MEDICINE MEETS VIRTUAL REALITY 15

Studies in Health Technology and Informatics

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in vivo, *in vitro*, *in silico*: Designing the Next in Medicine

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Preface
in vivo, in vitro, in silico: Designing the Next in Medicine

James D. WESTWOOD and Karen S. MORGAN
Aligned Management Associates, Inc.

Our culture is obsessed with design. Magazines, television, and websites publicize current trends in clothing, architecture, home furnishings, automobiles, and more. We design objects to convey ideas about wealth, status, age, gender, education, politics, religion, accomplishment, and aspiration. Design seems mysteriously vital to our well-being, like sleep and dreaming.

Sometimes designers can fuse utility and fantasy to make the mundane appear fresh—a cosmetic repackaging of the same old thing. Because of this, medicine—grounded in the unforgiving realities of the scientific method and peer review, and of flesh, blood, and pain—can sometimes confuse "design" with mere "prettifying."

Design solves real problems, however. It reshapes material, image, and data into something more useful than was previously available. It addresses challenges of increasing complexity and data overload. It simplifies tasks to reduce confusion and error. It accelerates adoption and training by making new tools more intuitive to use. It comforts clinicians as well as patients by giving engineering a friendly interface.

This year's theme acknowledges the importance of design—currently and as an opportunity—within the MMVR community.

in vivo. We design machines to explore our living bodies. Imaging devices, robots, and sensors move constantly inward, operating within smaller dimensions: system, organ, cell, DNA. Resolution and sensitivity are increasing. Our collaboration with these machines is burdened by vast quantities of input and output data. Physician to machine to patient to machine to physician and back again: it's a crowded information highway prone to bottlenecks, misinterpreted signals, and collisions. Out of necessity, we design ways to visualize, simplify, communicate, and understand complex biomedical data. These can be as basic as color-coding or as advanced as Internet2. In our measurement and manipulation of health, the design of information is critical.

in vitro. Using test tubes and Petri dishes, we isolate *in vivo* to better manipulate and measure biological conditions and reactions. The bold new field of tissue engineering, for example, relies on creating an imitation metabolic system for growing artificial body parts. Scientists carefully design the scaffolding to which cells will group themselves on their own. The artificial guides nature's path inside a glass container as we strive to improve what nature gives us.

in silico. We step out of the controlled *in vitro* environment and into a virtual reality. The silica mini-worlds of test tubes and Petri dishes are translated into mini-worlds contained within silicon chips. In the *in silico* lab, algorithms replace chemicals and

proteins in the quest for new drugs. On a different scale, we design simulations of biological systems to serve as educational tools. A simulated human body improves learning by utilizing intuition, repetition, and objective assessment. In surgical training, we are replacing patients with computers, in part because the latter is less susceptible to pain and less likely to hire a lawyer.

The future of medicine remains within all three environments: *in vivo*, *in vitro*, and *in silico*. Design is what makes these pieces fit together—the biological, the informational, the physical/material—into something new and more useful.

And what is the next in medicine? We cannot say, but we hope it offers solutions to the very real challenges that are now upon us: an aging global population; disparities between rich and developing nations; epidemic, disaster, and warfare; and limited economic and natural resources. We are eager to see what new tools are designed to confront these old problems, each involving medicine in some way.

We are thankful to all who have made MMVR15 possible and that, after fifteen years, MMVR remains a place where so many talented, visionary, and hardworking individuals share their research to design the next in medicine.

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