A Comparison of the Features of Multimedia and Virtual Reality for Use in Learning

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INTRODUCTION

- Long duration missions will require crew to perform tasks long after training, or tasks for which no specific training was received.
- Identifying the most cost-effective and efficient method for providing such training will enhance crew productivity and safety.
- Multimedia (MM) and Virtual Reality (VR) are two candidates for training which need to be evaluated.

PREVIOUS WORK in FCSD

- **60-day LMLSTP**: Compared two-way videoconferencing (CU-See Me) with MM for assembly and instrumentation tasks. Participants preferred using videoconferencing for a straightforward task, but commented that MM training would provide better long-term retention. Within MM application, participants favored video and diagrams.
- **90-day LMLSTP**: Compared MM with and without a "self-test". No significant differences found for performance measures, but participants reported feeling more confident after practicing with "self-test". Again, videos and diagrams were the most used and highest rated features.
- **Previous VR demonstrations**: VR not previously used for a training study, but often demonstrated for modeling purposes.

OBJECTIVES & APPROACH

- The objective of this study was to compare the features of VR and MM training with two types of tasks: assembly and instrumentation.
- The scenarios focused on "just-in-time" training, where the tasks must be performed immediately.
- The user performed the tasks from memory to ensure an appropriate comparison between MM and VR (i.e., neither MM or VR materials were available at test).

METHOD

- Total of 12 participants (4 males, 8 females)
  - All participants familiar with WWW navigation & ThinkPad usage
  - All participants novices with VR environment and navigation
- Three sessions:
  1. Familiarization with MM & VR software
  2. Test Session 1
  3. Test Session 2
- Test sessions counterbalanced with respect to training type (MM or VR) and task type (assembly or instrumentation)
- After each task, and after the completion of both sessions, participants completed questionnaires rating the usefulness of the training features. Free-form comments were also provided.

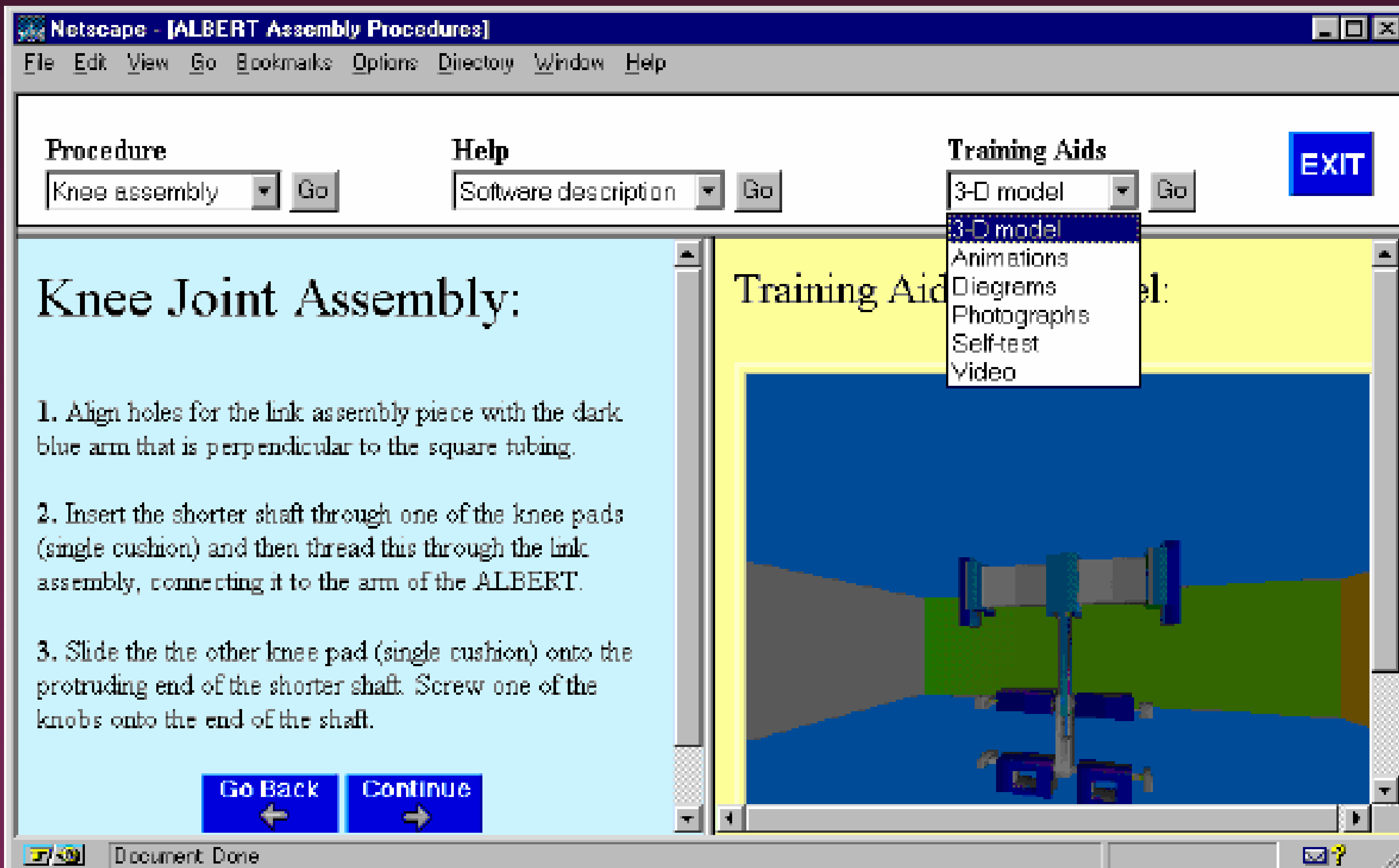
DESCRIPTION OF THE MM APPLICATION

- Interactive Web sites written in HTML and JavaScript. Netscape was used on an IBM ThinkPad to present the material and to access local server.

- The software contained:
    1. **Procedures**: detailed text (incl. pop-up windows), cue cards
    2. **Help**: Troubleshooting tips, software assistance (intro.)
    3. **Training Aids**: Diagrams, Photographs, Video/Animation
    4. **Self-test**

- Participants were instructed to view whichever features they desired, in any order, and as many times as they felt necessary.

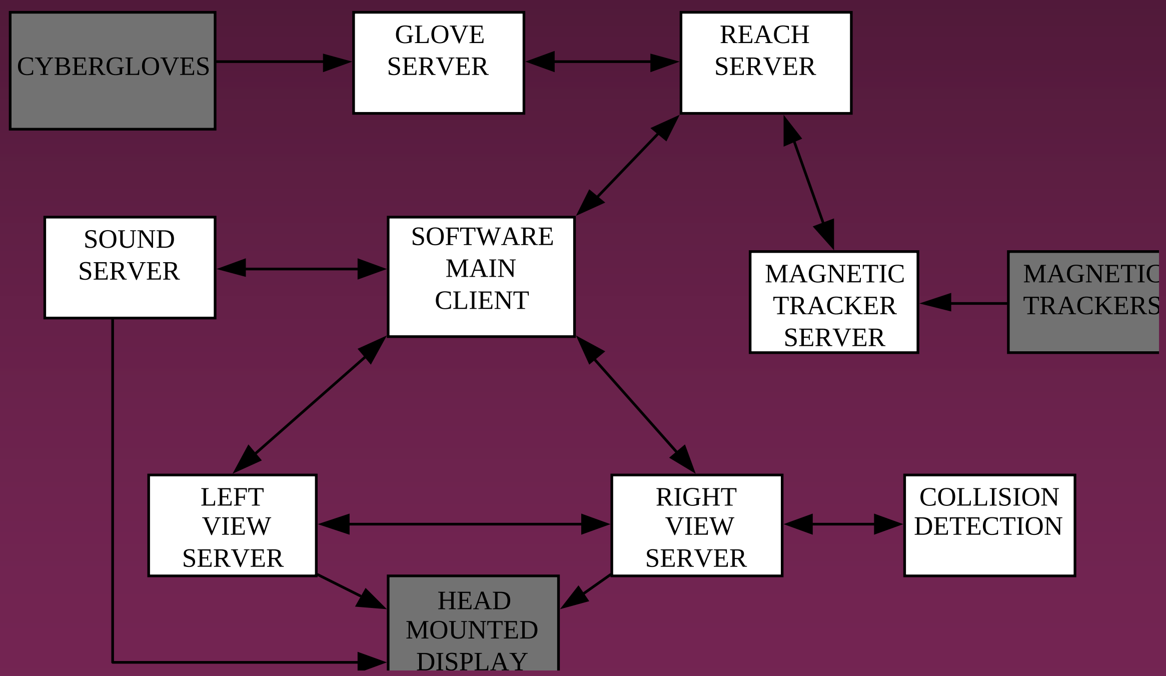
EXAMPLE MM SCREEN



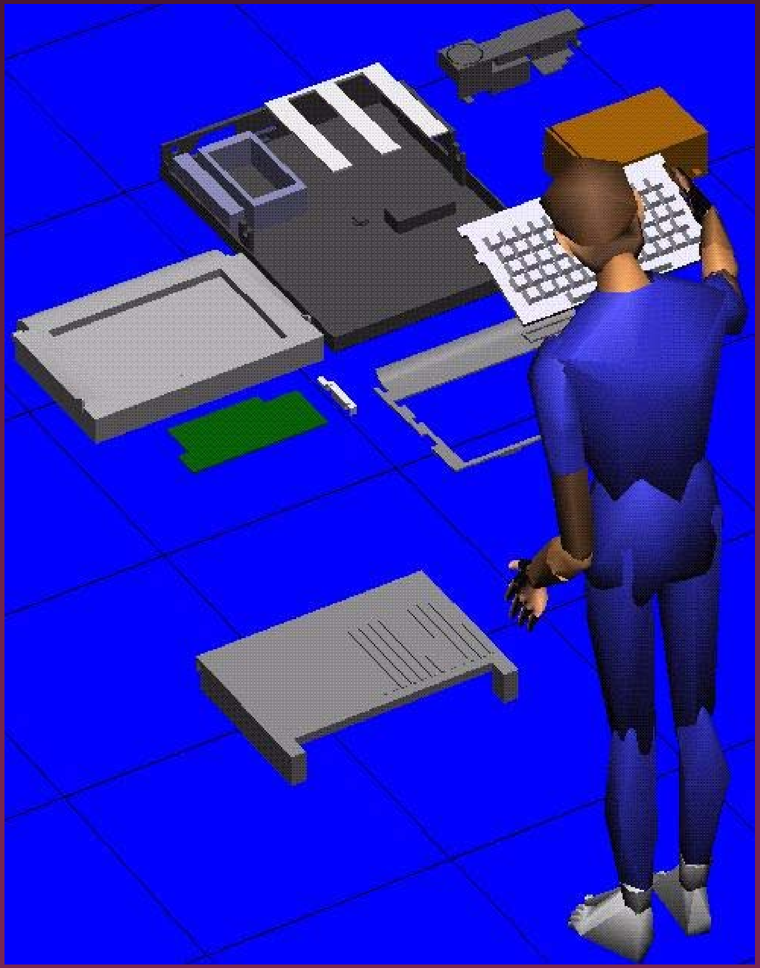
DESCRIPTION OF THE VR SYSTEM

- Hardware: Two data gloves, four magnetic trackers, a head-mounted display, and an SGI ONYX workstation
- The magnetic trackers recorded position and orientation of the participant’s upper body, head, and arms.
- The head-mounted display presented a pair of 3-D stereo images.
- Participants controlled a human model and interacted with objects within the virtual environment.

VR SOFTWARE/HARDWARE INTEGRATION



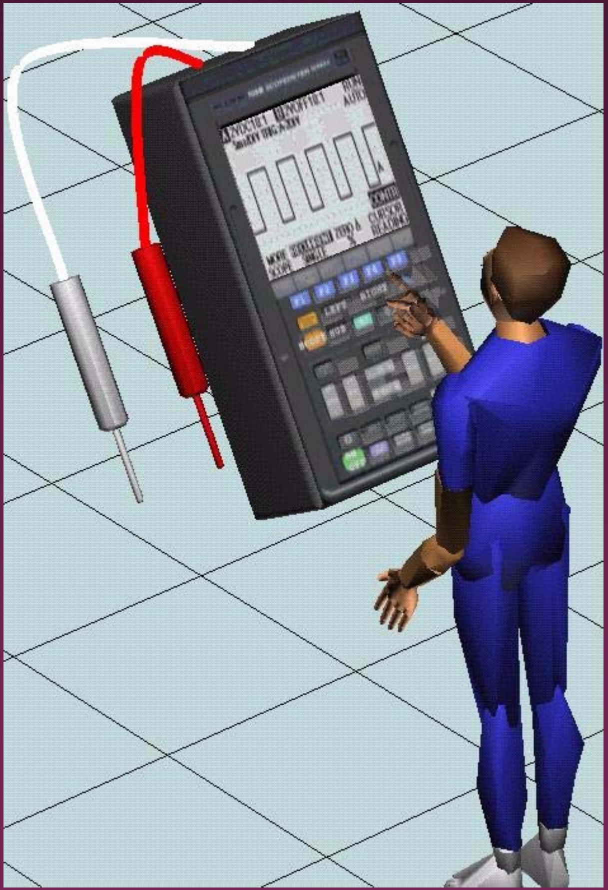
A PARTICIPANT USING THE VR EQUIPMENT



VR FEATURES

- **Animation**: Enabled participants to watch how each of the task steps should be performed. Controlled with pointing gesture.
- **Virtual Simulation**: Allowed the participant to perform the task in the virtual environment. Controlled by grasping/touching an object with either hand.
- **Audio**: A sound-clip activated “tutor” guided the learning process in both the animation and virtual simulation.
- Participants first viewed the animation and were then allowed to repeat the animation or perform the virtual simulation. They could repeat these features as often as desired.

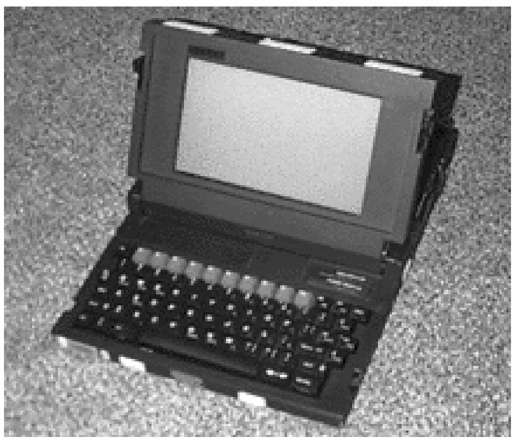
Task Representations in VR



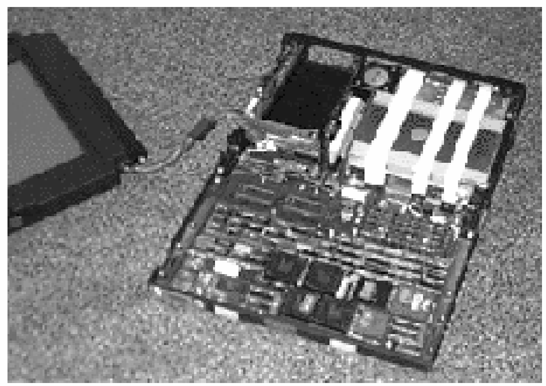
DESCRIPTION OF THE TASKS

- **Assembly task**: Assembly of a GRiD laptop computer; addressed physical/motor skills.
- **Instrumentation task**: Perform a specific set of procedures to take a voltage self-diagnostic of a Scopemeter; addressed cognitive/perceptual skills.

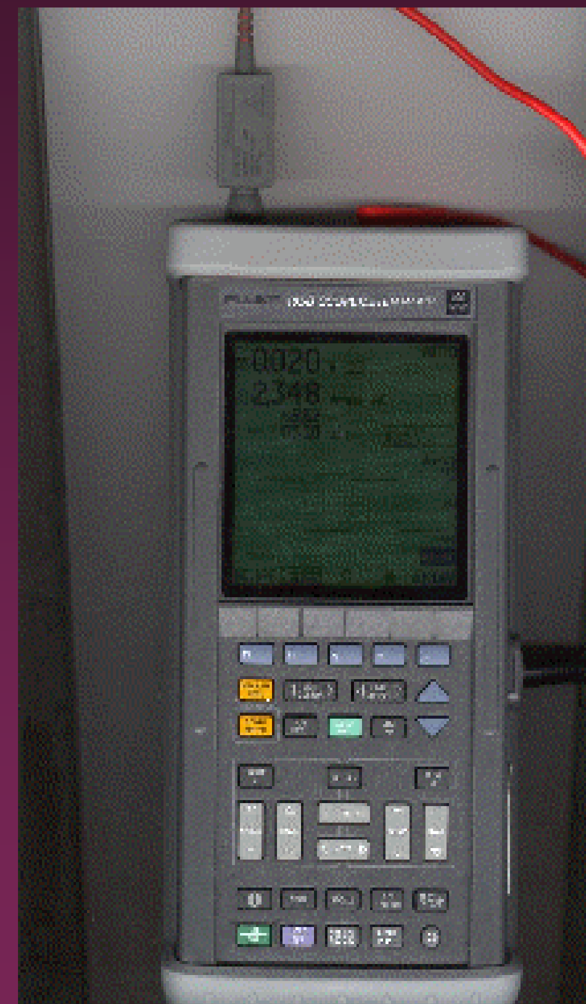
GRiD & Scopemeter Tasks



GRiD - ASSEMBLED



GRiD - PARTIALLY ASSEMBLED



EXPERIMENTAL DESIGN

Condition	Session #	Training Type	Task	# of Participants
1	1	MM	GRiD	3
	2	VR	Scopemeter	
2	1	MM	Scopemeter	3
	2	VR	GRiD	
3	1	VR	Scopemeter	3
	2	MM	GRiD	
4	1	VR	GRiD	3
	2	MM	Scopemeter	

- **Independent Variables**: task type (physical vs. cognitive) & training type (MM vs. VR)
- **Dependent Variables**: time to perform training, time to perform task, number of errors committed, number of times VR & MM features were used, subjective ratings of feature usefulness

RESULTS

TRAINING	TASK	TRAINING TIME	TASK TIME	ERRORS
MM	GRiD	49.4 min.	20 min.	0.7
VR	GRiD	20.3 min.	22 min.	2.8
MM	Scopemeter	43.5 min.	4 min.	1.3
VR	Scopemeter	25.2 min.	6.5 min.	4.7

- Note: Most errors during test were those mentioned only in the audio portion of the VR training; they were not represented visually.

MM FEATURE USE

- **GRiD task**: video, self-test, and photos were the features used the most and also rated the highest.
- **Scopemeter task**: self-test, animation, and cue cards were used the most and were also rated highly.
- **Both tasks**: All features received average ratings within the “acceptable” range.
- Preferred features were similar to previous MM LMLSTP demonstrations. However, participants in the current study focused more on one or two features, as opposed to browsing among all the features.

VR FEATURE USE

- **GRiD task**: The animation and virtual simulation were viewed the same number of times and for a similar amount of time. Both features were rated highly.
- **Scopemeter task**: Animation viewed more often and for a longer duration than virtual simulation. Animation rated "highly acceptable"; virtual simulation rated "unacceptable".
  - Participants found it difficult to "activate" Scopemeter buttons in VR environment. Detracted from learning.
- **Audio**: Rated unacceptable for both tasks. Audio messages presented simultaneous with participants' visual or motor activites were found to be distracting.

LEARNING STYLE & PERFORMANCE STRATEGIES

- Longest MM training times were for visual learners; shortest times for auditory learners.
- Usefulness of diagram and self-test rated highest by kinesthetic learners. Video/animation rated highest by visual learners.

- Longest VR training times were for visual learners; shortest times for auditory learners.
- Visual learners viewed the animation most often; kinesthetic learners utilized the virtual simulation most often (GRiD task only).
- Kinesthetic learners committed the most errors during the Scopemeter task; visual learners the least.

MM CONCLUSIONS

- Beneficial to have multiple means of presenting information for different types of tasks, as well as for various individual learning styles.

- Errors committed during self-test were not repeated during actual task performance. Self-test also provided confidence.
  - Beneficial to include self-test as a final test for task readiness

- Recommendations: add audio to video clips, enlarge size of video window

VR CONCLUSIONS

- VR useful for physical/motor type tasks. Participants commented that this may be especially true for those that require a special environment (i.e., EVA), or are too expensive/large to be performed in a laboratory.
- Users need to be more familiar with body movement in VR environment so this effort does not detract from learning.
- Recommendations: play audio track at times with no other feature use, add ability to repeat individual steps, add greater detail

EXCERPTS FROM PARTICIPANTS' COMMENTS

- "I think VR and MM are both valid training approaches. VR gave me a better feel for actually performing the task, while MM gave me greater flexibility in how I learned to perform the task and provided me with the details I needed to perform the task."

- "I felt both methods could be very effective depending on the type of task."

FUTURE WORK

- Further studies of MM and VR are needed to optimize training material for different types of tasks and individuals:
  - more participants
  - novice vs. experienced VR users
  - advanced MM and VR systems
    - ability to provide more details/close-ups
    - addition of audio to MM; text or photos to VR
    - easier navigation
    - force feedback
- Perform a comprehensive study including more training media in identical task scenarios.

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