries captured during the logging procedures using only a browser. Therefore, any team member can easily navigate and return to their conceptual design data. Alternatively, a PDF version of the writing/drawing content can be downloaded from the website for local storage and inclusion in reports and other documents. The digital project logbook was subsequently removed form the online repository to avoid confusion with the sophomore work.

An assessment instrument was developed as part of this project to address the documents that will be created by the students as part of their design projects. This project focuses on the actions surrounding the group design activities that are common to the conceptual design process in a sophomore design course. This focus requires a more specific logbook assessment form that highlights the critical elements of conceptual design process and the appropriate documentation. The basis for the assessment are the five basic steps of a conceptual design process (after the definition of problem requirements). A rubric was developed to qualitatively indicate the student's level of success in documenting the team's design work. This rubric will be used to guide student performance in the use of their digital logbooks as well as by the instructor to assess in process design artifacts from the digital capture without disturbing the flow of data in the design activity. The areas addressed by the conceptual design rubric are listed below and the complete rubric is located in the appendix. The conceptual design rubric and a traditional logbook rubric are located on the project website.

- Analyze and subdivide functional requirements
- Identify set of functional alternatives for each subsystem
- Develop design alternatives for each subfunction
- Compose product architectures
- Select compatible and viable subsystem alternatives



Example of student design document



Example of student design document

Beginning with the fall semester, the digital pen logging system was used during the mechanical engineering sophomore design class. Each lab of twenty students were provided with a pen and logbook for use during the lab period. Data was collected for the first two labs of the semester in which students designed and built simple cardboard machines. Because the students have not yet received substantial instruction in design process, their work on the first two labs was not assessed for design quality. Instead, the development focus was on the processes for successfully using the pens and archiving logbook data. Each student team created a website through which their logbook entries for each project were organized. These first two labs highlighted the great potential of the digital logging system (see chip flipper and chip stacker) and allowed the students to provide valuable feedback on the process. A tip sheet was developed to avoid common mistakes in activating and downloading pen information which improved data return dramatically between labs. Approximately fifty logbook entries can be viewed and heard at the repository website.

Expenditures

Project funds have been applied as follows.

Salaries	
Jay McCormack	$2,899.54
Steve Beyerlein	$1,739.73
Hardware/Software	
18 pen computers	$2,699.10
VM Ware Fusion	$39.99
Total	$7,378.36

VMware Fusion is a software tool that enabled the pen computer software to run on the Apple computers that we already had in place. This was necessary because the Livescribe OSX software was delayed (and has not yet been released). The project was also supported through the donation of three PCs for use with the pens in the lab environment. Technical assistant Nathan Barrett has been actively involved in the project as the direct technical support for students during lab and has coordinated the data upload and sharing processes. Future budget items include compensation for the technical assistant and the acquisition of several more pen units.

Timeline

The digital pens will again be an active part of the sophomore design course labs in the sixth week of the semester. At this time, students will have been instructed in the skills needed to perform an iterative function and form design. Also, the student's will be tackling a multi-week project at this time. Up until now, projects have not exceeded a single lab period, limiting the active use of the pens for out of class reference. Their usefulness in this application will be assessed and improved where needed throughout this semester. Additional pens will be purchased later. These pens will be deployed in a senior design setting in the spring semester of 2009. The objective will be to capture the design logging at the tail end of conceptual design where documentation must be solidified before moving to geometric modeling (CAD) tools.

The project team has gathered numerous examples of student logbooks from this phase of design in addition to the twenty years of project experience by project member Steve Beyerlein. Combined, this data will form the basis for a logbook comparison. A baseline of sophomore level documentation from the conceptual design process is being gathered from a sample of logbooks from past semesters.

Appendix

Rubric for documentation of the conceptual design process

This rubric focusses on the student's success on documenting the conceptual design process. The conceptual design process is generally considered to begin with the creation of a user needs document and ends with the selection of a single design concept. A conceptual design typically has less detail than is required for manufacturing but sufficient detail to make informed engineering decisions.

	Low	Med	High
Identification of overall functional requirement	Basic input and output flows are not identified. No graphical representation of information. Misidentified or missing statement of product function.	Minor input and output flows are missing or misidentified. Statement of product function is present, but potentially misleading or awkward. A graphical representation of the model is employed.	Black box, graphical model of the product. Inputs and outputs identified completely. Succinct statement of product function clearly identified.
Exploration of subfunction solutions	No consideration of product function was documented or was captured in a non graphical form.	Major product subfunctions were identified and structured in a visual/graphical representation. Connection between major input/output flows and subfunctions is established.	Extensive exploration of multiple product subfunctions through detailed graphical models. All product flows are correctly connected to functional models.
Exploration of alternate form solutions	Concept geometry is not represented or is captured intermittently. A limited number of alternatives was explored. Established function did not serve as the basis for form.	Concept geometry is sketched at a moderate level of detail, including sufficient exploration for the major product functions. Use of function before form process is mixed.	Concept geometry is sketched in sufficient detail to make decisions. Correspondence between function and form is noted and logical. Functional model served as a catalyst for geometric models.
Select subsystem design solution	No clear logic is presented for concept selection. Selected concept may not be among the represented design alternatives.	A comparison of alternatives is modeled in a logical manner. Some selection criteria is incomplete with respect to the specs.	Solution options are organized in a structure that adds to decision maker's understanding of the solution and to facilitate decision making process. Logic behind the selection of solutions is documented through a comparison to specs and other solutions.
Composition of product architecture	A complete vision of the product function and geometry is not produced.	A complete representation of the geometry is present which illustrates some interface problems. A composite functional representation is produced, but is incomplete or awkward.	Models of subfunction are composed into a complete functional representation. Geometry of subsolutions are are outlined in a schematic form and sketched in a composite representation. The product architecture adds credibility to the solution as a whole.