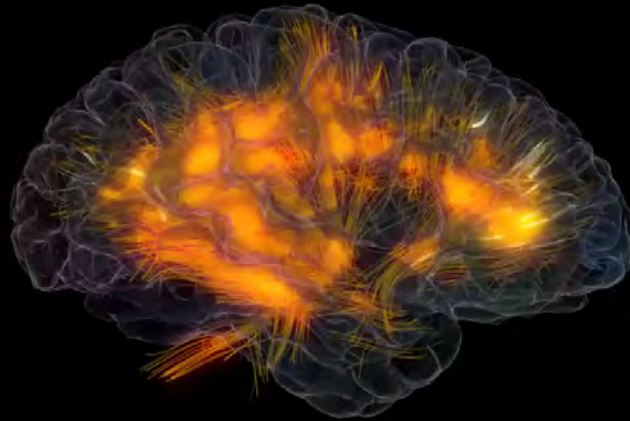


*How Virtual and Augmented Reality Will Transform **Healthcare***

Walter Greenleaf PhD



**VIRTUAL HUMAN
INTERACTION**

— L A B —

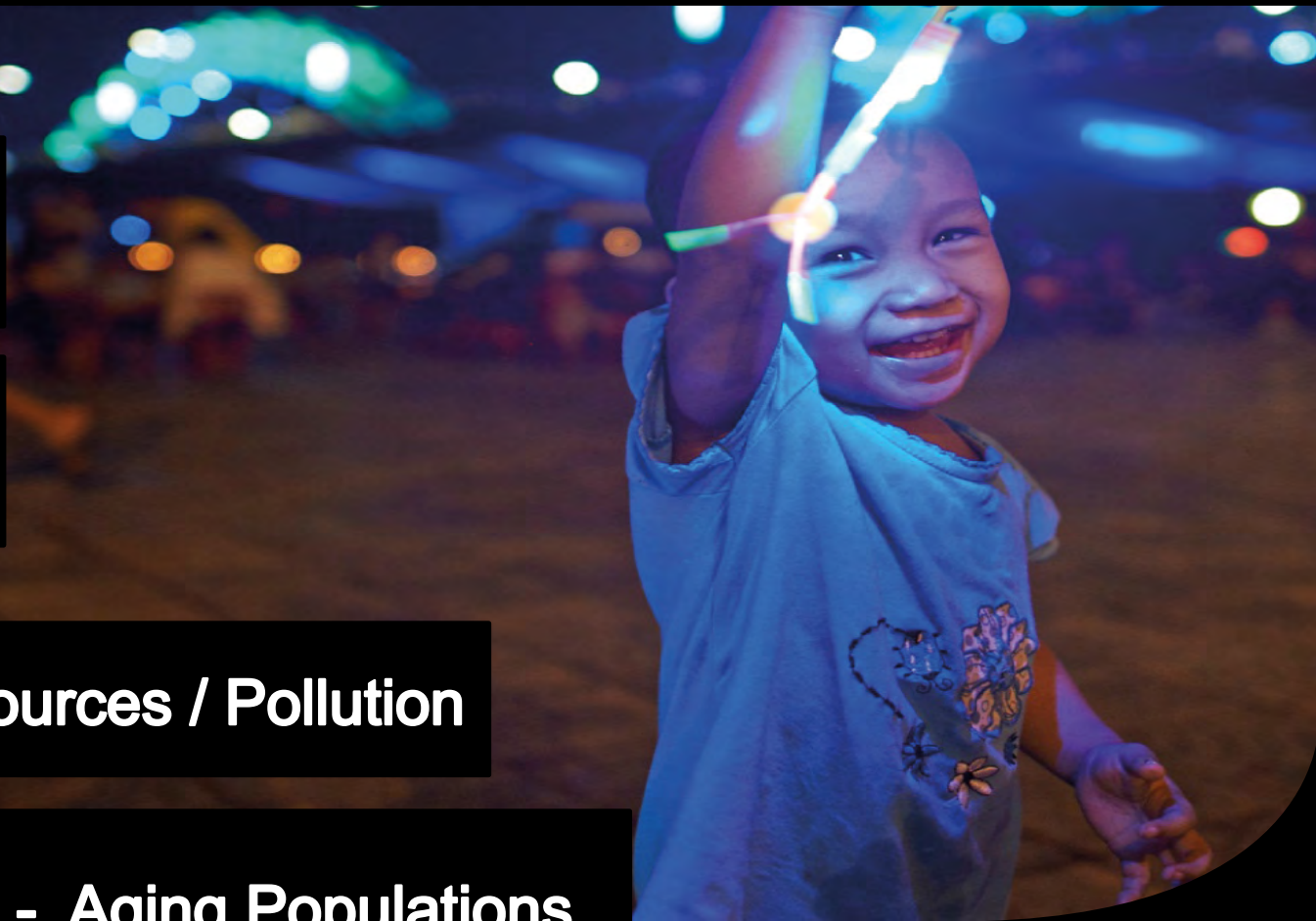
Stanford
University

Political Conflict

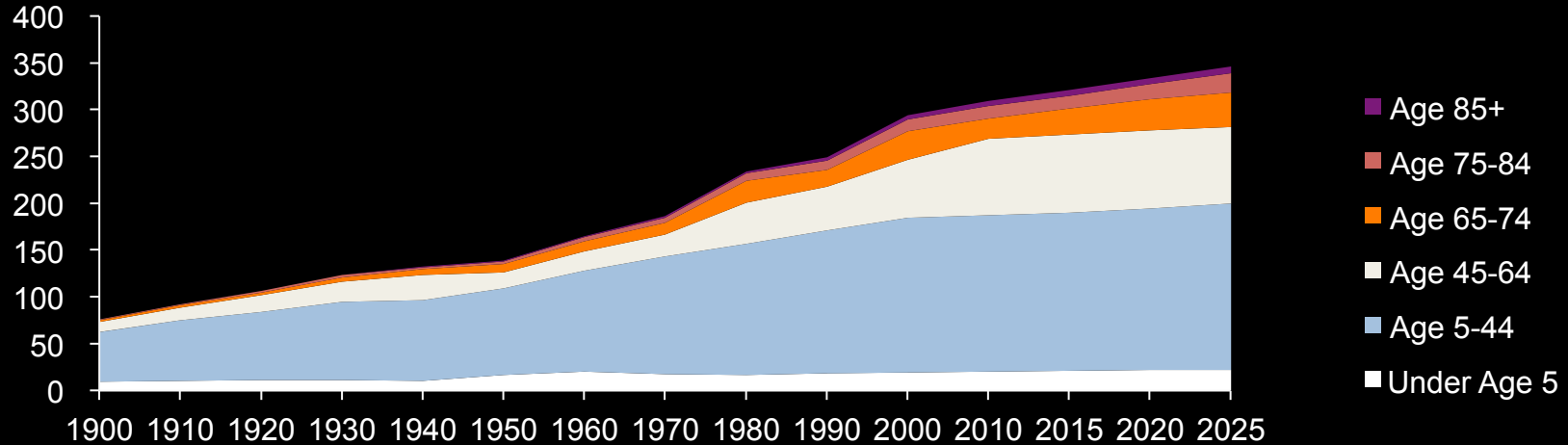
Global Warming

Depletion of Resources / Pollution

Healthcare Crisis - Aging Populations



Healthcare Crisis: Aging Populations





Transforming HealthCare with Technology

Digital Health Revolution

- Mobile Health / eHealth
- Wearable Sensors
- **Patient Centered**
- Leverages Internet:
social, competitive, collaborative

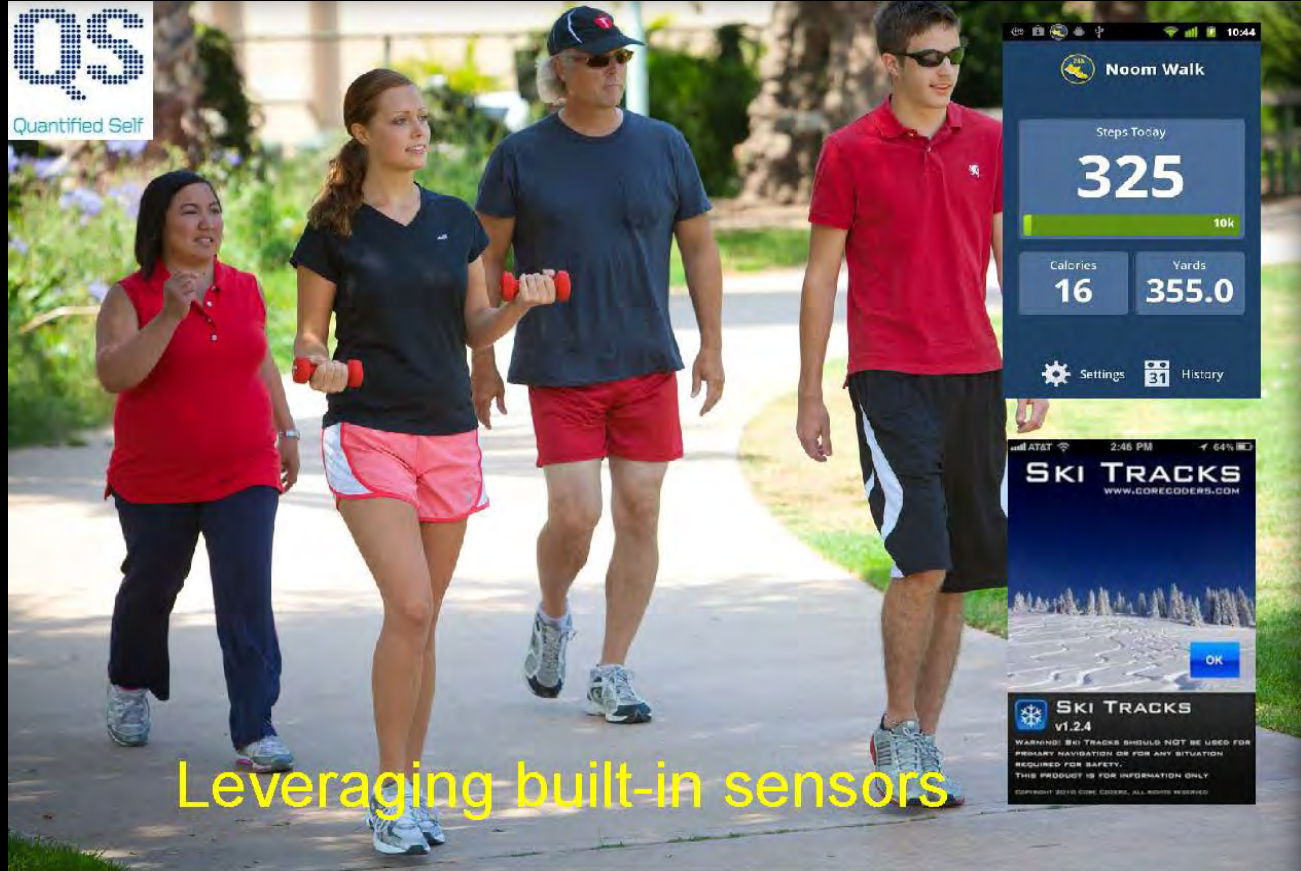


New Technologies for Healthcare

Major Trends:

- Transformation from analog to digital
- Transformation from location-based and time limited to any location, and available 24/7
- Patient focused - patient engaged in their own care
- Emphasis on prevention and behavior change

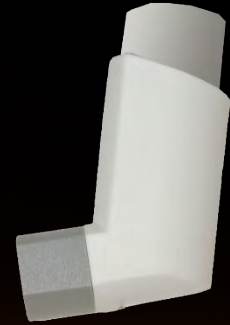
The Quantified Self Movement: Early Adopters



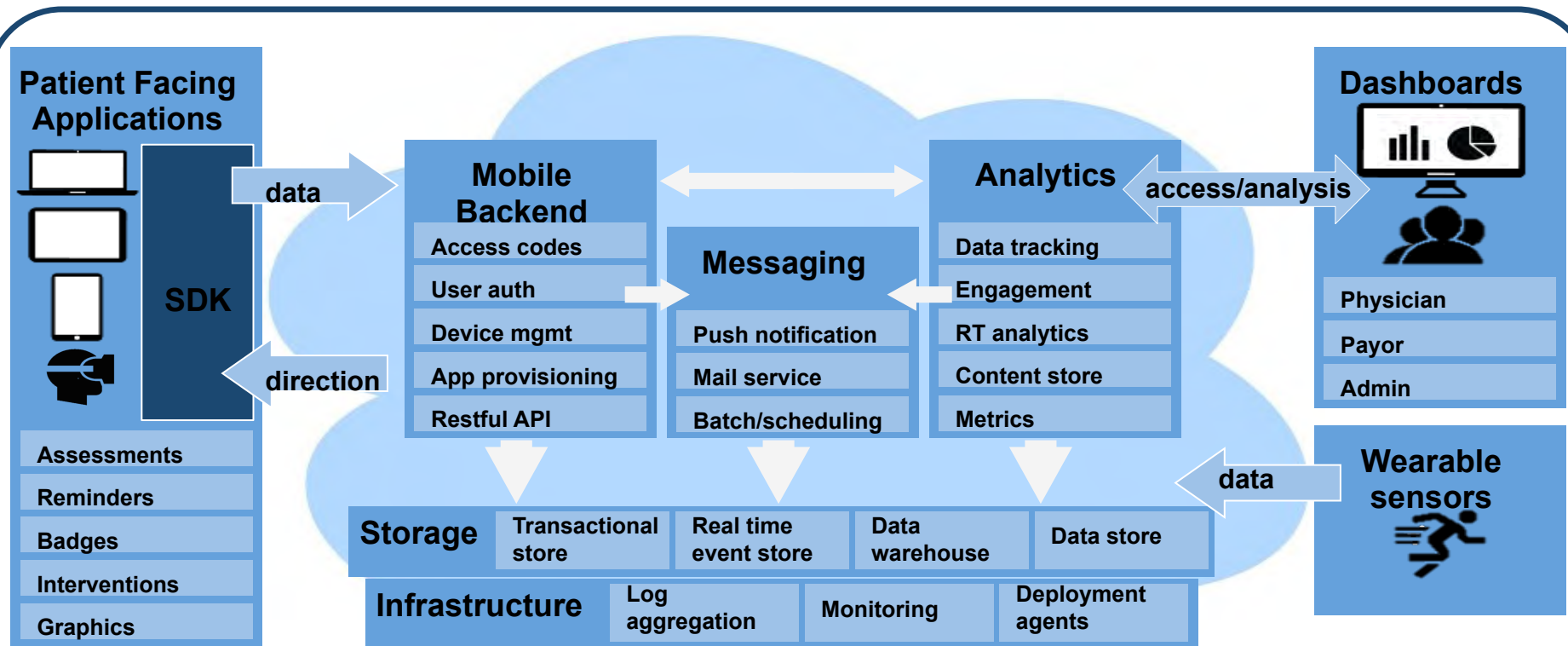
Leveraging built-in sensors



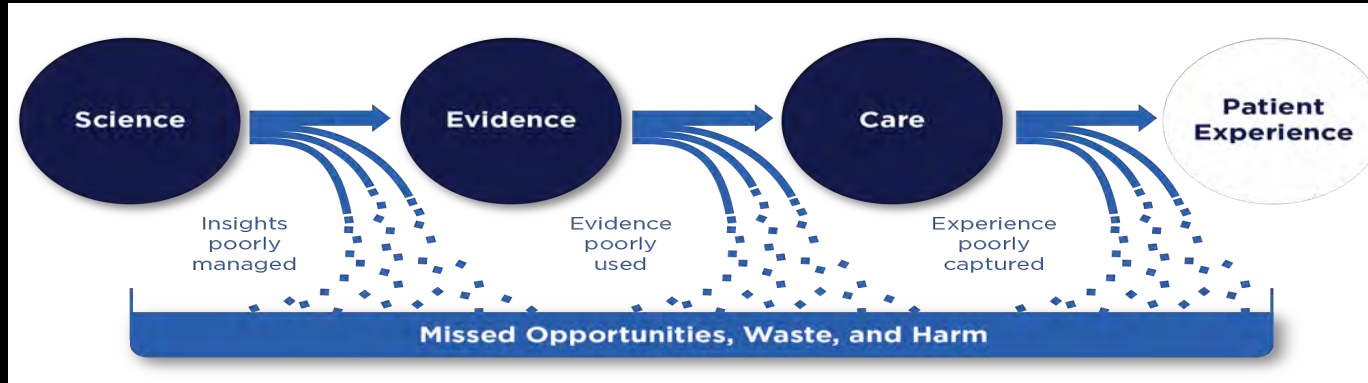
Every medical device reinvented



Digital Health Platforms deliver interventions to patients, and parse data for enhanced decision-making



Digital Health Platforms deliver interventions to patients parse data for enhanced decision-making

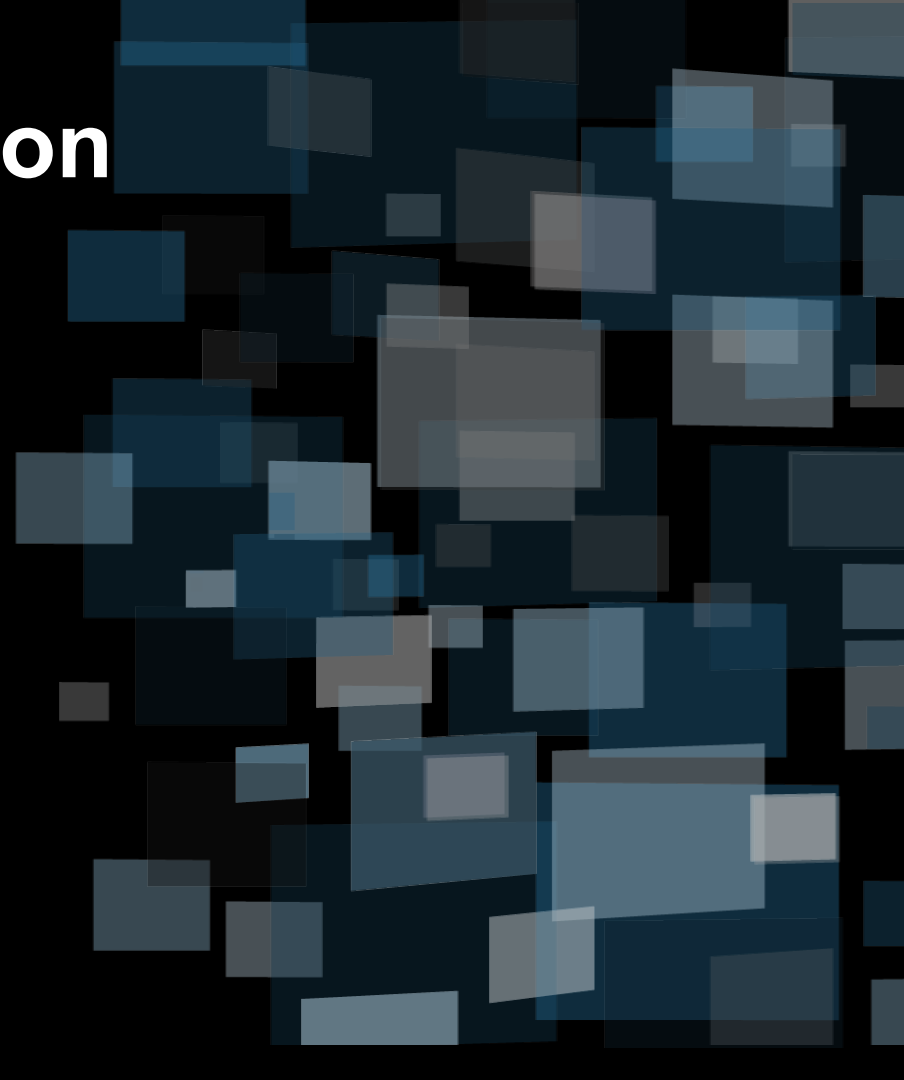


Objective data
Behavior and activities
Linked to intervention
Population trends



Digital Health Revolution

Medical Applications
of Virtual Reality
Technology



Virtual Reality Technology For Medicine



- Current technologies and concepts are founded on more than *30 years of research and development*
- Recent changes in cost and access make VR affordable
- VR tech is currently used for prevention, evaluation, treatment and chronic disease management
- **After years of validation and use by early adopters - VR technology is poised to move to the mainstream**
- On the horizon: enhanced, ubiquitous, informative and integrated

VR and AR technology will *significantly* impact Medical Care

- Prevention and Wellness
- Objective Assessments
- **Improved Adherence**
- Facilitated Behavior Change
- Distributed Care Delivery
- Management of Chronic Conditions



VR Technology Has Evolved

First general purpose and commercially available VR systems.

Now, after more than 30 years of research and development...



Virtual Reality Technology
On the way to becoming a commodity –
available at consumer prices



Now is the time for VR

VR technology is now affordable, scalable and accessible to the marketplace. The VR category is attracting interest and investments from major players.



Samsung - GearVR



Sony – PlayStation VR



Facebook - Oculus



Microsoft - HoloLens



HTC - Vive



OSVR



THE VR FUND 2016 VR INDUSTRY LANDSCAPE

JUNE v1.6

APPLICATIONS/CONTENT
 TOOLS/PLATFORM
 INFRASTRUCTURE

LOCATION BASED	SPORTS/LIVE EVENTS	SOCIAL	GAMES	ENTERTAINMENT	ENTERPRISE	HEALTHCARE	EDUCATION

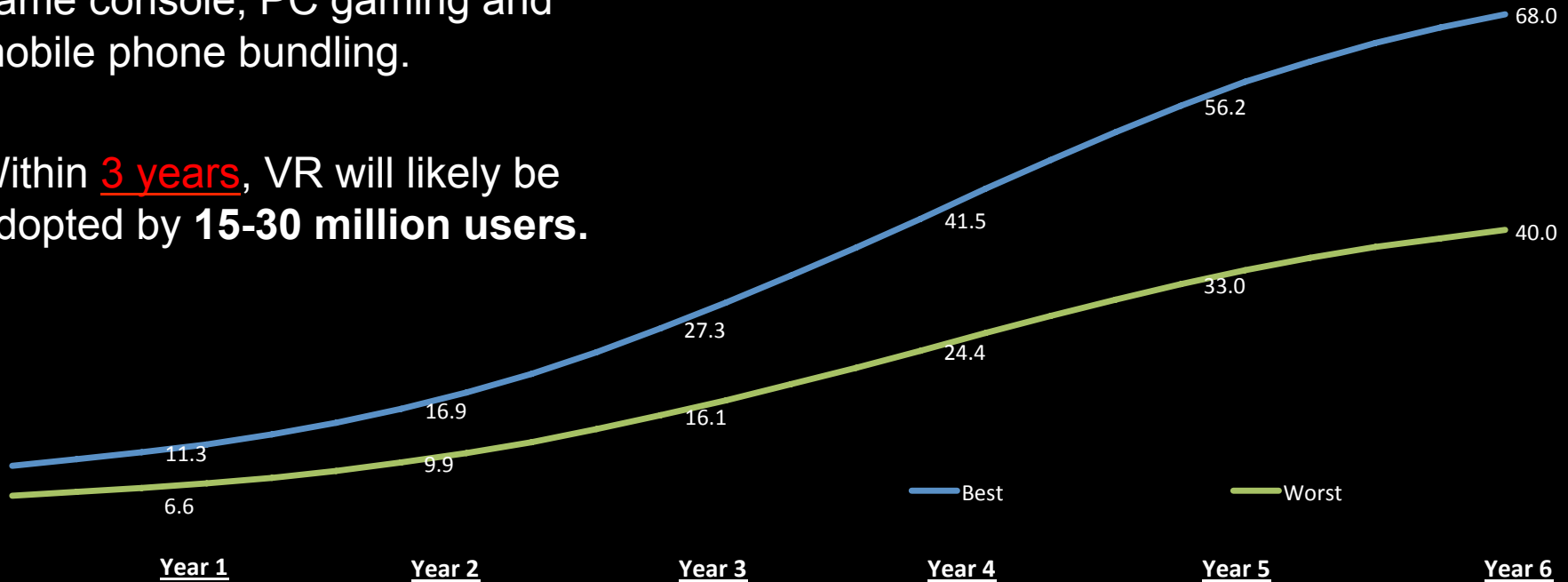
DISTRIBUTION (APPS/MEDIA)	3D TOOLS (ENGINES/AUDIO)	REALITY CAPTURE (360 VIDEO/NEXT GEN)

HMD (TETHERED/MOBILE)	INPUT (HAND/EYE/WEARABLE/OMNI TREADMILLS/HAPTICS)

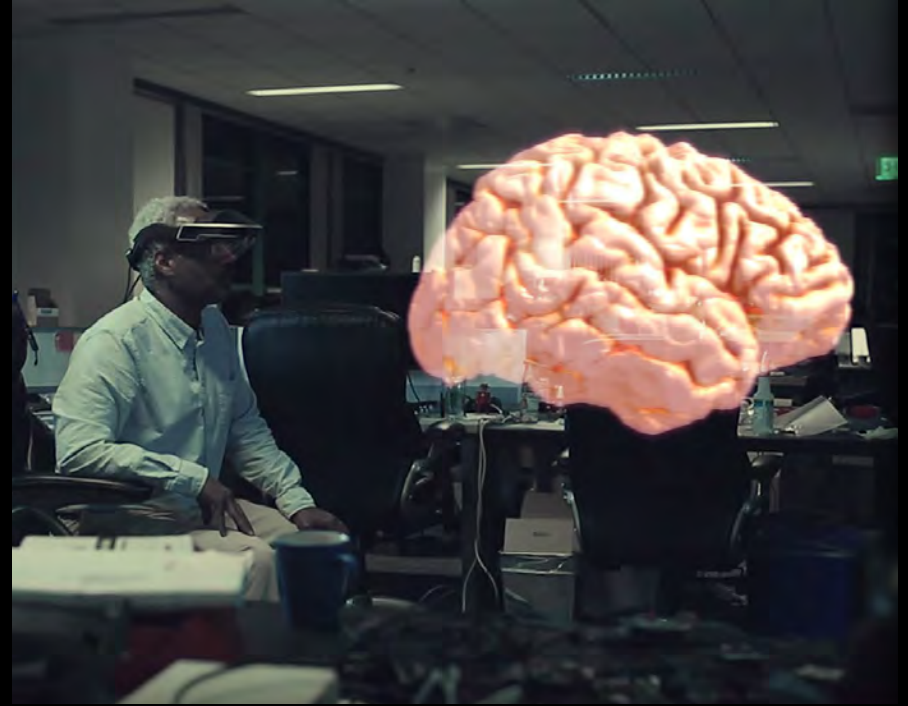
Within 6 years, VR will likely be adopted by 40-70 million users

Initial adoption will be driven through game console, PC gaming and mobile phone bundling.

Within 3 years, VR will likely be adopted by **15-30 million users.**



AR Technology





Medical Applications of Virtual Reality Technology

Although entertainment, social connection and gaming will drive the initial adoption of VR technology, the deepest and most significant market for VR will be in clinical care and in improving health and wellness.

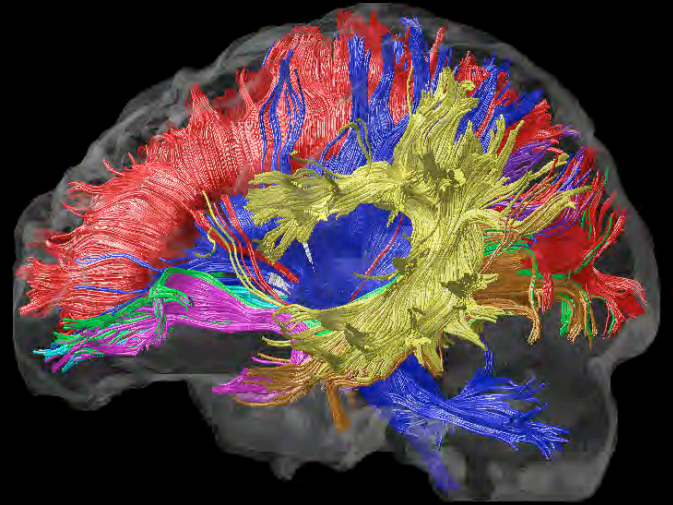
The list of clinical interventions made possible by VR is long. VR technology also facilitates clinical assessments and medical training, as well as providing for improved surgical skill training and procedure planning.

Personal health and wellness can be improved by using VR to engender better nutrition, promote healthy lifestyles, and to reduce stress and anxiety.

As the cost of healthcare rises, VR technology can serve as an effective telemedicine platform to reduce costs of care delivery, and improve clinical efficiency

MEDICAL APPLICATIONS OF VR

- Health & Wellness
- Medical Training
- Clinical Assessments
- Medical Interventions



Medical Training

- Clinical Skill Training
- Surgical Skill Training
- Interpersonal Skill Training
- Use of Equipment and Tools
- Team Training - eg: Emergency Department, Surgical Team
- Emergency Response Training and Rehearsal
- Empathy



Surgical Training: Preoperative Planning & Image Guided Surgery

Rapidly becoming the standard for training...

...and soon to be part of the standard of care.



DIAGNOSTIC ASSESSMENTS

- Medical Image Review
- Neuropsychological Assessments
- Activities of Daily Living Assessments
- Physical Medicine – OT / PT
- Behavioral Medicine – psychology, psychiatry



New Approaches for Cognitive Assessment

RESET

Digitized Neurocognitive Tool Set

This product evolves traditional paper and automated evaluations to a more sophisticated level..

It also produces a robust intervention that challenges cognitive skills.



A LONG LIST OF MEDICAL INTERVENTIONS



- Physical Therapy and Rehabilitation
- Neuro-rehabilitation - Stroke and Traumatic Brain Injury
- Speech Therapy
- Optical Rehabilitation –
 Strabismus, Amblyopia
- Acute and Chronic Pain
- Surgical Planning

Virtual environments are used clinically to treat several important **mental and behavioral health problems**

- Drug and alcohol abuse
- Schizophrenia
- Post-traumatic stress disorder (PTSD)
- Generalized Anxiety Disorder
- Mood Disorders - Depression
- Mild Cognitive Impairment
- Autism Spectrum Disorder
- ADHD



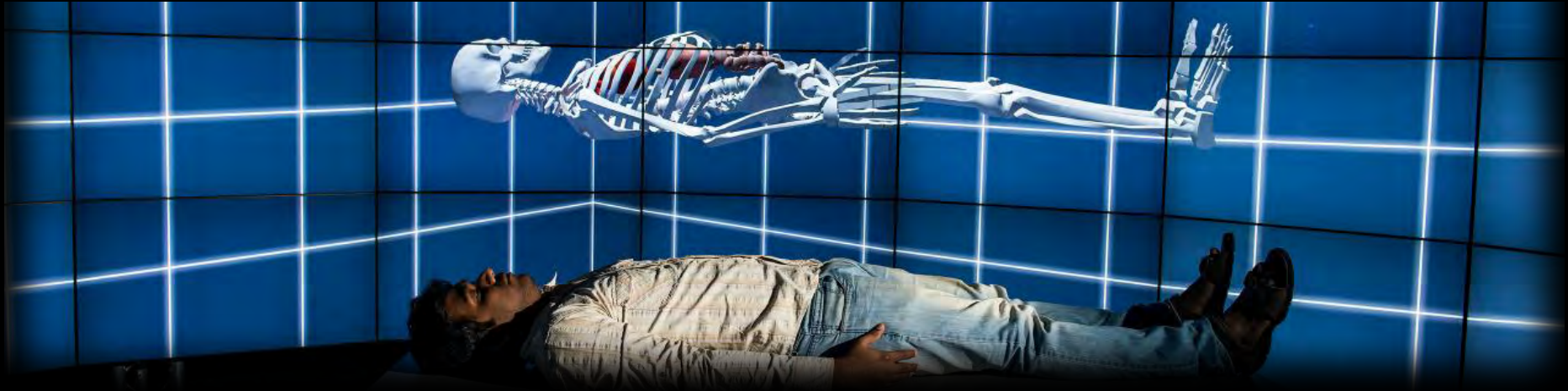
Virtual environments are used clinically to treat several important **behavioral health problems**

- Phobia and anxiety disorders
- Obsessive Compulsive Disorder (OCD)
- Developmental disabilities
- Conduct disorders
- Anger management
- Eating disorders
- Impulsive disorders
- Learning disabilities
- Neuro-cognitive disorders



HEALTH AND WELLNESS

- Weight Management
- Cognitive Function Training –
 Sequencing, Situational Awareness,
 Decision Making
- Exercise
- Stress Management
- Disability Solutions
- Addressing Isolation
- Grief Counseling
- Mood and Resilience





Why Now?

Over 40 years of academic research and over 3000 studies demonstrate that VR can improve behaviors, attitudes, and health.

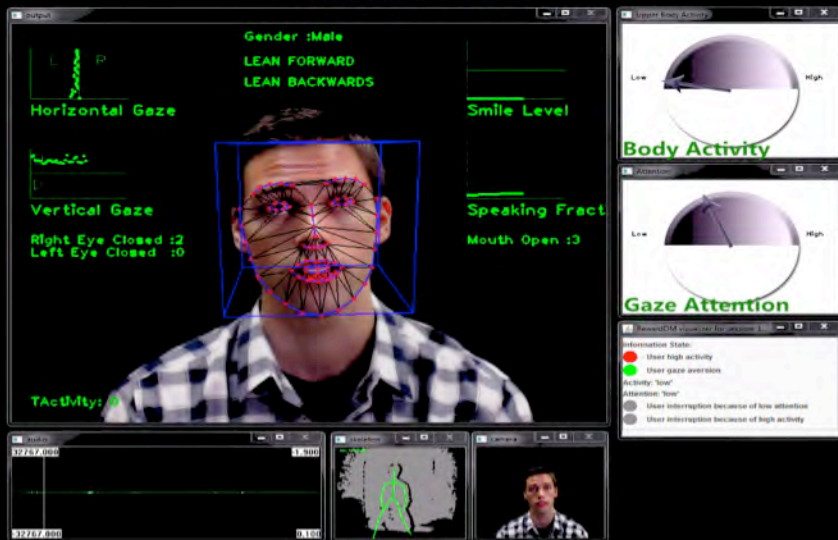
Until now, the technology was expensive, bulky, and difficult to use. Today, we have the advancements to bring VR to scale in healthcare.

Portable Telemedicine Platform



Virtual Humans For Training, Confidential Interaction, and Telemedicine Support

MultiSense



SimSensei



Some Examples



PTSD, Phobias, and Anxiety Disorders

- Exposure-based treatments can be conducted in the safety and comfort of an office setting
- Effective tools for treating a variety of clinical problems, in particular anxiety and addictive disorders
- Fully immersive environments, which include the use of a head mounted display, 3D sound, tactile stimulation via shaking platform, and olfactory stimulus are used for PTSD therapy



RISK AVOIDANCE TRAINING

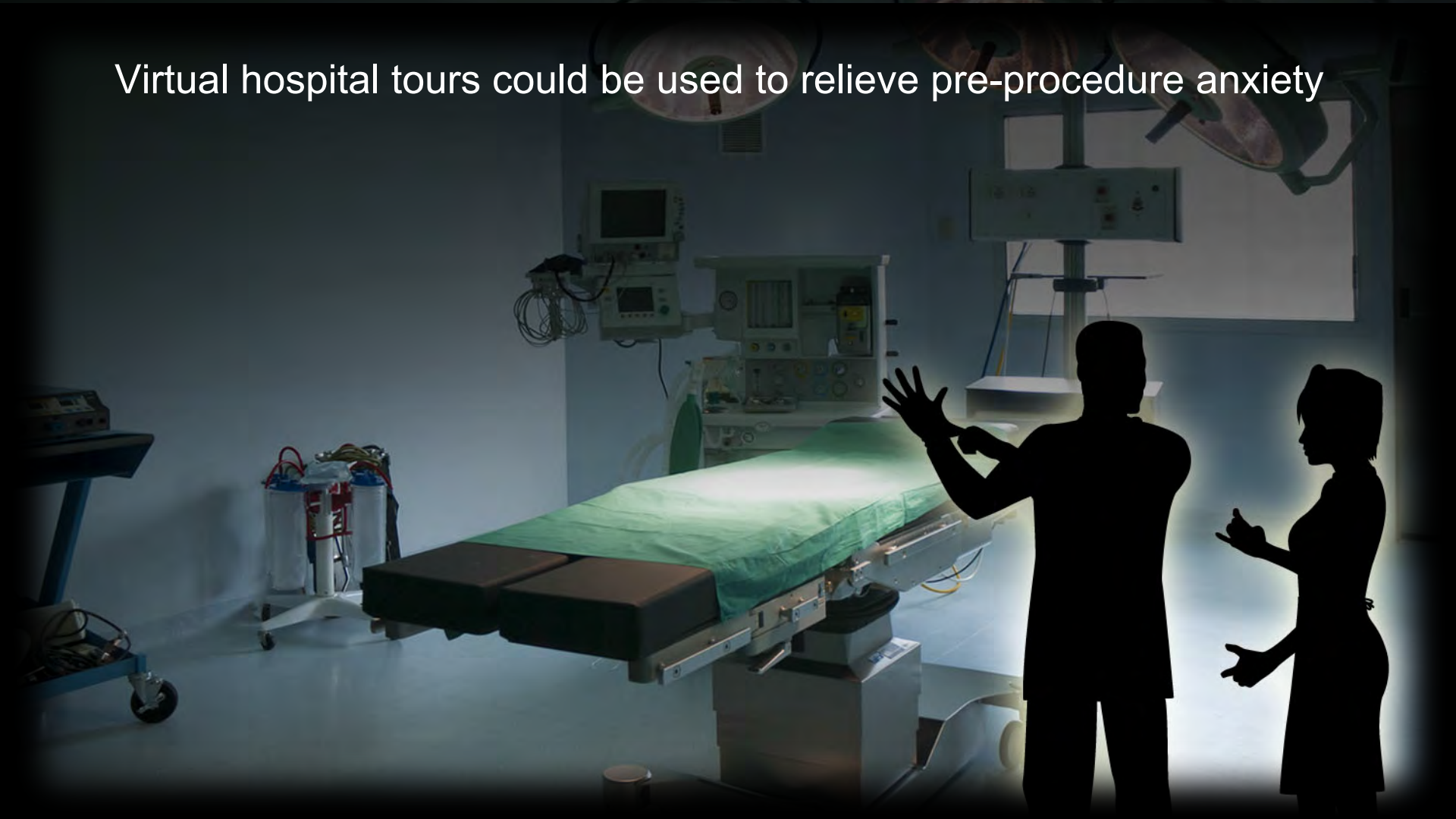
Refusal skill training for those who need help with addictions



Stress Inoculation – Risk Preparation



Virtual hospital tours could be used to relieve pre-procedure anxiety



Build Empathy for Underserved Populations



VR can be used to help train doctors and staff to better understand the patient perspective.



How does it work?

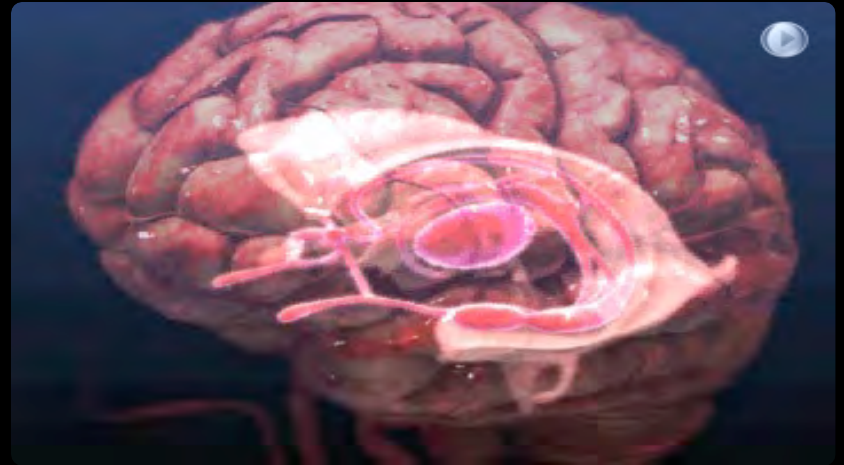


The Neuroscience of How VR Promotes Behavior Change

VR can promote behavior change by taking advantage of the way our brain's learning and reward systems function

VR systems can:

- Activate neuroplastic change via reward systems
- Shorten the feedback loop – show progress
- Leverage mirror neuron systems



The Neuroscience of How VR Promotes Behavior Change

- It is necessary to activate the associated brain system to enable neuro-plasticity
- Repetition is required
- It is critical to engage the brain's reward systems
- **Attention** drives Cholinergic system
- **Novelty** drives Noradrenergic/Serotonergic system
- **Reward** drives Dopaminergic system



Leveraging Mirror Neurons



Ability to change attitudes and behavior after “being” one’s future self.

Your Future Self



- Students interacted with 3-D avatars of future self.
- Asked to allocate \$1K between present expenses, a fun splurge, checking account, & retirement account.
- Participants who interacted with future self put more than twice as much money into retirement account.

Virtual Reality Technology For Medicine



- Current technologies and concepts are founded on more than *30 years of research and development*
- Recent changes in cost and access make VR affordable
- VR tech is currently used for prevention, evaluation, treatment and chronic disease management
- **After years of validation and use by early adopters - VR technology is poised to move to the mainstream**
- On the horizon: enhanced, ubiquitous, informative and integrated

For More Information:

Walter Greenleaf, PHD

WalterG@Stanford.edu

@WalterGreenleaf

Stanford
University



VIRTUAL HUMAN
INTERACTION
— L A B —