Hypothesis
Your claim about what benefit the system offers.

Design project teams share an assortment of documents and files during the course of a project, such as paper sketches, post-its, idea logs, typed reports, web links, and pictures. What would be an effective medium for the sharing and exchange of these various materials amongst team members?

We propose the “Paper Collaborator”, which seeks to make document sharing easy and effective by presenting the entirety of what has been shared on an interactive wall in the team’s shared workspace. The physical presence of project-related information will increase the shared awareness and inter and intra-group communication. By bringing together documents related to different people on a single shared platform, it encourages discussions, facilitates sharing of ideas, and reduces logistical burdens of a group’s creative process. This in turn improves the overall productivity of the team.

Evaluation Plan
A concrete plan for how you will test your hypothesis.

In order to perform a concrete evaluation, we are partnering with a team from the ME310 class, who are working on the “Daikin Personal Climate” project - which is about increasing the efficiency of personal air-conditioning systems and reducing energy costs. The team regularly exchange project documents, research papers and pictures. It is stipulated that they update their Project Wiki everyday - therefore all that they share is also uploaded into the Wiki.

We begun our evaluation last week by setting up our prototype in the shared workspace of the ME310 course - the ME310 Loft, Floor 5, Terman Engineering Building. The team has daily meetings within this shared workspace. Through our prototype, each team member can see and access everybody else’s contribution.

Figure 1a: The design problem posed by Daikan: “the possible future of office air conditioning”
Figure 1b: The ME310/Daikan design team
Figures 1c&d: Screenshots from the project Wiki
The initial reaction was encouraging - one of the team members remarked that this was a cool and innovative way to do teamwork. Other groups requested a Paper Collaborator of their own. Currently, we have constructed a functional display with manual input of data. Now that the ball has begun to roll, we shall transfer the job of updating the display with new data to the project members. That way, we can gather more input about how they would like to update information on a daily basis with minimal overhead with the idea that eventually the update process would be automated using our observations as design guidelines for that automation.

To do so, in the upcoming weeks, we intend to observe the team when they meet at a group discussion and observe how they shall use the overall content. This way we can identify what is relevant to put up on the display and what is not. We also intend to interview the team members individually and collectively for their suggestions regarding how they would want information to be structured around the display.

We are also planning to evaluate the other ME310 Project teams that use the prototype and get their input on the benefits and drawbacks of a user outside of the main project team.

Current Prototype
An explanation of your current prototype.

Courtesy of Professor Scott Klemmer and Ron Yeh, we have managed to get a Dell Laptop exclusively for evaluating our project idea. Our current prototype includes the following:

* A Dell Laptop
* A Nokia Bluetooth-enabled Anoto pen
* Anoto Paper
* Post-it Notes with thumbnail views of the shared documents stuck onto them
* A transparent Acrylic Board to which the laptop has been fixed, upon which surface the post-it icons are placed.

We would like to extend our gratitude to Ron Yeh, who has been very supportive and helpful to us. He has been kind enough to share his material and code for using the Nokia Anoto Pen and Anoto Paper. The code records the relative position of the Anoto Pen on the Anoto Paper, and associates the paper position with a file url or a web-page url. We have extended the Java code
to handle an unlimited number of position-file/url mappings and store those mappings in a file so that they persist even after shutting down and restarting the application.

Once we got the code running, we took thumbnail size printouts of the documents that are shared by the Daikin team. We cut the Anoto Paper also into small squares. Then we stuck one thumbnail and one anoto paper square onto one post-it note. This way, we made 61 post-it notes and stuck them up on the Acrylic Board, next to the Laptop. We ran the program and then associated each anoto paper square with a corresponding thumbnail. By clicking anywhere inside the anoto paper, users can see the corresponding document/link open up in the laptop. We have set up this prototype in the ME310 Loft to make it always available for the Daikin Team.

Figure 3. The full display prototype before installation. Acrylic sheet with mounted laptop (left because manipulation typically occurs with the right hand), post-it icons with thumbnails and anoto paper input randomly arranged, and hooks so that we can easily move the display to see which location, heights, etc. are most conducive to use.

Figure 4. Paper Collaborator prototype integrated in the Daikin team’s shared workspace. A height between standing and sitting was chose by those present at time of installation. Static bulletin board is to the right of the user, conference table is left and behind (sorry we need a better photo).
**Further Development**
The development you plan to do by the end of the quarter.

Currently, we have begun evaluating only with pictures posted on the ME310 Wiki. We shall extend this by printing out thumbnails of documents and other media also, and integrating those post-its with the existing ones. We are also researching and looking for an optimal way to arrange the post-its so that information is aggregated in the most useful format which could be used to eventually make the display autonomous. Our further development work shall mainly be directed by the results of our initial evaluation, which shall conclude this weekend.

We are also considering the use of bar-codes on post-it notes (with thumbnail views of documents & pictures) and use a webcam to recognize the bar-code and open the respective file/url. This shall be a competing technology to the Anoto pen (with respects to robustness, availability, and effort), and we believe it shall be interesting to see how camera-based recognition scales in this environment.

We would also like to experiment with a larger scale display - perhaps projecting onto the entire shared workspace wall - which will change the interaction dynamics from a few users to many users to determine whether such a tool is more effective when used by small groups (this display currently accommodates 1 - 4 users) or when it can accommodate use by larger groups.

Additionally are exploring the possibilities of using a blog that accepts emails with attachements as input.

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**Related Work**
A brief summary of related work.

Whittaker and Schwartz[1995] compared the performance of two software development teams. One team used electronic means to co-ordinate their work, while the other used a wall-sized bulletin board in a shared space. They found that the board encouraged discussion, while the emailed documents did not “substantially contribute” to the project.
Baudisch, Good, and Stewart[2001] recognized the benefits of being able to have an overview of all available information to provide a context for focusing in on the details of specific information. They established the context by superimposing their detailed display over the overview display, while we are attempting to establish the context while keeping the detailed display and the overview display physically distinct.

Churchill, Nelson, Denoue, and Girgensohn[2003] investigated the difference between content sharing online and content sharing by posting to a physical space. They found that the content posted to the physical space became topics of conversation and lead to interaction.

Moran, Saund, van Melle, Gujar, Fishkin, Harrison [1999] “Design and Technology for Collaborage: Collaborative Collages of Information on Physical Walls.” Focus is on manipulating data through tangible representations on a wall. Our approach focuses more on the impact of presence. How does the increased presence of shared objects influence the reuse behavior of these items?

**Semi-Related Work**
Some tangentially related ideas and work.

- Interactive Wallpaper
- Visual Constructs in Physical Space
- Annotating Physical Space
- Location Linked Information
- Scanning/X-ray Metaphor Displays