

Polymorphic Collaboration: Beyond Relaxed WYSIWIS in Visage-Link

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ABSTRACT

Collaborative systems can be considered to occupy positions along a continuum from face-to-face meetings to abstract communication. Consider data visualization systems that lie along this continuum. At the one end, participants can all see the same visualizations at the same time; in fact, they're practically breathing the same air. At the other end, collaboration is markedly different: participants are free to construct their own representations, and their interactions must be deeper; more about the interpretation of the information than its presentation. This paper discusses the aspects of such a collaborative system, its practicality and usefulness, and some of the pitfalls discovered during the pursuit of it.

The research system built to explore this polymorphic (multiple independent representations) collaboration is Visage-Link, an extension of the Visage direct manipulation information-centric environment developed by MAYA Design.

Tightly-coupled collaborative presentation is referred to as WYSIWIS (What You See Is What I See). Relaxed-WYSIWIS systems have been developed that loosen the coupling. Visage-Link resides in the space *beyond* relaxed WYSIWIS.

KEYWORDS

Polymorphic Collaboration, CSCW, WYSIWIS, relaxed WYSIWIS, Visualization

MAYA's Visualization Environment: Visage

MAYA's Visage [1] research has centered around information-centric visualization and direct manipulation. Visage has evolved over a number of years to become a visualization environment where users can "feel like they're getting their hands on the data." Users interact with data by dragging it (actually, dragging an onscreen element that represents it) from one visualization to another. In a sense, this is a step beyond Human Computer Interaction (HCI) to Human-Information Interaction (HII). It is an extremely visual environment with little text, few menus, and no

dialog boxes. Visage is designed to be more of a cyberspace environment with a consistent physics, not a WIMP¹ GUI². Queries, filtering, navigation, and so on are all handled through direct manipulation and drag and drop.

Much of the power of Visage is derived from its notion of Polymorphism – when elements are dragged from one visualization frame to another, they morph to the new representation. Dragging elements from a bar chart to a map, for example, will cause them to change from bars to map icons, and to move to their geographic location.

Visage-Link: Extending Visage into the Collaborative Realm

MAYA's challenge in extending Visage was to consider how Visage could be extended into the collaborative realm without losing any of its information-centric character. (We refer to the research project to explore this issue, as well as the system itself as Visage-Link³.) How does polymorphism extend into multi-user scenarios? Can users initiate collaborative sessions using direct manipulation and drag and drop means? The goal was to incorporate features for collaboration into Visage without causing it to lose any of its character, and to leverage the power of polymorphic visualizations for group use.

The Span of Collaborative Systems

Consider the many ways people can work together, whether computer- or technology-supported or not. Face-to-face meetings can be held, perhaps by using an airplane or automobile. Video conferencing systems generally attempt to get as close as possible to the face-to-face experience (while aiming to be more cost-effective than travel). Many readily available computer-based collaborative systems

¹ Windows, Icons, Menus, Pointers; today's canonical user interface paradigm.

² Graphical User Interface.

³ Funded in part by DARPA as "A Medium for Distributed Collaboration in Information Intensive Domains"

focus on providing a WYSIWIS⁴ environment. Examples include Microsoft's NetMeeting and AT&T's VNC; a few shared whiteboards attempt to provide WYSIWIS sharing. Some collaborative systems are farther along this continuum yet – Saul Greenberg's Fisheye Text Editor [2] is a good example of relaxed-WYSIWIS groupware. In the Fisheye Text Editor, users all use the same tool to visualize (and edit) a single document, but they are not required to have identical views. In fact, their views are intended to differ; that is what gives relaxed-WYSIWIS systems their power.

Visage-Link goes beyond relaxed WYSIWIS to polymorphic collaboration: users share a domain of discourse; a collection of data concepts, but not their visualizations. (See Figure 1) In this way, the collaboration can be deeper – it is about the information, not the presentation. Again, users' views are intended to differ; that is where the power of polymorphism lies.

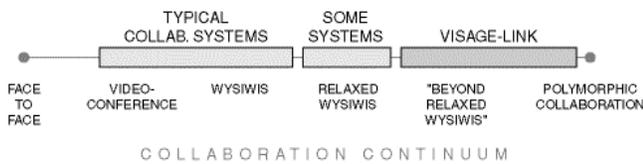


Figure 1: A Collaboration Continuum

The Visage-Link User Interface

As mentioned earlier, Visage's interface is designed so Visage feels more like an environment than a canonical application. There is no menu bar; there are no window decorations like titles, status bars, and resize handles, and visualization frames have only the thinnest of borders. The object is to propagate the illusion that users are interacting directly with the data. (Though the elements onscreen can only ever be *representations* of the data.) (See Figure 2)

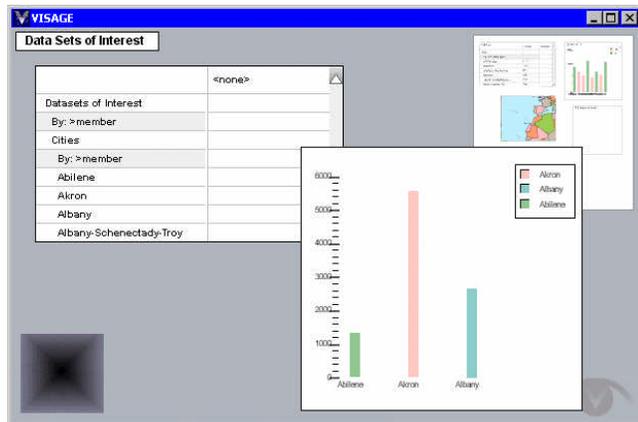


Figure 2: A simple Visage workspace

⁴ What You See Is What I See; sometimes considered the holy grail of collaboration, as WYSIWYG (What You See Is What You Get) has long been considered the pinnacle of user interface paradigms.

The challenge when developing the user interface for Visage-Link was to allow users to initiate and control collaboration on a frame-by-frame basis without damaging the existing information-centric paradigm.

Some aspects were straightforward. For example, since Visage is a visualization system (after all), handling collaborator discovery and organization can be done by including user information in the data store, just as any other data. This allows users to manipulate collections of collaborators and to use any existing visualizations to search for other participants, filter participant lists, and so on. Visage's standard map frame can be used to display the geographic location of any collaborator.

Initiating a collaborative session and controlling that session required the introduction of a new user interface feature. We desired to give users as much autonomy to control the scope of their collaboration as possible; replicating a user's workspace for another user would be tantamount to building yet another WYSIWIS system, which is counter to the Visage-Link research agenda. (However, Visage-Link can operate in a broad enough band of the collaboration continuum that it is capable of working as a WYSIWIS – tightly coupled – system.) Another important goal was to leverage the existing notion of lightweight visualization frames that can be created quickly and easily on an ad hoc basis; competent Visage users create and destroy frames constantly as they explore the data and create, refine, and test hypotheses.

The invention of "attachments" that extend a Visage frame to allow that frame to be shared with another user satisfied these goals. Any frame (which is essentially a visualization of a collection of data concepts) can become the object of collaboration. Users can keep some visualizations private and share others. They can share some frames with one user and other frames with another user, all in the same Visage session. The attachments were designed for users to initiate sharing by dragging collaborators onto the attachments, allowing standard visualization frames to be used to organize the collaborators.

In Visage-Link, the process to share a frame involves only a few steps: First, a user adds the Link attachment to the frame they wish to share. Second, they drag another user into the attachment. The frame will appear on the second user's workspace, at which point the second user can begin to interact with the data or modify their copy of the visualization. Figure 3 shows a map frame with the sharing attachment connected (in David Bishop's workspace), and a concept representing another user sitting on the desktop nearby ("hoffmann" represents Kevin Hoffmann):

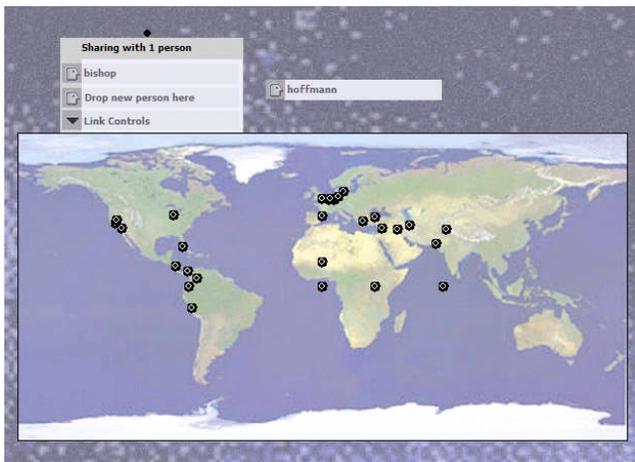


Figure 3: A frame, with the sharing attachment

Figure 4 shows the results of dragging the element representing Kevin Hoffmann into the sharing attachment. This will cause the frame to appear on Kevin’s screen. Note that the “Sharing with n people” title of the sharing attachment always the total number of collaborators sharing a frame (which is why it starts out at “1 person” – this represents you).

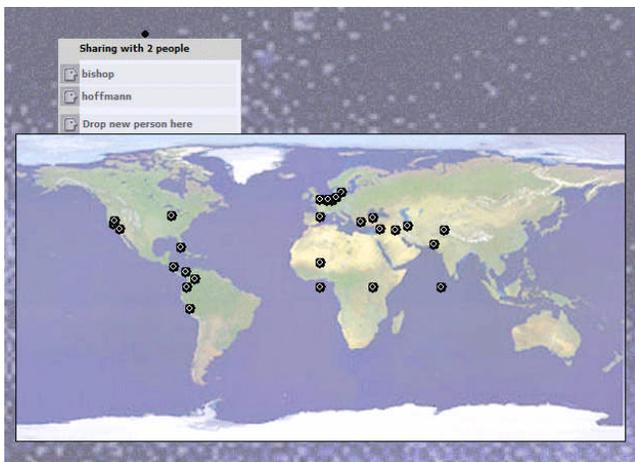


Figure 4: A frame shared between Bishop and Hoffmann, as indicated by the Visage-Link attachment.

The beauty of this method is that information about collaborators is no different from any other data in Visage – collaborators locations can be mapped based on their geographic location, organized by their interests, even charted based on objective criteria, because all these visualization frames already exist in Visage (it is a visualization environment, after all). Second, the collaboration is a natural extension of Visage – the Visage-Link attachment works, by definition, with any frame, and this is supported by the information architecture and system architecture. Any new frame added to the system by MAYA or end users will naturally be available to be shared; a user need only connect the Visage-Link attachment.

The Power Of Polymorphism

Once a collaborative session is established and two or more users are sharing a frame, any changes made to the data set visualized in the shared frame will be seen by all collaborators. Dragging new data elements into a frame will allow the other collaborators to see them as well. Removing elements from a frame will cause them to disappear from other collaborator’s frames as well. (See Figure 5)



Figure 5: Sharing data by dragging it into a shared frame.

Collaboration as just described is toward the WYSIWIS end of the spectrum for Visage. Users aren’t sharing the application, nor are they sharing as much as the workspace, but the frames are displaying the same visualization. In this tightly-coupled mode, frames closely track each other – if one user changes the axes of a chart or changes the map from a world map to one of the United States, the other users will see the same change. Useful, and important in many cases, but the Visage-Link research agenda was to push the envelope toward deeper collaboration based on the polymorphism already well-supported in Visage.

Users can “morph” frames individually without changing other users’ presentation. The data collection stays the same, but the visualization changes. This is what we refer to as *polymorphic collaboration* – one user may be looking at a map, while another is viewing the same data collection in a spreadsheet-like frame or a plot chart. Users can tailor their frames to their role, their skill set, or a localized task or hypothesis without affecting other users visualizations.

One user may be looking at a plot that allows them to make judgments based on the ratio of population to crime rate of world cities, while another may be viewing the same set of cities on a map. In this way, users can bring different skill sets together to attack a problem without having to know anything about the other users' domains of expertise. In WYSIWIS collaboration scenarios, the assumption is made that you and I want to see similar representations. In Visage-Link, the assumption is made that you and I care about sharing the data, and want to control our own presentation in order to have a deeper collaborative experience.

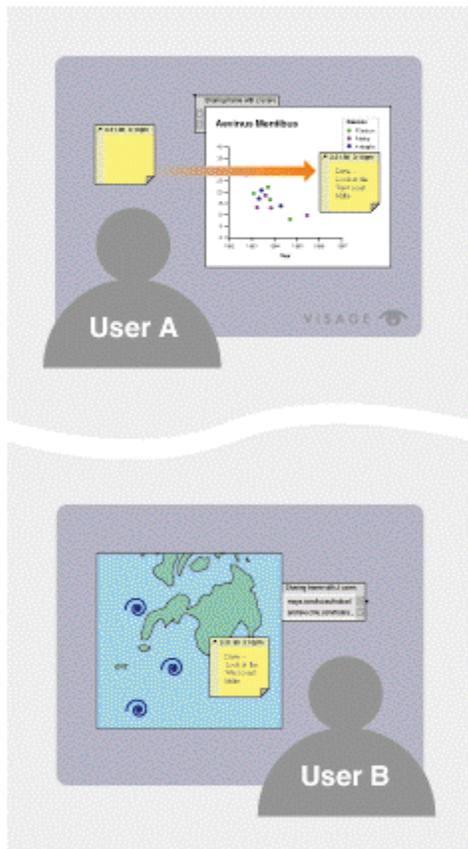


Figure 6 - Polymorphic collaboration: both users view the same data set, but with different presentations

Lesson: Too Much Of A Good Thing?

Polymorphic collaboration does not come without its pitfalls. Maintaining context among a collaborative group when it is unknown what kind of visualization other users are viewing is obviously difficult. Indicating focus is equally hard – a user with a map may wish to refer to items by their geography, saying, “The five trucks grouped together in the northwest,” which won’t indicate much of anything to another user who has organized a bar chart to show the truck’s capacities.

Many visualization systems include a notion of *painting* or *marking*, which is generally used to color data items based on some criteria or to highlight outliers or interesting features. In Visage, marking is used as well, and it is

especially useful when the same data concepts are represented as elements in multiple frames that contain different visualizations. Marking all the high crime cities in a bar chart showing comparative crime rates will automatically and simultaneously mark them in a map frame and a spreadsheet frame. In a polymorphic environment, this is one of the highest value features supporting data exploration and hypothesis validation.

Since Visage-Link relies on polymorphic collaboration (above and beyond polymorphic visualization), marking was extended to allow *shared marking*. When users morph their frames so they are viewing different visualizations, they can rely on shared marking to indicate focus. This allows a user to perform a visual query, like selecting the coastal cities on a map, then mark the selected cities to indicate to a user who isn’t viewing a map which cities are being discussed.

In a sense, this is backing down slightly from the fully-polymorphic end of the collaboration continuum; it turns out that if users visualizations are too divergent, discussions are so abstract that the value of polymorphism is lost. Visage-Link addresses this with several features. First, by allowing the users to control how tightly linked their visualizations are, from isomorphic (when one user morphs their frame, other users’ frames follow) to polymorphic (maximum autonomy to morph frames). Second, by including shared marking to provide users a method for indicating focus even when everything else about their visualizations is different.

An interesting discovery was made while developing the Visage-Link system: without shared marking, users invented ways to indicate focus on their own. Typically, one user would alternately remove and replace data elements from a visualization by repeatedly dragging them out of and back into a frame. Doing this makes the elements “blink” on other users screens, as their visualizations update to show the proper collection of data. An ingenious approach, but not exactly an optimal user interface, not a very scalable solution, and quite dependent on network speed.

SUMMARY

A collaboration continuum was shown in Figure 1, where systems were placed according to how tightly coupled users’ views are with each other. Visage-Link was built to explore the end of this spectrum where data presentation was completely independent for each user forcing the domain of discourse to be *only* the data.

Developing this system required careful thought to maintain the character of Visage and to leverage its drag-and-drop behavior and direct-manipulation “feel.” It also required implementation of features to support users when collaborating in the polymorphic realm beyond relaxed WYSIWIS, including controls for varying the degree of frame coupling as well as focus indication schemes like shared marking.

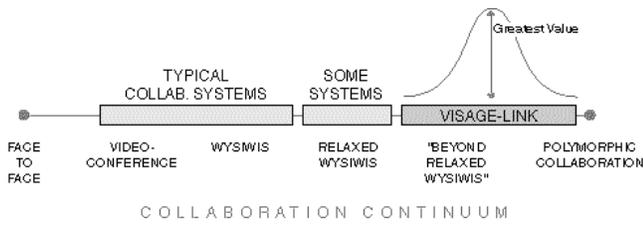


Figure 7: The greatest value for collaboration beyond relaxed WYSIWIS comes before maximum polymorphism.

Polymorphic collaboration has great value as a deep collaborative device, as long as it is not pursued so fully that users are left in a realm that's too abstract.

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