Tangible WorkFlow

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ABSTRACT

This paper outlines a new tangible way of doing project management. Current tools offer limited possibilities for interaction and collaboration. We present a system that allows for visualization of project workflows as streams of water trying to flow past valves which represent deadlines. We also describe a set of intelligent tokens which can be used to interact with the system in an intuitive way. The intention of the system is to present the user with an easy and visual way of managing large projects which allows for more hands-on and flexible planning, easier collaboration and a spatial way of organizing information.

Author Keywords

Tangible User Interface(TUI), Project Management, Wireless Communication, tokens, Augmented Reality.

ACM Classification Keywords

H.1.2: Models and Principles: User/Machine Systems. H.5.2: Information Interfaces and Presentation: User Interfaces. J.7: Computer Applications: Computers in Other Systems.

INTRODUCTION

Project Planning and Management are an integral part of any organization. They are tedious and time consuming tasks which require continuous collaboration and interaction between people. Despite the developments in human-centric design and tangible user interfaces, little research effort has been invested in making the area of project management more tangible. In this paper, we propose to apply principles from interactive tabletop technologies to project management to make it more tangible and open up new interaction possibilities. By using physical tokens to manipulate digital information like deadlines and tasks we provide the user with ample room to organize objects spatially. This helps in the thinking process and enables the user to solve complex planning problems in easier ways [1]. The users can easily collaborate around such a space and can interact with multiple tokens at the same time. These tokens can be modified by the user physically. Thus the tokens not only embody the digital information but also enable the user to map physical changes made to the tokens to changes in the application.

We begin by analyzing some of the existing project management tools, looking at the functionalities they offer and where they lack. We then discuss the affordances physical token and digital tabletops offer to the project management and planning process. Next we explain some of the key features of our design - "The Tangible Workflow" and the tokens. We discuss how they allow for meaningful interaction. We then conclude with challenges we faced and future work that could be done in this area.

BACKGROUND AND MOTIVATION

The idea of Tangible Workflow was inspired by looking at how tasks within projects are organized in a chronological fashion. Thus, the project workflow can be visualized in a sense like water streams where each stream represents a path through the project. We can add "*valve*s" as deadlines to these streams to represent the tasks that need to be performed in order to progress through the project. This provides a more visual way of imagining the project workflow process. Further, humans then use their hands and fingers actively and efficiently to organize and rearrange information. However, the digital tools currently used for project management do not leverage these physically manipulations skills. Thus, the token approach to interact with the digital world will allow the users to use more natural movements to manipulate the deadlines and tasks.

Current Project Management Tools:

Most of the current project management tools are web-based. They focus on time-tracking, document sharing and communication part of Project Management. Tools like Basecamp, Central Desktop, and Huddle [2] provide online project collaboration services that include the ability to create and manage projects, private and public to-do lists, milestones, messaging, upload and share files etc. A plethora of such online tools exists, however none address the need to make this interaction more physical and tangible. None offer the flexibility to move tasks and deadlines around and organize them in an intuitive manner spatially. The current way of visualizing the progress made in a project inhibits physical manipulation and is not engaging. The collaboration is mostly remote and the tools fail to take advantages of conference rooms and meeting settings where people do the actual planning of the project and collaborate with one another. Overall, the tools are boring and mundane. They don't give the user a clear visualization of where they stand and exactly which task blocks another one from executing. They allow for very little physical interaction since they are just projections from behind a screen.

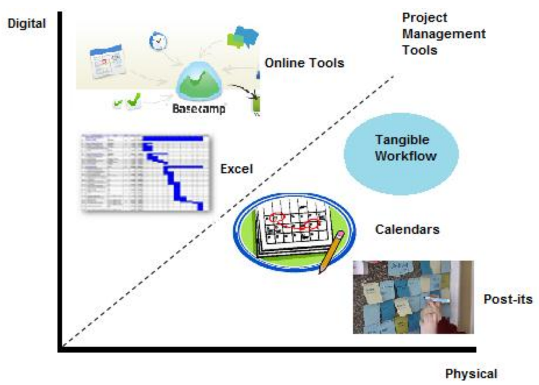


Fig 1: Current Project Management tools and how our tool places in comparison to them

Why tangible user Interfaces are better:

Today, the way we manipulate and communicate information has been moving steadily and more rapidly away from the physical world that we have grown accustomed to over the years. Bits and atoms have been drifting apart to form two parallel worlds, with very limited interaction between them. As Ishii and Ullmer say, the interactions between people and the digital world are now largely confined to GUI (Graphical User Interface)-based boxes sitting on desktops or laptops. The interactions with these GUIs are disjoint from the ordinary physical environment within which we live and interact.

Tangible user interfaces (TUIs) have made great progress towards leveraging our physical manipulation abilities to interact with digital information. Fitzmaurice et al. [3] pioneered physical 'handles' to digital objects. TUIs with handles operate by sensing the user's manipulation of each handle, and displaying related visual representation of the data being manipulated. Various projects like Designer's Outpost[4] and DataTiles [5] have used the tokens as surfaces where the digital information can be projected on the token. On the other hand, TUI interfaces like the SenseTable[1] utilize tokens merely as cursors to control the GUI under it. Physical objects allow for a richness in interaction that is unparalleled by traditional computing interfaces. While the former can naturally make use of all five physical senses of the human body, the latter is still restricted to audio-visual outputs and a very limited sense of touch for inputs. Thus, TUI reduces cognitive load and more direct form of manipulation than the GUI alone.

Moreover, using physical objects that directly embody the digital information or media that they represent enriches the TUI interaction even more. Ishii's Music Bottles [6] and Want et al's work with embedded RFID tags [7] are examples of TUIs that do not implement handles to manipulate a GUI overlay. Instead, the shape and features of the objects themselves governs the way people interact with it. By leveraging the user's experience and their understanding of the object's form and function, we can enable a more intuitive interaction with digital information.

OUR SOLUTION

As discussed in the above sections, the problem is that the current tools for project management are lacking in physical interaction and the ability to render their content in a spatial way. To make this process more interactive, 'physical' and stimulating, we propose to use an interactive surface, which uses 'smart' tokens to manipulate data.

[1] **Sensetable** http://www.pattenstudio.com/projects/sensetable/

Concept:

The backdrop of our interface is a farmland, which needs to be irrigated. The idea is to equate the typical work cycle of a team to the flow of irrigation streams. The streams represent work channels/classification, which indicate the way the work gets divided into different teams. Tasks are represented as *valves* that restrict the flow of water. As a team starts working on a particular task, it keeps opening up the *valve*. The end goal is to have a *valve* completely open before a certain deadline, failing which the surrounding region will alarm by showing a temporary 'flood'. Therefore, the presence of *valves* also represents deadlines. Hence to keep the area green, teams need to keep pace with their schedule.

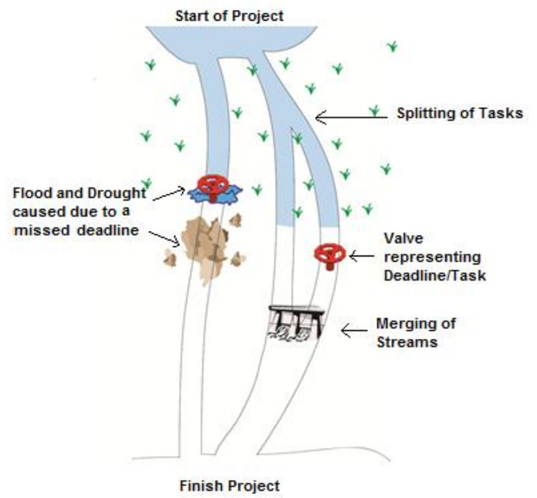


Fig 2: As shown, the streams represent separate routes through the task that need to be performed. The red valves represent deadlines/task and the streams can merge and split depending on the relationships and dependencies between the tasks. A missed deadline is represented by a flood and imagery of drought after the missed deadline caused due to the unopened valve. The dam represents an implicit deadline that gets created when streams merge because the consecutive tasks require tasks along both the streams to be complete before progress can be made. If one stream reaches the dam but the other one doesn't, the water won't flow through the dam till the second stream also reaches the dam. This gives a visual idea of where exactly the project is blocked.

Setting: Our system is designed to be situated in a conference room of an organization where teams periodically meet to track their progress. We would want the users to be able to use the conference table as the interactive surface over which the tokens could be tracked. This allows for collaborative use of the workspace where different teams could work on their part on the same space while viewing others do their part.

Functionalities:

Our system can be used to:

- Create work flow of a project
- Add tasks and set deadlines using tokens
- Display a Progress bar and offer an intuitive way for users to indicate their progress
- Record meetings and take notes relating to each task.
- Associate each task's data spatially with tokens.

How tokens Work:

Creating a Work Flow: To create a workflow, we will have special dedicated tokens that can materialize a 'stream' and edit their structure. Streams could be merged or split, just like tasks get divided.

- Creation token (Hoe): The physical features and symbolic meaning of this token is representative of a shovel. We foresee that because this task does not require fine-tuning, this would be used like a hoe. It could possibly have rollers at the bottom to slide across the table.

Fig 3: A hoe shaped token allows for easier and intuitive creation of streams.

- Deletion token (Sand Sprinkler Can): To edit/delete a stream, we could use this token to pour digital sand on to that area. As above, this does not focus on precision, as the user would not be fine-tuning his streams.

Fig 4: Sand sprinkle for deleting streams

Dealing with tasks: Our tasks are represented as *valves*. The token used for manipulating *tasks* would be representative of *valves*. The intuitive actions a user could perform with a *valve* are:

- <u>Bumping/Pushing</u> down on it: This action relates well to imprinting/engraving, so this would **add** a new *valve* at that position.

Fig 5: Bumping Motion to Insert Valve

- Moving over a *valve*: When our system recognizes that the user has placed a token over an existing *valve*, it would **select** it. This way, the user could view/edit the details/placement of a task. Once a *valve* gets selected, the related stream region would get highlighted to indicate it being active.

- Pushing/Pulling: Once a token selects a task, if a user tries to move the token, he would be **shifting** the *valve*, and hence its deadline. In response to this behavior, depending on the importance of the task the token would resist the motion. Hence, apart from visual display of selecting a *valve* and trying to move it, the user gets physical feedback. The more important a task, the harder it is to shift it.

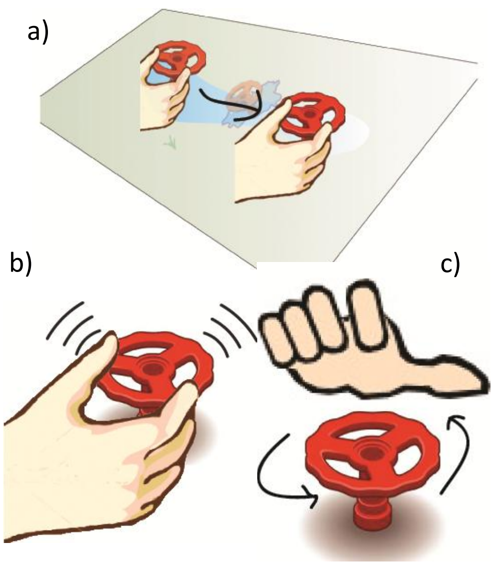


Fig 6: a) Shows the moving of valves to adjust deadlines. b) Shows the motion of shaking the valve to delete a selected valve. c) Shows the motion of twisting a valve to indicate progress made on the current task.

- Shaking: This motion is that of an eraser, hence once a *valve* is selected, shaking the token would **delete** it.

- Twisting: This is the most intuitive motion when holding a *valve*. This opens up the *valve* to allow more flow; hence a user could twist this to communicate to the system that he has finished a part of his task. This would be reflected in the **progress** bar, which would be displayed around the selected *valve*.

Dealing with Information: Now we know how to add tasks to our workflow.

Displaying and Adding Information: To add information to the task, we would need advanced objects that take input from a user and append it to the information related to a task. For each *valve*, our system would display a tag containing the name of the project. Once we select a *valve*, we would have a cloud pop up next to the task, which shows more detail (the team members, the managers, emails related to this task, the progress bar, etc.). For more detailed information, we would have small soft pebbles. Once put over a selected stream, they get activated and act as extensions of a task. These could then be either:

- Placed on the table to show a digital panel, which works more like a touch screen notebook.
- Thrown on the wall (like magnetic pellets) to display information on the wall in clusters. The more the pebbles of a task, the more the information displayed. This uses the spatial setting to organize information around the room.

Another important feature, which our system would support, is capturing the meeting notes, hence recording the audio of a meeting. We could use these pebbles to activate a recorder as well and to playback the meetings.

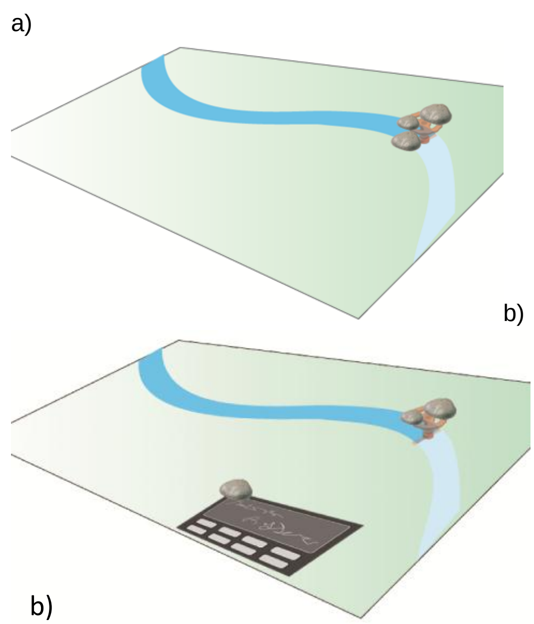


Fig 7: a) Pebbles can be placed on a particular task/stream to select it. b) After selecting the task, when pebbles are placed on the sides of the table they show a digital keypad as shown to allow the user to insert and edit information related to the task.

User Experience:

- Using streams and water flow creates a soothing atmosphere. Hopefully, this would bring down the stress and tension in a work environment and help the users focus better on the task rather than the details of meddling with a computer to take notes, etc.
- Lets the user see how he fits in into the bigger scope of the whole project and with other sub-tasks. With the current tools, a teammate might know his role in the team, but might not understand his responsibility with respect to the bigger project. This way, he is able to understand his part better and realize how he relates to others on the same project.
- In order to add a deadline/task, a user does not need to concentrate hard on calculating the date of a deadline. He just eyeballs the deadline visually. This makes it more appealing to the user. This allows for more flexibility as changing the deadlines is as simple as shifting *valves*. Hence while brainstorming, it allows for much more experimentation.
- Feedback from our system and attributes of the tokens: Our tokens imitate and inherit characteristics from the physical objects they represent. The user, having a preconceived notion of the usage of those objects uses the tokens respectively. Hence, for example, while creating/deleting streams, he would be using a miniature plough token, which would relate to physical labor. While moving *valves*, important tasks would offer more resistance, signifying their value. Hence, the user is able to use his perception of how to use a token to do work, which makes it more natural for him to use them for related actions.

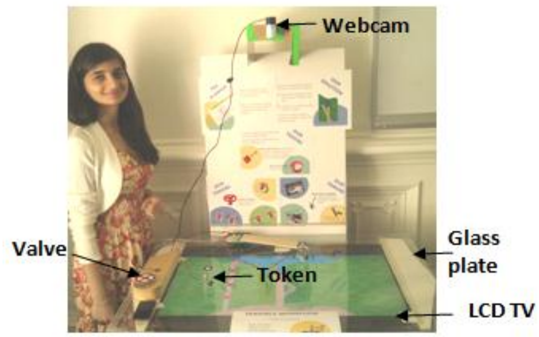
PROTOTYPE DESIGN

Setup:

Ideally, our system would be built using a large tabletop surface with capacitive sensing for the tokens, which would communicate via wireless with the main processor. This set up would be quite similar to the Sensetable developed by MIT Media Labs, as far as technology goes. However, due to our limited time and resources, we opted for a vision based solution.

Our setup consists of a large flat-screen LCD TV placed horizontally on a table. The TV screen is covered with a glass plate on top for protection. A High Definition USB webcam is mounted about 4 feet above the surface so that it can view the entire screen when focused on it. The mount for the webcam also doubles up as a poster that highlights key features of our project.

Our tokens are small, easy to hold glass bottles with a Force Sensitive Resistor (FSR) attached to the side. The real system would detect the placing down of tokens on the surface, but our prototype detects the force of a user gripping the token. Because placing a valve on top of each token would interfere with our vision based token tracking (explained below), we had a valve at one end of the system. The valve is attached to a potentiometer that measures the rotation of the selected valve. (The exact working of the system is explained in detail subsequently). All sensors are interfaced to a laptop that runs our program using an Arduino UNO board.



a)

b)

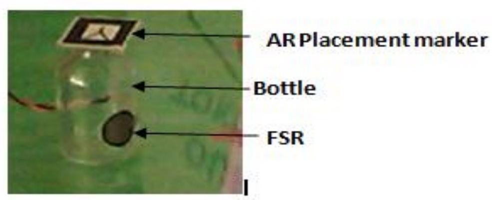


Fig 8: a) Our setup b) Prototype token

We used Processing 1.2 as the programming environment. The vision based token tracking was enabled by the NyAR Toolkit for Processing.[2] NyARToolkit is a computer vision tracking library that allows for the creation of augmented reality applications that overlay virtual imagery on the real world. To do this, it uses video tracking capabilities in order to calculate the real camera position and orientation relative to square physical markers in real time.**(Wikipedia)** The

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[2] NyARToolkit http://nyatla.jp/nyartoolkit/wiki/index.php?FrontPage.en

physical markers are small pieces of paper with different patterns attached to the top of our tokens.

Fig 9: Hiro and Kanji, our two place markers for the NyARToolkit to track tokens.

Working of prototype:

We created a static project schedule that illustrates some typical constructs that occur during project management. Apart from user defined deadlines, the structure of a workflow diagram implicitly defines deadlines.

A *join* is two streams that merge, representing two tasks that need to be independently completed before the project can progress further. Even if one task is signaled as complete, water cannot flow past a join until the other task is also signaled as complete.

A *fork* is the point where two streams diverge. This represents the start of two parallel tasks that can execute independent of each other.

a) b)

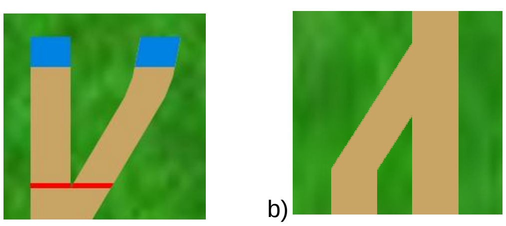

Fig 10: a) A *join* of two parallel tasks. b) a task that *forks* to form two parallel tasks

As soon as the system is turned on, water starts flowing at a pre-determined rate to mark the passage of time. If a project is on schedule, any valve should have been opened before water reaches it. Failing this, the flow of water gets blocked and the stream flashes black to alert the user of the bottleneck.

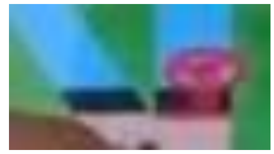

Fig 11: Valve blocking the flow of water. Notice that this is a join, so opening just one valve still doesn't allow the other stream to flow water. Both valves need to be opened to pass water to the next section.

We have two tokens implemented – Hiro the creator of deadlines and Kanji the remover.

To create a deadline, Hiro is moved to a spot close to the deadline's desired location. Gripping the token harder places a valve at the nearest stream location. Hiro can also be used to move deadlines – placing it on a valve and pressing hard selects the valve, which will then move along with the token.

a)

b)

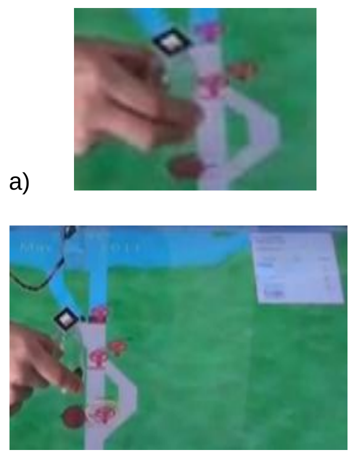

Fig 12: Using Hiro to a) create a deadline b) display task related information

Displaying information about any task is as easy as placing Hiro on the task. A popup window on the right corner displays related emails, documents and meeting recordings related to the task on which Hiro is placed.

Deletion of valves and completion of tasks are easily done with Kanji. The interface to delete valves is very similar to adding valves – simply place Kanji over a valve and the token hard.

The completion of a task is registered by opening the valve. First, Kanji is placed on the valve to select it. Then, the valve is turned. Once it is fully open, the user sees the valve turn transparent, and the valve will start allowing water to pass through it.

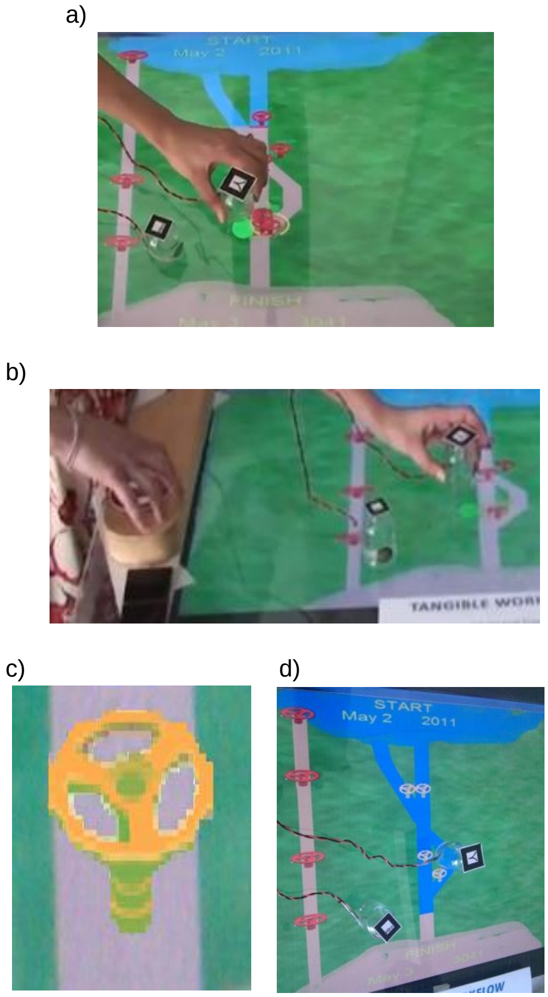

Fig 13: Completing a task using Kanji. The task is selected (a) and the valve is rotated (b). A completed valve turns transparent as shown in c) The stream flowing through open valves in d).

EVALUATION

Prototype Evaluation:

The main aim of the prototype was to see how people respond to the metaphor of streams representing workflow. The initial prototype had features like adding, moving and deleting *valve*s using tokens. Most people responded well to the initial prototype and were excited about the idea and the potential it holds. They provided us with constructive feedback. Some things we learned while observing people interact with the prototype are:-

- People found moving and adding the *valve*s using tokens pretty intuitive.
- They were able to grasp the idea of *valve*s representing tasks and stopping the workflow very easily.
- Most people really liked the idea of being able to see all the information related to the deadline/task in one place using the tokens.
- They liked how one could visually clearly see how the project was progressing and how much time was left.
- People sometimes tried to pick up the tokens instead of dragging them. Possible causes for this could be the token design inhibited it from being dragged easily since it had wires attached to it. In our final design we would like to have wireless communication between the tokens and the table. Hence would not have wires that hinder the flexibility and movement of the tokens.
- There was latency due to the vision based approach and hence using infrared table sensors or wireless communication would be better.

Future Evaluation Procedures:

To test the ease of use and efficiency of our final design we would like to compare it with existing systems. We would like to do a study where the system is installed in a conference room and have teams use this system and their existing system to organize their project and then compare the ease of use and the functionalities.

CONCLUSION

In this paper, we have identified a problem with the need for a tangible solution. We have developed a novel way of visualizing project workflows as streams of flowing water. This allows users to easily get an idea of their progress in the big picture of things.

We have also described new ways of interacting and manipulating information using intelligent tokens. These tokens are unique to the nature of the action being performed.

From the initial reactions to our system, we find that our solution to the problem is promising. There is high potential for future investigation along the same track, as people relate easily to the spatial sense and visual appeal of our system.

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