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FOREWORD

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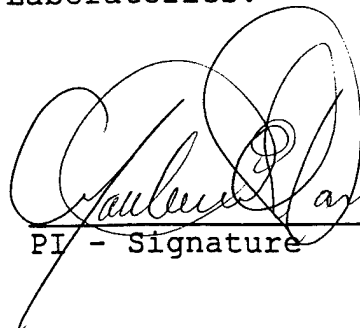
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## INTRODUCTION

### Subject

This report documents the progress achieved on the "Operating Environment of the Future" (OEF) project sponsored by the Defense Advanced Research Projects Agency (DARPA) from initial project award in October 1995 through concept demonstration in December 1996. This report updates the interim report submitted in October 1996 by reflecting the results of the December 1996 concept demonstration.

### Purpose

The purpose of the OEF project is to develop the next-generation, multi-platform, tri-service military integrated medical environment.

### Scope

The scope of the project encompassed three principle systems within the OEF: 1) the Intuitive Display and Command System (IDACS) providing real-time information management through integrated displays, hands-free interface, local / remote connectivity, and a wireless, multi-media environment; 2) the Smart Surgical System (SSS) integrating physiological sensors with the surgical platform, incorporating advanced materials, and optimizing ease-of-use, mobility, and deployability; and 3) the Intelligent Virtual Patient Environment (IVPE) employing modified actual surgical instruments and a simulated patient for the improvement of surgical skills, training in battlefield procedures, and automation of performance measurement.

### Background

The OEF project is one of several advanced medical technology programs initiated by the Defense Advanced Research Projects Agency (DARPA), targeting reduction in mortality and morbidity of the wounded soldier through improved far-forward combat casualty care. Emphasis in this initial phase was placed on developing a "breadboard" IDACS, with correspondingly less effort on the SSS and IVPE elements.

## OBJECTIVE

The objective of the initial phase of the OEF project, documented in this report, was to develop a "breadboard" Intuitive Display and Command System (IDACS) to demonstrate the effectiveness of an integrated, wireless, hands-free command-and-control station for the Operating Room.

## APPROACH

The approach employed in developing the IDACS was to modify and integrate off-the-shelf hardware, mock-ups, and existing software to provide basic hands-free control and display, making use of mature software modules, software development processes, and systems integration practices.

## RESULTS and DISCUSSION

The results of this initial phase were demonstrated to DARPA in December 1996, and included:

1. Developing, using modified commercial components, a wireless link for transmitting real-time video and overlaying graphics and imagery. During the demonstration, a real-time video image of the Smart Surgical System surgical table and a separately generated graphical images of a patient heart rate trace were combined by IDACS and wirelessly transmitted for display on a large screen monitor.
2. Developing, using modified commercial components, a wireless link for transmitting patient record archival data to the medical team. During the demonstration, stored patient data (including heart rate, temperature, and blood pressure) was transmitted wirelessly from the IDACS to the large screen monitor.
3. Developing a brass-board mock-up (non-functioning) body-worn Surgeon Interface Unit (SIU) that included such commercial components as a stereo see-through visor display, stereo audio, speaker-independent voice recognition, wireless voice / video receiver, and wireless data transceiver. During the demonstration, all components of the mock-up hardware were displayed.
4. Developing a brass-board mock-up central command-and-control system which interprets a limited set of commands in managing the surgical environment through wireless command and control of cameras and patient data display. During the demo, this hands-free command-and-control capability was demonstrated in re-positioning the video camera above the Smart Surgical System surgical table and in calling up archived patient data for display on IDACS monitors.
5. Developing software to filter and interpret acoustic signals from the Smart Surgical System to provide the current heart rate and associated waveform on IDACS monitors. During the demonstration, this capability was demonstrated using a hand-held acoustic sensor.

In addition, progress was demonstrated on the other two components of the OEF as well, albeit limited, given the emphasis on IDACS. For the Smart Surgical System, a conformal antenna was used to wirelessly transmit the signal from the acoustic monitor embedded in the composite surgical table, the latter having been formed via a resin transfer molding process. For the Intelligent Virtual Patient Environment (IVPE), cognitive abilities associated with endoscopic surgery were identified, as were initial voice-recognition and anesthesia requirements, and a front-end requirements generation and analysis "decision support system" software tool was developed (essentially a high fidelity, qualitative and quantitative relational database).

#### REFERENCES

ARPA Solicitation BAA94-14, 27 January 1994.

"Operating Environment of the Future", Northrop Grumman Proposal X700-94-046A, 29 March 1994.

"Operating Environment of the Future", Northrop Grumman Revised Proposal X700-94-295, 22 December 1994.

"Operating Environment of the Future" DARPA Cooperative Agreement DAMD17-95-2-5022, 22 September 1995.

"Operating Environment of the Future: Interim Progress Report", Northrop Grumman Corporation Letter N560-96-329, 28 October 1996.

## APPENDICES

### Bibliography of Meetings

Medicine Meets Virtual Reality 4  
DARPA Advanced Biomedical Technology Workshop  
January 1996

Biosphere 2  
DARPA Advanced Biomedical Technology Conference  
June 1996

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