

Collaboratively Improvising Magic: An Approach to Managing Participation in an On-Line Drama

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Abstract. We describe how a behind-the-scenes production crew managed participation in an on-line improvised dramatic performance in a shared virtual world that was broadcast to viewers. We introduce the approach of collaboratively improvising magic, where participants indirectly request interactions with objects through extended incantations, rather than manipulating them directly. Invisible stage-hands follow these participants around the world, monitoring their activities and granting requests when appropriate. We describe how this was realised in *Avatar Farm*, a two hour long improvised drama that involved four members of the public, seven actors and an extensive production crew. We discuss the provision of technical support within the MASSIVE-3 system to realise our approach. Empirical analysis of interaction in *Avatar Farm* illustrates some key issues. We see how participants weave accounts of technical problems into the narrative; how actors vary the pacing of the narrative to co-ordinate the timing of a local scene in relation to parallel scenes that are happening elsewhere; amongst other matters. We conclude with some general lessons from our approach for CSCW.

Introduction

In *Computers as Theatre*, Brenda Laurel proposed an approach to interaction where computers are considered as a form of theatre rather than as tools, and where the focus of design is on engaging users with content rather than with

technology (Laurel, 1992). She suggested that various behind-the-scenes activities are required to maintain engagement and to orchestrate users' experiences.

Nearly ten years later, CSCW technologies such as collaborative virtual environments (CVEs) are being used increasingly for on-line games, performances, role-playing and other leisure and entertainment applications (Dodsworth, 1997). These applications take the idea of computers as theatre quite literally and so have to deal head-on with the challenge of managing participation from behind-the-scenes. What activities are required to ensure the smooth running of an event, and how can participation be guided and shaped, especially in time-critical situations such as performances or TV shows?

One approach, directly derived from traditional theatre and television, is to employ a production crew to monitor events and to intervene where necessary. An example can be seen in *Out of this World*, an experimental inhabited television show in which members of the public and professional actors staged a gameshow in a CVE that was broadcast to a viewing audience (Benford et al., 1999). A member of the production crew used dedicated management software to monitor the show and to move participants to key positions at particular times so as to ensure that the show followed a tightly defined schedule. In contrast, in a recent on-line performance called *Desert Rain*, the production-crew and performers employed more subtle techniques to gently steer individual participants and embed advice and instructions within the performance without fracturing their engagement (Koleva et al., 2001).

This paper describes the experience of managing participation within a recent experimental inhabited television show called *Avatar Farm* in which four players and seven actors improvised a two hour long drama spanning four virtual worlds. The non-linear, branching narrative structure of *Avatar Farm* posed significant challenges for managing participation. We focus on how the players, actors and a behind-the-scenes production crew collaborated to improvise complex interactions with objects, wrapped up in the metaphor of magic. In essence, the players and actors would use objects to invoke magical effects within the world and the production crew, including a team of invisible stage-hands, would try to respond appropriately. Our paper motivates this approach and describes the organisation of the production crew and the design of new management software to support them. We follow this with an account of how *Avatar Farm* was practically managed including an examination of how magic was collaboratively improvised in one scene presented in detail. We close by highlighting issues pertinent to the management of similar events and to CSCW at large.

An Introduction to *Avatar Farm*

While *Out of this World* had demonstrated the potential of dedicated software to support the management of a relatively fast-pace on-line event, it had also been roundly criticised for a lack of empathy for and detail in its characters and

adopting a clichéd format from conventional television. Our goal for *Avatar Farm* was therefore to engage members of the public in a more richly dramatic experience and also to explore the potential of CVEs to support new narrative forms. Our overall approach involved three steps:

1. We began by establishing a small on-line virtual community called *Ages of Avatar* alongside Sky Television's [.tv] channel using Microsoft's VWorlds dial-up CVE platform (Craven et al., 2000). This provided us with a pool of established characters and worlds from which to draw inspiration and material, as well as a group of committed players who were familiar with one another and who shared a common history.
2. We recreated new versions of the virtual worlds, selected avatars and objects from the *Ages of Avatar* within the MASSIVE-3 CVE platform running on a dedicated Local Area Network at Nottingham. This enabled us to take advantage of MASSIVE's real-time audio capabilities, desktop and immersive interfaces, and also new facilities for managing events in virtual worlds and post-producing 3D recordings of these events.
3. We selected four key members of the *Ages of Avatar* community to be players in *Avatar Farm*. These persons were notable for their liveliness and commitment in participation in the on-line community. They joined us in a purpose built inhabited television studio in Nottingham for two days in June 2000 where they collaborated with seven professional actors, a story writer and a production crew, to improvise a drama loosely based around their familiar characters and worlds. We chose actors who were experienced in engaging members of the public in more conventional role play situations and improvised theatre.

The result of these activities was *Avatar Farm*, a two-hour long improvised drama structured as four 25 to 40 minute long 'chapters', involving 15 virtual characters, played by 11 people that was both web-cast live and also recorded. *Avatar Farm* was a fable involving gods, tricksters and innocents abroad. The four players from the *Ages of Avatar* were reawakened in the more or less familiar virtual worlds to find them repossessed by the feuding gods Virbius, Egeria and Attis and their various sidekicks. The players were initially enslaved and used as pawns in the gods' struggles. However, by observing closely they came to learn the history of the feud as well as the secrets of magic within the worlds, and so gained the power to free themselves, resolve the feud and restore harmony to the worlds.

In chapter one, the four players were reawakened and were then immediately separated and taken to different worlds to meet the gods for the first time. Chapter two involved the players learning how to gain special powers such as flying, changing appearance and becoming invisible. They also learned how to trigger "time-rifts" – ghostlike playbacks of scenes from the past (part of a backstory that had been recorded by the actors on previous days). In chapter three, the players' loyalties to one another were tested as part of a series of cruel games to the point

where they rebelled. Further time-rifts revealed more of the history of the feud. Finally, in chapter four the players, rose up to overthrow the villains of the piece.

From the point of view of this paper, a key characteristic of this drama was its complex and non-linear, branching narrative structure. The core of the story was based upon the four players' experiences. For much of the time they were separated and involved in parallel scenes, often taking place in different worlds. As each followed their own thread through the story, their paths would cross at various points and occasionally they would all meet for a pivotal scene before splitting up again. Even when not directly involved with the four players, the actor-controlled characters remained active, carrying out their normal background activities. Replaying pre-recorded scenes within the live worlds gave the story a relatively complex temporal structure. Finally, the use of props and other objects in the worlds to achieve various special effects was central to the story and involved the participants in relatively complex sequences of utterances and gestures as we shall see.

Managing Participation in *Avatar Farm*

Managing participation in *Avatar Farm* proved to be challenging for several reasons.

- The non-linear and distributed nature of the drama required the crew to monitor and manage concurrent scenes.
- There was greater scope for improvisation and autonomy by the players than there was with the tightly-scripted gameshow format of *Out of this World*.
- A subtle approach was required so as not to break the player's engagement with events and to ensure that their actions appeared to be a natural part of the story at all times (in contrast to *Out of this World* where relatively obtrusive interventions such as suddenly moving all players to a new location seemed to be broadly acceptable within the context of a television gameshow).

Given these challenges, we chose an approach to managing *Avatar Farm* that combined three key elements.

1. We adopted the approach of 'improvising magic'. Rather than directly manipulating objects to achieve an effect, participants would have to indirectly request the effect by gathering key objects, moving, gesturing and speaking aloud. Invisible stage-hands would observe these incantations and would invoke the desired effect on the player's behalf. These helpers could also grant the players new special capabilities. This collaboration between the participants and stage-hands was then wrapped up in the metaphor of magic.
2. We distributed the responsibilities for management among a behind-the-scenes crew and provided them with various physical and on-line facilities for monitoring *Avatar Farm* and for communicating with one another.

3. We extended MASSIVE-3 with new interfaces to allow crew members to intervene in events, directly manipulating objects and players as well as granting and revoking the capabilities for the players to do this themselves.

The following sections focus on each of these three elements in detail.

Granting Capabilities and Improvising Magic

At the start of *Avatar Farm*, the players were able to perform only a few basic actions with their avatars. These were: moving around on the ground plane; talking so that they could be heard by other nearby avatars; picking up an object, waving it about and putting it down; carrying an object while moving; and replaying one of ten pre-recorded gestures. At times, the story required the ability to limit even these basic actions; for example, particular players might occasionally be frozen to the spot or disallowed from picking up certain objects.

Central to the story was the way in which different players subsequently gained additional capabilities or learned how to invoke various magical effects. These included: flying up to a fixed height; becoming invisible; changing appearance between a number of pre-determined avatars; moving through the portals that linked the four worlds together; snooping on other players' distant conversations; becoming immune to the powers of particular gods; and triggering a time-rift (the replay of a pre-recorded scene within a live world). In terms of the story, these capabilities and magical effects might be granted by other characters, especially the gods, or might arise from the correct use of particular objects. Examples of the latter include:

- feeding a purple tuft to the world serpent by depositing it on a feeding hole and then making the correct incantation could trigger a time-rift;
- licking a camouflage lizard could confer the ability to change appearance;
- eating a blue mushroom would render one temporarily impervious to the powers of the god Virbius.

One approach to supporting these capabilities and effects would have been to program them directly as part of the *Avatar Farm* application software as if it were an interactive computer game. A player directly manipulating an object (e.g., selecting it) would, through this, invoke its effect. However, we were concerned make the structure of *Avatar Farm* as open as possible to improvisation and a pre-programmed approach seemed did not seem flexible enough in this context.

A key element of improvisation in the theatre and in other arts is the possibility of taking advantage of interesting, yet unforeseen, interactions between participants. To allow flexibility for this, we wanted to be able to choose at any moment whether it would be appropriate to grant an effect and if so, exactly how and when it should be realised. In this way, the timing of an effect could be controlled to fit in with ongoing interaction between participants. Indeed, whether an effect is granted at all could also become a dramatic element. These are

outcomes which would be impossible or excessively complex to program in advance. Some effects would also require coordinating multiple players. For example, a time-rift would be a major moment in the story and it would make sense to gather several players together to witness it. However, this would involve finding these players (who might be engaged in activities elsewhere) and persuading them to move to the location of the time-rift. It would be difficult to predict how long this might take. Finally, we were well aware of the possibility that the coordination of the narrative might break down – especially for such a multi-threaded, branching structure as *Avatar Farm*. We needed an approach which would enable us to repair and recover from breakdowns. Pre-programming object-behaviours might have hindered this if, for example, a set of behaviours were to execute autonomously and erroneously.

In the light of considerations, we adopted an alternative strategy – improvising object-interactions. In this case a number of crew members, ‘stage-hands’, were also present but invisible within the worlds. These had the ability to manipulate objects and avatars and to directly trigger special effects such as replaying pre-recorded scenes; moving or constraining players and objects; making players and objects appear, disappear and change appearance; and granting and revoking permissions to pick up particular objects and move through portals. The invisible stage-hands followed the players around, monitoring their activities and triggering effects in response. Improvising a single logical action from the point of view of the players would often involve the stage-hand in a quite complex sequence of more atomic actions. For example, actions such as eating a mushroom or feeding a tuft had to be composed out of more basic actions such as moving objects and making them invisible. Particularly complex sequences involving more than one player would require several stage-hands to coordinate their behind-the-scenes manipulations.

The players’ interactions with objects were therefore indirect and collaborative; they had to request that something happen and a stage-hand then had to respond. However, this collaboration was somewhat unconventional as the stage-hand was invisible and the player was not meant to know that they were present.

Another key characteristic of this approach is that interaction was slowed down. It could take from a few seconds to several minutes for one or more stage-hands to spot that an action was being requested, to decide whether to respond and to make the response happen. We therefore decided to dress up the process of improvising interactions in various extended incantations. We would require the players to act out elaborate rituals involving gathering objects and placing them in key locations and making extended sequences of movements, gestures and utterances in order to invoke an effect. Even where the players gained new abilities such as flying at will, these would be granted in a magical way – as a gift

bestowed from the gods or as a result of an extended incantation. We anticipated that this approach would result in two key benefits.

1. The result and timing of any request could be left open – everyone knows that magic is dangerous, unpredictable in its timing and liable to go wrong if the magician makes only the slightest mistake. We hoped that the metaphor of magic would enable the players to accept and work around delays and failures.
2. Extended sequences of actions would be more visible, predictable, dramatic and therefore interesting to watch. Helpers would have sufficient time to spot that a request was being made, to marshal the necessary resources and to plan their response. The camera crew creating the broadcast from the virtual world would similarly be able to predict in advance when and where interesting action was likely to happen. In particular, it would be clear a long time in advance that an interaction was building and that the crew would be required to act in the future. Finally, viewers would hopefully find the interaction easier to follow and more interesting to watch.

The following sections describe the organisation of people and technology that supported this approach of collaboratively improvising magic within *Avatar Farm*.

Organisation of the Production Crew

There were two categories of people involved in *Avatar Farm*. The cast (four players and seven actors) and a behind-the-scenes production crew as follows:

Story director – assumed overall responsibility for directing events within the world. This involved monitoring the progress of the event as a whole, deciding on the course of the plot, and instructing actors and crew members accordingly.

Director's assistant – supported the story director and assumed particular responsibility for coaching the actors

Software manager – assumed overall charge of MASSIVE-3.

Stage-hands – the four invisible helpers who were charged with the task of improvising interactions as described above. In general, each was assigned to follow a different player, although the story director might occasionally assign them other specific duties. One was also responsible for cueing and replaying the pre-recorded time-shifts.

World-manager – a further invisible helper specifically responsible for granting and revoking access controls on portals, thereby controlling which characters could move into which worlds at which times. They were also responsible for access control on the ability to pick up some objects.

Actor helpers – two crew members who physically supported the two actors who were using immersive VR interfaces, for example, helping to put on and take off the equipment and also holding their microphones.

Player helpers – two crew members to support the players.

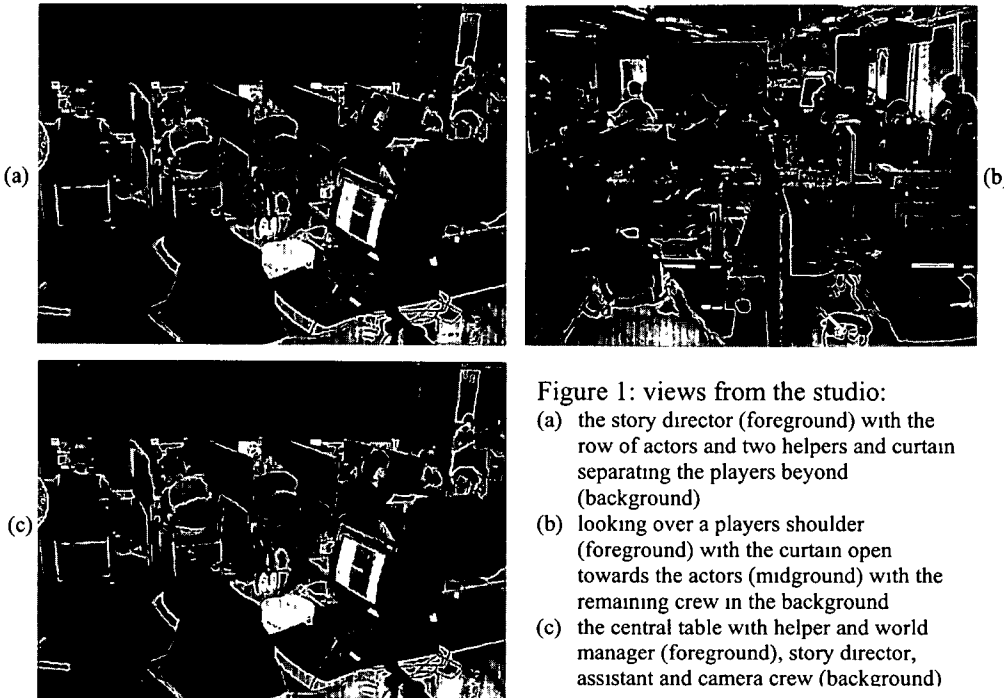
Virtual camera operators – were responsible for capturing different views of the action in the virtual worlds using purpose built virtual camera interfaces, each of which could track four different camera views at a time.

Camera director – responsible for selecting which camera view would be web-cast live at any moment in time.

Web-cast team – a team of two people who maintained and monitored the web-cast software and content.

Floor manager – responsible for coordinating activities and communication within the physical inhabited TV studio.

These people were located in a shared studio space as shown in Figure 1. Several features of this arrangement are relevant to this paper. First, the only partitions in the space were black curtains. As a result, the players could not see the behind-the-scenes production areas when the world was live, but there was some potential for audio overspill, which also meant that the production crew had to be careful not to talk loudly or make other noises. Second, the space was designed to encourage mutual awareness among key members of the crew. In particular, the story director, their assistant, world manager, helper responsible for temporal links and camera crew were arranged facing across a shared table so that they could peripherally monitor each other's affairs. A large projected view of the actual broadcast was also visible to the camera crew and many of the other crewmembers.



There were also opportunities for physical communication within this set-up and in particular, the floor manager and various actor and player helpers could move freely around the space in order to monitor events and pass messages.

In addition to the physical design of the studio space, the MASSIVE-3 software was also configured to allow different roles to oversee events and to communicate. The story director and assistant were invisibly present within the worlds and they and the stage-hands, world-manger, camera operators, camera director and software manager could monitor the conversation between the actors and the players in the part of the world were they were currently located. A separate audio talk-back system allowed the story director to speak directly to any individual stage-hand, actor or the world manager in order to pass out instructions.

In other words, there were many opportunities, both in terms of on-line communication and the design of the physical studio space for the various crew members, especially the story director, helper and actors to monitor events within the world and to communicate with one another in order to support the process of improvising magic within *Avatar Farm*.

The Stage-Hand and World-Manager Interfaces

We now focus on the design of the stage-hand and world-manager interfaces in more detail as these were central to the process of improvising magic. The stage-hand interface consisted of two windows, one containing controls for manipulating entities (objects or avatars) as shown in Figure 2 and a second offering a view of the world.

A stage-hand would select an entity to be managed from the list in the lower part of the interface. Upon selection their view of the world would be moved to centre on this entity. The stage-hand could zoom and rotate this viewpoint while focused on this entity using the camera controls at the bottom right of the control panel. The virtual camera would lock onto and track the entity as it moved. Once selected, the entity could be managed.

The constraint control manoeuvred the entity around the world with the speed of movement being goverened by a slider on the control panel. Depending on the type of entity selected, different properties could then be altered using the controls at the top-right. If the entity was an object, the stage-hand could select whether it was visible or not. For an avatar they could:

- set whether it was visible or invisible;
- select its appearance from a among a pre-defined selection of geometries;
- alter the scale factor of its geometry (making it grow and shrink);
- grant or revoke its ability to fly, control its own visibility and appearance.

The world manager interface was similarly split into two parts. The world manger could select a world to view and could position their viewpoint either relative to the origin of the world or to a specific entity (by selecting one from the given

list). To change the access control on either a portal or an object, they would select the portal or object from a list, select an avatar from a second list, and then set whether this avatar had access.

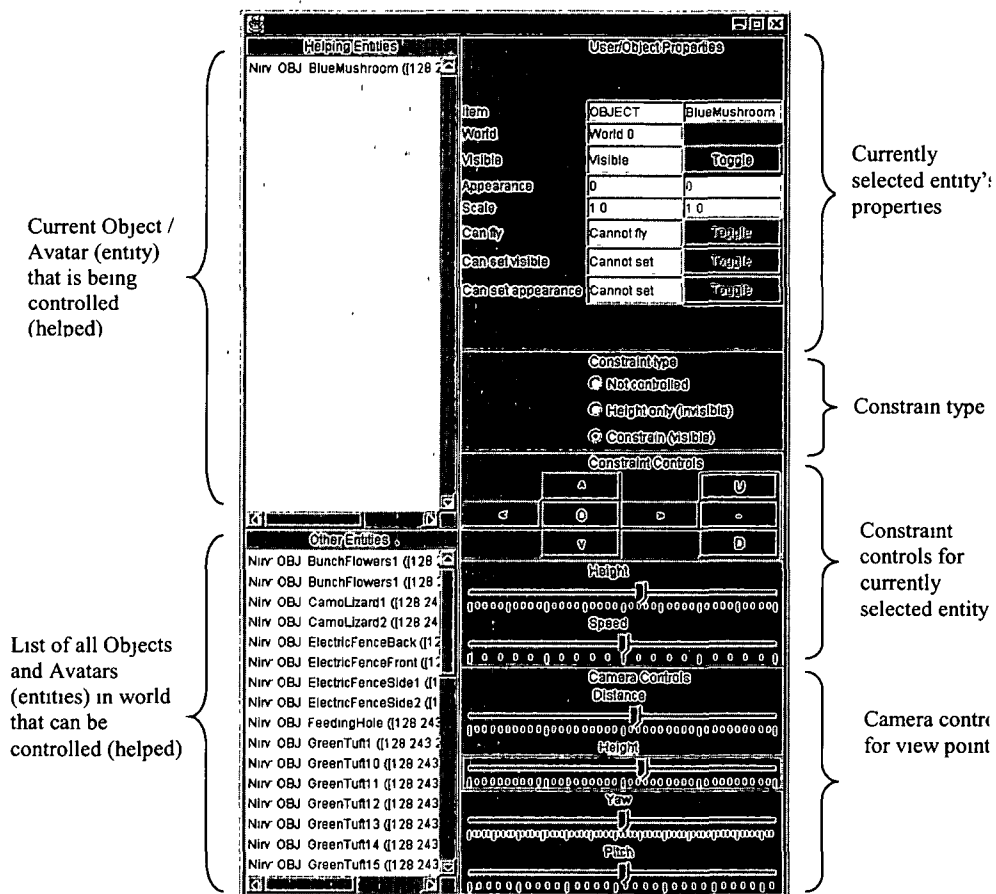


Figure 2: the stage-hand interface

In Practice: The Management of Magic

To appraise our approach to the management of participation in *Avatar Farm*, we now explore a specific example of the process of improvising magic at work. Our example is taken from chapter 4, the final chapter of *Avatar Farm*. It takes place within the child-like world called Kindergarten and involves three main characters: the player Maple, Squeaky Clean (sidekick of the arch-villain Attis and a scheming trickster) and Botchov (authoritarian butler to the chief-god

Virbius). We focus on an extended section of narrative that lasts for approximately fifteen minutes in which Squeaky persuades Maple to play a trick on Botchov, causing him to be eaten by the world-serpent. We have chosen this because it is one of the more complex sequences in the drama in terms of interactions with objects and hence behind-the-scenes-activity.

Using 3D Record and Replay to Analyse *Avatar Farm*

The following analysis of our chosen sequence has exploited a novel 3D record and replay mechanism that we have implemented within MASSIVE-3. This logs and timestamps every action within a locale (a region of a virtual world) (Greenhalgh et al., 2000), including every movement, object interaction, and speech of every avatar within that locale. A recorded log file can then be linked back into a live locale at a later time using a “temporal link” so that when it is replayed the recorded action appears to be recreated within the live world and mixed with the live action. Live participants can then fly around the recording, viewing it from any angle, listening to the audio or following any character.

To support our analysis, we have edited the 3D recordings of *Avatar Farm* so that the invisible stage-hands are now made visible in the virtual world so that we can see their actions alongside those of the players and actors. We could repeatedly view and hear the process of improvising magic in the virtual world from any angle. We also have access to a parallel video recording of the production crew in the physical studio space during this sequence. The images of the virtual world that are included in this paper were generated by replaying the 3D recordings, positioning a live-virtual camera within them and then using a screen-capture tool. They therefore show snapshots of the action as it happened.

How Maple and Squeaky Clean Tricked Botchov

The story director originally planned our chosen scenes to unfold as follows. The player Maple, aided by Squeaky, would feed a purple-tuft to the world-serpent and perform a specific incantation in order to trigger a time-rift. This would show them both a scene from the past in which Botchov was playing with his long lost sister Octavia and discussing various family secrets, especially “the secret of the green teapot”. Squeaky would then teach Maple how to change appearance by picking up and licking a camouflage lizard and performing a second incantation. Maple would then take on the guise of Octavia in order to trick Botchov. Maple, disguised as Octavia, would encounter Botchov. He would use the secret of the green teapot (that surely only Octavia could know) in order to convince Botchov that he is indeed Octavia. He would tell Botchov that he has to stand on the feeding hole if he wants to join Octavia in the land where she now dwells. He would then be eaten by the world serpent, but not before Maple and Squeaky have first revealed how he has been duped!

In fact, as the following description shows, enacting this sequence of events is not straightforward due to various unforeseen circumstances involving other threads of the narrative that are taking place elsewhere as well as various local technical and interactional difficulties. However, Maple, Squeaky and Botchov eventually do manage to successfully improvise a version of the trick on Botchov, supported by the stage-hands. The table below summarises some of the key moments in this sequence of events along with our commentary as to what is happening behind-the-scenes. Figure 3 shows various moments from this scene. Maple appears as a red humanoid figure with brown hair. Squeaky has a green body, no legs and long ears and horns. Botchov is wearing a butler's uniform. Octavia (Maple in disguise) appears as a girl with pigtails. Finally, the stage-hands appear as cameras pointing at the character that they are currently controlling (though, remember, stage-hands are rendered from the 3D recording here, they were not originally seen by participants). White rings around a character's head indicate the current volume of their speech.

Event	Commentary
<p>Squeaky Clean briefs Maple about the trick - see Figure 3 (a).</p> <p>Maple, guided by Squeaky Clean, begins the incantation to cause a time-rift.</p>	<p>Initially we can see one stage-hand on Maple, but they are soon joined by a second</p> <p>Squeaky Clean's dialogue at this point makes various explicit references to how Maple should use their computer to trigger the gestures that are required by the incantation (e.g., "press key 9")</p>
<p>Squeaky Clean places the tuft on the feeding hole</p> <p>Maple finishes the incantation. However, no time-rift occurs.</p>	<p>Squeaky Clean and Maple do not know that a 3D replay cannot be triggered at this point because another one is already taking place in the world Nirvana as part of a parallel thread of the story. The <i>Avatar Farm</i> set-up does not include the resources required to replay more than one recording at a time</p>
<p>Squeaky Clean "Try the incantation once more."</p> <p>Squeaky Clean continues guiding Maple through the second incantation</p>	<p>A third stage-hand has now become concerned with the progress of events and has attached themselves to Maple. All three can be seen in Figure 3(b). It should be noted that, in the performance itself, the stage-hands are invisible to one another as well as to Maple and Squeaky Clean</p>
<p>Maple: "Has it worked?" (at the end of the second incantation)</p> <p>Squeaky Clean: "No... there is a time distortion already in place which is breaking up the equilibrium of the world"</p>	<p>The second incantation hasn't worked either as the parallel time-rift in Nirvana is still playing out</p> <p>Squeaky Clean has now heard (probably from the story director over the talk-back system) that there is a problem triggering the replay and is providing an account of this in terms of the narrative</p>
<p>Squeaky Clean now suggests that Maple use the camouflage lizard in order to turn into Octavia. He explains the necessary actions and incantations</p> <p>Maple grasps the camouflage lizard</p>	<p>Squeaky is pressing on anyway. Again, his dialogue contains more references to pressing particular keys on the keyboard.</p> <p>At this point one of the stage-hands leaves the scene</p>

Maple completes the relevant incantation

Squeaky Clean: “. . . and you’ve changed into . . .”

Squeaky Clean. “ Desmond! . . .try again!”

Squeaky Clean. “. . . No Tock-Tock!! ”

Squeaky Clean: “ No . . . Octavia!!! You are an incredibly powerful avatar to have gone through so many changes”

Maple: “Wow” (laughs)

Squeaky Clean now instructs Maple about using the secret of the green teapot to convince Botchov that he is indeed Octavia

Botchov arrives. Squeaky Clean now makes himself invisible

Maple. “I am the spirit of Octavia ”

Squeaky Clean. (evil cackle)

Maple continues to act out the trick on Botchov He reveals the secret of the green teapot and lures Botchov onto the feeding-hole

Squeaky Clean explains to Maple that he needs to reveal himself as Maple

Maple: “I am Maple not Octavia”

Squeaky Clean makes himself visible (Figure 3 (f))
Botchov acts surprised.

Maple. “Bye Bye”

Squeaky Clean. “Well done Maple”

Maple: “I think I got everything in there”

Squeaky Clean now engages Maple in conversation for a couple of minutes, recapping recent events. He then asks him whether he has ever seen the maze in this world.

(see Figure 3 (c)), shortly followed by another, leaving just one stage-hand on Maple. They change him into Desmond, the wrong character (he is supposed to become Octavia).

The stage-hand now changes Maple into Tock-Tock (still the wrong character). The exclamation “try again”, of course, can be heard by Maple and the stage-hand and understood as an instruction to both.

The stage-hand now changes Maple into Octavia, correctly (Figure 3 (d)).

Squeaky Clean is once again accounting for technical problems in terms that make sense to the narrative at this point

A second stage-hand attaches to Maple, followed by a third.

He needs to do this through dialogue as the replay that would have given this vital information was never seen. He also reminds Maple to talk in a high pitched voice One of the stage-hands leaves so there are now two in attendance.

Note: As an actor, Squeaky does not need a stage-hand to do this for him.

Forgetting his instructions, Maple begins in a low voice but then switches to a higher register.

Squeaky Clean is using a stage-whisper here Botchov and Maple will be able to hear this

One stage-hand now moves over to be on Botchov while the other remains on Maple.

The other stage-hand now moves from Maple to Botchov (being unaware that a stage-hand is already there). There is now no stage-hand on Maple. The stage-hands move Botchov downwards so that he is halfway into the hole (Figure 3 (e))

Squeaky Clean again uses a stage whisper.

However, Maple’s microphone connection has temporarily failed and it takes several such whispers before it resumes and Maple is heard to respond. Botchov acts as if he doesn’t hear, but Squeaky’s whispers help him to understand that there is a technical problem with Maple.

This is the cue to change appearance. One stage-hand now moves back onto Maple. He switches Maple’s appearance back to being his normal self

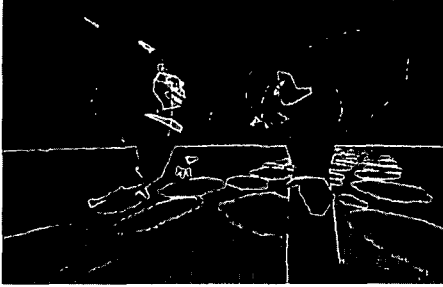
The stage-hand on Botchov drags him entirely down through the hole and out of sight

Squeaky is delaying Maple at this point The main action will soon move to the world Trade and Power However, the portals between worlds are all closed right now because a time-shift is happening

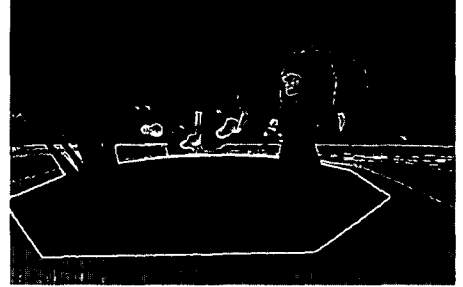
Squeaky Clean: "Soon we will be going to Trade and Power"

elsewhere (a known bug in MASSIVE triggered by using a portal during a time-shift)

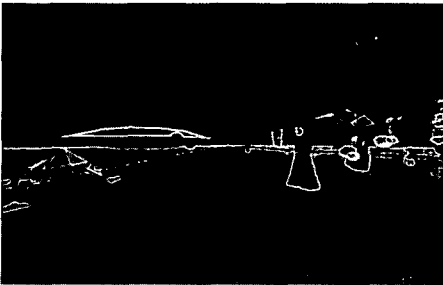
Squeaky Clean has received instructions from the story-director over talkback that he now needs to go Maple to the world Trade and Power where the cast is being assembled for the final climatic scene



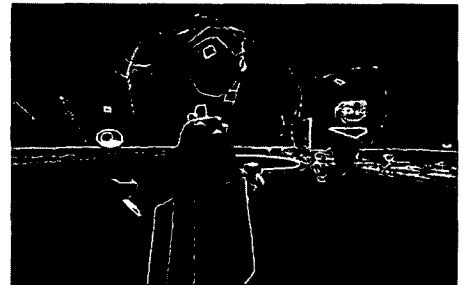
(a) Squeaky Clean (left) briefs Maple (right)



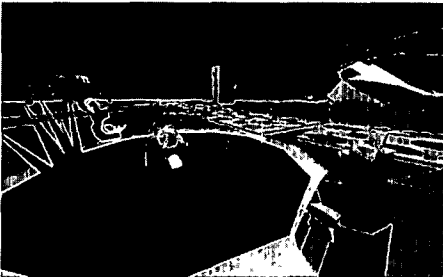
(b) Maple incants with 3 stage-hands present



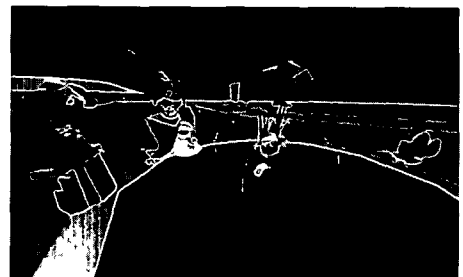
(c) Maple grasps the camouflage lizard



(d) Maple is changed into Octavia



(e) Botchov is lowered into the hole



(f) Squeaky Clean reveals himself

Figure 3: snapshots from the trick on Botchov

The above sequence of events shows how the cast and stage-hands struggle to overcome various unforeseen circumstances to more or less successfully improvise a version of the planned scene. Maple certainly manages to pull off a complicated trick on Botchov, albeit with extensive support from Squeaky Clean.

However, this sequence of events also sheds light onto the ways in which improvisation occurs and the relationship between the work that is taking place “on stage” and the work that is taking place “behind-the-scenes”.

Making Drama out of a Crisis

Previous studies of CVEs and other CSCW technologies have observed how participants often account and compensate for technical difficulties through their talk (Bowers et al., 1996; Hindmarsh et al., 1998). In our example however, Squeaky Clean not only provides such accounts but carefully embeds them into the context of the drama. When a stage-hand struggles to find the correct new appearance for Maple we hear that this is because he is: “an incredibly powerful avatar to have gone through so many changes”. Earlier, when it was not possible to replay a 3D flashback we heard that “there is a time distortion already in place which is breaking up the equilibrium of the world”. Indeed, it is often possible for an actor or player to formulate their contribution in such a way that it can be heard (by another actor or player) and overheard (by a stage-hand or other production crew member) simultaneously (e.g. Squeaky Clean’s instruction to “try again” above). We suggest that the approach of improvising magic provides skilled actors with plenty of room for manoeuvre when it comes to improvising such accounts and we are sceptical whether this would be so easy if interaction were more mechanical and immediate.

Indeed, we have examples of the (non-professional) players also engaging in such creative accounting for events. In a scene a few minutes after our description ends, we see Maple improvising an account for another delay in a purple tuft triggering a time-rift. Squeaky Clean observes: “The purple tufts sometimes take a long time to work” to which Maple retorts “I should imagine so especially after he [the serpent] has had a long meal”. Such accounts, even or perhaps especially when ironic, allow the participants to maintain their engagement with the story while providing improvised content which an actor could further develop, all the while covering a delay while the production crew troubleshoots a problem.

Coordinating Help

We have noted in our extended example that, at various times, up to three stage-hands can be seen in the vicinity ready to help out with events. This testifies to the ability and willingness of the stage-hands to monitor unfolding events, check up on them and be ready to help. However, in the example given, we see several moments where two or more stage-hands have attached themselves to a character, even though only one is necessary to bring about a necessary effect. This suggests that there were occasional coordination problems between the stage-hands. This is confirmed by noting that, at the crucial moment in the trick on Botchov, we see the two helpers on Maple both detach and move over to Botchov, when what was

required was one to change Maple back to his normal appearance as the other lowered Botchov into the hole.

This and other examples indicate that an awareness of the talk between participants and having visual access to the graphical worlds they inhabit are not enough to cue one in how to effectively deliver help as a stage-hand. One also needs to have an awareness of what other stage-hands are doing as well as be sensitive to instructions given by the story director. During the example above, there was occasional use of talkback to facilitate this. We also have examples of people physically leaving their workstations to go over and talk to stage-hands or check behind the curtain separating the players from the production crew, and so forth. In other words, our technical arrangements did not compensate for the occasional need for activity in the physical world to coordinate help. Indeed, when their responsibilities in the virtual world eased off, a number of members of the crew were willing to spontaneously serve as 'runners' if the need arose.

Delaying and Hurrying Tactics

As noted previously, the branching, non-linear structure of *Avatar Farm* posed a number of challenges to its producers. In particular, a scene that is taking place in one location might be affected by parallel scenes that are happening elsewhere. This might be for technical reasons such as in our example when the time-rift cannot be triggered and the portals between worlds cannot be used because another time-rift is already happening. It might be for dramatic reasons, such as when a major scene takes place that requires the players to gather together. For whatever reason in a non-linear narrative that involves groups of people in different scenes, local plans will often have to accommodate events elsewhere.

The approach of improvising magic provides some flexibility for managing the timing of local scenes. It is easy to prevent participants from triggering effects that would be dangerous or inappropriate and actors can employ various tactics to delay players or hurry them along. We see Squeaky Clean employ such tactics towards the end of our chosen sequence where he first reiterates the events which occurred, thereby delaying Maple from engaging in any subsequent activity while also making it clear to anyone who might be overhearing that the essential elements of the scene are completed. Squeaky Clean then changes pace, hurrying Maple along, after instructions have been received from the story director. Throughout, Squeaky Clean and Maple remain 'in character', improvising narratively appropriate talk as they go.

Technological Interaction within Improvised Talk

Our approach has been one of organising a narrative so that the improvised enactment of it contains adequate cues for behind-the-scenes personnel to realise that certain actions of technical significance need to be performed. For the most part this works implicitly in that talk about a purple tuft or a blue mushroom will

be heard while this cues associated technical changes to be actioned. That is, typically, it is not necessary to directly refer to technical arrangements to get technical consequences. Exceptions to this worked rather inelegantly. In the above example, on several occasions we hear Squeaky referring to specific key presses. Players are required to use the keyboard to trigger up to ten different pre-canned gestures in particular sequences as part of making incantations. Such references stand out awkwardly against the general flow of the dialogue. Rather than refer to particular gestures by name (e.g. 'bow'), Squeaky explicitly instructs Maple in the key presses the player should use. There are several reasons for this. Although the association of keys to gestures was fixed throughout *Avatar Farm*, both actors and players had trouble fluently remembering it. To ensure correct performance, actors kept extensive notes close to hand and took to mentioning keys by their names rather than risk a misunderstanding. Hence, inelegant mentions of "key9" and so forth intrude the dialogue. In this and other ways, it seems that the complexity of the gesturing hindered the process of improvising. While extended rituals may be useful in slowing down the pace of interaction both for viewers and behind-the-scenes crew, they need to be designed carefully.

Now You See Me, Now You Don't

A key feature of *Avatar Farm* is the way in which various participants and crew members were made invisible and/or inaudible. Invisibility featured in the story itself, for example, when Squeaky Clean made himself invisible during the trick on Botchov. It was also used to separate front-stage from back-stage; the stage-hands were present within the worlds but were both invisible and inaudible. However, these manipulations of visibility raised some interesting issues.

The stage-hands were invisible to the actors, players and viewers front-stage, but also to one another and to the story director and other crew members back-stage. Even though they had been assigned to follow different players before the event, they appeared to find it difficult to coordinate their actions. We have already seen how it was problematic for the stage-hands to coordinate amongst themselves in giving help. Naturally the fact that they were invisible to each other in the virtual environment did not help in this.

The relationship between audibility and visibility also requires deeper consideration. Squeaky Clean's various stage whispers provide a good example. He cannot be seen, but his whispers can be heard by anyone nearby including Maple and Botchov. Botchov benefits from hearing them (even though the story says that he can't) as presumably they help him determine his own reaction to events. Maple can also hear them. Does he believe that Botchov cannot (it can be difficult to judge who can hear whom in a virtual world) or is he going along with the convention of the stage whisper? If these matters are ambiguous for us as analysts, then it is likely they were unclear to at least some of the participants too.

Conclusion

We have described an approach to managing participation in an inhabited television show called *Avatar Farm*, an example of an on-line interactive drama with a branching, non-linear narrative structure. Rather than directly manipulate virtual objects, participants are required to indirectly request interactions that may then be granted by invisible stage-hands who follow them around the world as part of a larger behind-the-scenes production crew. These requests are then dressed up in the metaphor of invoking magic. We met with partial success in following this approach in *Avatar Farm*. On the one hand, players, actors and crew-members did manage to collaboratively improvise some quite complex scenes involving a variety of magical objects. However, this process was not without its difficulties, especially with regard to the behind-the-scenes coordination of the invisible helpers. Our experience suggests several useful refinements to this approach.

First, the use of invisibility to separate front-stage from back-stage needs careful handling. It may be that a more flexible mechanism for supporting variable views within CVEs would be more appropriate. The technique showing different participants different layers of information in a CVE (Smith and Mariani, 1997) might help alleviate these problems. Indeed, MASSIVE-3 includes a mechanism called aspects that can be used to define subjective layers of information. Future events might more gracefully handle the separation between front-stage and back-stage through aspects rather than through global invisibility. The players and actors would appear in a front-stage aspect that would be seen by everybody. The crew would be in a back-stage aspect that would not be seen by the viewers and players (but would be by the actors). Ideally, participants would be able to dynamically move between aspects so as to pass from front to back stage and vice versa in order to make dramatic entrances into the action (cf. similar remarks about the visibility of cameras in *Out of this World*, Bowers, in press). An analogous treatment of the distribution of audio is also pointed to so that dramatic conventions like stage-whispers can be supported.

Second, while the approach of using a stage-hand to realise object-behaviours was worked with here fairly exclusively, more mixed approaches might be appropriate in future explorations. For example, one can imagine a narrative world in which some object-behaviours could be programmed in advance and directly triggered by participants, alongside others which require mediation from a stage-hand. Perhaps simple object-behaviours or those which are relatively inconsequential in terms of unfolding the narrative could be given advance programmatic support, while more complex behaviours or those which trigger significant shifts of drama need to be collaboratively worked through. Similarly, some behaviours and capabilities need to be granted in a precisely timed fashion to mesh with surrounding dialogue sensibly (imagine an actor saying to a player "... now you can fly...") while other behaviours (e.g. a serpent

which autonomously slithers around the scene) could be initiated without such specific timing.

Third (and giving a further example of the relations between narrative structure and interaction), it must be observed that some interaction sequences were hard for our (non-professional) players to pick up. It was not always easy for them to follow what was required of them – especially when an extended sequence of actions had to be performed to accomplish some goal. Several of the actors who were trained in improvisation complained that the players sometimes “blocked offers” (i.e. refused to take up a suggestion that might carry the improvisation forward). This commonly occurred not because the players were naïve in improvisation but because they were still trying to get up to speed with the last thing that was demanded of them or were in the process of practicing some action sequence which was soon to be required. This argument is another example of the close ties which should exist between reflections on narrative form, improvisation, technical provision and interaction formats: narrative space needs to be reserved for trying out new powers or in-line rehearsal.

All this said, we suggest that the approach of improvising object-interactions can provide a useful alternative to programming object-interactions in advance. It might be especially appropriate when the narrative or technology are likely to be unpredictable. With the former, actors and producers need to respond as freely as possible to participants’ actions. In the latter, failures and unforeseen constraints in the technology need to be woven into the framework of the story. In *Avatar Farm*, as a research project, we needed to accommodate both.

We believe that our approach opens out a number of new directions for research. First, we suggest that future applications of CVEs may be based more on improvised performance and less on pre-programmed gameplay and that our approach of recognising and supporting behind-the-scenes roles is a viable solution to the production problems of such applications. Where necessary cover-stories can be often be elegantly included in a narrative to explain technical performance and other constraints and anomalies to participants: dreams, sci-fi physics, ghosts and other supernatural phenomena all suggest themselves!

Second, as a general topic of interest within human-computer interaction (HCI) research, we suggest our application area presents boundary conditions on ‘direct manipulation’ (DM) interfaces. The DM approach emphasises interaction routines with immediate feedback, physical manipulation of interface objects and reversibility of operations (Hutchins et al., 1985) For very good practical reasons to do with the nature of improvised drama and supporting its production, we might occasionally prefer routines which are protracted with delayed or withheld feedback, involving social exchange not just physical manipulation, and with, if the narrative so demands it, irreversible consequences! It is perhaps time to overhaul classical HCI design-lore in the face of the manifold requirements of cooperative systems.

Finally, it is worth noting that our general design emphasis is one of giving people technical resources which they can use as part of their coordination activities, rather than mandate coordination in a heavyweight way. The unfolding of a narrative and the provision of associated technical capabilities are socially mediated matters in our approach. The narrative is not automatically maintained (e.g. through the use of some narrative 'parser' which checks progress against a script), nor are object-behaviours pre-programmed. Our whole design philosophy has been to embed technologies in social practice. We have maintained this theme right from the establishment of an on-line community from which 'players' were drawn, through to designing technologies, interfaces and interaction methods which are intended to cohere with experimental narrative forms and improvised dialogue. While we cannot promise magic from socio-technical design strategies, we hope we have shown a reasoned approach to the support of novel forms of participation in on-line virtual worlds.

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