



National Research Council Report: “Virtual Reality: Scientific and Technological Challenges”

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Chapters

Part I: Overview

Part II: Research and Technology

- Some Psychological Considerations
- The Visual Channel
- The Auditory Channel
- Haptic Interfaces
- Position Tracking and Mapping

Chapters



Part II: Research and Technology

- Whole-Body Motion, Motion Sickness & Locomotion Interfaces.
- Speech, Physiology & Other Interface Components.
- Computer Hardware & Software for the Generation of Virtual Environments.
- Telerobotics
- Networking & Communications

Chapters



Part II: Research and Technology

- Evaluation of Synthetic Environment Systems
- Specific Applications of Synthetic Environment Systems

Purpose of the Report Committee



The NRC Committee on Virtual Reality Research & Development

- The purpose of the committee was to “recommend a national research and development agenda in the area of virtual reality”.
- Committee consisted of 17 university, corporate and governmental experts in the field of virtual reality & telerobotics.

Criteria Used to Construct the Research Agenda



Science and technology criteria.

- Research areas that could advance the state-of-the-art.

Practical applications criteria.

- Research areas likely to have practical application in the not-too-distant future.

Leverage criteria.

- Leverage, cost-effectiveness & ratio of payoff to effort.

Categories of Proposed Research Agenda



- *Application domains.*
- *Some psychological considerations.*
- *Development of improved synthetic environment technology.*
- *Evaluation of synthetic environment systems.*

Application Domains of Synthetic Environment Systems



Recommendations

Application Domains Recommendation



Four application domains show the most promise for SE:

- Design, manufacturing and marketing.
- Medicine & health care.
- Hazardous operations.
- Training.

Application Domains Recommendation



Research needs in these domains should be used as one of the principal means to focus SE technology development & testing.

Application Domains - Special Project Recommendation



Two projects should receive special attention:

- Modeling the human body for purposes of medical education, surgical planning and providing explanations of procedures and outcomes to patients.
- Studying the transfer of knowledge and skill gained in training in a VE to performance in a real-world task environment.

Psychological Considerations

Recommendations



Psychological Considerations - Recommendations



Support for psychological studies organized around the following objectives:

- Development of a comprehensive, coherently organized review of theory and data on human performance characteristics from the viewpoint of SE systems.
 - Including basic sensorimotor resolution, perceptual illusions, info. transfer rate & manual tracking.

Psychological Considerations - Recommendations



- Development of a theory that facilitates quantitative predictions of human responses to alterations in sensorimotor loops for all channels, with special emphasis on:
 - Degradations in performance resulting from deficiencies in SE technology (e.g. in the form of distortions, time delays and system noise).

Psychological Considerations - Recommendations



- Supernormal performance achievable through introduction of purposeful enhancing distortions.
- Radical sensorimotor transformations that arise, for example, in connection with the use of sensory substitution or strongly non-anthropomorphic telerobots.
- Methods of accelerating both adaptation to various types of alterations and readaptation to normal conditions.

Psychological Considerations - Recommendations



- Channel interaction effects that occur with multimodal interfaces.
- Factors governing the occurrence, kind and magnitude of sopite sickness from SE exposure.
- Factors governing the strength of subjective telepresence and its relationship to objective performance.

Psychological Considerations - Recommendations



Development of cognitive models that will facilitate effective design of VE systems for purposes of education, training and information visualization.

Psychological Considerations - Recommendations



Development of improved understanding of the possible deleterious effects of spending substantial portions of time in SE systems.



Development of Improved Synthetic Environment Technology

Recommendations



Human-Machine Recommendations

Support of research on visual displays, haptic interfaces and locomotion interfaces.

- HMDs.
- Tool-handle interfaces.
- Locomotion interfaces.

Position Tracking & Mapping Recommendations



A multiphase research & development approach:

- Conduct research & development on mechanical & inertial trackers.
- Explore the possibility of obtaining improved cost-effectiveness in tracking by using hybrid systems.

Position Tracking & Mapping Recommendations



- Carefully monitor commercial developments in magnetic, acoustical and optical trackers, in eye trackers, and in trackers directed toward registration problems in augmented reality.

If market forces do not drive the development of these trackers, federal research support is urged.

Testing & Evaluation Recommendation



The establishment of a set of standards or an independent laboratory to evaluate SE interface devices.

Computer Hardware Recommendation



No aggressive federal involvement in computer hardware development in the SE area at this time.

- Hardware development remain largely a private-sector activity.
- Should serious lags in development occur, the gov't might then consider strategies for leveraging private-sector development efforts.

Software Recommendation



A major unified research program be created that focuses on those areas of development directly related to the generation, implementation, and application of VEs.

Topics to be considered



- Multimodal human-computer interactions.***
- Rapid specification & rendering of visual, auditory and haptic images.***

Topics to be considered



- *Models & tools for representing & interacting with physical objects under multimodal conditions (including automated model acquisition from the real world).*

Topics to be considered



- *Simulation frameworks.*
- *A new time-critical, real-time operating system suitable for VEs.*
- *Registration of real and virtual images in augmented-reality applications.*

Topics to be considered



- *Navigational cues in virtual space.*
- *Behavior of autonomous agents.*
- *Computer generation of auditory and haptic images.*

Telerobotics Recommendations



Support be given to improving control algorithms, improving methods for constructing and using predictive displays, and improving methods for realizing effective supervisory control strategies.

Telerobotics Recommendations



Four areas of hardware development:

- Multiaxis, high-resolution tactile sensors.
- Robot proximity sensors for local guidance prior to grasping.
- Multiaxis force sensors.
- Improved actuator & transmission designs.

Telerobotics Recommendations



Research be conducted on issues that arise when microtelerobots are used in teleoperation.

Consideration be given to the development & application of distributed telerobotic systems.

Telerobotics Recommendations



The establishment of intercommunication standards for point-to-point connections in coarse-grained parallel computational architectures.

- However, for apps with demanding I/O operations, the committee does not recommend new real-time, development systems or operating systems.

Networking Recommendation



The federal government provide funding for a program (to be conducted with industry & academia in collaboration) aimed at developing network standards that support the requirements for implementing distributed VEs on a large scale.

Networking Recommendation



Funding of an open VE network that can be used by researchers, at a reasonable cost, to experiment with various VE network software developments and applications.

Evaluation of Synthetic Environment Systems

Recommendations



Evaluation Recommendations



The federal government encourage the SE system developers it supports to include a comprehensive evaluation plan in the early design stages of their research projects.

Evaluation Recommendations



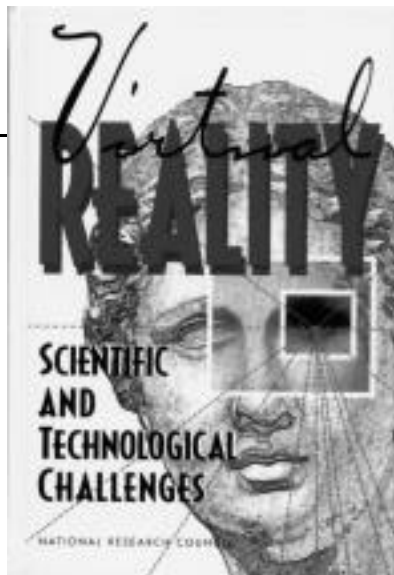
The federal government help coordinate the development of standardized testing procedures for use across studies, systems and laboratories, particularly in those areas in which the private sector has not acted.

Recommendations ...

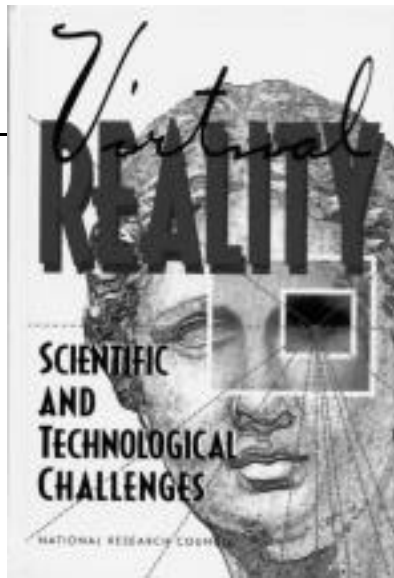


Now, these are all the recommendations to the government by the NRC Committee...

- The purpose of the report is to advise the government how to spend its research dollars.
- It is up to the responsible program managers to actually implement the recommendations...



- Where to get the NRC report “Virtual Reality: Scientific & Technological Challenges”
- ISBN 0-309-05135-5
- National Academy Press
 - 202-334-3313 or
 - 800-624-6242



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- ISBN 0-309-05135-5
- Maruzen Co. Ltd., 3-10, Nihonbashi 2-Chome, Chuo-ku, Tokyo, Japan.