California Assembly Committee on
Arts, Entertainment, Sports, Tourism, and Internet Media

Informational Hearing

Honorable Ian C. Calderon, Chair

Friday, August 21, 2015
10:00 a.m. – 1:00 p.m.
University of Southern California
Los Angeles, California

Jay Obernolte, Vice Chair
Members: Hansen Chu, David Hadley, Marc Levine, Jose Medina, Adrin Nazarian

Staff:
Dana L. Mitchell, Chief Consultant
Sonia R. Valverde-Strong, Committee Secretary

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ASSEMBLY COMMITTEE ON
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Informational Hearing on California's Video Game Industry: *Staying on Top of a Changing Game*

August 21, 2015, 10:00 am to 1:00 pm
University of Southern California
SCI Building, Room 108
Los Angeles, California

I. Opening Remarks

Honorable Ian C. Calderon, Chair
Members of the Committee

II. Industry Overview

Erik Huey, Senior Vice President
Government Affairs, Entertainment Software Association

Tracy Fullerton, Director
University of Southern California Games Program

Kevin Klowden, Managing Director
California Center and Managing Economist, Milken Institute

III. Holding our lead: Opportunities to strengthen California's position

Peter Marx, Chief Technology Officer, Los Angeles Mayor's Office of Innovation

Will Koch, Deputy Director, California Competes Tax Credit Program
Governor's Office of Business and Economic Development (GO-Biz)

IV. Case Studies

Craig Hagen, Director, Global Government Affairs, Electronic Arts, Inc.

V. What Does the Future Look Like?

Walt Scacchi, PhD., Director of Research
Institute for Virtual Environments and Computer Games
University of California, Irvine

VI. Public Comments

VII. Closing Remarks

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Background and Studies

- Fast Facts on the California Economy
- 2015 Essential Facts About the Computer and Video Game Industry
- The Culture of Innovation: What Makes San Francisco Bay Area Companies Different?
- Frequently Asked Questions – California Competes Credit
- Gaming Tax Credits: A Developer's Guide to Free Money

Fast Facts on the California Economy

Compiled by: Assembly Committee on Jobs, Economic Development, and the Economy
Assemblymember Eduardo Garcia, Chair

California Gross Domestic Product (GDP)

- California's economy is the eighth largest in the world – larger than Russia, Italy, India, and Canada.[1]

- In 2014, California GDP grew from $2.2 billion to $2.3 billion. California's largest private industry sectors: Finance, insurance, real estate, rental, and leasing (20.2% of state GDP); trade, transportation, and utilities (12.7% of total GDP); professional and business services (12.0% of state GDP); and manufacturing (12.0% of state GDP).[3]

Comparison of 2014 GDPs

Country	GDP	Country	GDP
1 - United States	$17.41 trillion	9 - Italy	$2.14 trillion
2 - China	$10.38 trillion	10 - India	$2.05 trillion
3 - Japan	$4.61 trillion	11 - Russia	$1.85 trillion
4 - Germany	$3.86 trillion	12 - Canada	$1.78 trillion
5 –United Kingdom	$2.94 trillion	13 - Australia	$1.44 trillion
6 – France	$2.84 trillion	14 - Korea	$1.41 trillion
7 - Brazil	$2.35 trillion	15 – Spain	$1.40 trillion
8 - California*	$2.31 trillion		

Source: Department of Finance[2]

Firms, Employment and Wages

- There were 701,899 firms in California in 2012: 62% had less than 5 employees, 89% had less than 20 employees, 98% had less than 100 employees, and 99% had less than 500 employees (federal small business definition). About 5,660 firms in California had 500 employees or more. [4]

- There were 19 million workers in the California labor force in June 2015 with 17.8 million individuals employed. Month over incease of 35,000 jobs. This represents a 483,000 (2.8%) increase in jobs over the prior year.[5]

- In June 2015, nonfarm employment rose in six industry sectors. The largest job gains were in the professional and business services (+12,700); education and health services (+6,900); trade, transportation, and utilities (+5,100); financial services (+3,700); manufacturing (+3,100) and other services (+1,500).[6]

- California exported $174.1billion in products in 2014 to 229 foreign countries.[7] Mexico ($25.4 billion) and Canada ($18.2 billion) are the state's largest export markets.[8] California imported $403.4 billion in products from other countries in 2014, accounting for 17.2% of total U.S. imports in 2014.[9] China ($137.7 billion) and Mexico ($41.2 billion) are the state's largest import markets.[10]

- California median household income in 2013 was $61,094 ($53,046 for U.S.)[11] with 16.8% of individuals and 23.5% of people under 18 lived in poverty (federal basic definition). Using the more comprehensive method, which accounts for geographic differences, transfer payments, and out-of-pocket expenses over a 3-year term, 23.4% of California residents live in poverty, as compared to 15.9% nationally.[12]

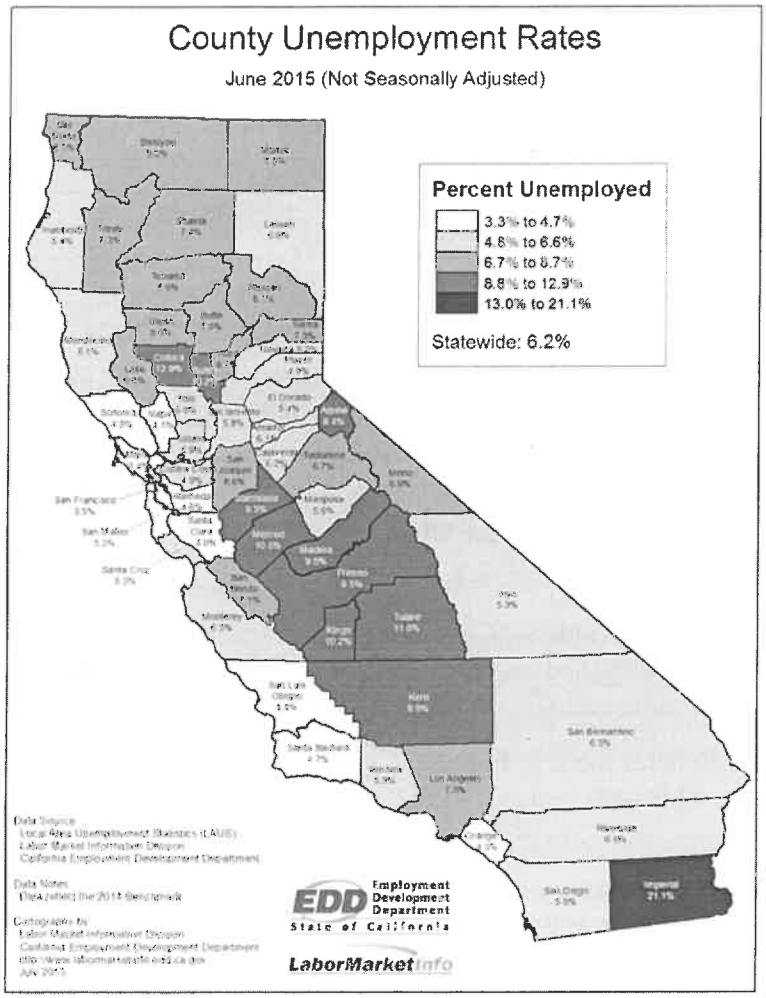
Future California Job Market

- The Employment Development Department is responsible for accessing future employment needs based on regional industry clusters. *The chart displays employment projections for 2010-2020, including new and replacement jobs.*

Projections for California employment for 2010-2020

	Industry Sector	Net Jobs		Industry Sector	Net Jobs
1	Hospitality and Tourism	868,186	6	Information and Technology	322,032
2	Retail	731,292	7	Professional, Scientific, & Technical Services	313,080
3	Health Care Services	584,560	8	Financial Services and Real Estate	275,464
4	Education & Knowledge Creation	525,875	9	Construction	263,157
5	Professional and Business Services	445,157	10	Transportation and Logistics	183,710

Source: Employment Development Department[13]



June Unemployment

- In June 2015, the California seasonally adjusted unemployment rate was 6.3, down 0.1% from the prior month and down 1.2% from the prior year.[14] This figure represents 1.1 million unemployed workers.[15] Over the same period, the national unemployment rate was 5.3%. *The map displays unemployment rate by county.*[16]
- The highest unemployment rates by race and ethnicity were among blacks (13.2%), Hispanics (7.9%), and whites (6.5%).[17]
- Most Californians, 79.8% generally worked full time. There were 1.1 million persons in California who worked part time involuntarily. They comprise 6.4% of all employed workers during the survey week.[18]
- By age group, the highest unemployment group was among workers 16 to 19 (22.7%) up 0.4% over the prior month.[19] The largest group of unemployed persons, when sorted by duration, were those unemployed for less than 5 weeks, which represented 26.8% of all unemployed.[20]

Prepared by: Toni Symonds, Chief Consultant, and the 2015 JEDE interns, Janna Ayoub, Benjamin Arriaga, and Norberto L. Miranda

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[1] Top Countries Ranked by Its GDP, California's World Ranking 2014, http://www.dof.ca.gov/html/fs_data/latestecondata/FS_Misc.htm, accessed 6/29/15
[2] Top Countries Ranked by Its GDP, California's World Ranking 2013, http://www.dof.ca.gov/html/fs_data/latestecondata/FS_Misc.htm, accessed 6/29/15
[3] "*Value Added by Industry as a Percetnage of GDP*" prepared by Bureau of Economic Analysis, released 4/23/2015
[4] 2012 U.S. and State Industry Totals Data, Statistics of U.S. Businesses, U.S. Census http://www.census.gov/econ/susb/ or http://www2.census.gov/econ/susb/data/2012/us_state_totals_2012.xls, accessed 4/08/15
[5] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf , accessed 8/10/15
[6] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf accessed 8/10/15
[7] International Trade Administration, U.S. Department of Commerce, "Global Patterns of a State's Exports," http://tse.export.gov/TSE/PrintPreview_Map.aspx?COL=3&DESC=true or http://tse.export.gov/TSE/MapDisplay.aspx accessed 4/09/15
[8] International Trade Administration, U.S. Department of Commerce, "Global Patterns of a State's Exports," http://tse.export.gov/TSE/PrintPreview_Map.aspx?COL=3&DESC=true or http://tse.export.gov/TSE/MapDisplay.aspx accessed 4/09/15
[9] U.S.Census,"State Imports for California 2014", http://www.census.gov/foreign-trade/statistics/state/data/imports/ca.html, accessed 4/09/15
[10] U.S. Census, "State Imports California 2014", http://www.census.gov/foreign-trade/statistics/state/data/imports/ca.html, accessed 3/9/15
[11] U.S. Census, ACS for U.S. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_S1903&prodType=table, and CA http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_S1903&prodType=table accessed 08/11/2015
[12] U.S. Census, ACS, https://www.census.gov/content/dam/Census/library/publications/2014/demo/p60-251.pdf accessed 08/12.2015
[13] EDD, Quarterly Market Review, April 2014 http://www.calmis.ca.gov/SpecialReports/Statewide_REA_Profile_Jun2014.pdf, Accessed 4/09/15
[14] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf , accessed 8/10/15
[15] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15
[16] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15
[17] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15
[18] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15
[19] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15
[20] EDD, Labor Market Review, June 2015, http://www.calmis.ca.gov/file/lfmonth/calmr.pdf, accessed 8/10/15

2015

SALES, DEMOGRAPHIC AND USAGE DATA

ESSENTIAL FACTS

ABOUT THE COMPUTER AND VIDEO GAME INDUSTRY

entertainment® software association

"Video games are ingrained in our culture. Driven by some of the most innovative minds in the tech sector, our industry's unprecedented leaps in software and hardware engages and inspires our diverse global audience. Our artists and creators continue to push the entertainment envelope, ensuring that our industry will maintain its upward trajectory for years to come."

—Michael D. Gallagher, president and CEO,
Entertainment Software Association

WHAT'S INSIDE

WHO IS PLAYING

AT PLAY

THE BOTTOM LINE

WHO WE ARE

OTHER RESOURCES

The 2015 Essential Facts About the Computer and Video Game Industry was released by the Entertainment Software Association (ESA) in April 2015. The annual research was conducted by Ipsos MediaCT for ESA. The study is the most in-depth and targeted survey of its kind, gathering data from more than 4,000 American households. Heads of households and the most frequent gamers within each household were surveyed about their game play habits and attitudes.

WHO IS PLAYING

OVERVIEW

155 million

Americans play video games

There are an average of

TWO GAMERS

in each game-playing U.S. household

FOUR OUT OF FIVE

U.S. households own a device used to play video games

"The [video game] industry is producing a steady stream of games that continue to expand their nature and impact – they can be artistic, social, and collaborative, with many allowing massive numbers of people from all over the world to participate simultaneously."

—The New Media Consortium's 2014 K-12 Horizon Report

51%

of U.S. households own a dedicated game console

42%

of Americans play video games regularly (3 hours or more per week)

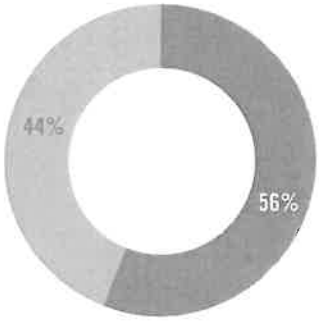
WHO IS PLAYING

GAMER DEMOGRAPHICS

The average game player is **35** years old

AGE
of Game Players

26% under 18 years
30% 18-35 years
17% 36-49 years
27% 50+ years



GENDER
of Game Players

56% male
44% female

Women age 18 or older represent a significantly greater portion of the game-playing population (33%) than boys age 18 or younger (15%)

The most frequent **FEMALE GAME PLAYER** is on average **43 years old**
and the average **MALE GAME PLAYER** is **35 years old**

The average number of years gamers have been playing video games: **13**

WHO IS BUYING

GAMER PURCHASING

WHO BUYS COMPUTER AND VIDEO GAMES?

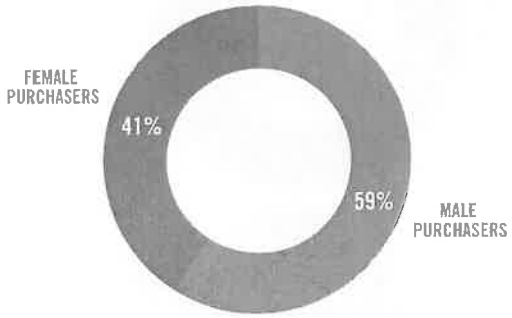
37

is the average age of the most frequent game purchaser

29%

of the most frequent game players currently pay to play video games online

Of the most frequent game purchasers:



THE MOST FREQUENT GAMER FEELS THAT COMPUTER AND VIDEO GAMES PROVIDE MORE VALUE FOR THEIR MONEY (47%) COMPARED TO DVDS (28%), GOING TO MOVIES (14%), AND MUSIC (12%)

"Games offer immediate feedback, you can see your progress, you can try something and be frustrated but later learn more... that's why game play is so engaging to us."

—Barbara Chamberlin, project director at the New Mexico State University Learning Games Lab

AT PLAY

HOW WE PLAY

39%

of the most frequent gamers play social games

Top three types of video games that the most frequent gamers play most often:

31%
Social Games

30%
Action

30%
Puzzle/Board Game/Card Game/Game Shows

TOP DEVICES MOST FREQUENT GAMERS USE TO PLAY GAMES: PC (62%), DEDICATED GAME CONSOLE (56%), SMARTPHONE (35%), WIRELESS DEVICE (31%), DEDICATED HANDHELD SYSTEM (21%)

Top three types of video games that the most frequent gamers play most often on their wireless or mobile devices:

31%
Social Games

14%
Puzzle/Board Game/ Card Game/Game Shows

5%
Action

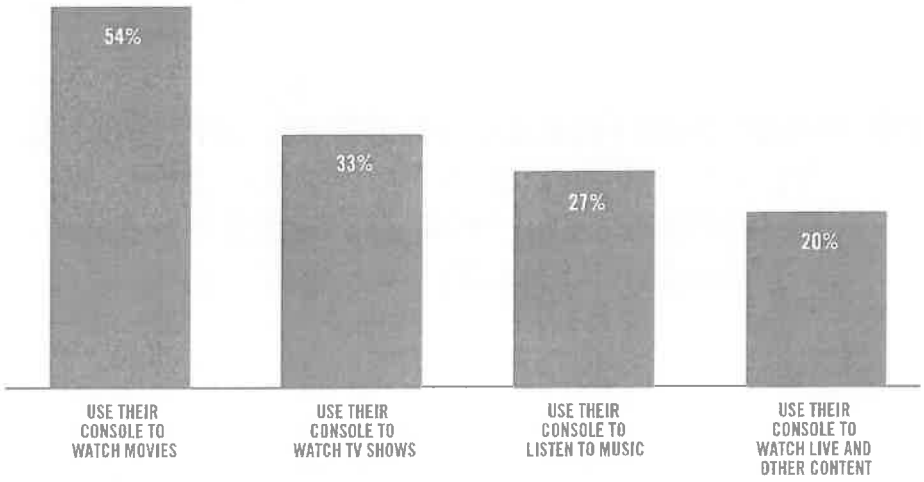
Gamers who are playing more video games than they did three years ago are spending <u>less</u> time:

39% watching TV

40% going to the movies

47% watching movies at home

Gamers who own dedicated game consoles use them for other entertainment media, in addition to playing games:



The most frequent gamers who play with others spend an average of

6.5 Hours per week playing with others online

5 Hours per week playing with others in-person

AT PLAY

HOW WE PLAY

56%

of the most frequent gamers play with others, including:

42% friends

21% family members

16% parents

15% spouse/partner

"Millennials are putting [video games] at the center of their entertainment preferences, but it is a new kind of gaming that is more social, interactive and engaging."

— Neil Howe, president of LifeCourse Associates and leading researcher on millennials

54%

of the most frequent gamers play a multiplayer mode at least weekly

54%

of the most frequent game players feel video games help them connect with friends

45%

feel video games help them spend time with family

AT PLAY

PARENTS AND GAMES

69%
of parents regularly check a game's rating before making a purchase

84%
of parents are aware of the ESRB rating system

PARENTS CONTROL WHAT THEIR KIDS PLAY

91%
of parents believe that the parental controls available in all new video game consoles are useful. Further, parents impose time usage limits on video games more than any other form of entertainment:

79%
of parents place time limits on video game playing

72%
of parents place time limits on Internet usage

70%
of parents place time limits on TV viewing

66%
of parents place time limits on movie viewing

Of the games rated by ESRB in 2014:

41%
received an E (Everyone) rating

21%
received an E10+ (Everyone 10+) rating

23%
received a T (Teen) rating

14%
received an M (Mature) rating

AT PLAY

PARENTS AND GAMES

91%

of parents whose children play games are present when games are purchased or rented

90%

require their children to get permission before buying or renting a video game

94%

of parents always or sometimes pay attention to the video games their child plays

63%

of parents say video games are a positive part of their child's life

59%

of parents whose children are gamers play computer and video games with their children at least weekly

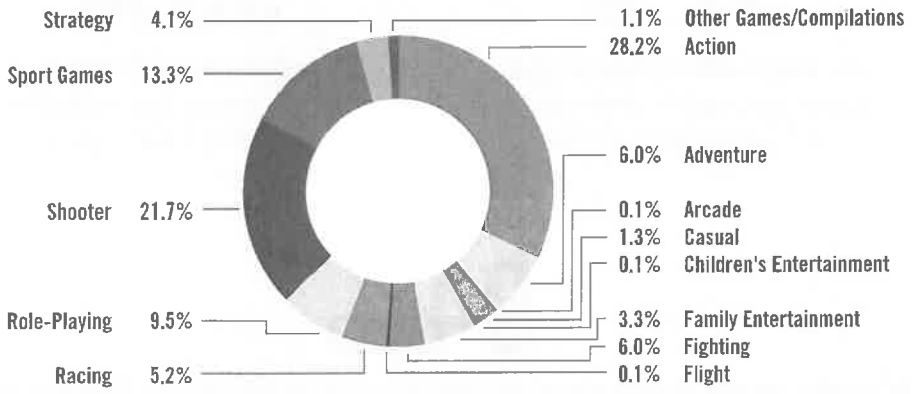
TOP 5 REASONS PARENTS PLAY GAMES WITH THEIR KIDS:

1. It's fun for the entire family: 85%
2. Because they're asked to: 75%
3. It's a good opportunity to socialize with their child: 75%
4. It's a good opportunity to monitor game content: 58%
5. They enjoy playing video games as much as their child does: 54%

THE BOTTOM LINE

TOP SELLERS

Best-Selling VIDEO GAME Super Genres by Units Sold, 2014

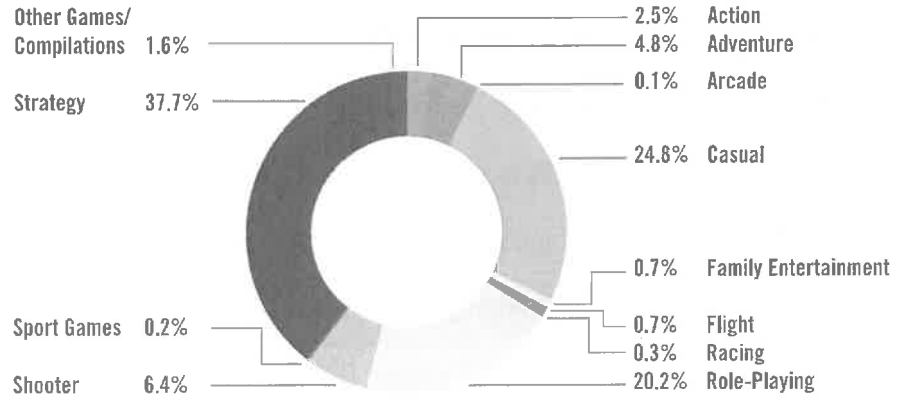


Source: The NPD Group/Retail Tracking Service

"Video games are complex systems composed of rules that interact. Gamers must think like a designer and form hypotheses about how the rules interact so they can accomplish goals and even bring about emergent results. Thinking like a designer in order to understand systems is a core 21st-century skill."

— Dr. James Paul Gee, Mary Lou Fulton Presidential Professor of Literacy Studies at Arizona State University

Best-Selling COMPUTER GAME Super Genres by Units Sold, 2014



Source: The NPD Group/Retail Tracking Service

THE BOTTOM LINE

TOP SELLERS

TOP 20 SELLING VIDEO GAMES OF 2014

BY UNITS SOLD

RANK	TITLE	ESRB RATING
1	CALL OF DUTY: ADVANCED WARFARE	MATURE
2	MADDEN NFL 15	EVERYONE
3	DESTINY	TEEN
4	GRAND THEFT AUTO V	MATURE
5	MINECRAFT	EVERYONE 10+
6	SUPER SMASH BROS.	EVERYONE 10+
7	NBA 2K15	EVERYONE
8	WATCH DOGS	MATURE
9	FIFA 15	EVERYONE
10	CALL OF DUTY: GHOSTS	MATURE
11	TITANFALL	MATURE
12	LEGO MARVEL SUPER HEROES	EVERYONE 10+
13	THE LEGO MOVIE VIDEOGAME	EVERYONE 10+
14	FAR CRY 4	MATURE
15	DISNEY INFINITY 2.0	EVERYONE 10+
16	NBA 2K14	EVERYONE
17	MARIO KART 8	EVERYONE
18	JUST DANCE 2015	EVERYONE 10+
19	MIDDLE EARTH: SHADOW OF MORDOR	MATURE
20	BATTLEFIELD 4	MATURE

Source: The NPD Group/Retail Tracking Service

TOP 20 SELLING COMPUTER GAMES OF 2014

BY UNITS SOLD

RANK	TITLE	ESRB RATING
1	THE SIMS 4	TEEN
2	THE SIMS 3: STARTER PACK	TEEN
3	DIABLO III: REAPER OF SOULS	MATURE
4	THE ELDER SCROLLS ONLINE	MATURE
5	WORLD OF WARCRAFT: WARLORDS OF DRAENOR EXPANSION PACK	TEEN
6	DIABLO III	MATURE
7	TITANFALL	MATURE
8	THE SIMS 3: ISLAND PARADISE EXPANSION PACK	TEEN
9	THE SIMS 3 SEASONS EXPANSION PACK	TEEN
10	ELDER SCROLLS V: SKYRIM	MATURE
11	THE SIMS 3: UNIVERSITY LIFE EXPANSION PACK	TEEN
12	THE SIMS 3: PETS	TEEN
13	THE SIMS 3: INTO THE FUTURE EXPANSION PACK	TEEN
14	ELDER SCROLLS ANTHOLOGY	TEEN-MATURE
15	DRAGON AGE: INQUISITION	MATURE
16	STARCRAFT II: WINGS OF LIBERTY	TEEN
17	THE SIMS 3: SUPERNATURAL EXPANSION PACK	TEEN
18	WORLD OF WARCRAFT: BATTLE CHEST 2013	TEEN
19	CIVILIZATION V	EVERYONE 10+
20	STARCRAFT II: HEART OF THE SWARM EXPANSION PACK	TEEN

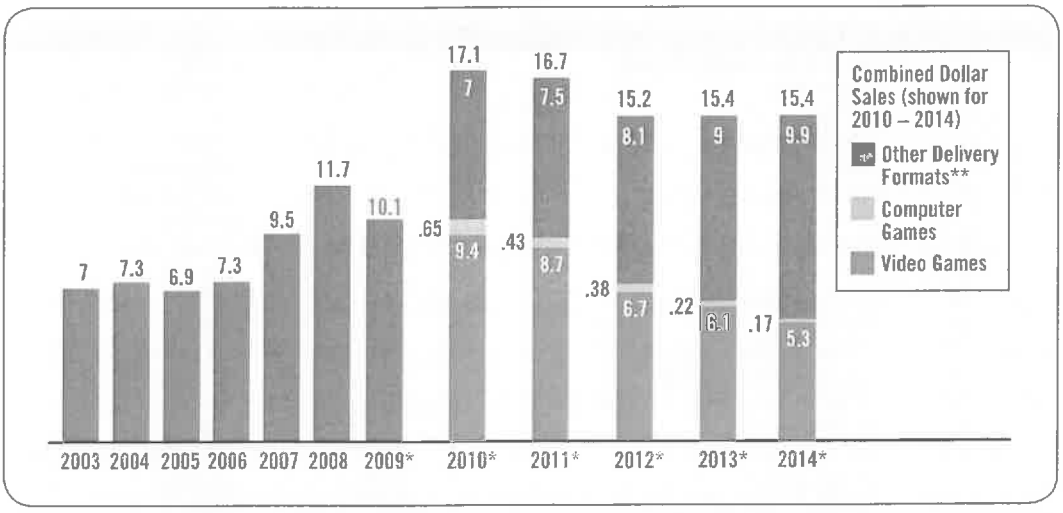
Source: The NPD Group/Retail Tracking Service

THE BOTTOM LINE

SALES INFORMATION

U.S. Computer and Video Game DOLLAR Sales

DOLLARS IN BILLIONS

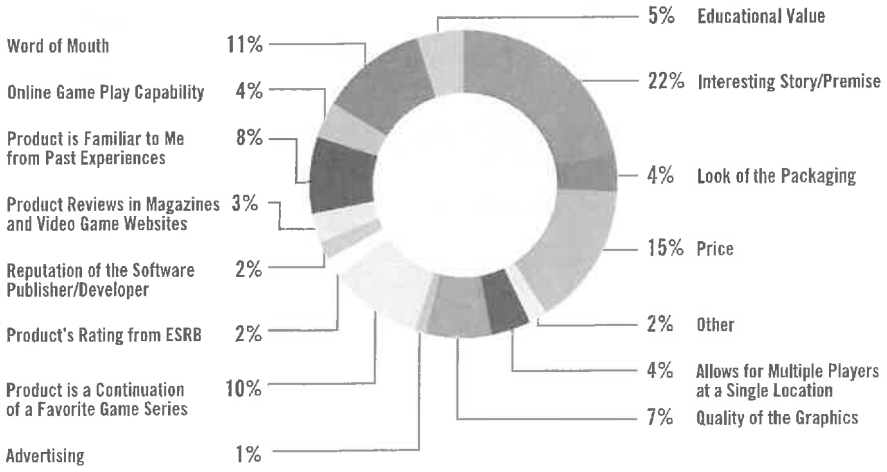


Source: The NPD Group/Retail Tracking Service, Games Market Dynamics: U.S.

* *Figures include total consumer spend.*

** *Other delivery formats include subscriptions, digital full games, digital add-on content, mobile apps, social network gaming and other physical delivery. 2003-2009 figures are sales of new physical content at retail exclusively.*

Factors influencing decisions to purchase video games:

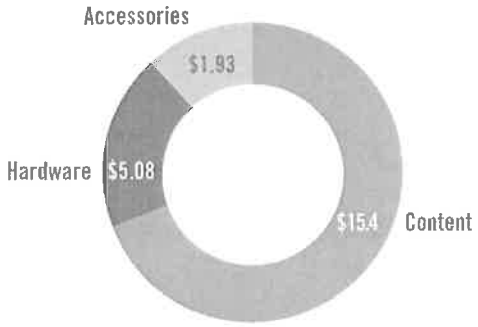


THE BOTTOM LINE

TOTAL CONSUMER SPEND ON GAMES INDUSTRY

Total Consumer Spend on Games Industry 2014

DOLLARS IN BILLIONS

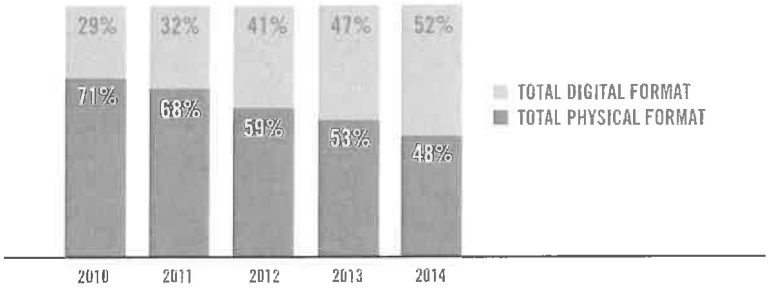


TOTAL: $22.41 BILLION

Source: The NPD Group/Games Market Dynamics: U.S.

> **"If it weren't for video game enthusiasts and the absolute commercial need to keep them happy with ever-better graphics requiring ever-higher processor speeds, complex computer graphics would still be found only in the high-priced domains of the business and science world."**
>
> *— Ralph Baer, inventor of the Brown Box and pioneer of the home video game console*

Recent Digital* and Physical Sales Information



Source: The NPD Group/Games Market Dynamics: U.S.

*Digital format sales include subscriptions, digital full games, digital add-on content, mobile apps and social network gaming.

entertainment software association

ABOUT THE ENTERTAINMENT SOFTWARE ASSOCIATION

The Entertainment Software Association (ESA) conducts business and consumer research, and provides analysis and advocacy on issues like global content protection, intellectual property, technology, e-commerce and the First Amendment in support of interactive software publishers. ESA owns and operates E3 and represents video game industry interests on federal and state levels.

To learn more, visit TheESA.com and follow us on Twitter: @RichatESA or @ESAGovAffairs.

ESA MEMBERS AS OF MARCH 2015

345 GAMES	www.spike.com/press/shows/345-games
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WHO WE ARE

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UBISOFT, INC.	www.ubisoftgroup.com
WARGAMING PUBLIC COMPANY, LTD.	www.wargaming.com
WARNER BROS. INTERACTIVE ENTERTAINMENT INC.	www.warnerbros.com/videogames
XSEED GAMES	www.xseedgames.com

OTHER RESOURCES

ESA PARTNERS

Learn more about the ESA and its programs at www.theESA.com.

ENTERTAINMENT SOFTWARE RATING BOARD | WWW.ESRB.ORG
The Entertainment Software Rating Board (ESRB) is a non-profit, self-regulatory body established in 1994 by ESA. ESRB independently assigns computer and video game content ratings, enforces advertising guidelines and helps ensure responsible online privacy practices for the interactive entertainment software industry.

ACADEMY OF INTERACTIVE ARTS & SCIENCES | WWW.INTERACTIVE.ORG
The Academy of Interactive Arts & Sciences (AIAS) was founded in 1996 as a not-for-profit organization to recognize outstanding achievements in interactive entertainment. The AIAS conducts the annual D.I.C.E. Awards to promote and acknowledge exceptional accomplishments in the field. In 2002 the Academy created the D.I.C.E. Summit dedicated to exploring approaches to the creative process and artistic expression as they uniquely apply to the development of interactive entertainment.

INTERNATIONAL GAME DEVELOPERS ASSOCIATION | WWW.IGDA.ORG
The International Game Developers Association (IGDA) is the largest non-profit membership organization serving individuals who create video games. The IGDA advances the careers and enhances the lives of game developers by connecting members with their peers, promoting professional development and advocating on issues that affect the developer community. These core activities advance games as a medium and game development as a profession.

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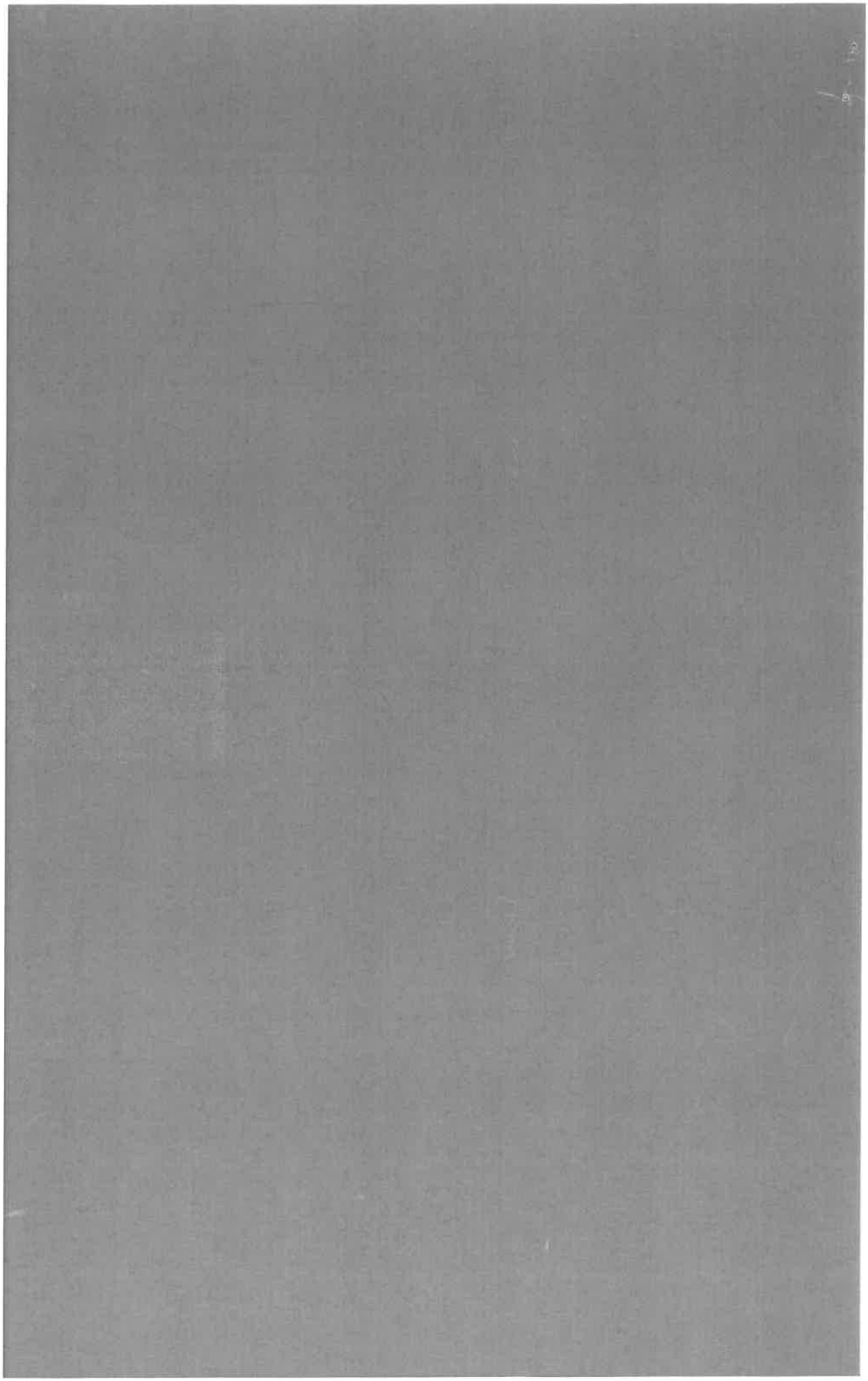
VIDEO GAME VOTERS NETWORK | WWW.VIDEOGAMEVOTERS.ORG
The Video Game Voters Network (VGVN) is a grassroots organization of voting-age gamers who organize and take action in support of computer and video games. Since its creation in 2006, more than 500,000 grassroots activists have joined the VGVN.

ESA FOUNDATION | WWW.ESAFOUNDATION.ORG
Created by the American entertainment software industry, the ESA Foundation works to make a positive difference in the lives of America's youth by providing scholarships to the next generation of industry innovators and supporting charitable organizations and schools that leverage entertainment software and technology to create educational opportunities. ESA Foundation is primarily supported by proceeds from its signature annual fundraiser, "Nite to Unite – for Kids" and other charitable initiatives.



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The Culture of Innovation

What Makes San Francisco Bay Area Companies Different?

A Bay Area Council Economic Institute and Booz & Company Joint Report

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March 2012

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Google Inc.
Griffin Partners
HCL Technologies Ltd.
Hewlett-Packard Company
Intel Corporation
JDS Uniphase Corporation
KLA-Tencor Corporation
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Contents

Foreword

The claim has long been made that companies based in the San Francisco Bay Area owe their leadership in innovation to something different in how they go about the innovation process. This report represents a first empirical assessment of the "culture of innovation" that characterizes these innovation leaders. The goal is to contrast these companies with their global peers in order to better understand where the source of their innovative prowess lies.

For almost a decade, in its annual Global Innovation 1000 study, Booz & Company has ranked the top 1,000 public companies by their research and development spending and analyzed how that spending influences their overall financial performance. The results are clear: success at innovation is not just a blend of hard elements such as the number of researchers, the amount that they receive in funding, or the number of patents they receive. Indeed, the study has consistently shown that the absolute amount spent does not correlate with financial performance at all.

Instead, the current study indicates that the most innovative companies appear to have a "secret sauce" that makes them different from their peers—a distinct culture of innovation that ensures that their chosen innovation strategy is clearly aligned with their overall corporate strategy. This secret sauce is the glue that guarantees a high degree of coherence between what they aspire to achieve and how they go about it. Until recently, however, this claim has not been empirically tested.

The Bay Area Council Economic Institute and the Bay Area Science and Innovation Consortium (BASIC), the Economic Institute's science and technology affiliate, have also been keenly aware of the importance of this issue, given their belief that the source of the Bay Area's innovation success cannot be found in easily quantifiable performance measures alone. So Booz & Company and the Economic Institute decided to supplement the Global Innovation 1000 study, with a series of questions designed to empirically test what companies mean when they talk about their culture of innovation, and with additional surveys and interviews targeted specifically at Bay Area companies. In this way we were able to empirically assess the companies in the most innovative region on earth to see if there was indeed something unique in the culture of the companies here. The results are described in this report.

Executive Summary

The Bay Area is famous for its long history of leadership in computing, semiconductors, software, biotechnology, the Internet and other innovation-based industries. But what makes it unique, beyond its talent base and access to capital? What exactly is the often celebrated "West Coast culture of innovation"? In conjunction with its 2011 Global Innovation 1000 study, Booz & Company worked with the Bay Area Council Economic Institute, the strategic research arm of the Bay Area Council, a consortium of more than 275 companies in the San Francisco Bay Area, to identify the strategic, cultural, and organizational attributes that have led to the sustained success of this region. This effort included segmenting the survey results received from Bay Area companies in order to better understand what cultural and organizational elements make them different, and conducting supplementary interviews with Bay Area executives to deepen that understanding.

The survey conducted as part of the Global Innovation 1000 study classifies companies according to three strategic profiles: Need Seekers, Market Readers, and Technology Drivers. What differentiates them is primarily their approach to markets and customers. Companies following the model we call "Need Seekers" tend to concentrate on gathering the deepest insights possible into both the articulated and unarticulated needs and desires of their customers. "Market Readers" look to meet the needs of their customers, but they typically follow already established trends in the overall market. Finally, "Technology Drivers" depend to the greatest extent on their own technical expertise to develop attractive products and services. Thus, Need Seekers tend to want to be first to market, Market Readers tend to be fast followers, and Technology Drivers tend to bring their technology-driven products to market with somewhat less regard for timing. While companies following any of the three approaches can outperform their peers, the study found that Need Seekers tend to be better aligned both culturally and strategically than the other two models *(See Chapter 5.)*

By this critical measure, companies in the Bay Area do indeed stand out. Our research found that they are almost twice as likely to follow a Need Seeker innovation model, compared to the general population of companies in the Booz global survey—46 percent versus 28 percent—while the proportion of Technology Drivers is almost exactly the same as the overall population. And they are almost three times as likely to say their innovation strategies are tightly aligned with their overall corporate business strategies—54 percent, compared with just 14 percent among all companies.

When asked if their corporate cultures supported their strategies, 46 percent of Bay Area companies strongly agreed—compared with just 19 percent of all companies—more than double the general population.

It may come as something of a surprise that companies in the Bay Area are no more likely to follow the Technology Drivers innovation model than are companies in general. But that only strengthens the argument: while Bay Area companies, like many top innovators, have found success in creating path-breaking new technologies, they are also almost twice as likely as companies in general to have developed the capabilities needed to provide a superior understanding of the stated and unstated needs of their end customers. It isn't just about how many transistors you can fit on a chip, but also about how such advances can lead to products and services that gain unprecedented traction in the marketplace through superior insight into customers, as well as the development of practical value propositions that will win those customers' business.

1 Introduction

This report is the product of a dual effort between Booz & Company and the Bay Area Council Economic Institute. As it has done for the past six years, Booz & Company conducted its annual Global Innovation 1000 study, concentrating in 2011 on the effect of culture on corporate innovation performance. In parallel, the Bay Area Council Economic Institute conducted a similar study, concentrating on a smaller set of companies in the Bay Area. Both studies included interviews of a number of innovation executives, both in and out of the Bay Area, in order to add color and depth to the empirical findings.

As always, the Booz & Company study began by identifying the 1,000 public companies around the world, for which public data on R&D spending was available, that spent the most on research and development in 2010. Then it analyzed key financial metrics for each of those companies from 2001 through 2010, including sales, gross profit, operating profit, net profit, R&D expenditures, and market capitalization. All foreign currency sales and R&D expenditure figures through 2010 were translated into U.S. dollars at 2010 daily average exchange rates. In addition, data on total shareholder return was gathered and adjusted for each company's corresponding local market.

Each company was coded into one of nine industry sectors (or "other"), and into one of five regional designations as determined by each company's reported headquarters location. To enable meaningful comparisons both within and across industries, the R&D spending levels and financial performance metrics for each company were indexed against the industry group's median values.

Separately, an online survey of nearly 600 innovation leaders in companies around the world was conducted in order to explore the role of corporate culture as it relates to innovation and financial performance. Survey respondents were also asked a series of questions to help classify their companies into one of three core profile models: "Need Seekers," "Market Readers" or "Technology Drivers." (See Chapter 4.) The characterization of each company according to one or another of the models was based on an objective analysis of their answers. Together, these results were analyzed to reveal the links between innovation strategy and culture.

This year, as part of the Global Innovation 1000 study, the Economic Institute encouraged Bay Area Council member companies both to participate in the Booz global survey and to make themselves available for focused interviews to help interpret the results. Then, as Booz & Company

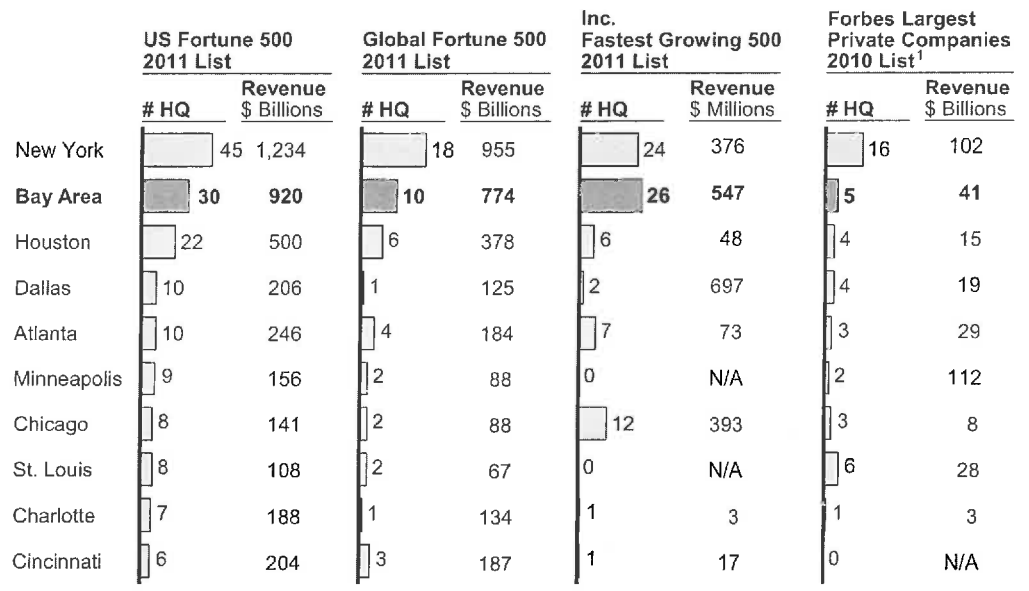
conducted the analysis of the global survey results,* a separate analysis was conducted of the Bay Area-based respondents, and their results were compared and contrasted with the global survey population.

*For a more in-depth look at the results of the 2011 Global Innovation 1000 study, visit booz.com or follow these links: http://www.strategy-business.com/article/11404?gko=dfbfc or http://www.booz.com/global/home/what_we_think/featured_content/innovation_1000_2011

2 Innovation in the Bay Area

Innovation lies at the heart of the Bay Area's economy, and the region is widely considered to be the world's leading center for innovative activity, particularly in technology. The region's ability to retain this distinction is a result not just of the many technological advances it has achieved, but also of the ongoing creation of new business paradigms that produce new companies and redefine entire industries. A large number of the Bay Area's leading companies have been created in the past 40 years. Many are quite young, and most were started by entrepreneurs.

Many of the largest and fastest growing companies in the U.S. are based in the Bay Area.



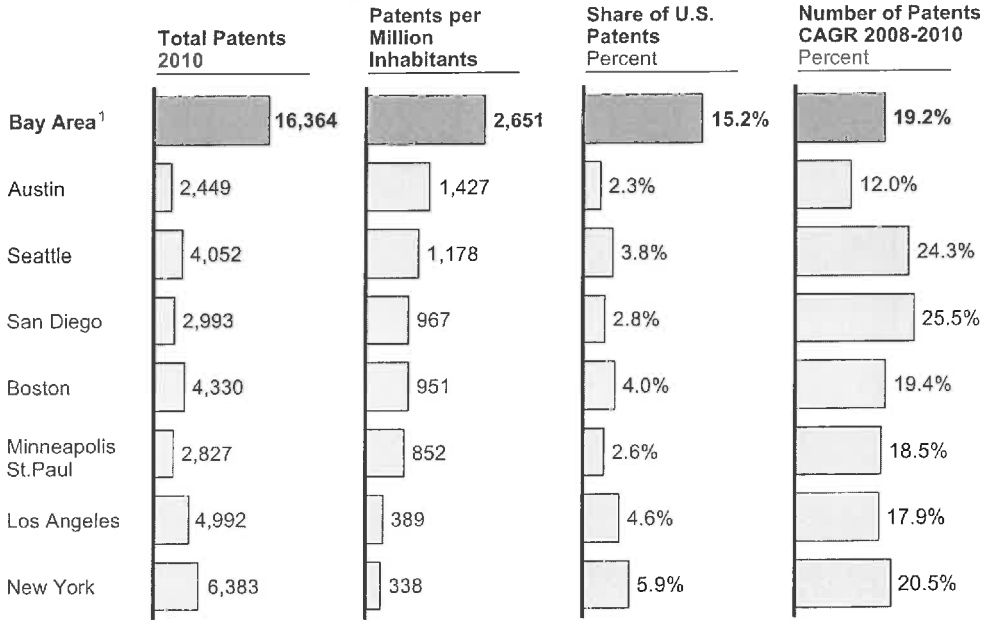
1 Forbes largest private companies list comprises 223 companies; revenues for a number of Forbes largest private companies are calculated by using Forbes estimate or company provided estimate.

Source: Fortune Magazine, Inc. 500, Forbes; McKinsey & Company analysis; Bay Area Council Economic Institute

The Bay Area's formula for success has been studied closely around the world. Much of it can be attributed to three critical factors: infrastructure (both hard and soft), finance, and culture. The first two can be acquired, while the third—the subject of this report—is more difficult to replicate.

The Bay Area hosts what is possibly the world's greatest assembly of scientific research capacity. Five national laboratories call the region home: Lawrence Livermore, Lawrence Berkeley, Sandia, NASA Ames and the Stanford Linear Accelerator. The region is also home to five of the nation's leading research universities: UC Berkeley, UC San Francisco, UC Davis, UC Santa Cruz and Stanford. These institutions are joined by an array of independent research laboratories, such as SRI, PARC, and the Buck Center on Aging. Many private sector companies maintain their own world-class research facilities, including Agilent, Apple, Genentech, Google, HP, IBM, Intel, Lockheed Martin, and many others.

The Bay Area remains at the head of its peers in terms of patents granted.

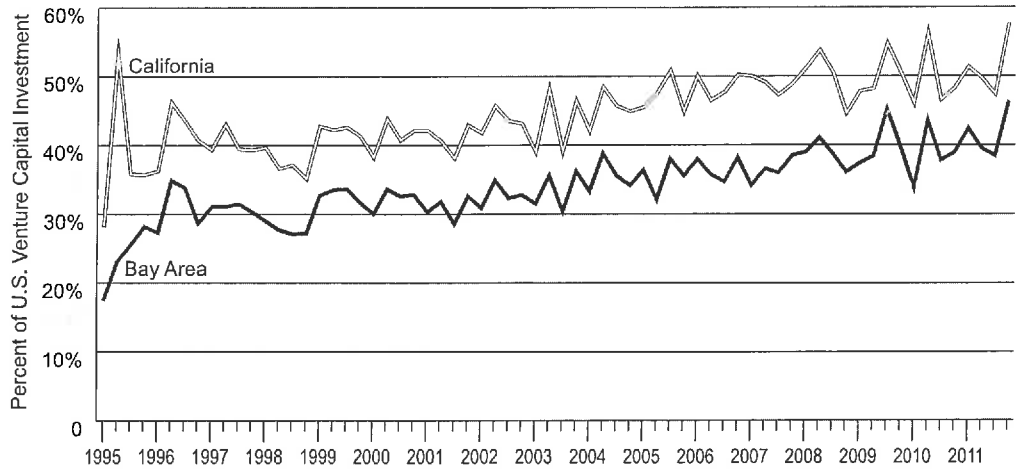


1 Data for San Francisco and San Jose MSAs

Source: U.S. Patent and Trademark Office, U.S. Census Bureau; McKinsey & Company analysis; Bay Area Council Economic Institute

University and industry resources are brought together through two of the four California Institutes for Science and Innovation: QB3 (California Institute for Quantitative Biosciences), which focuses on the convergence of information and biotechnology, and CITRIS (Center for Information Technology Research in the Interest of Society). Other specialized research centers, such as JBEI (Joint Bio-Energy Institute), a collaboration of universities and national laboratories, have been created in recent years to focus on specific challenges, such as the conversion of plants to energy. The depth and diversity of all of the many research efforts in the region provide a core of basic science and technology, as well as a large pool of faculty, students, and scientific entrepreneurs who staff and build companies based on these technologies.

The Bay Area captures between 35 and 40 percent of U.S. venture capital investment.



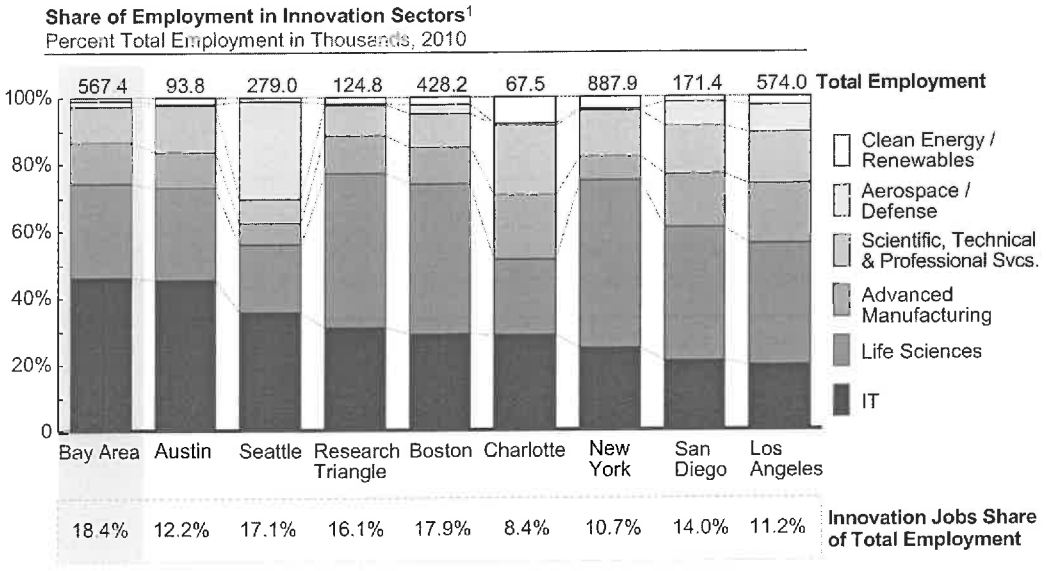
Source: PWC MoneyTree; Bay Area Council Economic Institute analysis

Another distinctive element of the Bay Area's success is venture capital, an industry that was created in the Bay Area and continues to thrive here. The amount of venture capital money invested from year to year may vary, but between 35 and 40 percent of all venture funding in the U.S. is routinely invested in the Bay Area. At certain times and in particular industries, that percentage can be much higher. In mid-2010, 70 percent of all venture investment in clean technologies, and 50 percent of global investment in the sector, were targeted for California, primarily the Bay Area. Venture funding, as well as the funding of very young companies by angel investors, has fueled much of the technology commercialization in the region and many of its most successful companies.

As a result, the Bay Area is home to the world's largest assembly of information technology, biotechnology, Internet, digital entertainment, and cleantech firms. The proximity of these companies to each other, and the fluidity with which people and ideas move between them, creates further opportunities for growth and development in every sector.

This leads to the region's critical human element—the highly educated, motivated workforce that sustains its fast pace of technology development and commercialization. The Bay Area is closely identified with entrepreneurship and a strong culture of risk-taking. In its business environment, failure is not a bar to future success. Serial entrepreneurs, many from overseas, are common, and they regularly fund and mentor new generations of young companies. This spirit of acceptable risk, willingness to invest where technology and future markets intersect, and ongoing creation of new business paradigms, lies at the heart of the Bay Area's innovation culture. It is the one element of the region's success that has been the most difficult to export.

Innovation jobs represent a larger share of jobs in the Bay Area than anywhere else in the country.



1 Innovation sectors were defined as industry NAICS code with higher than average U.S. productivity, preferably with high growth and capacity for intellectual or scientific progress

Source: Moody's Analytics, BLS; McKinsey & Company analysis; Bay Area Council Economic Institute

3 The 2011 Global Innovation 1000

This report, as noted, is a collaborative effort between the Bay Area Council Economic Institute and Booz & Company. It was developed based on Booz & Company's 2011 Global Innovation 1000 study, subtitled *Why Culture Is Key*, which focused on how culture informs and affects the innovation process.

Key Findings of the 2011 Global Innovation 1000 Study

Overall, corporate spending on innovation rose 9.3 percent in 2010, to a new high of $550 billion. The increase, which followed the only decline in the seven years the Global Innovation 1000 study has been tracking R&D spending, is attributable largely to a major rebound in corporate revenues.

The top 20 global spenders averaged 10 percent R&D growth, representing $142 billion in R&D on sales of $1.6 trillion. Roche Holding AG led the global pack for the second year in a row, with an R&D outlay of $9.6 billion of its $45.7 billion in revenues; that works out to an R&D intensity rate (ratio of revenue to R&D expenditure) of more than 21 percent. Toyota Motor, the top R&D spender for several years prior to the recession, increased spending by less than 1 percent, falling from fourth place in the rankings to sixth. Pfizer (2nd), Novartis (3rd), Microsoft (4th) and Merck (5th) rounded out the top five spenders. Ford was the only company exiting the top 20, and 18th-ranked AstraZeneca was the sole newcomer.

Fully 68 percent of all companies Booz & Company tracked increased their R&D spending in 2010. Three industries accounted for $36.1 billion, or 77 percent, of the total $46.8 billion increase: computing and electronics, health, and automotive. Industries experiencing the greatest percentage increase in R&D spending were software and Internet (11 percent), health (9.1 percent) and industrials (8.5 percent).

- **The computing and electronics sector realized the biggest absolute increase in R&D spending and remained the #1 industry in innovation expenditures, accounting for 28 percent of the total.** With revenues up 14.2 percent, the sector increased innovation outlays by 6.1 percent, or $16.9 billion. However, for the first time since the inception of the Global Innovation 1000 study, no high-technology company was ranked among the top three R&D spenders.
- **Health was second among industry sectors in its share of total R&D expenditures, at 22 percent. The industry increased outlays by 9.1 percent, or $10.4 billion, the highest rate of increase among the top three industries in 2010 and in line with the overall R&D increase of**

9.3 percent across all sectors. The health sector, whose R&D expenditures are chiefly by pharmaceutical firms, captured four of the top five spots in spending among the Global Innovation 1000 and accounted for eight out of the top 20 firms in total R&D spending.

- **Automotive retained third place with a 15 percent share of total spending, due to a spending boost of 8 percent, or $8.8 billion, in 2010, a significant change after cutting R&D outlays by 14 percent in 2009.** Revenues for the auto sector were up 16.5 percent over last year.

Globally, every region increased innovation spending in 2010, a significant turnaround compared to the previous year, when the three regions making up the lion's share—North America, Europe and Japan—all cut back. India- and China-based firms again increased their total R&D outlays at a far higher rate than companies in the three largest regions:

- The turnaround was cautious among companies headquartered in Europe and Japan, which increased R&D spending by an average 5.8 percent and 1.8 percent, respectively. North American companies, after cutting R&D by nearly 4 percent in 2009, increased R&D spending by 10.5 percent in 2010—beating the overall global growth rate of 9.3 percent.

- China and India—and to a lesser extent countries outside of North America, Europe, Japan, and Asia—continued to boom, albeit from a small base. Accounting for 2 percent of global R&D outlays in 2010, Chinese and Indian companies upped R&D investment by more than 38 percent, almost identical to the previous year's growth pace. Companies from other regions around the world boosted R&D spending almost 14 percent.

When it comes to innovation, spending doesn't correlate with success. As part of its web-based survey of nearly 600 innovation executives from more than 400 leading companies in every major industry sector, Booz & Company asked innovation leaders to name the companies they considered to be the most innovative in the world. For the second year in a row, Apple led the top 10, followed by Google and 3M. In 2011, Facebook was named one of the world's most innovative companies for the first time, entering the list at number 10. The top 10 most innovative firms outperformed the top 10 R&D spenders across three key financial metrics over a five-year period—revenue growth, EBITDA (earnings before interest, taxes, depreciation and amortization) as a percentage of revenue, and market cap growth. This is consistent with the findings in the previous year's survey. Just three of the top 10 spenders also ranked among the top 10 innovators: Microsoft, Samsung and Toyota Motor.

State of California
Franchise Tax Board

Frequently Asked Questions - California Competes Credit

The Governor's Office of Business and Economic Development (GO-Biz) administers the California Competes Tax Credit (CCTC). Applications for the credit are available to businesses that want to locate or stay and grow in California. Tax credit agreements are negotiated between taxpayers and GO-Biz and are approved by the California Competes Tax Credit Committee (Committee). The Committee consists of the State Treasurer, the Director of the Department of Finance, the Director of GO-Biz, and one appointee each by the Speaker of the Assembly and Senate Committee on Rules. For more information on how to obtain a credit agreement, visit the GO-Biz website.

Businesses will commit to certain employment or project investment requirements, we refer to as "milestones," as part of the credit agreements. The legislation that enacted this credit requires us to review certain businesses books and records to ensure that businesses are in compliance with the agreed upon milestones.

We designed these Frequently Asked Questions (FAQs) to assist businesses with the credit and our review process. The GO-Biz website has additional FAQs available.

General Credit Information

1. What taxable years is the credit available?
2. Can the credit reduce tax below tentative minimum tax?
3. Is this credit refundable?
4. Can my business carry the credit forward to future years?
5. Can my business assign the credit to an affiliated corporation under R&TC Section 23663?

Credit Usage

1. The credit agreement requires my business to meet the project milestones before it earns a credit. How do I report the credit?
2. How does my business claim the credit on its tax return?

CCTC Reviews

1. Once my business obtains a credit agreement from GO-Biz, what is FTB's role?
2. Which businesses will be subject to a review?
3. What is a "small business" for CCTC purposes?

4. Is the CCTC Review the same as when your Department audits my business tax return?
5. My business provided GO-Biz with a lot of information when it applied and will continue to provide it to them during the entire agreement period. Will your Department have access to this information?
6. What is the purpose of the review?
7. What are some examples of acceptable records to show that my business met the milestones?
8. What procedures and guidelines will your Department follow for these reviews?
9. Will your Department perform a review only once or multiple times?
10. How will your Department contact me for a review?
11. What happens during a review?
12. Will the information I provide to your Department during the review remain confidential?

Breaches and Recapture

1. What happens if your Department determines that my business is not in compliance with the credit agreement?
2. What does GO-Biz consider a breach?
3. What happens after your Department notifies GO-Biz of a possible breach?
4. Who decides on a credit recapture?
5. How does my business report a recapture on its tax return?

Miscellaneous Information

General Credit Information

1. **What taxable years is the credit available?** It is available for all taxable years that begin on and after January 1, 2014, and before January 1, 2025.

2. **Can the credit reduce tax below tentative minimum tax?** Yes.

3. **Is the credit refundable?** No.

4. **Can my business carry the credit forward to future years?** Yes, the carry forward period is 6 years.

5. **Can my business assign the credit to an affiliated corporation under R&TC Section 23663?** Yes, get more information about credit assignment.

Credit Usage

1. **The credit agreement requires my business to meet the project milestones before it earns a credit. How do I report the credit?** In general, if your business meets the milestones for a taxable year as specified in the credit agreement, then the credit for that year is earned

and may be claimed on its tax return. If the milestones for a taxable year are not met, the credit is not earned for that taxable year.

2. **How does my business claim the credit on its tax return?** They use credit code 233 to claim it.

CCTC Reviews

1. **Once my business obtains a credit agreement from GO-Biz, what is FTB's role?** We may review your business' books and records to determine compliance with the credit agreement. We call this review activity a "CCTC Review" or "review."

2. **Which businesses will be subject to a review?** We must review every business that receives a credit agreement, unless it is a small business. We may review a small business when it is appropriate.

3. **What is a "small business" for CCTC purposes?** In general, it is a trade or business with less than $2 million gross receipts. GO-Biz specifies if a credit agreement is for a small business.

4. **Is the CCTC Review the same as when your Department audits my business tax return?** No. The CCTC review is to determine if your business is in compliance with the credit agreement. It is not an income tax audit. Your business tax return remains subject to audit.

5. **My business provided GO-Biz with a lot of information when it applied and will continue to provide it to them during the entire agreement period. Will your Department have access to this information?** The information you provide to GO-Biz is available to us. We use it during our review to determine if your business is in compliance with the credit agreement.

6. **What is the review's purpose?** The review's purpose is to determine credit agreement compliance. The credit agreement has yearly milestones for California full-time employment, salary levels, and project investment. Our primary focus is to verify these milestones.

7. **What are some examples of acceptable records to show that my business met the milestones?**

Employment and Compensation Levels

Payroll reports and records to support:

- Hire dates, hours, or weeks worked.
- Wages and salary levels for new employees and compensation paid.

Project Investment

- Authorization for expenditures, invoices, deeds, contracts, lease/rental agreements etc.
- Project documents, timelines, capitalized costs, schedule of project costs etc.
- Summary analysis of changes in property, plant, and equipment.
- Depreciation records.
- General ledger records.

The above is not all inclusive. Acceptable records depend upon the specific project. We may also consider alternative documents.

8. **What procedures and guidelines will your Department follow for these reviews?** We will follow the procedures and guidelines in FTB Notice 2014-02.

9. **Will your Department perform a review only once or multiple times?** In general, the credit agreements are for 5 years with an additional 3 years to maintain employment increases and salary levels. Since the credit agreement period may be up to 8 years, we may conduct a review once or multiple times.

10. **How will your Department contact me for a review?** We will send you a contact letter to begin a review. It will include the reviewer and supervisor contact information.

11. **What happens during a review?** We will request information to determine if your business is in compliance with the credit agreement. When we finish the review, we will send you a letter that states whether your business is in compliance with the credit agreement or there is a possible breach.

12. **Will the information I provide to your Department during the review remain confidential?** Yes. We consider any information that you provide during the review confidential. However, in the event that we determine that your business is not in compliance with the credit agreement, we will provide GO-Biz with information that explains the basis for our determination.

Breaches and Recapture

1. What happens if your Department determines that my business is not in compliance with the credit agreement? We would consider this a possible breach. We will provide information to you and GO-Biz that explains the basis for our determination.

2. What does GO-Biz consider a breach?

A breach includes one or more of the following:

- Failure to furnish us or GO-BIZ with information.
- Material misstatements in any information your business provided to GO-Biz.
- Failure to materially satisfy or maintain the milestones.

3. **What happens after your Department notifies GO-Biz of a possible breach?** In general, GO-Biz will contact you and allow you some time to resolve it. If you are unable to resolve the breach, GO-Biz may recommend a recapture to the Committee.

4. **Who decides on a credit recapture?** GO-Biz will recommend a credit recapture to the Committee. If the Committee makes the decision to recapture a credit, GO-Biz will notify you and us about the recapture and the amount.

5. **How does my business report a recapture on its tax return?** Your business will report it on its tax return for the taxable year the Committee makes the recapture decision. If your business does not report it on its tax return, we will send you a bill.

Miscellaneous Information

If you have questions about the CCTC review process, contact GEDI@ftb.ca.gov.

Gaming Tax Credits: A Developer's Guide to Free Money

By Brendan Sinclair

FRI 24 MAY 2013 2:28PM GMT / 10:28AM EDT / 7:28AM PDT
DEVELOPMENT

Government give-backs aren't limited to Montreal. Here are dozens of North American programs for developers, from Puerto Rico to PEI

As TV infomercial star and Riddler-inspired fashionista Matthew Lesko would say, "The government is giving away FREE MONEY to game developers!" Or to put it less colorfully but more accurately, there are dozens of government programs in the United States and Canada offering tax credits and rebates for companies producing video games.

With the help of the Entertainment Software Association and Pricewaterhouse Coopers, *GamesIndustry International* compiled the below list of 28 tax incentive programs that developers can take advantage of to bolster their bottom lines. We've tried to include the broad strokes benefits and restrictions on these programs, but many of the incentives were too complex to concisely recap in this space. For that reason, we've also done our best to provide links to government websites and the agencies overseeing the programs.

As with anything approaching a free lunch (or a tax-deductible one, for that matter), there are usually strings attached. Most payroll tax credits and rebates only cover wages paid to residents, with non-resident pay being incentivized at a reduced rate, or not at all. There are similar restrictions on what production expenses can qualify for these programs, with some programs stipulating that projects purchase whatever they need locally whenever possible.

Then there are limits on the size of the projects that can be funded. Some incentives are designed for games with huge teams and long development times; others were intended to support much smaller projects. Many of the programs were actually designed for TV and movie production, and have been expanded to cover digital media projects as well. Some states also offer sales tax exemption for certain production expenses, or have different rules on when companies can actually claim benefits.

The point is, there's a lot more to consider when assessing the value and suitability of these programs than just the information provided below. For instance, Puerto Rico's 40 percent tax credit on income and production costs tops even Quebec's incentive offerings, but there's no comparison between the two talent pools developers would have access to. Reliability is also a key factor; Quebec has offered its incentives for years, showing a long-term commitment to supporting the gaming industry within its borders. And while we don't want to question Puerto Rico's commitment to its own program, it's recent enough that it has yet to assist a single developer.

It should also be noted that this list is not a comprehensive overview of the available government support. Some states and provinces have other, complementary programs designed to encourage companies (not just game developers) to relocate or expand their businesses in the province or state. For example, Utah has its Economic Development Tax Increment Financing program, which offers up to 30 percent tax credit for new state revenues created over a 5-10-year period. Wherever possible, we've provided links to the most specific information about each program available online, most of which include contact information for government representatives who can help answer

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questions.

United States

State/Territory	Program	Incentive	Notes	Agency
Alabama	Alabama Film Incentive	Rebates on 35% of Alabama labor, 25% of non-payroll expenditures	Total production cost must fall between $500,000 and $20 million	Alabama Film Agency
Arkansas	Arkansas Film Commission	Rebates on 20% of qualifying expenditures, plus 10% for Arkansas labor	Companies must spend $200,000 on the project in a six-month period	Arkansas Film Commission
Colorado	Colorado Film Incentive	Rebates on 20% of Colorado expenditures	Program has limited funding each fiscal year	Colorado Office of Film, Television, Media
Connecticut	Digital Media and Motion Picture Tax Credit	10% to 30% tax credit on Connecticut expenditures	Credits issued on a sliding scale; only >$1 million productions get full 30% credit	Department of Economic and Community Development
Florida	Entertainment Industry Financial Incentive Program	20% to 30% tax credit on expenditures (including wages)	$8 million incentive cap per project	Office of Film & Entertainment
Georgia	Entertainment Industry Investment Act	20% to 30% tax credit	Project must spend minimum $500,000 on qualified Georgia expenditures, entire program has a fiscal year cap of $25 million	Georgia Film, Music & Digital Entertainment Office
Hawaii	Motion Picture, Digital Media, & Film Production Tax Credit	15% to 20% tax credit on Hawaii expenditures	$8 million cap per qualified production	Hawaii Film Office
Louisiana	Digital Interactive Media and Software Development Incentive	35% tax credit on labor, 25% tax credit on expenses	No cap, no minimum requirement, option to take a rebate worth 85% of tax credit	Louisiana Economic Development
Maine	The Maine Attraction Film Incentive	Tax rebate on 12% of Maine resident labor, tax credits on 5% of other production expenses	Minimum qualified expenditure of $75,000, credit cannot exceed taxes owed	Maine Film Office
Michigan	2013 Film and Digital Media Incentive	32% of payroll, 27% of production expenditures	Minimum $100,000 spend required, incentives reduced beginning in 2015	Pure Michigan Film Office
Mississippi	Motion Picture Production Incentive	25% rebate of base investment made in the state, 30% of resident payroll	$50,000 minimum spend to qualify, $8 million rebate cap per project	Mississippi Department of Revenue
New Jersey	Edison Innovation Digital Media Tax Credit Program	20% tax credit for payroll and production expenses	Minimum $2 million of qualified expenditures, half of which are NJ resident salaries, must create and maintain 10 new full-time jobs with minimum $65,000 salary	New Jersey Motion Picture & Television Commission
New Mexico	NM Refundable Film Production Tax Credit	25% tax credit on labor and qualifying expenditures	No minimum spend requirement, claims to be submitted annually	New Mexico Film Office
North Carolina	Digital Media Credit	15% of wages, 20% on research expenses paid to NC schools	Minimum $50,000 spend to qualify; $7.5 million cap on credits received	North Carolina Department of Commerce
Ohio	Ohio Motion Picture Tax Credit	35% tax credit for resident wages, 25% for other expenditures	Minimum $300,000 Ohio spend to qualify	Ohio Film Office
Puerto Rico	Puerto Rico Production Tax Credit	40% tax credit on wages, production costs	Minimum spend of $100,000	Puerto Rico Film Commission

	Program			
Rhode Island	Motion Picture Tax Credit	25% tax credit on wages, production costs	Minimum spend of $100,000, $5 million cap on credit	Rhode Island Film and TV Office
Texas	Moving Image Industry Incentive Program	Up to 17.5% of wages and expenses	No cap on amount, $100,000 minimum spend required	Texas Film Commission
Utah	Motion Picture Incentive Program	Up to 20% tax credit on payroll and in-state spending	$6.8 million annual incentive cap for the program	Utah Film Commission
Virginia	Virginia Motion Picture Production Tax Credit	Up to 20% tax credit for wages and expense, plus up to an extra 20% on wages if eligible spending tops $1 million	Minimum $250,000 in-state spending to qualify	Virginia Film Office
Wisconsin	Wisconsin Film Tax Credit	25% wages and expenses	Wages for first three years of development must top $100,000	Department of Tourism

Canada

Province	Program	Incentive	Notes	Agency
British Columbia	BC Interactive Digital Media Tax Credit	17.5% of qualified BC labor	Minimum cost restrictions apply	Ministry of Finance
Manitoba	Manitoba Interactive Digital Media Tax Credit	40% of eligible labor	Max credit of $500,000 per project	Manitoba Innovation, Energy, and Mines
New Brunswick	NB Digital Media Development Program	30% of eligible labor	Max rebate of $15,000 per employee, $500,0000 rebate per year	New Brunswick Department of Economic Development
Nova Scotia	NS Digital Media Tax Credit	Lesser of 50% of eligible labor or 25% of total Nova Scotia expenditures (with bonuses for development outside Halifax)	Set to expire Dec. 31, 2013	Nova Scotia Department of Finance
Ontario	Ontario Interactive Digital Media Tax Credit (OIDMTC)	40% of eligible labor and eligible marketing/distribution costs	Max marketing/distribution credit of $100,000 per project	Ontario Media Development Corporation
Prince Edward Island	PEI Video Game Labour Rebate	30% of eligible labor	Rebates payable on a quarterly basis	Innovation PEI
Quebec	Quebec Tax Credit for the Production of Multimedia Titles	Up to 37.5% of eligible labor	Credits can be used for individual titles or overall activity	Invest Quebec

The Texas Experience

- Texas Moving Image Industry Incentive Program
- Texas Incentives Lure Video Game Companies
- Tax Breaks for Game Makers = Epic Fail

http://gov.texas.gov/film/

Texas Moving Image Industry Incentive Program

The Texas Moving Image Industry Incentive Program (TMIIIP) is designed to build the economy through the moving image industry and create jobs in Texas. TMIIIP provides qualifying film, television, commercial, visual effects and video game productions the opportunity to receive a cash grant based on a percentage of a project's eligible Texas expenditures, including eligible wages paid to Texas residents. Grants vary by budget levels and types of productions, and are issued upon completion of a review of the project's Texas expenditures. This incentive program is in addition to Texas' Sales Tax Exemptions.

If you are interested in the incentive program please contact a member of the incentives team for further information at 512-463-9200.

FILM & TELEVISION PROJECTS »

Base Incentive Rate	5% - 20%
*Underutilized or Economically Distressed Areas Incentive	Additional 2.5%
Minimum In-state Spend	5% for $250,000 - $1 million 10% for $1 million - $3.5 million 20% for $3.5 million+
Qualifying Expenses	Wages, Invoices and Petty Cash
Per Project Cap	None
Qualified Labor	First $1 million of each Texas Resident
Program Qualifications	70% of paid crew and 70% of paid cast members, including extras, must be Texas Residents 60% of total production days must be completed in Texas

- Feature Films
- Documentaries
- Episodic Television Series
- Television Episodes
- Television Movies
- Miniseries
- Interstitial Television Programming
- Nationally Syndicated Talk Show
- *For Reality Television see separate section below.*

Program Overview

- Texas spending can include eligible pre-production, production and post-production expenditures.

COMMERCIALS »

Base Incentive Rate	5% - 10%
*Underutilized or Economically Distressed Areas Incentive	Additional 2.5%
Minimum In-state Spend	5% for $100,000 - $1 million 10% for $1 million+
Qualifying Expenses	Wages, Invoices and Petty Cash
Per Project Cap	None
Qualified Labor	First $1 million of each Texas Resident
Program Qualifications	70% of combined paid crew and cast, including extras, must be Texas Residents 60% of total shooting days must be completed in Texas

- National Commercials
- Regional Commercials
- Series of Commercials
- Infomercials
- Interstitial Advertising
- Music Videos
- Educational Videos
- Instructional Videos

Program Overview

- Texas spending can include eligible pre-production, production and post-production expenditures.

VIDEO GAME PROJECTS »

Base Incentive Rate	5% - 20%
*Underutilized or Economically Distressed Areas Incentive	Additional 2.5%
Minimum In-state Spend	5% for $100,000 - $1 million 10% for $1 million - $3.5 million 20% for $3.5 million+
Qualifying Expenses	Wages, Invoices and Petty Cash
Per Project Cap	None
Qualified Labor	First $1 million of each Texas Resident
Program Qualifications	70% of paid employees must be Texas Residents 60% of total production days must be completed in Texas

- Computer
- Mobile Electronic Device
- Browser or Web Based Console
- Console Handheld Console

- Stand-Alone Arcade

Program Overview

- No cap on incentive amount.

REALITY TELEVISION »

Base Incentive Rate	5% - 10%
*Underutilized or Economically Distressed Areas Incentive	Additional 2.5%
Minimum In-state Spend	5% for $250,000 - $1 million 10% for $1 million+
Qualifying Expenses	Wages, Invoices and Petty Cash
Per Project Cap	None
Qualified Labor	First $1 million of each Texas Resident
Program Qualifications	70% of combined paid crew and cast, including extras, must be Texas Residents 60% of total shooting days must be completed in Texas

- Nationally Syndicated Reality Series
- Nationally Syndicated Talk Shows
- Nationally Syndicated Contest or Game Shows

Program Overview

- Texas spending can include eligible pre-production, production and post-production expenditures.

VISUAL EFFECTS »

Project Type	Film & Television	Commercials
Base Incentive Rate	5% - 20%	5% - 10%
*Underutilized or Economically Distressed Areas Incentive	Additional 2.5%	Additional 2.5%
Minimum In-state Spend	5% for $250,000 - $1 million 10% for $1 million - $3.5 million 20% for $3.5 million+	5% for $100,000 - $1 million 10% for $1 million+
Qualifying Expenses	Wages, Invoices and Petty Cash	
Per Project Cap	None	
Qualified Labor	First $1 million of each Texas Resident	
Program Qualifications	70% of total paid crew and cast, including extras, must be Texas Residents 60% of total production days must be completed in Texas	

- VFX Projects completed for Feature Films
- VFX Projects completed for Television
- VFX Projects completed for Commercials

Program Overview

- Incentive rates are based on the type of project and projects must adhere to required threshold qualifications.
- Texas spending can include eligible pre-production, production and post-production expenditures.

Texas Film Commission • Office of the Governor, Economic Development and Tourism
P.O. Box 13246 • Austin, Texas 78711 • (512) 463-9200 • (512) 463-4114 fax

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THE TEXAS TRIBUNE

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Texas Incentives Lure Video Game Companies

by Edgar Walters | Oct. 4, 2013 | 8 Comments

Enlarge Photo by Callie Richmond

Employees play games during their lunch break at Twisted Pixel, a video game company in Austin. Texas is second in the nation for video game industry employment and promoting further growth with incentives and training.

In the lobby of the Twisted Pixel Games studio in Austin, a futuristic motorcycle welcomes visitors with an electric blue glow. The robotic motorcycle stars in LocoCycle, a new video game produced almost entirely in Texas.

If Twisted Pixel plays its cards right, Texas could reimburse the company for up to 15 percent of in-state expenses on the project.

The state — ranked second in the nation in video game employment, with roughly 5,000 residents working in the industry — is not content to hold steady. With the industry

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THEMOST

already spending millions in the state, lawmakers see video game companies as an important component of economic growth. Last month, the Texas Film Commission expanded its incentive program to attract video game makers.

The state's incentive program, which industry officials say is among the largest in the nation, offers cash grants to film, television and video game productions for wages paid to Texas residents, along with other spending in the state. Legislators allocated $95 million to the program for 2014-15, up from $32 million in 2012-13.

Video game companies that spend at least $3.5 million in Texas can now apply for a 20 percent base reimbursement from the commission, plus a sales tax exemption on production equipment. Previously, the maximum base reimbursement rate was 15 percent, and companies had to spend at least $5 million to qualify. Although the state would not disclose specific figures on how much the video game industry brings in, companies that received incentives from the film commission in 2012 spent $52.5 million in the state.

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"As our games get bigger, there's the ability to get more back from the state," said Chieu Phan, finance manager for Twisted Pixel, which has received $67,922 in grants for three projects since 2010.

Josh Havens, a spokesman for Gov. Rick Perry, said in an email that unlike programs in other states, the one in Texas "focuses on keeping money in the state by providing grants to qualified projects for Texas wages paid and in-state spending."

Twisted Pixel relocated from Indiana in 2008 because of the Austin Chamber of Commerce's efforts to lure the company, Phan said.

"They talked about the film incentives program, and that was one of the reasons why Twisted Pixel chose Austin, not to mention the food locales" she said.

Another reason, Phan said, was Texas' reputation as a hotbed for talent.

According to the Entertainment Software Association, which represents American video game companies, Texas is home to 24 colleges and universities that offer video-game-related courses and programs. More are on the way, including a University of Texas at Austin post-baccalaureate program that will enroll students in 2014.

Another, the Southern Methodist University Guildhall graduate program, has existed since 2003. Gary Brubaker, its director, said the program began after game developers told the school that they "have a harder time finding good quality talent than getting capital or investors." He said Texas' incentives for video game companies were often better than those for oil and gas companies.

Critics say the grants are unnecessarily generous state subsidies. "That cash grant no doubt exceeds what the company would have paid on the sales tax," said Greg LeRoy, executive director of Good Jobs First, a Washington group that promotes corporate and government accountability in economic development.

Calvin Johnson, a tax law professor at the University of Texas at Austin, said video game companies also received significant federal tax benefits. He said a set of deductions and another research and development credit made the video game industry the most heavily subsidized in the country.

"This is corporate welfare, making the rich richer," Johnson said.

Proponents argue that the incentive money is crucial to keeping Texas competitive in the industry. When Texas first extended its incentive program to include video games, it was among the first states to do so. Now more than 20 states offer similar programs.

"We don't have to be here in Austin, Texas," Phan said. "We can be anywhere else."

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Tax Breaks for Game Makers = EPIC FAIL

Alexis Garcia | May. 6, 2014 5:01 pm

"Video games are the most heavily subsidized industry in America," says Calvin H. Johnson, professor of law at the University of Texas at Austin. "Tax ordinarily reduces your return by a third and this is an industry which instead of paying tax on a third of their profits *doubles* their profits. That is weird."

Last year, video game companies earned over $20 billion in revenue last year in the U.S.—and with expansion into mobile and tablet devices those profits are expected to grow. The promise of a consistent multi-billion dollar revenue stream makes gaming an alluring industry for cash-strapped states who are hungry to get a piece of the action.

Many states have gone so far as to offer generous tax incentives to companies willing to set up shop within their borders. Texas is leading the way in this approach and is aggressively targeting gaming companies with sweetheart tax deals.

Under the Texas Moving Image Industry Incentive Program, the Lone Star state has set aside $95 million in funds over the next two years toward grants for both filmmakers and

developers—making it the largest incentive program in the nation. And so far it seems to be working. Texas is now only second to California when it comes to video game employment.

But are these subsidies creating enough economic growth to justify their cost? Johnson, who specializes in tax law, thinks that video game makers are enjoying a tax deal that's too good to be true.

"If you're going to double the rate of return for federal subsidies then you really ought to have a good justification that the public is getting a benefit equal to that incredibly intense incentive," Johnson states. "And I must admit, I'm not convinced that the unemployed son spending 17 hours in the basement of his mother's house working on his Doom 3 is making a grand contribution."

The New York Times points out that tax breaks for video games are historically rooted in credits for research and development that were established in the mid-1950s to encourage investment in innovation. In 1969—three years before the first home video games were commercially released—Congress expanded the tax credit to include software development. Another research and design credit was added in 1981 to keep America's auto industry competitive with Japan.

Because of the uniqueness of the video game industry, which extends across the realms of entertainment, online retail, and software development, gaming companies can combine these tax breaks in ways other entertainment businesses cannot.

In addition to these federal breaks, supporters of state incentive programs say these subsidies are necessary to keep America competitive in the global economy. They argue that without them, gaming jobs could be outsourced to nations with friendlier corporate tax rates. (The U.S. corporate tax rate is currently the highest in the world.)

But several studies have called into question the effectiveness of these programs—a 2013 analysis done by the Tax Foundation found that film tax incentives only generate 30 cents in tax revenue for every dollar spent. And though Texas is strengthening their gaming and film incentives, more states —like Kansas, Missouri, and Connecticut—are scaling back or eliminating their programs altogether.

Johnson welcomes the contraction as he feels that these subsidies benefit the gaming industry at the expense of other businesses. He argues that over-subsidizing video game companies could not only be harming overall economic growth, but innovation in game design that these credits are intended to encourage.

"There isn't any reason we should double the rate of return for those gamers because you're subsidizing games that people don't really want that much. You're wasting stuff because things are twice as cheap and they ought to be twice as profitable. The market ought to decide these things."

About 5 minutes.

Produced by Alexis Garcia. Camera by Paul Detrick.

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Virtual Reality and Games

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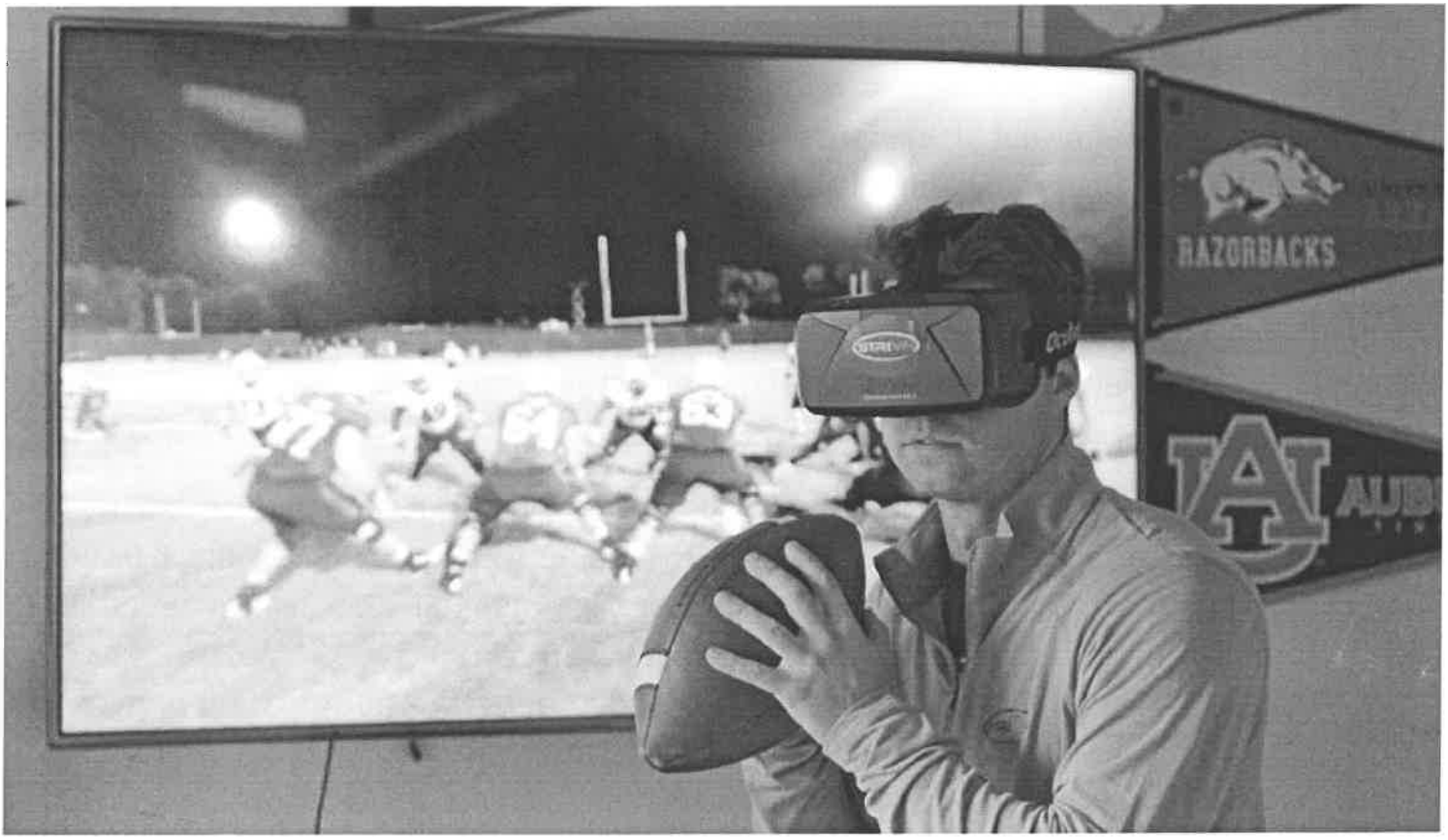
TECH VIRTUAL REALITY

Here's why NFL teams are training in virtual reality

by John Gaudiosi @JohnGaudiosi AUGUST 10, 2015, 4:31 PM EDT



StriVR technology brings every position on the football field to life through 360-degree video
StriVR

Four NFL teams are using startup StriVR's 360-degree VR technology in training camp.

What do the San Francisco 49ers, Arizona Cardinals, Minnesota Vikings, and Dallas Cowboys have in common?

All four NFL teams are using 360-degree virtual reality from startup StriVR Labs to help players and coaches analyze plays on the field.

StriVR's VR technology, designed by former Stanford kicker Derek Belch of StriVR Labs, uses 360-degree high definition video capture of each position on the football field and every play on both offense and defense for each team it works with.

Unlike Eon Sports VR's Sidekiq, which uses 3D video game-style graphics to teach players, StriVR focuses on 360-degree video for a reason.

"All of the research coming out of Stanford's VR Lab is that the human gait is incredibly important in how our brain perceives something," Belch says. "It's imperative for the high-speed, fast decision-making athletes to see natural gaits of other players in VR. Even if you're looking at a good video game, the avatars are not going to move like real people, so your brain will tune out. It will have a cool factor, but not a presence factor there." Belch wrote his master's thesis on virtual reality as a training tool while he was an assistant football coach at Stanford.

Stanford quarterback Kevin Hogan had the three best games of his career after using the VR technology in 2013. After seeing those types of positive results with the Stanford football team, Belch founded his startup in January 2014 and sold the concept to college football programs at Clemson, Auburn, Arkansas, Dartmouth, and Vanderbilt.

This year, Belch took StriVR to the NFL. Once the Cowboys started raving about the technology, additional NFL teams signed on. And Belch expects to add more college and pro teams to his list of clients.

The Cowboys, which signed a two-year deal with StriVR, have built a soundproof room in their video department for coaches and players to use the technology. Head coach Jason Garrett says that StriVR allows him to get closer to all 22 players so he can see details like where they have their feet, where their eyes are looking, and hand placement. Ultimately, being closer than the traditional video wideshot allows coaches to coach better.

"VR is going to be a tool that is going to be helpful for us as we go forward," Garrett says.

Belch says VR is helping both college and NFL teams safely prepare players for games without requiring them to be on the field where they risk injury, as well as having to deal with intense summer heat. Both college football and the NFL have strict rules and restrictions on how much time can be spent on the field, so virtual reality allows players to simulate being there from the comfort of an air-conditioned room.

While Belch believes VR can help every player on the field improve their mental timing and performance, Cowboys quarterback Brandon Wheedon finds StriVR invaluable because it provides him reps that he doesn't get as a backup.

There's also a rewind option that allows players to rewatch plays again and again. Coaches can even see what the player is seeing and speak to them through the VR headphones. It's because of this type of personalized instruction that down the line, Belch believes VR may replace film watching completely.

StriVR currently runs on the Oculus Rift, but Belch expects the technology to expand to HTC Vive and other VR platforms in the future.

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USC

Institute for Creative Technologies

Medical Virtual Reality

Research Lead: Albert "Skip" Rizzo
Website: medvr.ict.usc.edu

Download a PDF overview.

The MedVR Lab at the University of Southern California Institute for Creative Technologies is devoted to the study and advancement of uses of virtual reality (VR) simulation technology for clinical purposes. In diverse fields including psychology, medicine, neuroscience and physical and occupational therapy, the ICT MedVR Lab explores and evaluates areas where VR can add value over traditional assessment and intervention approaches. Areas of specialization are in using VR for mental health therapy, motor skills rehabilitation, cognitive assessment and clinical skills training.

Mental and Behavioral Health
The current goal of the MedVR Mental Health Lab is to continue developing the use of advanced technologies in the discipline of psychology, more specifically to the assessment, training and treatment of stress-related disorders. In addition to further developing applications that can be used in assessment, training and treatment, we are expanding into various areas of neuroscience, incorporating measures of allostatic load into our work with resilience and PTSD.

Game Based Rehabilitation
Virtual reality (VR) technology can be used effectively to improve performance and participation for persons receiving rehabilitation services. Our User Centered Design approach combines customized, flexible VR software with low-cost commercially available devices to deliver comprehensive, evidence-based rehabilitation training approaches for hospital, clinic, and community-based settings in a variety of client populations.

Neurocognitive Assessment and Training
Virtual environments provide standardized, safe and yet flexible platforms for neuropsychological assessment and training. Users can be exposed to complex multimodal stimuli within immersive virtual worlds to help clinicians assessing and rehabilitating cognitive functions in civilian and military populations. The USC ICT's MedVR group focuses on the design, development and validation of such virtual environments for individuals with stroke, traumatic brain injury and similar neurological disorders. We place a strong emphasize on grounding our work in clinical and scientific methodology while integrating cognitive, motor and mental functions across our projects in an interdisciplinary team of researchers.

Virtual Humans

Virtual humans have become an important component of many virtual reality applications as they provide for believable and more natural interactions than traditional interfaces afford. MedVR's virtual humans are built upon a broad set of technologies developed over the past decade at ICT. Virtual humans enable applications such as virtual guides for medical information outreach, simulated standardized patients for medical training, and personalized coaches for rehabilitation and wellness. To this end, the MedVR virtual human team has been pioneering the development of an architecture and set of tools that enable research workgroups and non-programmers to design and build virtual characters to solve their application goals.

USC Institute for Creative Technologies

ARL

Medical Virtual Reality

The ICT MedVR Lab explores and evaluates areas where VR can add value over traditional assessment and intervention approaches. Areas of specialization are in using VR for mental health therapy, motor skills rehabilitation, cognitive assessment and clinical skills training

SELECTED RESEARCH PROJECTS

SimCoach

SimCoach is a web-based virtual human designed to provide an *anonymous* and *accessible* way to overcome some of the existing resistance to seeking care, to facilitate communication about mental health issues, and to help soldiers, veterans and their families to realize that there are resources available for them. SimCoach can ask a series of questions about the user's symptoms and provides access to relevant resources.

Virtual Iraq/Afghanistan

Virtual Iraq/Afghanistan, delivers virtual reality exposure therapy for treating post-traumatic stress. Currently in use at over 60 clinical sites, including VA hospitals, military bases and university centers the *Virtual Iraq/Afghanistan* exposure therapy approach has been shown to produce a meaningful reduction in PTS symptoms.

Stress Resilience In Virtual Environments (STRIVE)

STRIVE is a pre-deployment approach to understanding and training troops for combat stress. It includes a realistic combat experience portrayed within a virtual reality story and an interaction with an intelligent virtual mentor that can explain how the brain and the body react to stress and present relevant exercises for managing it.

Games for Rehabilitation

ICT's Games for Rehab Lab focuses on the creation of virtual reality and game-based tools that can improve both assessment and training. Current prototypes include *Jewel Mine*, a rehabilitation therapy tool designed to motivate patients with stroke, traumatic brain or spinal cord injuries.

Virtual Patients

This effort builds virtual standardized patient applications for clinician training that integrate models of emotion and personality into the language and state of the character, as well as investigates the use of dramatic interactive narratives involving virtual patients in order to elicit engagement in learning.

At the University of Southern California Institute for Creative Technologies leaders in artificial intelligence, graphics, virtual reality and narrative advance low-cost immersive techniques and technologies to solve problems facing service members, students and society.

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6/2012

Virtual Reality Applications to Address the Wounds of War

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Numerous reports indicate that the incidence of posttraumatic stress disorder (PTSD) in returning Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) military personnel is creating a significant behavioral health care challenge. These findings have served to motivate research on how to better develop and disseminate evidence-based treatments for PTSD. This article details how virtual reality applications are being designed and implemented across various points in the military deployment cycle to prevent, identify, and treat combat-related PTSD in OEF/OIF service members and veterans.

The summarized projects in these areas have been developed at the University of Southern California Institute for Creative Technologies (USC ICT), a US Army University Affiliated Research Center, and will detail efforts to use virtual reality to deliver exposure therapy and provide stress resilience training prior to deploy-

ment. A brief discussion will follow that details work developing and evaluating virtual human agents in the role of virtual patients that represent military personnel for training the next generation of clinical providers. As well, research and development creating virtual humans serving in the role of online health care guides that can be used to support anonymous access to military-relevant behavioral health care information will be discussed.

INTRODUCTION TO CLINICAL VIRTUAL REALITY

The US Department of Defense (DoD) continues to make a significant investment in research and development of virtual reality (VR) technology for a wide range of training applications.[1] This investment, along with rapid advances in the underlying engineering enabling technology, also has supported the development of innovative VR clinical assessment and intervention tools in both the military and civilian sectors. By its nature, VR applications can be designed to simulate naturalistic environments. Within these virtual environments, researchers and clinicians can present ecologically relevant stimuli embedded in a meaningful and familiar simulated context.

VR simulation technology also offers the potential to create systematic human testing, training and treatment environments that allow for the precise control of complex, immersive, dynamic 3-D stimulus presentations, within which sophisticated interaction, behavioral tracking, user response, and performance recording is possible. When combining these assets within the context of functionally relevant, ecologically enhanced VR scenarios, a fundamental advancement emerges in how human assessment and intervention can be addressed in many clinical and research disciplines. VR-based testing, training, and treatment approaches that would be difficult, if not impossible, to deliver using traditional methods are now being developed, taking advantage of the assets available with VR technology.[2]

This unique match between VR technology assets and the needs of various clinical application areas has been recognized by a determined and expanding group of researchers and clinicians who not only understand the potential impact of VR technology, but have also now generated a significant literature that documents the many clinical and research targets where VR can add value over traditional assessment and intervention methods.[2-13]

Virtual reality has now emerged as a promising tool in many domains of clinical care and research.

More specifically, a short list of areas where clinical VR has been usefully applied includes fear reduction in persons with specific phobias;[6,7,14] treatment for PTSD[9-11,15-17] stress management in patients with cancer;[18] acute pain reduction during wound care; physical therapy with burn patients[19] and others undergoing painful procedures;[20] body image disturbances in patients with eating disorders;[12] navigation and spatial training in children and adults with motor impairments;[2,21] functional skill training and motor rehabilitation with patients having central nervous system dysfunction (eg, stroke, traumatic brain injury, spinal cord injury, cerebral palsy, multiple sclerosis, etc);[4,22] and for the assessment and rehabilitation of attention, memory, spatial skills, and other cognitive functions in both clinical and unimpaired populations.[6,13,23]

To do this, VR scientists have constructed virtual airplanes, skyscrapers, spiders, battlefields, social settings, beaches, fantasy worlds, and the mundane (but highly relevant) functional environments of the schoolroom, office, home, street, and supermarket. Emerging research and development also is producing artificially intelligent virtual human patients that are being used to train clinical skills to health professionals[24,25] and to serve as anonymously accessible, online health care guides.[11] Based on these parallel advances in research and technology, VR has now emerged as a promising tool in many domains of clinical care and research.

VIRTUAL REALITY DEFINITIONS AND TECHNOLOGY

Virtual reality has been very generally defined as "... a way for humans to visualize, manipulate, and interact with computers and extremely complex data."[26] From this baseline perspective, VR can be seen as an advanced form of human-computer interface[27] that allows the user to "interact" with computers and digital content in a more natural or sophisticated fashion relative to what is afforded by standard mouse and keyboard input devices.

In some cases, with the aid of specialized VR display devices, users can become "immersed" within a computer-generated simulated environment that changes in a natural/intuitive way with user interaction. VR sensory stimuli can be delivered by using various forms of visual display technology that can present real-time computer graphics and/or photographic images/video along with a variety of other sensory display devices that can present audio, "force-feedback" touch sensations, and even olfactory content to the user.

However, VR is not defined or limited by any one technological approach or hardware set-up. The creation of an engaged VR user experience can be accomplished using combinations of a wide variety of interaction devices, sensory display systems, and in the design of content presented in a computer-generated graphic world.

For example, "Immersive VR" can be produced by combining computers, head-mounted displays (HMDs), body tracking sensors, specialized interface devices, and real-time graphics to immerse a participant in a computer-generated simulated world that changes in a natural way with head and body motion. Thus, an engaged immersive virtual experience can be supported by employing specialized tracking technology that senses the user's position and movement and uses that information to update the sensory stimuli presented to the user to create the illusion of being immersed "in" a virtual space where they can interact.

One common configuration employs a combination of an HMD and head tracking system that allows delivery of real-time computer-generated images and sounds of a simulated virtual scene rendered in relationship to user movements that correspond to what the individual would see, hear, and feel if the scene were real. In these immersive systems, one of the key aims is to perceptually replace the outside world with that of the simulated environment to create a specific user experience.

Immersive HMD VR has been most commonly employed in applications where a controlled stimulus environment is desirable for constraining a user's perceptual experience within a specific synthetic world. This format has been often used in clinical VR applications for anxiety disorder exposure therapy, analgesic distraction for patients suffering from acutely painful medical procedures, and in the cognitive assessment of users with central nervous system dysfunction to measure performance under a range of systematically delivered task challenges and distractions.

By contrast, "non-immersive VR" is commonly experienced using modern computer and console games systems (as well as in non-game research lab generated systems). This format presents a 3-D graphic environment on a flat screen monitor, projection system, or television (no real world occlusion) within which the user can navigate and interact.

Virtual reality exposure therapy offers a way to circumvent the patient's natural avoidance tendency.

Albeit delivered on a less immersive display, such graphic worlds are still essentially a VR environment, presented on these widely available commodity display systems have the capacity to provide the user with significant options for interaction with dynamic digital content using traditional computer and game interface devices (eg, keyboard, mouse, game pads, joysticks, etc). This is in addition to more complex interaction devices that can track more natural user activity (eg, data gloves, 3-D mice, treadmills and some high-end "force feedback" exoskeleton devices).

Recently, off-the-shelf systems, such as the Microsoft Kinect, are now being shown to provide a novel way for users to interact with virtual environments (VEs) using natural body interaction via low-cost 3-D camera-based sensing of full body movement.[28]

This article will illustrate how VR has been used to enhance the delivery of prolonged exposure therapy, provide stress resilience training, and to enhance clinical interactions with virtual human representations.

VIRTUAL REALITY PROLONGED EXPOSURE FOR PTSD

Among the many approaches that have been used to treat persons with PTSD, prolonged exposure (PE) therapy appears to have the best-documented therapeutic efficacy.[17,29-31] Such treatment typically involves the graded and repeated imaginal reliving and narrative recounting of the traumatic event within the therapeutic setting. This approach is believed to provide a low-threat context where the client can begin to confront and therapeutically process the emotions that are relevant to a traumatic event as well as decondition the learning cycle of the disorder via a habituation/extinction process.

While the efficacy of imaginal exposure has been established in multiple studies with diverse trauma populations,[17,32,33] many patients are unwilling or unable to effectively visualize the traumatic event. In fact, avoidance of reminders of the trauma is inherent in PTSD and is one of the cardinal symptoms of the disorder.

Virtual Reality Exposure Therapy

To address this problem, researchers have recently turned to the use of VR to deliver exposure therapy (VRET) by immersing users in simulations of trauma-relevant environments in which the emotional intensity of the scenes can be precisely controlled by the clinician, in collaboration with the patients' wishes. In this fashion, VRET offers a way to circumvent the patient's natural avoidance tendency by directly delivering multi-sensory and context-relevant cues that aid in the confrontation and processing of traumatic memories, without demand-

ing that the patient actively try to access his/her experience through effortful memory retrieval.

Within a VR environment, the hidden world of the patient's imagination is not exclusively relied upon and VRET may also offer an appealing treatment option that is perceived with less stigma by "digital generation" service members (SMs) and veterans who may be more reluctant to seek out what they perceive as traditional talk therapies. These ideas have been supported by three reports in which patients with PTSD were unresponsive to previous imaginal exposure treatments, but went on to respond successfully to VRET.[15-17] As well, VR provides an objective and consistent format for documenting the sensory stimuli that the patient is exposed to that is not possible when operating within the unseen world of the patient's imagination.

Virtual Iraq/Afghanistan

Based on this rationale and previous research, the USC ICT developed a "Virtual Iraq/Afghanistan" simulation that is being used in a variety of clinical trials to investigate the potential for this form of treatment. The treatment environment consists of a series of virtual scenarios designed to represent relevant contexts for VRET, including city and desert road environments. In addition to the visual stimuli presented in the VR HMD, directional 3-D audio, vibro-tactile, and olfactory stimuli of relevance can be delivered. Stimulus presentation is controlled by the clinician via a separate "Wizard of Oz" (where the subject interacts with what he or she believes to be an autonomous program, but one that is instead operated by an unseen person) interface, with the clinician in full audio contact with the patient. The design of the system was enhanced by feedback derived from user-centered tests with the application that were conducted at Fort Lewis, Washington, and within an Army Combat Stress Control Team in Iraq.[34]

This feedback from nondiagnosed personnel provided information on the content and usability of our application that fed an iterative design process leading to the creation of the current clinical scenarios. A detailed description of the Virtual Iraq/Afghanistan system and the methodology for a standard VRET clinical protocol can be found elsewhere.[35]

Initial clinical tests of the system have produced promising results. In the first open clinical trial, analyses of 20 active duty treatment completers (19 male, 1 female, mean age = 28 years; age range: 21 to 51 years) produced positive clinical outcomes.[9] For this sample, mean pre/post PTSD military checklist (PCL-M)[36] scores decreased in a statistical and clinically meaningful fashion: 54.4 (SD = 9.7) to 35.6 (SD = 17.4). Paired pre/post *t*-test analysis showed these differences to be significant ($t = 5.99$, df = 19, $P < .001$).

Correcting for the PCL-M, no-symptom baseline of 17 indicated a greater than 50% decrease in symptoms; 16 of the 20 completers no longer met PCL-M criteria for PTSD at post-treatment follow-up. Five participants in this group with PTSD diagnoses had pre-treatment baseline scores below the conservative cutoff value of 50 (pre-scores = 49, 46, 42, 36, 38) and reported decreased values at post treatment (post-scores = 23, 19, 22, 22, 24, respectively). Mean Beck Anxiety Inventory[37] scores significantly decreased 33% from 18.6 (SD = 9.5) to 11.9 (SD = 13.6), ($t = 3.37$, df=19, $P < .003$) and mean PHQ-9[38] (depression) scores decreased 49% from 13.3 (SD = 5.4) to 7.1 (SD = 6.7), ($t = 3.68$, df = 19, $P < .002$).

The average number of sessions for this sample was just less than 11. Positive results from uncontrolled open trials are difficult to generalize from and we have been cautious not to make excessive claims based on these early results. However, using an accepted military-relevant diagnostic screening measure (PCL-M), 80% of the treatment completers in the initial VRET sample showed both statistically and clinically meaningful reductions in PTSD, anxiety and depression symptoms, and anecdotal evidence from patient reports suggested that they saw improvements in their everyday life. These improvements were also maintained at 3-month post-treatment follow-up.

Additional VRET Studies

Other studies also have reported positive outcomes. Two early case studies reported positive results using this system.[39,40] Following those, another open clinical trial with active duty soldiers (n=24) produced significant pre/post reductions in PCL-M scores and a large treatment effect size (Cohen's d = 1.17).[41] After an average of seven sessions, 45% of those treated no longer screened positive for PTSD and 62% had reliably improved.

In a small preliminary quasi-randomized controlled trial,[42] seven of 10 participants with PTSD showed a 30% or greater improvement with VR, whereas only one of nine participants in a "treatment as usual" group showed similar improvement. The results are limited by small size, lack of blinding, a single therapist, and comparison to a set relatively uncontrolled usual care conditions, but it did add to the incremental evidence suggesting VR to be a safe and effective treatment for combat-related PTSD.

At the 2012 American Psychiatric Association annual meeting, McLay[43] presented data from a comparison of VRET with the traditional, evidence-based prolonged exposure approach in

active duty SMs. The results showed significantly better maintenance of positive treatment outcomes at 3-month follow-up for Virtual Iraq/Afghanistan system compared with traditional PE.[43] The overall trend of these positive findings (in the absence of any reports of negative findings) is encouraging for the view that VRET is safe and may be an effective approach for delivering an evidence-based treatment (prolonged exposure) for PTSD.

Four randomized controlled trials (RCTs) are ongoing with the Virtual Iraq/Afghanistan system with active duty and veteran populations. Two RCTs are focusing on comparisons of treatment efficacy between VRET and PE,[41,44] and another is testing VRET compared with VRET and a supplemental care approach.[45]

A fourth RCT[46] is investigating the additive value of supplementing VRET and imaginal PE with a cognitive enhancer called D-Cycloserine (DCS). DCS, an N-methyl-d-aspartate partial agonist, has been shown to facilitate extinction learning in laboratory animals when infused bilaterally within the amygdala prior to extinction training.[47] The first clinical test in humans that combined orally administered DCS with VRET was performed by Ressler et al[48] with participants diagnosed with acrophobia ($n = 28$). Participants who received DCS plus VRET experienced significant decreases in fear within the virtual environment at 1 week and at 3 months post-treatment, and reported significantly more improvement than the placebo group in their overall acrophobic symptoms at 3-month follow-up.

The DCS group also achieved lower scores on a psychophysiological measure of anxiety than the placebo group. The current multi-site PTSD RCT (National Intrepid Center of Excellence, Cornell-Weill, and the Long Beach Veterans Affairs Medical Center) is testing the effect of DCS vs. placebo when added to VRET and PE with active duty and veteran samples ($n = 300$). DoD funding support for these RCTs underscore the interest that the DOD/Veterans Affairs (VA) has in exploring this innovative approach for delivering exposure therapy using VR.

Evidence-Based Nature of VRET

While RCTs are the gold standard for emerging treatment approaches to gain wide acceptance by the scientific community, it should be noted that at its core, the therapeutic model/principle that underlies VRET (cognitive-behavior therapy [CBT] with exposure) is in fact evidence-based. VRET is simply the delivery of this evidence-based treatment in a format that may serve to engage a wider range of patients in the necessary confrontation and processing of traumatic memories or "fear-structures"[49] needed for positive clinical outcomes. Thus, even equivalent positive results with PE in these RCTs would validate its use as another safe and evidence-based therapeutic option.

The VRET approach also could serve to draw SMs and veterans into treatment, many of whom have grown up "digital" and may be more likely to seek care in this format compared with what they perceive as traditional talk therapy. This is important since numerous reports from both military and civilian blue ribbon panels underscore the importance of breaking down "barriers to care" for improving the awareness, availability, accessibility, and acceptance of behavioral health care in the military,[50] Institute of Medicine,[30,31] Dole-Shalala Commission Report,[51] the Rand Report,[52] and American Psychological Association.[53]

VIRTUAL REALITY RESILIENCE TRAINING

Resilience is the dynamic process by which individuals exhibit positive adaptation when they encounter significant adversity, trauma, tragedy, threats, or other sources of stress.[54] The core aim of resilience training is to promote psychological fitness and better prepare service members for the psychological stressors that they may experience during a combat deployment. There is a powerful rationale for developing methods that promote SM resilience and psychological fitness prior to a combat deployment.

Shift in Military Policy

The current urgency to address the psychological wounds of war in SMs and veterans also has driven an emerging focus within the military on emphasizing a proactive approach for better preparing service members for the emotional challenges they may face during a combat deployment to reduce the potential for later adverse psychological reactions such as PTSD and depression. This focus on resilience training prior to deployment represents no less than a quantum shift in military culture and can now be seen emanating from the highest levels of command in the military. For example, in an *American Psychologist* article, Army General George Casey[55] states that "... soldiers can 'be' better before deploying to combat so they will not have to 'get' better after they return." He then calls for a shift in the military "... to a culture in which psychological fitness is recognized as every bit as important as physical fitness."

Connection between Thinking and Feeling

This level of endorsement can be seen in practice by way of the significant funding and resources applied to a variety of resilience training programs across all branches of the US military.[56-58] Perhaps the program that is attempting to influence the largest number of service members is the Comprehensive Soldier Fitness (CSF)

program.[58] This project has created and disseminated training that aims to improve emotional coping skills and ultimate resilience across all Army SMs. One element of this program draws input from principles of cognitive-behavioral science, which generally advances the view that it is not the event that causes an emotion, but rather how a person appraises the event (based on how they think about the event) that leads to the emotion.[59]

From this theoretical base, it then follows that internal thinking or appraisals about combat events can be "taught" in a way that leads to more healthy and resilient reactions to stress. This approach does not imply that people with effective coping skills do not feel some level of "rational" emotional pain when confronted with an event that would be challenging emotionally and mentally to any individual. Instead, the aim is to teach skills that may assist soldiers to cope with traumatic stressors more successfully.

The core motive with such efforts is to provide resilience training that would promote psychological fitness and reduce the later incidence of PTSD and other psychological health conditions upon redeployment home (eg, depression, suicide, substance use). A recent study on the CFS program reported results from a longitudinal study over 18 months with 22,000 soldiers indicating positive outcomes,[60] but this report has been criticized for its exclusive reliance on self-report data and on other methodological grounds.[61] Regardless of those academic "battles," the post-deployment psychological health statistics are alarming and provide a compelling justification for continued efforts to better prepare SMs for the onslaught of emotional challenges that they may face during a combat deployment.

'Stress Resilience in Virtual Environments'

Recently, the USC ICT has begun development of the STress Resilience In Virtual Environments (STRIVE) project, which expands on the Virtual Iraq/Afghanistan simulations developed for VRET. The STRIVE project aims to foster stress resilience by creating a set of combat simulations that can be used as contexts for SMs to experientially learn stress reduction tactics and cognitive-behavioral emotional coping strategies prior to deployment.

This approach involves immersing and engaging SMs within a variety of virtual "mission" episodes where they are confronted with emotionally challenging situations that are inherent to the OEF/OIF combat environment. Interaction by SMs within such emotionally challenging scenarios aims to provide a more meaningful context in which to engage with psychoeducational information and to learn and practice stress-reduction tactics and cognitive coping strategies that are believed to better prepare a SM for the psychological challenges that may occur during a combat deployment.

To accomplish this, STRIVE is being designed as a 30-episode interactive narrative in VR, akin to being immersed within a "Band of Brothers" type storyline that spans a typical deployment cycle. Within these episodes, SMs will get to know the distinct personalities of the virtual human characters in their squad and interact within an immersive digital narrative that employs cinematic strategies for enhancing engagement with the evolving storyline (eg, strategic use of narration, montage shots, dynamic camera direction).

At the end of each of the graded 10-minute episodes, an emotionally challenging event occurs, designed in part from feedback provided by SMs undergoing PTSD treatment (eg, seeing/handling human remains, death/injury of a squad member, killing someone, the death/injury of a civilian child). At that point in the episode, the virtual world "freezes in place" and a virtual human "mentor" character emerges from the midst of the chaotic VR scenario to guide the user through stress-reduction psychoeducational and self-management tactics, as well as providing rational restructuring exercises for appraising and processing the virtual experience. The resilience training component is drawing on evidence-based content that has been endorsed as part of standard classroom-delivered DoD stress resilience training programs, as well as content that has been successfully applied in nonmilitary contexts (eg, humanitarian aid worker training, sports psychology).

'Context-Relevant Learning'

In this fashion, STRIVE provides a digital "emotional obstacle course" that can be used as a tool for providing context-relevant learning of emotional coping strategies under very tightly controlled and scripted simulated conditions. Training in this format is hypothesized to improve generalization to real world situations via a state-dependent learning component,[62] and further support resilience by lever-

aging the learning theory process of "latent inhibition," which is defined as delayed learning that occurs as a result of pre-exposure to a stimulus without a consequence.[63,64] Thus, the exposure to a simulated combat context is believed to decrease the likelihood of fear conditioning during the real event.[65]

The STRIVE project also incorporates a novel basic science protocol. While other stress resilience research efforts typically incorporate one or two biomarkers of stress and or resilience, the STRIVE projects will measure what we refer to as the "physiological fingerprint of stress," commonly called allostatic load (AL). The theoretical construct of AL, initially developed by one of the STRIVE collaborators, Bruce McEwen, is a measure of cumulative wear and tear on physiological symptoms due to chronic stress.[54] As a theoretical construct, it is a preliminary attempt to formulate the relationship between environmental stressors and disease, by hypothesizing mechanisms whereby multiple kinds of stressors confer risk simultaneously in multiple physiological systems.

Allostasis, Equilibrium, and Homeostasis

The construct of AL is based on the widely accepted response called allostasis. Sterling and Eyer[66] defined allostasis as the body's set points for various physiological mechanisms, such as blood pressure or heart rate, which vary to meet specific external demands, eg, emotional stress. McEwen and Stellar[54] furthered our understanding of allostasis by broadening its scope. Rather than discuss allostasis in terms of a single set point that changed in response to a stressor, they described allostasis as the combination of all physiological coping mechanisms that are required to maintain equilibrium of the entire system. Thus, allostasis is the reaction and adaptation to stressors by multiple physiological systems that brings the system back to equilibrium.

The related concept of homeostasis refers specifically to system parameters essential for survival.[67] To place AL into the context of allostasis requires the view that allostasis does not always proceed in a normal manner. Any of the major physiological systems (eg, inflammatory, metabolic, immune, neuroendocrine, cardiovascular, respiratory) in the process of responding to stress can exact a cost, or an AL, that can result in some form of physiological or psychological disturbance.

This project represents a direct application development effort while also serving as an "ultimate Skinner Box" for the study of stress reactions.

McEwen[68] identified four types of AL: frequent activation of allostatic systems; a prolonged failure to shut off allostatic activity after stress; a lack of adaptation to stress; and an inadequate response of allostatic systems leading to elevated activity of other, normally counter-regulated allostatic systems after stress (eg, inadequate secretion of glucocorticoid resulting in increased cytokines normally countered by glucocorticoids). Any of these types of AL intervene with the normal stress response of allostasis, thus increasing the negative health impact from stress. This will increase one's risk for disease in the long-term and may preclude the short-term development of physical hardiness and psychological resilience.

In a first study of its kind, the STRIVE project will determine if AL can predict acute response to stress (eg, electroencephalogram, galvanic skin response, electrocardiogram, pupil dilation, etc) when participants are exposed to the stressful simulated VR missions. Further analyses will determine if AL can predict participants' responses to virtual mentor instructions on how the participants can cope with stress through resilience training. If we find that AL is capable of predicting either short-term response to stress or the ability to learn stress resilience, there would be numerous implications for the future use of AL, including identification of leadership profiles and for informing the development of appropriate training systems for all SMs.

Pilot research on this project is ongoing at the Immersive Infantry Training center at Marine Corps Base Camp Pendleton. This project is noteworthy in that it represents a direct application development effort (resilience training) while also serving as an "ultimate Skinner Box" for the scientific study of stress reactions using objective physiological assessment measures.

USE OF 'VIRTUAL HUMANS'

Recent shifts in the social and scientific landscape have now set the stage for the next major movement in clinical VR with the "birth" of intelligent virtual humans. With advances in the enabling technologies allowing the design of ever more believable context-relevant "structural" VR environments (eg, combat scenes, homes, classrooms, offices, markets), the next important challenge will involve populating these environments with virtual human (VH) representations that are capable of fostering believable interaction with real VR users.

This is not to say that representations of human forms have not usefully appeared in previous clinical VR scenarios. In fact, since the mid-1990s, VR applications have routinely employed

VHs to serve as stimulus elements to enhance the realism of a virtual world simply by their static presence. However, seminal research and development has appeared in the creation of highly interactive, artificially intelligent and natural language-capable VH agents that can engage real human users in a credible fashion. No longer at the level of a prop to add context or minimal faux interaction in a virtual world, VH representations can be designed to perceive and act in a 3-D VR world, engage in face-to-face spoken dialogues with real users (and other virtual humans), and in some cases they are capable of exhibiting human-like emotional reactions. Both in appearance and behavior, VHs have now evolved to the point where they can become usable components for a variety of clinical and research applications.

These advances in VH technology have now supported developments for military behavioral health in two key domains: the creation of virtual patients that can be used for training novice clinician care providers in areas that are relevant for working with military populations; and virtual human support agents to serve as online guides for promoting anonymous access to psychological health care information, and for assisting military personnel and family members in breaking down barriers to initiating care.

VIRTUAL PATIENTS VS. HUMAN STANDARDIZED PATIENTS

Since 1963, when Howard Barrows, MD, at the University of Southern California, trained the first human standardized patient,[69] this approach using live actors has long been considered to be the gold standard medical education experience for both learning and evaluation purposes.[70-72] Human standardized patients (HSPs) are paid actors who pretend to be patients for educational interviews and provide the most realistic and challenging experience for those learning the practice of medicine because they most closely approximate a genuine patient encounter. HSPs are also a key component in medical licensing examinations. For example, HSPs are used on the United States Medical Licensing Examination (USMLE) Step 2 Clinical Skills exam, which is mandatory for obtaining medical licensure in the US.

The diversity of clinical conditions that human standardized patients can characterize is limited by human actors and their skills.

HSP encounters engage a number of clinical skill domains, including social, communication, judgment, and diagnostic acumen in a real time setting. All other kinds of practice encounters fall short of this because they either do not force the learner to combine clinical skill domains or they "spoon feed" data to the student with the practice case that turns the learning more into a pattern recognition exercise, rather than a realistic clinical problem-solving experience. The HSP is the only type of encounter where it is up to the learner to naturalistically pose questions to obtain data and information about the case that then needs to be integrated for the formulation of a diagnostic hypothesis and/or treatment plan.

Limitations of Human Standardized Patients

Despite the well-known superiority of HSPs to other instructional methods,[73,74] they are employed sparingly. The reason for this limited use is primarily due to the very high costs to hire, train, and maintain a diverse group of patient actors. Moreover, despite the expense of HSP programs, the standardized patients themselves are typically low-skilled actors and administrators face constant turnover resulting in considerable challenges for maintaining the consistency of diverse patient portrayals for training students. This limits the value of this approach for producing realistic and valid interactions needed for the reliable evaluation and training of novice clinicians. Thus, the diversity of clinical conditions that HSP can characterize is limited by availability of human actors and their skills. HSPs that are hired may provide suboptimal variation control and are limited to healthy appearing adult encounters. This is even a greater problem when the actor needs to be a child, adolescent, elder, person with a disability or in the portrayal of nuanced or complex symptom presentations.

The situation is even more challenging in the training of psychology/social work and other allied health professional students. Rarely are live standardized patients used in such clinical training. Most direct patient interaction skills are acquired via role-playing with supervising clinicians and fellow graduate students, with closely supervised "on-the-job" training providing the brunt of experiential training. While one-way mirrors provide a window for the direct observation of trainees, audio and video recordings are a more common method of providing supervisors with information on the clinical skills of trainees.

However, the imposition of recording has been reported to have demonstrable effects on the therapeuticprocess that may confound the end goal of clinical training[75] and the supervisor review of raw recordings is a time-consuming process that imposes a significant drain on resources.

Virtual Patients

The development and implementation of computer-generated virtual patients (VPs) could address these limitations by providing diverse varieties of digital clinical presentations with a high degree of consistency and sufficient realism.

In this regard, VPs can fulfill the role of human standardized patients by simulating diverse varieties of clinical presentations with a high degree of consistency, and sufficient realism, as well as being always available for anytime-anywhere training. Similar to the compelling case made over the years for clinical VR generally, VP applications can likewise enable the precise stimulus presentation and control (dynamic behavior, conversational dialogue, and interaction) needed for rigorous laboratory research, yet embedded within the context of an ecologically relevant simulated environment.

Virtual Patient with Conduct Disorder

The USC ICT began work in this area in 2007 with an initial project that involved the creation of a VP, named "Justin." Justin portrayed a 16-year-old male with a conduct disorder forced by his family to participate in therapy. The system was designed to allow novice clinicians to practice asking interview questions, to attempt to create a positive therapeutic alliance and to gather clinical information from this very challenging and resistant VP. Justin was designed as a first step in our research.

At the time, the project was unfunded and thus required our lab to take the economically inspired route of recycling a virtual character from a military negotiation-training scenario to play the part of Justin. The research group agreed that this sort of patient was one that could be convincingly created within the limits of the technology (and funding) available to us at the time. For example, such resistant patients typically respond slowly to therapist questions and often use a limited and highly stereotyped vocabulary. This allowed us to create a believable VP within limited resources for dialogue development. As well, novice clinicians have been typically observed to have a difficult time learning the value of "waiting out" periods of silence and nonparticipation with these patients.

We initially collected user interaction and dialogue data from a small sample of psychiatric residents and psychology graduate students as part of our iterative design process to evolve this application area. The project produced a successful proof of concept demonstrator, which then led to the acquisition of funding that currently supports our research in this area.

Sexual Assault Virtual Patient

Following our successful Justin proof of concept, our second VP project involved the creation of a female sexual assault victim, "Justina." The aim of this work was twofold: explore the potential for creating a system for use as a clinical interview trainer for promoting sensitive and effective clinical interviewing skills with a VP that had experienced significant personal trauma; and create a system whereby the dialogue content could be manipulated to create multiple versions of Justina. This was to provide a test of whether novice clinicians would ask the appropriate questions to assess whether Justina met the criteria for the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*) diagnosis of PTSD based on symptoms reported during the clinical interview.

For the PTSD content domain, 459 questions were created that mapped roughly 4-to-1 to a set of 116 responses. The aim was to build an initial language domain corpus generated from subject matter experts and then capture novel questions from a pilot group of users (psychiatry residents) during interviews with Justina. The novel questions that were generated could then be fed into the system to iteratively build the language corpus. We also focused on how well subjects asked questions that covered the six major symptom clusters that can characterize PTSD following a traumatic event.

While this approach did not give the Justina character a lot of depth, it did provide more breadth for PTSD-related responses, which for initial testing seemed prudent for generating a wide variety of questions for the next Justina iteration.

In the initial test, a total of 15 psychiatry residents (six females, nine males; mean age = 29.80 years, SD 3.67) participated in the study and were asked to perform a 15-minute interaction with the VP to take an initial history and determine a preliminary diagnosis based on this brief interaction with the character. The participants were asked to speak normally, as they would to a standardized patient, but were informed that the system was a research prototype that uses an experimental speech recognition system that would sometimes not understand them. They were instructed that they were free to ask any kind of question and the system would try to respond appropriately, but if it did not, they could ask the same question in a different way.

From post-questionnaire ratings on a 7-point Likert scale, the average subject rating for believability of the system was 4.5. Subjects reported their ability to understand the patient at an average of 5.1, but rated the system at 5.3 as frustrating to talk to due to speech recognition problems, out-of-domain answers, or inappropriate responses. However, most of the participants left favorable comments

that they thought this technology will be useful in the future, and that they enjoyed the experience of trying different ways to talk to the character to elicit an relevant response to a complex question.

When the patient responded back appropriately to a question, test subjects informally reported that the experience was very satisfying. Analysis of concordance between user questions and VP response pairs indicated moderate effects sizes for trauma inquiries (r = 0.45), re-experiencing symptoms (r = 0.55), avoidance (r = 0.35), and in the non-PTSD general communication category (r = 0.56), but only small effects were found for arousal/hypervigilance (r = 0.13) and life impact (r = 0.13). These relationships between questions asked by a novice clinician and concordant replies from the VP suggest that a fluid interaction was sometimes present in terms of rapport, discussion of the traumatic event, the experience of intrusive recollections, and discussion related to the issue of avoidance.

Low concordance rates on the arousal and life impact criteria indicated that a larger domain of possible questions and answers for these areas was not adequately modeled in this pilot effort and this is now being addressed in our next generation VH research and development.

We are currently collaborating with the USC School of Social Work, Center for Innovation in Research (CIR), which essentially is a master of social work degree program with an emphasis on military social work. The current project with CIR focuses on the creation of military VPs that will allow social work trainees to gain practical training experiences with VHs that portray behavior more relevant to military culture and common clinical conditions. A sample video of the military VPs being interviewed by a social work trainee (conducting a suicide assessment) can be found at: www.youtube.com/watch?v=CQTEcJJ_RhY.

Follow-on work to these VP projects has been funded to develop a toolkit that allows clinical educators to author VPs for clinical training. One of the aims of the system is to build an interface that allows clinical educators to create a VP with the same ease as creating a Powerpoint presentation. Such VPs, authored by clinical professionals, would then become available to an open source community to broaden the opportunities for diverse clinical training experiences.

The military culture needs to be modified so that mental health services are more accepted and less stigmatized.

ONLINE VIRTUAL HUMAN HEALTH CARE GUIDE

Research suggests that there is an urgent need to reduce the stigma of seeking mental health treatment in SM and veteran populations. One of the more foreboding findings in an early report by Hoge et al[76] was the observation that among Iraq/Afghanistan War veterans, "...those whose responses were positive for a mental disorder, only 23% to 40% sought mental health care. Those whose responses were positive for a mental disorder were twice as likely as those whose responses were negative to report concern about possible stigmatization and other barriers to seeking mental health care."

While US military training methodology has better prepared soldiers for combat in recent years, such hesitancy to seek treatment for difficulties that emerge upon return from combat, especially by those who may need it most, suggests an area of military mental health care that is in need of attention. Moreover, the dissemination of health care information to military SMs, veterans and their significant others is a persistent and growing challenge. Although medical information is increasingly available over the Internet, users can find the process of accessing it to be overwhelming, contradictory and impersonal.

Challenges to Providing Military Mental Health Services

Despite a Herculean effort on the part of the DoD to produce and disseminate behavioral health programs for military personnel and their families, the complexity of the issues involved continue to challenge the best efforts of military mental health care experts, administrators, and providers. Since 2004, numerous blue ribbon panels of experts have attempted to assess the current DoD and VA health care delivery system and provide recommendations for improvement,[50] including the National Academies of Science Institute of Medicine,[30] Dole-Shalala Commission Report,[51] the Rand Report,[52] and the American Psychological Association.[53] Most of these reports cite two major areas in need of improvement:

1) Support for RCTs that test the efficacy of treatment methodologies, leading to wider dissemination of evidenced based approaches.

Figure 1. SimCoach archetypes: retired Sergeant Major, female civilian, female aviator, battle buddy.

2) Identification and implementation of ways to enhance the health care dissemination/delivery system for military personnel and their families in a fashion that provides better awareness and access to care, while reducing the stigma of help-seeking.

For example, the American Psychological Association Presidential Task Force on Military Deployment Services for Youth, Families and Service Members[53] stated in 2007 that they were, "... not able to find any evidence of a well-coordinated or well-disseminated approach to providing behavioral health care to service members and their families." The APA report also went on to describe three primary barriers to military mental health treatment: availability, acceptability, and accessibility. More specifically:

1) Well-trained mental health specialists are not in adequate supply (availability).

2) The military culture needs to be modified so that mental health services are more accepted and less stigmatized.

3) Even if providers were available and seeking treatment was deemed acceptable, appropriate mental health services are often not readily accessible due to a variety of factors (eg, long waiting lists, limited clinic hours, a poor referral process and geographical location).

The overarching goal reported from this and other reports is to provide better awareness and access to existing care while concurrently reducing the complexity and stigma in seeking psychological help. In essence, new methods are needed to reduce such barriers to care.

SimCoach Created to Improve Military Mental Health Service Usage

The SimCoach project aims to address this challenge by supporting users in their efforts to anonymously seek health care information and advice by way of online interaction with an intelligent, interactive, embodied virtual human health care guide. The primary goal of the SimCoach project is to break down barriers to care (eg, stigma, unawareness, complexity) by providing military SM, veterans, and their significant others with confidential help in exploring and accessing health care content and, if needed, for encouraging and supporting the initiation of care with a live provider.

Rather than being a traditional Web portal, SimCoach allow users to initiate and engage in a dialogue about their health care concerns with an interactive VH. Generally, these intelligent graphical characters are designed to use speech, gesture, and emotion to introduce the capabilities of the system, solicit basic anonymous background information about the user's history and clinical/psychosocial concerns, provide advice and support, present the user with relevant online content, and potentially facilitate the process of seeking appropriate care with a live clinical provider.

An implicit motive of the SimCoach project is that of supporting users who are determined to be in need, to make the decision to take the first step toward initiating psychological or medical care with a live provider.

It is not the goal of SimCoach to breakdown all of the barriers to care or to provide diagnostic or therapeutic services that are best delivered by a live clinical provider. Rather, SimCoach was designed to foster comfort and confidence by promoting users' private and anonymous efforts to understand their situations better, to explore available options, and initiate treatment when appropriate. Coordinating this experience is a VH SimCoach, selected by the user from a variety of archetypical character options (see Figure 1), who can answer direct questions and/or guide the user through a sequence of user-specific questions, exercises, and assessments.

This interaction between the VH and the user provides the system with the information needed to guide users to the appropriate next step of engagement with the system or with encouragement to initiate contact with a live provider.

Again, the SimCoach project is not conceived as a replacement for human clinical providers and experts. Instead, SimCoach aims to start the process of engaging the user by providing support and encouragement, increasing awareness of their situation and treatment options, and in assisting individuals who may otherwise be initially uncomfortable talking to a live care provider.

Users can flexibly interact with a SimCoach character by typing text and clicking on character-generated menu options. Since SimCoach was designed to be an easily accessible Web-based application that requires no downloadable software, it was believed that voice recognition was not at a state where it could be reliably used at the start of the project in 2010. The feasibility of providing the option for spoken, natural language dialogue interaction is currently being explored to determine if off-the-shelf voice recognition programs are sufficiently accurate to maintain an engaged interaction between a SimCoach and a user.

The options for a SimCoach's appearance, behavior and dialogue has been designed to maximize user comfort and satisfaction, but also to facilitate fluid and truthful disclosure of clinically relevant information. Focus groups, "Wizard of OZ" studies, and iterative formative tests of the system were employed with a diverse cross section of our targeted user group to create options for SimCoach interaction that would be both engaging and useful for this population's needs. Results from these user tests indicated some key areas that were determined to be important, including user-choice of character archetypes across gender and age ranges, informal dialogue interaction, and interestingly, a preference for characters that were not in uniform.

Also, interspersed within the program are options that allow the user to respond to simple screening instruments, such as the PCL-M that are delivered in a conversational format with results fed back to the user in a supportive fashion. These screening results serve to inform the SimCoach's creation of a model of the user to enhance the reliability and accuracy of the SimCoach output to the user, to support user self-awareness via feedback and to better guide the delivery of relevant information based on this self-report data. Moreover, an enhancement in user engagement with a SimCoach may be produced if a more accurate assessment of the user's needs is derived from this process to inform the relevancy of the interaction.

SIDEBAR

Links to Online Videos Demonstrating Use of Virtual Reality for PTSD

- Approximately 60 videos from the USC Institute for Creative Technologies MedVR Research Group: www.youtube.com/playlist?list=UUQrbzaW3x9wWoZPI4-I4GSA&feature=plcp
- Video of a virtual patient with voice recognition: www.youtube.com/watch?v=CQTEcJJ_RhY

Focus on Privacy Protection

Engagement also is supported by ensuring that the specific health care content that a SimCoach can deliver to users is relevant to persons with a military background (and of course, to their significant others). This was addressed by leveraging content assets that were originally created for established DoD and VA websites specifically designed to address the needs of this user group (eg, after deployment, Military OneSource, National Center for PTSD). Our early research with this user group indicated a hesitancy to directly access these sites when users sought behavioral health information with a common complaint being that there was a fear that their use of those sites may be monitored and might jeopardize advancement in their military careers or later applications for disability benefits.

Despite significant efforts by the DoD and VA to dispel the idea that user tracking was employed on these sites, the prevailing suspicion led many of the users in our samples to conduct such health care queries using Google, Yahoo and Medscape. To address this user concern, supplemental content presented by the SimCoach (eg, video, self-assessment questionnaires, resource links) are typically "pulled" into the site, rather than directing users away "to" those sites.

'Go-to Relationship'

As the system evolves, it is our view that engagement would be enhanced if the user was able to interact with the SimCoach repeatedly over time. Ideally, users could progress at their own pace over days or even weeks as they perhaps develop a "relationship" with a SimCoach character as a "go-to" source of health care information and feedback. However, this option for evolving the SimCoach comfort zone with users over time would require significant database resources to render the SimCoach capable of "remembering" the information acquired from previous visits and to build on that information in similar fashion to that of a growing human relationship.

Moreover, the persistence of a SimCoach memory for previous sessions would also require the user to sign into the system with a user name and password. This would necessitate the SimCoach system to "reside" on a high security server, such that content from previous visits could be stored and accessed with subsequent visits.

Such functionality might be a double-edged sword, as anonymity is a hallmark feature to draw in users who may be hesitant to know that their interactions are being stored, even if it

resulted in a more relevant, less redundant, and perhaps more meaningful interaction with a SimCoach over time. Likely, this would necessarily have to be a clearly stated "opt-in" function, as the technology may support this in the future.

Users also have the option to print out a PDF summary of the SimCoach session. This is important for later personal review and for the access to links that the SimCoach provided in the session to relevant Web content or to bring with them when seeking clinical care to enhance their comfort level, armed with knowledge, when dealing with human clinical care providers and experts. We have also created software authoring tools that allows other clinical professionals to create SimCoach content to enhance the likelihood that the program will evolve based on other care perspectives and emerging needs in the future.

The current version of SimCoach is undergoing beta-testing with a limited group of test-site users. Results from this user-centered testing will serve to advance the development of a SimCoach system that is expected to undergo a wider release in 2013. Although this project represents an early effort in this area, it is our view that the clinical aims selected can still be usefully addressed within the limits of current technology. However, we expect that SimCoach will continue to evolve over time based on data collected from ongoing user interactions with the system and advances in technology, particularly with improved voice recognition.

Along the way, this work will afford many research opportunities for investigating the functional and ethical issues involved in the process of creating and interacting with VHs in a clinical or health care support context. While the ethical challenges may be more intuitively appreciated, the functional technology challenges also are significant. As advances in computing power, graphics and animation, artificial intelligence, speech recognition, and natural language processing continue to develop at current rates, we expect that the creation of highly interactive, intelligent VHs for such clinical purposes is not only possible, but probable.

CONCLUSIONS

This article detailed a range of applications that illustrate the current use of clinical VR to address the behavioral health care needs of those suffering from the wounds of war. If one reviews the history of the impact of war on advances in clinical care, it could be suggested that clinical VR may be an idea whose time has come. For example, during WW I, the Army Alpha/Beta Classification Test emerged from the need for better cognitive ability assessment; that development later set the stage for the civilian intelligence testing movement during the mid-20th century.

Innovations that emerge in military health care typically have a lasting influence on civilian health care.

As well, the birth of clinical psychology as a treatment-oriented profession was borne from the need to provide care to the many veterans returning from WW II with "shell shock." The Vietnam War then later drove the recognition of PTSD as a definable and treatable clinical disorder. In similar fashion, one of the clinical "game changing" outcomes of the OEF/OIF conflicts could derive from the military's support for research and development in the area of clinical VR that could potentially drive increased recognition and adoption within the civilian sector.

As we have seen throughout history, innovations that emerge in military health care, driven by the urgency of war, typically have a lasting influence on civilian health care long after the last shot is fired.

However, such impact will only occur if positive efficacy and cost-benefit outcomes are generated from research with these military-based VR applications. As in all areas of new technology design and development, it is easy for one to get caught up in the excitement that surrounds the potential for innovative clinical opportunities, while casting a blind eye to the pragmatic challenges that exist for building and disseminating useful and usable applications. Thus far, rational minds have prevailed among clinical VR developers and clinicians, most of whom have approached this area with an honest measure of enthusiastic vision, good science, and healthy skepticism. This has led to a growing interest in VR within the health care community as clinical tests are incrementally demonstrating that VR can be implemented safely, at a reasonable cost, and that it has now begun to yield clinical outcomes that are at the least equivalent to, and sometimes more effective than, the more traditional approaches. Thus, any rush to adopt VR should not disregard principles of evidence-based and ethical clinical practice.

In the end, technology is really no more than a tool. The technology in and of itself, does not "fix" anybody. Rather, these systems are designed to either train or extend the skills of a well-trained clinician, and in the case of SimCoach, to help a person to anonymously find the treatment they may benefit from with a live human provider.

These systems, while providing treatment options not possible until recently, will most likely produce therapeutic benefits when administered within the context of appropriate care via a thoughtful and professional appreciation of the complexity of these important behavioral health care challenges.

Note: Space limitations preclude the presentation of rich visual imagery of the work described in this article. The reader is invited to access Internet links provided in the Sidebar (see page 135) to view approximately 60 videos that are available for learning more about these projects.

REFERENCES

1. TechNewsDaily. U.S. Army Orders Virtual Reality Training for Soldiers. Available at: www.technewsdaily.com/2687-army-virtual-reality-training-games.html. Accessed Feb. 25, 2013.
2. Rizzo AA, Schultheis MT, Kerns K, Mateer C. Analysis of assets for virtual reality applications in neuropsychology. *Neuropsychol Rehabil*. 2004;14(1-2):207-239.
3. Glantz K, Rizzo AA, Graap K. Virtual reality for psychotherapy: current reality and future possibilities. *Psychother Theory Res Pract Train*. 2003;40(1-2):55-67.
4. Holden MK. Virtual environments for motor rehabilitation: review. Cyberpsychol Behav.2005;8(3):187-211.
5. Parsons T, Rizzo AA. Affective Outcomes of virtual reality exposure therapy for anxiety and specific phobias: a meta-analysis. *J Behav Ther Exp Psychiatry*. 2008;39(3):250-261.
6. Parsons TD, Rizzo AA, Rogers S, York P. Virtual reality in paediatric rehabilitation: a review. *Dev Neurorehabil*. 2009;12(4):224-238.
7. Powers M, Emmelkamp PMG. Virtual reality exposure therapy for anxiety disorders: a meta-analysis. *J Anxiety Disord*. 2008;22(3):561-569.
8. Rizzo AA, Kim G. A SWOT analysis of the field of virtual rehabilitation and therapy. *Presence-Teleop Virt Environ*. 2005;14(2):119-146.
9. Rizzo A, Difede J, Rothbaum BO, Reger G. Virtual Iraq/Afghanistan: development and early evaluation of a virtual reality exposure therapy system for combat-related PTSD. *Ann N Y Acad Sci*. 2010;1208:114-125.
10. Rizzo A, Parsons TD, Lange B, Kenny P, Buckwalter JG, et al.Virtual reality goes to war: a brief review of the future of military behavioral healthcare. *J Clin Psychol Med Settings*. 2011;18(2):176-187.
11. Rizzo A, Lange B, Buckwalter JG, et al. An intelligent virtual human system for providing healthcare information and support. *Stud Health Technol Inform*. 2011;163:503-509.
12. Riva G. Virtual reality in psychotherapy: review. *Cyberpsychol Behav*. 2005;8(3):220-230.
13. Rose FD, Brooks BM, Rizzo AA. Virtual reality in brain damage rehabilitation: review. *Cyberpsychol Behav*. 2005;8(3):241-262.
14. Opris D, Pintea S, Garcia-Palacios A, Botella C, Szamosko S, David D. Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. *Depress Anxiety*. 2012;29(2):85-93.
15. Difede J, Hoffman HG. Virtual reality exposure therapy for World Trade Center posttraumatic stress disorder: a case report. *Cyberpsychol Behav*. 2002;5(6):529-535.
16. Difede J, Cukor J, Jayasinghe N, et al. Virtual Reality exposure therapy for the treatment of posttraumatic stress disorder following September 11, 2001. *J Clin Psychiatry*. 2007;68(11):1639-1647.
17. Rothbaum BO, Hodges L, Ready D, Graap K, Alarcon R. Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. *J Clin Psychiatry*. 2001;62(8):617-622.
18. Schneider SM, Kisby CK, Flint EP.Effect of virtual reality on time perception in patients receiving *chemotherapy*. Support Care Cancer. 2011;19(4):555-564.
19. Hoffman H, Patterson D, Carrougher G. Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: a controlled study. *Clin J Pain*. 2000;16(3):244-250.
20. Gold JI, Kim SH. Kant AJ, Joseph MH, Rizzo AA. Effectiveness of virtual reality for pediatric pain distraction during IV placement. *Cyberpsychol Behav*. 2006;9(2):207-212.
21. Stanton D, Foreman N, Wilson P. Uses of virtual reality in clinical training: developing the spatial skills of children with mobility impairments. *Stud Health Technol Inform*. 1998;58:219-232.
22. Merians AS, Fluet GG, Qiu Q, Saleh S, Lafond I, Adamovich SV. Integrated arm and hand training using adaptive robotics and virtual reality simulations. *Proc 2010 Int Conference Disabil Virt Real Associated Technol*. 2012:213-222.
23. Rizzo AA, Bowerly T, Buckwater JG, Klimchuk D, Mitura R, Parsons RD. A virtual reality scenario for all seasons: the virtual classroom. *CNS Spectr*. 2006;11(1):35-44.
24. Lok B, Ferdig RE, Raij A, et al. Applying virtual reality in medical communication education: current findings and potential teaching and learning benefits of immersive virtual patients. *J Virt Real*. 2007;10(3):185-195.
25. Rizzo AA, Parsons T, Buckwalter JG, Kenny P. The birth of intelligent virtual patients in clinical training. *Am Behav Sci*. 2013, in press.
26. Aukstakalnis, S Blatner D. *Silicon Mirage: The Art and Science of Virtual Reality*. Berkeley, CA: Peachpit Press; 1992.
27. Rizzo AA, Buckwalter JG, Neumann U. Virtual reality and cognitive rehabilitation: a brief review of the future. *J Head Trauma Rehabil*. 1997;12(6):1-15.
28. Lange B, Koenig S, Chang C-Y, Et al. Designing informed game-based rehabilitation tasks leveraging advances in virtual reality. *Disabil Rehabil*. 2012;34(22):1863-1870.
29. Bryant RA. Psychosocial approaches of acute stress reactions. *CNS Spectr*. 2005;10(2):116-122.
30. IOM (Institute of Medicine). Treatment of posttraumatic stress disorder: an assessment of the evidence. (2007). Available at: www.nap.edu/catalog/11955.html. Accessed Feb. 25, 2013.
31. IOM (Institute of Medicine). *Treatment for Posttraumatic Stress Disorder in Military and Veteran Populations: Initial Assessment*. Washington, DC: The National Academies Press; 2012.
32. Rothbaum BO, Hodges LF, Smith S, Lee JH, Price L. A controlled study of virtual reality exposure therapy for the fear of flying. *J Consult Clin Psychol*. 2000;68(6):1020-1026.
33. Rothbaum BO, Schwartz A. Exposure therapy for posttraumatic stress disorder. *Am J Psychother*. 2002;56(1):59-75.
34. Reger GM, Gahm GA, Rizzo AA, Swanson RA, Duma S. Soldier evaluation of the virtual reality Iraq. *Telemed J E Health*. 2009;15(1):101-140.
35. Rothbaum B, Difede J, Rizzo, A. *Therapist Treatment Manual for Virtual Reality Exposure Therapy: Posttraumatic Stress Disorder in Iraq Combat Veterans*. Atlanta: Virtually Better Inc.; 2008.
36. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD checklist (PCL). *Behav Res Ther*. 1996;34(8):669-673.
37. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol*. 1988;56(6):893-897.
38. Kroenke K, Spitzer RL. The PHQ-9: A new depression and diagnostic severity measure. *PsychiatrAnn*. 2002;32(9):509-521..
39. Gerardi M, Rothbaum BO, Ressler K, Heekin M, Rizzo AA. Virtual reality exposure therapy using a virtual Iraq: case report. *J Trauma Stress*. 2008;21(2):209-213.
40. Reger GM, Gahm GA. Virtual reality exposure therapy for active duty soldiers. *J Clin Psychol*. 2008;64(8):940-946.
41. Reger GM, Holloway KM, Candy C, et al. Effectiveness of virtual reality exposure therapy for active duty soldiers in a military mental health clinic. *J Trauma Stress*. 2011;24(1):93-96.
42. McLay RN, Wood DP, Webb-Murphy JA, et

al. A randomized, controlled trial of virtual reality exposure therapy for post-traumatic stress disorder in active duty service members with combat-related post-traumatic stress disorder. *Cyberpsychol Behav Soc Netw*. 2011;14(4):223-229.
43. Mclay RN. New Technology to Treat Post Traumatic Stress Disorder. Paper presented at the American Psychiatric Association Convention; May 8, 2012; Philadelphia, PA.
44. National Center for Telehealth and Technology. Exposure Therapy for Actice Duty Soldiers with Post Traumatic Stress Disorder (VRPE). (2010). Available at: clinicaltrials.gov/ct2/show/NCT01193725?term=Reger&rank=2. Accessed Feb. 1, 2013.
45. Beidel DC, Frueh BC, Uhde TW. Trauma Management Therapy for OIF/OEF Veterans. Department of Defense United States Army Military Operational Medical Research Program. (2010). Available at: www.psych.ucf.edu/faculty_beidel.php. Accessed Feb. 1, 2013.
46. Difede J, Rothbaum BO, Rizzo A. Enhancing Exposure Therapy for PTSD: Virtual Reality and Imaginal Exposure with a Cognitive Enhancer. Randomized Controlled Trial. (2010-2013). Available at: clinicaltrials.gov/ct2/show/NCT01352637. Accessed Feb. 1, 2013.
47. Walker DL, Ressler KJ, Lu KT, Davis M. Facilitation of conditioned fear extinction by systemic administration or intra-amygdala infusions of D-cycloserine as assessed with fear-potentiated startle in rats. *J Neurosci*. 2002;22(6):2343-2351.
48. Ressler KJ, Rothbaum BO, Tannenbaum L, et al. Facilitation of psychotherapy with d-cycloserine, a putative cognitive enhancer. *Arch Gen Psychiatry*. 2004;61(11):1136-1144.
49. Foa EB, Davidson RT, Frances A. The Expert Consensus Guideline Series: Treatment of posttraumatic stress disorder. *J Clin Psychiatry*. 1999;60(Suppl 16):3-76.
50. DOD Mental Health Task Force Report. (2007). Available at: www.health.mil/dhb/mhtf/MHTF-Report-Final.pdf. Accessed Feb. 25, 2007.
51. Dole-Shalala Commission. Serve, Support, Simplify: Report of the President's Commission on Care for America's Returning Wounded Warriors. (2007). Available at: www.nyshealthfoundation.org/content/document/detail/1782/. Accessed Feb. 25, 2011.
52. Tanielian T, Jaycox LH, Schell TL, et al. Invisible wounds of war: Summary and recommendations for addressing psychological and cognitive injuries. Rand Report. (2008). Available at: veterans.rand.org. Accessed Feb. 25, 2013.
53. American Psychological Association. Presidential Task Force on Military Deployment Services for Youth, Families and Service Members. The Psychological Needs of U.S. Military Service Members and Their Families: A Preliminary Report. (2007). Available at: www.apa.org/releases. Accessed Feb. 25, 2013
54. McEwen BS, Stellar E. Stress and the individual: Mechanism leading to disease. *Arch Intern Med*. 1993;153(18):2093-2101.
55. Casey GW Jr. Comprehensive soldier fitness: a vision for psychological resilience in the U.S. Army. *Am Psychol*. 2011;66(1):1-3.
56. Luthar SS, Cicchetti D, Becker B. The construct of resilience: a critical evaluation and guidelines for future work. *Child Dev*. 2000;713):543-562.
57. Hovar C. The Military Operational Medicine Research Program for the US Army. Available at: www.donhcs.com/hsr/21_march/doc/presentations/Carl%20Hover%20MRMC%20MOMRP%208%20slides.pdf. Accessed Feb. 25, 2013.
58. Cornum R, Matthews MD, Seligman MEP. Comprehensive soldier fitness: building resilience in a challenging institutional context. *Am Psychol*. 2011;66(1):4-9.
59. Ortony A, Clore G, Collins A. *The Cognitive Structure of Emotions*. New York, NY: Cambridge Press; 1988.
60. Lester PB, Harms PD, Herian MN, Krasikova DV, Beal SJ. The Comprehensive Soldier Fitness Program Evaluation. Report #3: Longitudinal Analysis of the Impact of Master Resilience Training on Self-Reported Resilience and Psychological Health Data. Available at: www.dma.wi.gov/dma/news/2012news/csf-tech-report.pdf. Accessed Feb. 25, 2013.
61. Public Broadcasting System (PBS). Health Experts Question Army Report on Psychological Training. (2012). Available at: www.pbs.org/newshour/updates/military/jan-june12/csf_training_01-02.html. Accessed Feb. 25, 2013.
62. Godden DR, Baddeley AD. When does context influence recognition memory? *Br J Psychol*. 1980;71(1):99-104.
63. Feldner MT, Monson CM, Friedman MJ. A critical analysis of approaches to targeted PTSD prevention: current status and theoretically derived future directions. *Behav Modif*. 2007;31(1):80-116.
64. Lubow RE, Moore AU. Latent inhibition: The effect of non-reinforced exposure to the conditioned stimulus. *J Comp Physiol Psychol*. 1959;52:415–419.
65. Sones HM, Thorp SR, Raskind M. Prevention of posttraumatic stress disorder. *Psychiatr Clin North Am*. 2011;34(1):79-94.
66. Sterling P, Eyer J. Allostasis: A new paradigm to explain arousal pathology. In: Fisher S, Reason J, eds. *Handbook of Life Stress, Cognition and Health*. New York, NY: Wiley; 1988:629-639.
67. McEwen BS. Sex, stress and the hippocampus: Allostasis, allostatic load and the aging process. *Neurobiol Aging*. 2002;23(5):921-939.
68. McEwen BS. Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology*. 2000;22(2):108-124.
69. Barrows HS, Abrahamson S. The programmed patient: A technique for appraising student performance in clinical neurology. *J Med Edu*. 1964;39:802-805.
70. Collins JP, Harden RM. The Use of Real Patients, Simulated Patients and Simulators in Clinical Examinations. Association for Medical Education in Europe. Available at: www.medev.ac.uk/resources/features/AMEE_summaries/Guide13summaryMay04.pdf. Accessed Feb. 25, 2013.
71. Adamo G. Simulated and standardised patients in OSCEs: achievements and challenges 1992–2003. *Med Teach*. 2003;25(3):262-270.
72. Jack B, Chetty V, Anthony D, et al. A Reengineered hospital discharge program to decrease rehospitalization: a randomized trial. *Ann Intern Med*. 2009;150(3):178-187.
73. Howley L, Szauter K, Perkowski L, Clifton M, McNaughton N. Quality of standardised patient research reports in the medical education literature: review and recommendations. *Med Educ*. 2008;42(4):350-358.
74. Berkhof M, Van Rijssen HJ, Schellart A, Anema J, Van der Beek A. Effective training strategies for teaching communication skills to physicians: an overview of systematic reviews. *Patient Educ Couns*. 2011;84(2):152-162.
75. Bogolub EB. Tape recorders in clinical sessions: deliberate and fortuitous effects. *Clin Social Work J*. 1986;14(4):349-360.
76. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med*. 2004;351(1):13-22.

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Behavioral Health and the Future: A Case for Virtual Therapies

Sandro Galea, MD, MPH, DrPH

Sandro Galea, MD, MPH, DrPH, *a leading expert in mental health effects of mass trauma, chairs the Department of Epidemiology at the Columbia University Mailman School of Public Health. He is also the Chair of the Institute of Medicine Committee on Treatment for Posttraumatic Disorder in Military and Veteran Populations.* ***Albert "Skip" Rizzo, PhD,*** *lead author on the paper which follows this relevant commentary, and I are members of this committee, formed in response to congressional concern over the growing crisis of posttraumatic stress disorder (PTSD) among military service members. The committee was specifically tasked by the Secretary of Defense to consider "the effectiveness of alternative therapies in the treatment of PTSD, including the therapeutic use of animals." Part I of the committee's report has been released. Part II will cover more specifics about virtual and other alternative therapies, and will be released in July 2014.*

– Elspeth Cameron Ritchie, MD, MPH (Col. US Army, retired)
Guest Editor for *Psychiatric Annals*' 2013 feature series on PTSD.

The nature of warfare has changed, in some respects substantially, over the millennia. One of the hallmarks of the United States' deployments in Operation Iraqi Freedom and Operation Enduring Freedom has been the dramatically lower proportion of war deaths (compared, for example to those in the Vietnam War) and the commensurate higher proportion of wounded soldiers who survive.[1] This shift is due, at least in part, to improved technology that protects soldiers in the battlefield, and to enhanced medical interventions that can stabilize and quickly transport a wounded soldier to definitive care.

However, despite these advances, our progress in applying technological innovation to help mitigate the psychological wounds of war has been much slower. Our most effective treatments for the sentinel psychological injuries that accompany trauma, particularly posttraumatic stress disorder (PTSD), continue to require repeated sessions of intensive face-to-face contact with clinicians, over many weeks.[2] While these treatments are effective in a large proportion of patients, they pose challenges to the day-to-day reality of soldiers, either to those deployed and hence far from readily available clinical care, or to the

many who return home but live at a distance from qualified clinicians.

The work summarized by Rizzo and colleagues[3] in this issue represents a tremendous effort over the past decade or so, to bridge some of this gap in care by the application of a growing number of technological platforms that provide remote treatments and preventive measures for psychological disorders that can be applied in circumstances that are less structured than typical clinician-patient encounters.

While Rizzo and colleagues wisely describe the next steps in the field's evolution as depending on "enthusiastic vision, good science, and healthy skepticism," they also provide us with enough data and evidence of this field's promise to instill hope and optimism in even the hardiest skeptic.

'PROMISING AND EXCITING'

There is much to be said on the topic. In the spirit of commentary, distilling some of the key areas to push forward on this work, I summarize here three particular reasons why the application of virtual (digital) technologies to addressing the psychological wounds of war are particularly promising and exciting, and, in parallel, three central hurdles that these technologies need to overcome.

It has become a truism that we live in a globalized, mobile world, and there is every reason to believe that this trend is inexorable.[4,5] This mobility upends the paradigm of treatments predicated on stable communities. Technological solutions can help overcome this challenge, either through the provision of consistent treatment by the same provider over digital forms of communication, or through treatments that are delivered virtually, untethered to a fixed provider.

The adoption of virtual therapeutic modalities capitalizes on technologies that are intimately familiar to generations who have grown up in a digital universe. This comfort-level with virtual technologies facilitates the delivery of mental health care to this and future generations of soldiers, who might otherwise let fear of stigmatization prevent them from seeking psycho-therapeutic care.[6,7]

Perhaps most intriguingly, the ubiquitous existence of portable digital devices introduces the potential for comprehensive prevention of the psychological consequences of trauma. Our ability to minimize the consequences of trauma before they occur is still limited, although there is a small body of literature on attempts to do just this.[8,9]

One of the sentinel barriers to this is identifying effective ways of delivering psychoeducational messages to those at risk, such as deployed soldiers who are hard to reach "in country". The use of mobile, portable devices to deliver psycho-therapeutic care creates opportunities previously unavailable, and not too long ago, unimaginable.

POTENTIAL BARRIERS

Paralleling these areas of potential are three particularly salient challenges.

First, although these technologies represent — through their accessibility and resonance with younger generations — avenues with great potential, the challenge is in how to ensure their implementation is systematic and rigorous. While the siren lure of these technologies might lead us to develop and broadly disseminate approaches that "should work", it is an urge we should resist. As Rizzo et al admirably outline, the systematic evolution of evidence-based treatments using novel digital platforms, tested rigorously, stands to revolutionize how we deliver psychological interventions.

Second, the accessibility of these methods, and their adoption across different platforms, creates the potential for multiple versions of particular approaches. This can be a strength, allowing us to adjust to local and specific contexts. It can also, however, diminish the effectiveness of a particular approach through numerous iterations.

While this has always been the case with psychological treatments (ie, any clinician can unsuccessfully adapt an evidence-based approach) it is of particular concern for virtual technologies that are not only readily modifiable but can spread virally in that modified state. Evidence-based systems should be in place to monitor the effectiveness of evolving virtual technologies.

And third, while digital therapies offer the potential to reduce stigma, we run the risk of diminishing the import of the treatment itself if it is too readily conflated with common past-times. Ultimately the intent of these approaches is deadly serious — the mitigation of the consequences of war and the treatment of debilitating psychological disorders. Somehow we need to strike the balance between accessibility and effectiveness.

The promise of these methods makes their emergence one of the most exciting developments in the field in decades. Their inherent challenges make their implementation worth watching. The article by Rizzo and colleagues gives us immense hope that we are on the right track.

doi: 10.3928/00485713-20130306-07

REFERENCES

1. Regan T. Report: High Survival Rate for US Troops Wounded in Iraq. *Christian Science Monitor.* Nov. 29, 2004.
2. *Effective Treatments for PTSD: Practice Guidelines from the International Society for Traumatic Stress Studies.* 2nd Edition. New York, NY: The Guilford Press; 2008.
3. Rizzo AS, Buckwalter JG, Forbell E, et al. Virtual reality applications to address the wounds of war. *Psychiatr Ann.* 2013;43(3):121-123.
4. Schafer A, Victor DG. The future mobility of the world population. *Transportation Research Part A: Policy and Practice.* 2000;34(3):171-205.
5. Federal Highway Administration Office of Policy and Governmental Affairs, Transportation Studies (HPTS). *The Next Generation of Travel: Research, Analysis and Scenario Development: Literature Scan Report Summary 2011.* Washington, DC: US Department of Transportation; 2011.
6. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med.* 2004;351(1):13-22.
7. Vogt D. Mental health-related beliefs as a barrier to service use for military personnel and veterans: a review. *Psychiatr Serv.* 2011;62(2):135-142.
8. Resnick H, Acierno R, Holmes M, Kilpatrick DG, Jager N. Prevention of post-rape psychopathology: preliminary findings of a controlled acute rape treatment study. *J Anxiety Disord.* 1999;13(4):359-370.
9. Ruggiero KJ, Resnick HS, Paul LA, et al. Randomized controlled trial of an internet-based intervention using random-digit-dial recruitment: the Disaster Recovery Web project. *Contemp Clin Trials.* 2012;33(1):237-246.

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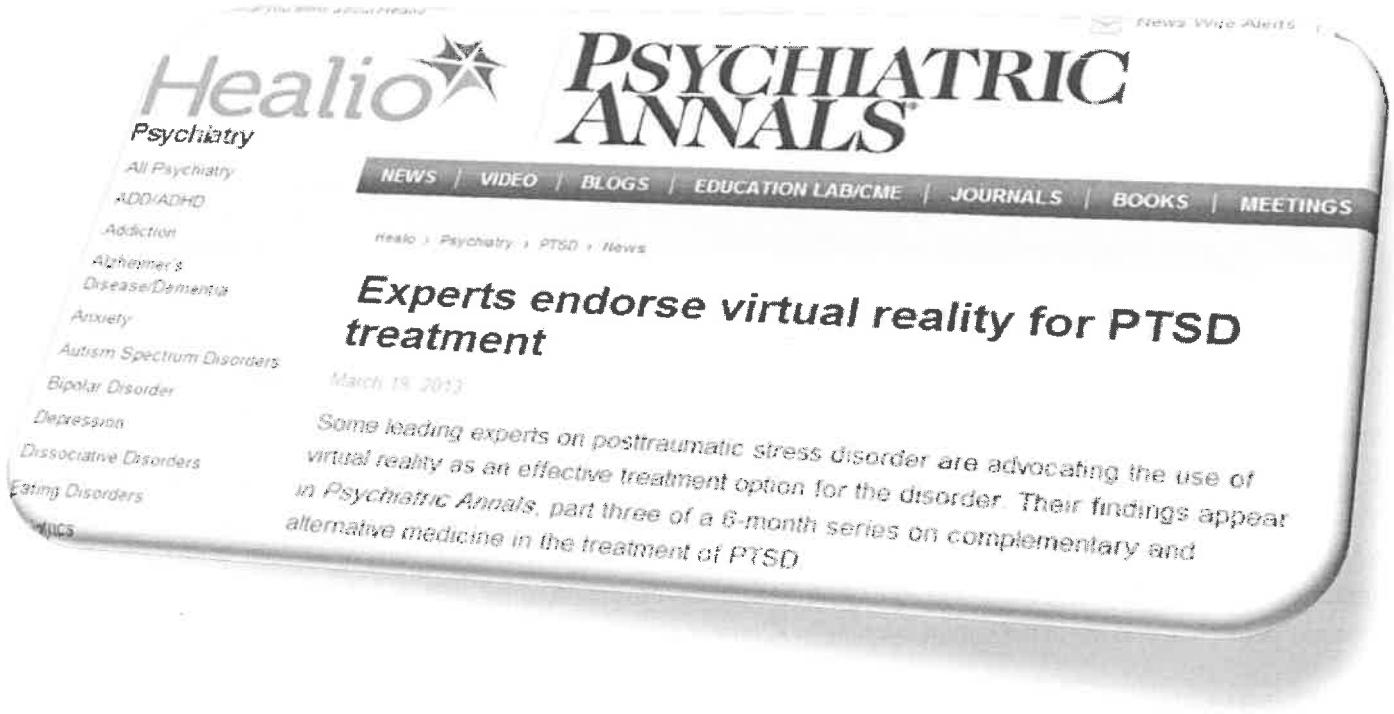
http://www.healio.com/psychiatry/ptsd/news/online/%7B08ECB8A4-6DED-420A-8627-600074759318%7D/Experts-endorse-virtual-reality-for-PTSD-treatment



Experts endorse virtual reality for PTSD treatment

- March 19, 2013

Some leading experts on posttraumatic stress disorder are advocating the use of virtual reality as an effective treatment option for the disorder. Their findings appear in *Psychiatric Annals*, part three of a 6-month series on complementary and alternative medicine in the treatment of PTSD.

See Also

- Report calls for more research on PTSD treatment for children ...
- Experts propose nerve blocks to treat PTSD
- Prewar vulnerabilities may contribute to PTSD as much as ...

"Virtual reality continues to evolve from the realm of expensive toy into that of functional technology," study investigator **Albert "Skip" Rizzo, PhD**, a research scientist at the University of Southern California Institute for Creative Technologies, told *Psychiatric Annals*. "New clinical [virtual reality] approaches — undreamed of back in the bygone days of the 20th century — are now possible with recent advances in low-cost technologies that often have their origins in the video game and entertainment industries."

In the article, Rizzo and colleagues detailed a number of viable applications for virtual reality in mental health care, ranging from exposure therapy for service members with PTSD to simulation programs in which clinicians can train with virtual patients.

Two particular programs, named "Virtual Iraq" and "Virtual Afghanistan," allow patients to work through their combat trauma in computer-simulated warzones. Field tested at Fort Lewis, Washington, and by service members deployed to Iraq, the programs simulate an environment replete with visual, audio, tactile and even olfactory stimuli. The clinician controls the simulated experience through a separate interface and remains in full audio contact with the user.

"As powerful and seductive as these new interactive and immersive technologies appear, one should never believe that technology alone 'fixes' anyone," Rizzo said. "Rather, the thoughtful use of new technologies to deliver clinical care may best be viewed as 'tools' that extend the skills of a well-trained clinician."

Although the researchers are cautious not to make excessive claims about the efficacy of this emerging technology, results from initial tests have been positive. For example, in the first open clinical trial of Virtual Iraq/Afghanistan (Rizzo and colleagues), active duty service members (n=20) showed a significant reduction in mean pre-/post-PTSD military checklist scores ($P<.001$). Participants' mean scores on the Beck Anxiety Inventory also decreased ($P<.002$).

Subsequent case studies and open trials also have indicated positive outcomes. According to the researchers, there are four ongoing randomized controlled trials with Virtual Iraq/Afghanistan. Two of the trials are comparing the treatment efficacy of virtual reality exposure therapy (VRET) vs. prolonged imaginal exposure, whereas another trial is comparing VRET with VRET plus a supplemental care approach. The fourth randomized controlled trial is investigating the treatment outcomes of supplementing VRET and imaginal exposure therapy with D-cycloserine, a cognitive enhancer that has been shown to aid in extinction learning in animal models.

Resilience training is another promising application for virtual reality. According to the researchers, a recent shift in military thinking has placed more emphasis — and with it more funding and resources — on better preparing service members for combat and the horrors of war. This evolution in mental health care in the armed services entails a variety of training programs that promote psychological fitness and aim to reduce PTSD symptoms upon redeployment home.

The Stress Resilience in Virtual Environments (STRIVE) project, developed by a team of USC research scientists, expands on the Virtual Iraq/Afghanistan programs by teaching service members valuable stress reduction tactics and coping skills prior to deployment. Participants engage in combat simulations represented in a 30-episode interactive narrative that spans an entire deployment cycle. The narrative is similar to that of *Band of Brothers*, a popular 2001 television drama that followed the World War II experiences of members of the 101st Airborne Division.

Each episode in STRIVE culminates with an emotionally challenging event, such as the death of a squad member or the injury of a civilian child, at which point the simulation is paused. A virtual human "mentor" then appears out of the ether and instructs the user on stress reduction and self-management techniques to cope with the emotionally challenging event.

However, patients are not the only potential beneficiaries of virtual reality. According to background information in the article, the use of actors who pretend to be patients has been the gold standard of medical education, but the high costs of hiring, training and maintaining actors for educational purposes, not to mention a high turnover rate, have been prohibitive. Evaluating audio and video recordings of mock sessions can also be time consuming. To address these limitations, USC researchers developed a virtual patient named "Justin," a male avatar aged 16 years with a conduct disorder.

See Also

- Report calls for more research on PTSD treatment for children ...
- Experts propose nerve blocks to treat PTSD
- Prewar vulnerabilities may contribute to PTSD as much as ...

Justin was eventually followed by "Justina," a female sexual assault victim. Together, these virtual patients represented a new educational platform whereby the novice clinician can learn critical interviewing skills by training with numerous versions of the characters, each having their own language corpus of potential responses.

Click below to watch a related video

The user-virtual human interaction also has been developed to help active service members, veterans and family members who are seeking treatment, according to the researchers. SimCoach is a similar technology in which military members can interact online with a virtual human who discusses issues common to military life, provides resources relevant to the user's reported symptoms and helps break down barriers to mental health care for those who may not otherwise feel comfortable interacting with a live human.

According to *Psychiatric Annals* Editor **Jan Fawcett, MD**, clinicians are responsible to stay informed of the latest approaches to mental health care, particularly those utilizing new technologies.

"Virtual reality therapies raise entirely new issues regarding types of therapies that show promise of increasing the availability of effective treatments, which means that clinicians will have to develop an understanding of the principles underlying these approaches so they can interface with them in a manner that will enhance their effectiveness," he said.

Rizzo said therapeutic approaches to mental health care must evolve to match society's growing acceptance of technology as an indispensible part of daily life, especially among younger service members who are familiar with this kind of technology from other media, including video games.

"Whether by clinician design or implementation, these tools are now providing opportunities to deliver evidence-based care in formats that may have a wide appeal to members of a society who are increasingly viewing technology not simply as a luxury, but as a natural part of everyday existence," Rizzo said. "Clinicians who scorn the use of such technological opportunities as somehow subverting an authentic clinical process are likely to find themselves in the same spot as those who thought 'talking movies' were just a fad."

For more information: Rizzo A. *Ann N Y Acad Sci.* 2010;1208:114-125.

YouTube Channel Link: http://www.youtube.com/user/albertskiprizzo

CNN's "The Next List", Full Episode (22mins) on the work of this lab:
http://www.youtube.com/watch?v=2wmM2aCZ3JA

http://nation.time.com/2013/04/03/embracing-virtual-reality/

The flood of behavioral-health problems in the military seems to have peaked. Fortunately, things stayed far from the degeneracy of the late 1960s and early 1970s described by Colonel Robert Heinl Jr. in his 1971 *Armed Forces Journal* article.

Things are definitely changing for the better.

It is now over two years since the publication of General Peter Chiarelli's *Health Promotion, Risk Reduction, Suicide Prevention Report 2010*, also known as the ***Red Book***. This report assessed the health of the force and outlined how improvements could be made. These improvements are trickling in. The seeds of long ago are bearing fruit.

In March, Dr. Albert Rizzo and his colleagues from the University of Southern California's Institute for Creative Technologies published the results of their work in the ***Psychiatric Annals***. Their virtual reality (VR) therapy — which is already evidence-based due to its adherence to cognitive-behavioral therapy and exposure therapy models — no doubt

has the potential to reach the thousands of patients who have had the most difficult and, dare I say, an impossible time interfacing and benefiting from traditional methods of therapy and mental health care delivery.

Simulation has long held the promise of shaping the mind through virtual experience free from the dangers of the real world. The observations that virtual traumatic experiences had real negative psychological effects were one of the indications for the existence of a complementary phenomenon where virtual safety experiences would have real positive psychological effects.

Indeed, the brain is fairly poor in distinguishing reality from simulation. The effects of the confusion between reality and fantasy were again laid bare when after the 9/11 attacks people with exposure to the World Trade Center collapse on **television** experienced post-traumatic stress symptoms similar to those who had experienced the events first hand.

Virtual reality therapy takes advantage of these basic interactions in **emotional processing** to re-associate the memory of a heretofore feared experience with feelings of safety rather than fear through meticulous and skillfully supported recreation of the memory and the immersion of the patient in an interactive process during which his/her memory of the experience is decoupled from fear and linked with feelings of safety and a sense of agency and mastery.

VR therapy should make it possible for the least amenable of patients to find care.

Allow me to narrate the story behind my optimism.

As an Army psychiatrist, like the rest of my colleagues, I faced some uniquely grim and absurd situations in the past 10 years.

Never did I imagine such an onslaught of behavioral problems, functional difficulties, mental illnesses, and stark neuropsychiatric injuries at the outset of my Army career in 1998. This onslaught included the tragedy of traumatic brain injuries, suicides, and homicides along with the patronizing and seemingly "cover-your-ass" screening of fully normal (in every statistical sense of the word) service members.

Over the years, I witnessed not only a change in the number of disordered and mentally ill service members, but also a changing character among the patients.

At the risk of oversimplification, I felt the change in the quantity of mental/behavioral health patients was due to the protracted duration and increasing incoherence of the wars in Afghanistan and Iraq, with their long and repeated mental toll and **diminishing returns** for nerves spent.

Again, at the risk of describing only the 20,000-foot view, the qualitative issues seemed to me to be related to the reduced resilience of our soldiers as if they were selected from among the "**75% of young adults** who cannot join the military."

The patients with my so-called qualitative issues seemed to possess some disadvantageous traits such as insecure attachment style, sensitivity, emotionality, impulsivity, and poor attention, among others. These characteristics do not constitute mental disorders *per se* but nevertheless predisposed these patients to disciplinary problems which often triggered punitive administrative measures per Army regulations (see section on "Complexity of High Risk Behavior" in the ***Gold Book***, an update of the *Red Book*).

Worse yet, these characteristics prevented this population's successful and trusting *interface* with the military-health system for recovery as evident by their high burden of disciplinary problems. Needless to say, the reaction of the system was far from benign as apparent by the "**neglect of soldiers**."

The VR therapy model developed, tested, and implemented at ICT has a far-improved chance of reaching the patient population with my so-perceived disadvantageous traits.

This young patient population naturally lives in a digital soup of overstimulation and distraction, supremely comfortable with **social media** and internet use for numerous things including **healthcare**. They appear to trust the internet, easily relate to **gaming** and simulation, and readily adopt new technologies which sidestep or accommodate their mainstream socially-defined disadvantageous characteristics.

All of these indicators bode well for VR therapy. Indeed, VR therapy should enhance creation of rapport and therapeutic alliance between the therapist and patient.

Although counterintuitive to some, and likely less applicable to the majority of psychiatric patient currently adequately treated through traditional face-to-face therapy, for the group of patients who are at the highest risk for mental/behavioral and recovery problems, VR therapy should be a far less stigmatizing, negative transference provoking, attention demanding, and countertransference inducing mode of therapy.

The VR therapy interface developed and scientifically elaborated at ICT appears to be just the mechanism needed to reach the patients who through no fault of their own are less optimally equipped to fend off behavioral problems and mental illnesses and recover from them once in the grip of the problem or illness. More research should be done to shed light on the patient who should have VR versus the traditional face-the-face therapy.

Artin Terhakopian is a psychiatrist and a major in the U.S. Army, but the views expressed here are his own. In the last decade, he worked at Walter Reed Army Medical Center in Washington, D.C., the William Beaumont Army Medical Center in El Paso, Texas, and the 10th Combat Support Hospital while it was deployed to Iraq. He is currently a student at the Command and General Staff College at Fort Leavenworth, Kansas.

Read more: http://nation.time.com/2013/04/03/embracing-virtual-reality/#ixzz2PQzPToL6

A Virtual Reality Scenario for All Seasons: *The Virtual Classroom*

By Albert A. Rizzo, PhD, Todd Bowerly, PhD, J. Galen Buckwalter, PhD, Dean Klimchuk, BA, Roman Mitura, MSc, PEng, and Thomas D. Parsons, PhD

ABSTRACT

Treatment and rehabilitation of the cognitive, psychological, and motor sequelae of central nervous system dysfunction often relies on assessment instruments to inform diagnosis and to track changes in clinical status. Typically, these assessments employ paper-and-pencil psychometrics, hands-on analog/computer tests, and rating of behavior within the context of real-world functional environments. Virtual reality offers the option to produce and distribute identical "standard" simulation environments in which performance can be measured and rehabilitated. Within such digital scenarios, normative data can be accumulated for performance comparisons needed for assessment/diagnosis and for treatment/rehabilitation purposes. In this manner, reusable archetypic virtual environments constructed for one purpose can also be applied for applications addressing other clinical targets. This article will provide a review of such a retooling approach using a virtual classroom simulation that was originally developed as a controlled stimulus environment in which attention processes could be systematically assessed in children with attention-deficit/hyperactivity disorder. This system is now being applied to other clinical targets including the development of tests

Needs Assessment:

As technical advances continue to emerge, the use of virtual reality for the assessment of cognitive and functional impairments due to central nervous system dysfunction is expected to become more common. Knowledge of this area will be required for the integration of this source of information in making clinical and scientific decisions.

Learning Objectives:

At the end of this activity, the participant should be able to:

- Identify four assets that virtual reality offers to advance the assessment of cognitive processes.
- Describe the rationale for how the virtual classroom simulation can be used to systematically assess attention performance.
- Describe results from a study of children with attention-deficit/hyperactivity disorder using the Virtual Classroom on the impact of distraction stimuli on attention performance and extraneous motor movement.

Target Audience: Neurologists and psychiatrists

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To Receive Credit for This Activity: Read this article, and the two CME-designated accompanying articles, reflect on the information presented, and then complete the CME quiz found on pages 63 and 64. To obtain credits, you should score 70% or better. Termination date: January 31, 2008. The estimated time to complete this activity is 3 hours.

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Disclosure: The authors do not have any affiliation or financial interest in any organization that might pose a conflict of interest.

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that address other cognitive functions, eye movement under distraction conditions, social anxiety disorder, and the creation of an earthquake safety training application for children with developmental and learning disabilities.

CNS Spectr. 2006;11(1):35-44

INTRODUCTION

Virtual reality (VR) has now emerged as a promising tool in many domains of therapy and rehabilitation.[1-3] The unique match between VR technology assets and the needs of various clinical application areas has been recognized by a number of authors[2,4-9] and an encouraging body of research has emerged.[1,7] Continuing advances in VR technology along with concomitant system cost reductions have supported the development of more usable, useful, and accessible VR systems that can uniquely target a wide range of physical, psychological, and cognitive clinical targets and research questions. What makes VR application development in the assessment, therapy, and rehabilitation sciences so distinctively important is that it represents more than a simple linear extension of existing computer technology for human use. VR offers the potential to create systematic human testing, training, and treatment environments that allow for the precise control of complex, immersive, dynamic three-dimensional (3-D) stimulus presentations, within which sophisticated interaction, behavioral tracking and performance recording is possible. Much like an aircraft simulator serves to test and train piloting ability, virtual environments (VEs) can be developed to present simulations that can assess, treat, and rehabilitate human functional performance under a range of stimulus conditions that are not easily deliverable and controllable in the "real-world." When combining these assets within the context of functionally relevant, ecologically enhanced VEs, a fundamental advancement could emerge in how human functioning can be addressed in many clinical and research disciplines. This potential was recognized early by VR pioneer, Myron Krueger,[10] in his prophetic statement that, "...Virtual Reality arrives at a moment when computer technology in general is moving from automating the paradigms of the past, to creating new ones for the future."

Treatment and rehabilitation of the cognitive, psychological, and motor sequelae of central nervous system (CNS) dysfunction often relies on assessment devices to inform diagnosis and to track changes in clinical status. Typically, these assessments employ paper-and-pencil psychometrics, hands-on analog tests, computer-delivered continuous performance tests and observation/rating of behavior in real-world functional environments or within the context of physical mock-ups. On one end of the spectrum, traditional neuropsychological approaches commonly use paper and pencil-based psychometric tests and training methodologies for impairment assessment and rehabilitation. Although these approaches provide highly systematic control and delivery of performance challenges, they have also been criticized as limited in the area of ecological validity, that is, the degree of relevance or similarity that a test or training system has relative to the real world, and in its value for predicting or improving daily functioning.[11-13] Adherents of this view challenge the usefulness of constrained paper-and-pencil tests and analog tasks for addressing the complex integrated functioning that is required for successful performance in the real world.

On the other end of the spectrum, a common method applied in the occupational sciences discipline to assess and rehabilitate functional abilities employs behavioral observation and ratings of human performance in the real world or via physical mock-ups of functional environments.[3] Mock-ups of daily living environments (ie, kitchens, bathrooms, etc.) and workspaces (ie, offices, factory settings, etc.) are typically built, within which individuals with motor and/or cognitive impairments are observed while their performance is evaluated. Aside from the economic costs to physically build these environments and to provide human resources to conduct such evaluations, this approach is limited in the systematic control of real-world stimulus challenges and in its capacity to provide detailed performance data capture. Futhermore, many functional environments in everyday life do not easily lend themselves to mock-ups, as is readily apparent in the domain of driving skill assessment and training. In this regard, "behind-the-wheel" driving assessments, considered to be the gold standard in this area, are often conducted in only the safest possible conditions (ie, good weather, low-traffic roadways, etc.), and actually provide a limited "window" into how driving performance would fare under more realistic (and often unpredictable) conditions.

A primary strength that VR offers assessment and rehabilitation is in the creation of simulated

realistic environments in which performance can be tested and trained in systematic fashion. By designing VEs that not only look like the real world but actually incorporate challenges that require functional behaviors, the ecological validity of assessment and rehabilitation methods could be enhanced.

Within a VE, the experimental control required for rigorous scientific analysis and replication can still be maintained within simulated contexts that embody the complex challenges found in naturalistic settings. Thus, on a theoretical level, VR-derived results could have greater predictive validity and clinical relevance for the challenges that patients face in everyday life. On a more pragmatic level, rather than relying on costly physical mock-ups of functional assessment and rehabilitation environments, VR offers the option to produce and distribute identical "standard" simulation environments. Within such digital assessment and rehabilitation scenarios, normative data can be accumulated for performance comparisons needed for assessment/diagnosis and for treatment/rehabilitation purposes.

While the expense to produce a standard VE may be initially high, this financial outlay could be dissipated with cost sharing by professionals adopting the environment. Reusable archetypic VEs constructed for one purpose could also be applied to other clinical targets. This has now been done with a "Virtual Classroom" scenario. While originally developed as a controlled stimulus environment in which attention processes could be systematically assessed in children in children with attention-deficit/hyperactivity disorder (ADHD) in the presence of varying levels of distraction, the system is now finding use for other clinical targets. Such applications that are being developed and tested using the Virtual Classroom include: expansion of the range of attention assessment tests (ie, a Stroop Interference testing system for all ages); translation of the Virtual Classroom to a wide field of view (FOV) display system to study eye tracking under distracting conditions in children with ADHD; development of the Virtual Classroom as a tool for anxiety assessment and graduated exposure therapy for "speaking in front of a class of your peers" in children with social anxiety disorder; an extension to the classroom to include a maze of halls leading out of the school for an earthquake evacuation and safety training application for persons with Down's syndrome and for children with learning disabilities.

This article will briefly describe the development of the VR classroom, along with some of the initial findings on its use with children with ADHD. This will be followed by a discussion of the environment as it is being developed and applied to new clinical targets. With current advances and continued cost reductions in both the hardware and software tools needed to use VR for clinical applications, a case will be made for the idea that significant benefits are looming on the horizon for the further integration of this form of simulation technology in the mental health and rehabilitation sciences.

THE VIRTUAL CLASSROOM PROJECT

Origins and Rationale

The original Virtual Classroom project began in 1999 as part of a basic research application program at the University of Southern California in Los Angeles aimed at developing VR technology applications for the study, assessment, and rehabilitation of cognitive and functional processes]. This work has primarily focused on the development of systems that address the cognitive and functional impairments seen in clinical populations with some form of CNS dysfunction. This work was seen to have the potential to improve our capacity to understand, measure, and treat the impairments typically found in clinical populations with CNS dysfunction as well as advance the scientific study of normal cognitive and functional/behavioral processes.

The Virtual Classroom is a head-mounted display (HMD) VR system for the assessment and possible rehabilitation of attention processes. This scenario has since been evolved from a research application into a more advanced prototype that is currently undergoing initial standardization testing. Our efforts[2] to target this cognitive process were supported by the widespread occurrence and relative significance of attention impairments seen in a variety of clinical conditions across the human lifespan. Most notably, attention difficulties are seen in persons with ADHD, acquired brain injury, and as a feature of various neurodegenerative disorders (ie, Alzheimer's disease, stroke, etc.). VR technology appears to provide specific assets for addressing these impairments that are not available using existing methods. HMDs that serve to occlude the distractions of the outside world are well suited for these types of cognitive assessment applications. Within an

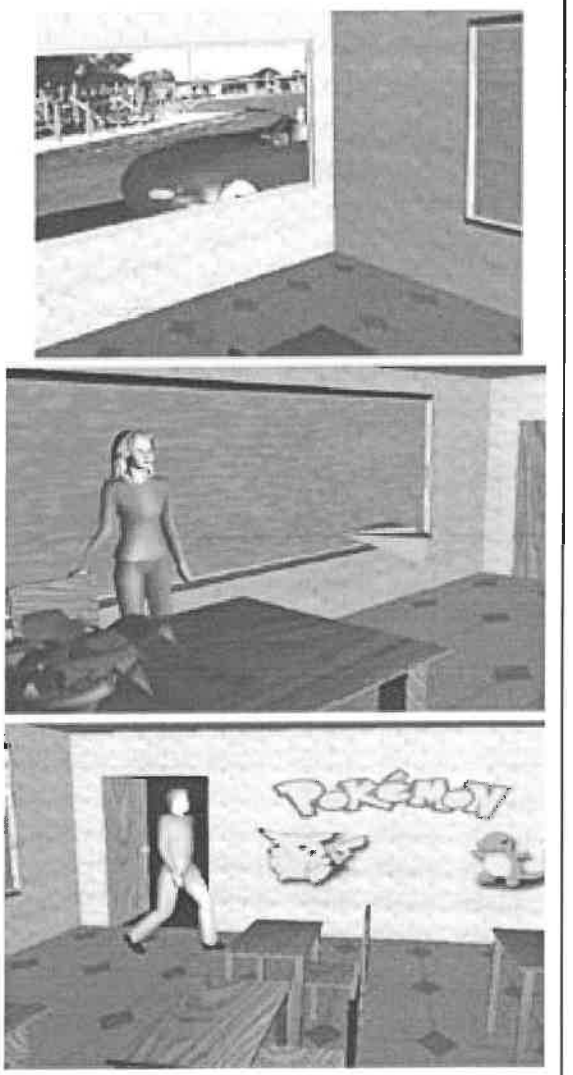
HMD, researchers and clinicians can provide a controlled stimulus environment where attention (and other cognitive) challenges can be presented along with the precise delivery and control of "distracting" auditory and visual stimuli within the VE. This level of experimental control allows for the development of attention assessment/rehabilitation tasks that are more similar to what is found in the real world and when delivered in the context of a relevant functional VE, stand to improve on the ecological validity of measurement and treatment in this area.

Our first project with the Virtual Classroom focused on the assessment of attention in children with ADHD. The heterogeneous features of ADHD, a behavioral disorder marked by inattention, impulsivity, and/or hyperactivity, have made consensus regarding its diagnosis difficult. Furthermore, traditional methods for assessing attention in children with ADHD have been questioned regarding issues of reliability and validity. Popular behavioral checklists have been criticized as biased and not a consistent predictor of ADHD, and correlations between concordant measures of ADHD, such as parent and teacher ratings of hyperactivity, have been repeatedly shown to be modest at best and frequently low or absent.[14,15] Due to the complexity of the disorder and the limitations of traditional assessment techniques, diagnostic information is required from multiple types of ADHD measures and a variety of sources in order for the diagnosis to be given.[14-17] Thus, in the area of ADHD assessment where traditional diagnostic techniques have been plagued by subjectivities and inconsistencies, it was believed that an objective and reliable VR approach might add value over existing approaches and methods.

THE VIRTUAL CLASSROOM SYSTEM

The initial research version of the system was run on a standard Pentium 3 processor with the nVIDIA G2 graphics card. The HMD used in this study was the V8 model from Virtual Research. Tracking[18] of the head, arm and leg used three six-degree of freedom magnetic "Flock of Birds" trackers from Ascension Technology Corporation.[19] In addition to tracking head movement in real time to update the graphics display in the HMD, the tracking system also served to capture body movement metrics from the tracked locations. This provided concurrent data on the hyperactivity component that is a commonly observed feature of ADHD. The research version of the Virtual Classroom scenario consisted of a standard rectangular classroom environment containing desks, a female teacher, a blackboard across the front wall, a side wall with a large window looking out onto a playground and street with moving vehicles, and on the opposite wall, a pair of doorways through which activity occurred (Figure 1). Within this scenario, children's attention performance was assessed while a series of common classroom distracters (ie, ambient classroom noise, activity occurring

FIGURE 1.
Scenes from the initial research version of the Virtual Classroom



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outside the window, etc.) were systematically controlled and manipulated within the VE. The child sat at a virtual desk within the Virtual Classroom and on-task attention was measured in terms of reaction time performance and error profiles on a variety of attention challenge tasks that were delivered visually using the blackboard or auditorily via a virtual teacher's voice.

USER-CENTERED DESIGN PILOT TESTING

Prior to any clinical tests, the early application of user-centered design methods is vital for the reasoned development of any VR application.[20,21] User-centered methods generally require the involvement of the targeted user group to provide feedback in the early design and development phase of scenario development. In the Virtual Classroom's user-centered design evaluation phase, 20 non-diagnosed children (6–12 years of age) tried various evolving forms of the system over the first year of development and their performance was observed while trying out a variety of basic selective and alternating attention tasks. All of the research presented in this article from all projects was approved by an institutional review board and written informed consent was obtained from subjects and their legal guardians if children. We also solicited feedback pertaining to aesthetics and usability of the VE and incorporated some of this feedback into the iterative design-evaluate-redesign cycle. Overall, these initial results indicated little difficulty in adapting to use of the HMD, no self-reported occurrence of side effects as determined by posttest interviews using the Simulator Sickness Questionnaire (SSQ)[22] and excellent performance on the stimulus tracking challenges.

Research Methodology

Following this user-centered design phase, we conducted a clinical trial that compared eight physician-referred males with ADHD (6–12 years of age) with 10 non-diagnosed male children. The groups did not significantly differ in mean age, grade level, ethnicity, or handedness and all children diagnosed with ADHD were currently taking stimulant medication as treatment for their condition. However, participants in the ADHD group were off medication during the testing period with all testing occurring between 9 AM and 11 AM prior to normal medication ingestion. Participants with ADHD were excluded from the study if they presented with comorbid autism, mental retardation, Full Scale intelligence quotient score <85, or head injury with loss of consciousness >30 minutes. These same exclusion criteria were applied to the normal control group. Research participants were instructed to view a series of letters presented on the blackboard and to hit the response button only after he viewed the letter "X" preceded by an "A" (successive discrimination task). The stimuli remained on the screen for 150 milliseconds, with a fixed interstimulus interval of 1,350 milliseconds. Participants were instructed to press a wireless mouse button as quickly and accurately as possible (with their dominant hand) upon detection of an X after an A (correct hit stimuli) and withhold their response to any other sequence of letters. Four hundred stimuli were presented during each of two 10-minute conditions. The two 10-minute conditions consisted of one without distraction and one with distractions (pure audio-classroom noises, pure visual-paper airplane flying across the visual field and mixed audiovisual-a car "rumbling" by the window, and a person walking into the classroom with hall sounds occurring when the door to the room was opened). Distracters were each displayed for 5 seconds, and presented in randomly assigned equally appearing intervals of 10 seconds, 15 seconds, or 25 seconds and 36 distracters (nine of each) were included in the 10-minute condition. As well, six-degree-of-freedom tracking from the head, arm, and leg was used to produce movement metrics needed to analyze the motor hyperactivity component of this disorder. VR performance was also compared with results from standard neuropsychological testing, although this data is not presented here as it is currently being written up as part of full submission focused on this particular experiment.

SUMMARY OF INITIAL VIRTUAL CLASSROOM RESULTS

- No significant side effects were observed in either group based on pre- and post-VR SSQ testing.
- Children with ADHD had slower correct hit reaction times compared with normal controls on the distraction condition (760 milliseconds versus 610 milliseconds; $t(1,16)=-2.76$, $P<.03$).
- Children with ADHD had higher reaction time variability on correct hits compared with

normal controls on both the no-distraction (SD=220 milliseconds versus 160 milliseconds; $t(1,16)=-2.22$, $P<.05$) and distraction conditions (SD=250 milliseconds versus 170 milliseconds; $t(1,16)=-2.52$, $P<.03$).

- Children with ADHD made more omission errors (missed targets) compared with normal controls on both the no-distraction (14 versus 4.4; $t(1,16)=-4.37$, $P<.01$) and distraction conditions (21 versus 7.2; $t(1,16)=-4.15$, $P<.01$).
- Children with ADHD made more commission errors (impulsive responding in the absence of a target) compared with normal controls on both the no-distraction (16 versus 3.7; $t(1,16)=-3.15$, $P<.01$) and distraction conditions (12.1 versus 4.2; $t(1,16)=-3.22$, $P<.01$)
- Children with ADHD made more omission errors in the distraction condition compared with the non-distraction condition (21 versus 14; $t(1,16)=-3.50$, $P<.01$). No such differences on omission and commission errors were found with the non-diagnosed children across no-distraction and distraction conditions.
- Exploratory analysis of motor movement in children with ADHD (tracked from head, arm and leg) indicated higher activity levels on all metrics compared with non-diagnosed children across both conditions.
- Exploratory analysis of motor movement in children with ADHD also indicated higher activity levels on all metrics in the distraction condition compared with the non-distraction condition. This difference was not found with the normal control children.

DISCUSSION OF INITIAL VIRTUAL CLASSROOM RESULTS

These data suggested that the Virtual Classroom had good potential as an efficient, cost-effective and scalable tool for conducting attention performance measurement beyond what exists using traditional methodologies. The system allowed for controlled performance assessment within an ecologically valid environment and appeared to parse out significant effects due to the presence of distraction stimuli. Additionally, the capacity to integrate measures of movement via the tracking technology further added value to this form of assessment when compared with traditional analog tests and rating scales. In this regard, a HMD appeared to be the optimal display format. Although one of the common criticisms of HMD technology concerns FOV limitations, in this application the limited FOV fostered head movement to supplement eye movement as the primary method for scanning the Virtual Classroom. This type of "poor-man's" tracking of behavioral attention within the controlled stimulus environment obtained in the HMD allowed for ongoing documentation as to where the user is "looking" during test content stimulus delivery. For example, a child missing a target while directly looking at the blackboard is illustrating an attentional error that is fundamentally different from the occurrence of a missed target due to the child looking out the window at a distraction. The documentation provided by head tracking in a HMD can be used to produce metrics of % time on task during stimulus "hit" trials as well as allowing for a re-creation of a naturalistic behavioral performance record for later review. In the current research, children with ADHD were found to miss targets due to looking away from the blackboard during 25% of the "hit" trials as opposed to normal subjects who were documented to be looking away at <1% of the time. This form of integrated cognitive/behavioral performance record of attention performance during delivery of systematic distraction is simply not obtainable using other methods. More detailed information on the rationale, methodology, and long-term vision for this project can be found in the reports by several researchers.[23,24]

Based on the initial results of this work an advanced version of the Virtual Classroom using more sophisticated graphics and system architecture was created (Figure 2). This version is now capable of delivering over 20 different types of distractions and allows for flexible building of distraction stimulus delivery profiles in addition to default scenarios that will be supported with normative data for comparisons across age and gender. Further, this functionally relevant "archetypical" environment was designed to be easily "retooled" for service to address other clinical targets and application areas. Since the creation of the latest version of the Virtual Classroom, multisite clinical tests have been conducted and, thus far, the results of this testing has replicated the initial findings from the original Virtual Classroom (A.A. Rizzo, PhD, et al., unpublished data, 2005). Results from those studies are currently being written up along with an update on the expanded clinical trials that are currently being designed for a series of pharmacologic trials.

DEVELOPMENT OF OTHER CLINICAL APPLICATIONS USING THE VIRTUAL CLASSROOM

Expansion of Attention Process Assessment Tasks: The Virtual Stroop Test

Researchers at the University of Victoria have conducted tests with the Virtual Classroom investigating complex attention performance using a virtual version of the Stroop test.[24] The Stroop effect is one of the most well established phenomena demonstrating interference control. The Stroop uses a color-word conflict design that requires the inhibition of a prepotent response to read color names when instructed to name conflicting ink colors.[25] There have been a plethora of different Stroop paradigms, but this is the first Stroop task to be designed and used within a VE (Figure 3) and the purpose of this initial study was to assess the validity of a Stroop task given in a VR classroom. The Virtual Classroom allows for a more controlled testing environment and reduces variability by controlling the participant's FOV and limiting the effects of unexpected visual and auditory distracters. It was hypothesized that the VR Stroop would produce "interference effects" similar to the classic paper and pencil format Stroop task. Eighty-one first-year psychology students (25 males, 56 females), between 17 and 33 years of age from the University of Victoria participated. The VR Stroop consists of two tasks. In the first task, colored boxes randomly appeared on the "chalkboard," and in the second task, color words written in different colors of chalk appear randomly on the chalkboard. In the second task, the stimuli are either "congruent" (eg, the word "RED" appears in red chalk), or "incongruent" (eg, the word "RED" appears in blue chalk). For each task, the virtual teacher stated a color as the stimulus appears on the board. The participant was instructed to click their mouse if the teacher's response correctly names the color of the chalk regardless of the actual color word.

Repeated measures analysis revealed mean reaction times (MRT) to colored boxes was significantly faster than MRT to congruent word stimuli, and both were significantly faster than MRT to incongruent word stimuli. The results demon-

FIGURE 2.
Scenes from the advanced prototype of the Virtual Classroom

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FIGURE 3.
Scenes from the Stroop test, an interference attention task

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strated that a Stroop test administered in a VR environment can produce "interference effects" similar to a classic Stroop task. As expected, the colored boxes required no interference control, and thus reaction times to these stimuli were the fastest. Responses to the congruent word stimuli were more cognitively demanding than responses to the colored boxes, and thus MRT was slower than that to boxes, but faster than that to incongruent word stimuli. The incongruent word stimuli were the most cognitively challenging, requiring interference control, and, as expected, produced the longest MRT. The reaction times to the VR Stroop were slower than those typically found in response to a classic Stroop task. This is believed to result from the extent of cognitive processing necessary to complete the VR Stroop task. Specifically, participants must process the pictured stimulus as well as a verbal stimulus (teacher's response), and then determine if the teacher's response "matches" their own before making a response. Research to investigate these effects in more detail is currently underway.

Wide Field of View System to Study Eye Tracking Under Distracting Conditions in Children with Attention-Deficit/ Hyperactivity disorder

In collaboration with the VR research group at St. Anselm College in New Hampshire,[27] the Virtual Classroom has been configured to be displayed on an Elumens VisionStation® (Figure 4). This research is evaluating the combination of the scenario and display system integrated with head movement and eye-tracking technology.[27] The use of the Virtual Classroom with this display and response capture system provides a testbed for comparing performance in this non-HMD, wide FOV system with findings from the original HMD application. If concordant results are found between these systems, such findings would lend support for the use of the lower-cost HMD method in spite of its limited FOV. Alternatively, added performance information from the eye-tracking data acquired in the VisionStation® application, would be useful in its own right and could enhance our understanding of visual scanning behavior in persons with ADHD. Previous research has suggested that evaluation of eye-tracking may be useful in a VE,[28] predicted it to be a good measure of sustained attention[29] and found eye-tracking algorithms to be useful for correctly classifying adolescents with ADHD.[30]

FIGURE 4.
Virtual Classroom displayed on an Elumen's VisionStation® with eye and head tracking

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Thirty-six boys (8–14 years of age) have participated in this research to date. Nineteen were diagnosed with ADHD, and 16 served as non-diagnosed control subjects. Following informed consent and assent, a technician placed the View Eye XTracking System helmet on the participant's head and the eye tracker was calibrated and the SensoMotoric Instruments system recorded participants' eye movement within the Virtual Classroom. Participants were placed in front of the VisionStation® and the Virtual Classroom vigilance task was then administered followed by a standard continuous performance attention task delivered on a flatscreen computer monitor. During testing, the subject's parents filled out a demographic questionnaire and The Behavior Assessment System for Children (BASC) parent report form.[31] The BASC is a behavioral rating scale consisting of four subscales: attention problems, hyperactivity, internalizing problems, and adaptive skills.

For the ADHD group, a strong correlation was found between overall scores on the Virtual Classroom and the flatscreen test, as well as on the attention problems subscale of the BASC. However, the attention problems subscale of the BASC did not correlate with the flatscreen test. In addition, the ADHD group performed significantly poorer than controls on overall scores and had more omission errors in the Virtual Classroom (similar to results found in previous tests with the HMD system). Eye-tracking analysis revealed the ADHD group was more likely to look off task when the cue (the letter A) appeared on the board than

the control group. Future research will investigate eye-movement data with free and cued recall of aspects of the Virtual Classroom and its relationship to galvanic skin response measures, teacher behavior ratings and classroom observation data.

The Virtual Classroom as a Tool for Anxiety Assessment and Exposure Therapy in Children and Adolescents with Social Anxiety Disorder

Researchers from the Child Study Center at the Virginia Polytechnic Institute are now commencing tests of the Virtual Classroom with children and adolescents diagnosed with social anxiety disorder (SAD). SAD is characterized by a marked and persistent fear of social or performance situations in which embarrassment or humiliation might occur. Children and adolescents with SAD report substantial distress across many social situations, including public performances (reading or reciting in front of others, performing in a play) and ordinary social interactions (starting conversations, joining in on conversations, talking to adults, or talking on the telephone). Frequently, when exposed to possible scrutiny by others, youths with SAD fear they might do something or act in a way that will be embarrassing or humiliating and this creates substantial distress for the majority of children with this disorder.[32] The classroom represents a context in which socially anxious children and adolescents typically experience their greatest struggles and consequences.[33] Accordingly, their reactions in a virtual classroom setting could provide data that is relevant for determining a diagnosis of social anxiety disorder, provide assessment data for determining outcomes following various cognitive-behavioral interventions and for the actual delivery of graduated exposure therapy.

The Virtual Classroom is now undergoing initial user trials for the assessment of SAD in children and adolescents. This adaptation of the Virtual Classroom environment, incorporating specific situations relevant for school related activities, represents a much-needed link between laboratory and situational (in vivo) based assessment. Applied in this format, the user is positioned in the front of the Virtual Classroom and given a set of open-ended topics that they are asked to "speak about" to the class. Initial physiological and self-report data is being collected in order to determine anxiety and reactivity to the stimuli in the current classroom (Figure 5). Contingent on these results, the scenario will be modified to include the capacity to control the number of virtual students in the classroom audience as well as their "behavior" in terms of activity and direct gaze levels.

Earthquake Safety Training with Persons with Developmental and Learning Disabilities

Researchers at Aristotle University of Thessalonika in Greece, are about to begin test trials using an expanded version of the Virtual

FIGURE 5.
Virtual Classroom perspective from the front of the class as applied in initial user trials with children diagnosed with social anxiety disorder

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FIGURE 6.
Virtual Classroom expansion to include hallways/outdoor schoolyard for earthquake safety training

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Classroom for earthquake safety training in children with developmental and learning disabilities. Children with these forms of disability often have cognitive impairments that limit the degree to which they can learn from traditional reading and lecture methods. Procedural learning "by doing" trials within a VE may address this challenge. The design of this scenario included an expansion of the classroom to include a series of school hallways and part of an exterior schoolyard (Figure 6). The classroom interior is populated with 12 students and a teacher, each capable of realistic emotive responses to an earthquake situation, such as showing fear, communicating distress to varying degrees and movement around the classroom. When an earthquake event is triggered, the virtual humans respond appropriately, items in the VE respond with some degree of physics, and the environment shakes along with the appropriate sound effects. Safety training will be provided via two basic modes of interaction—a guided "storytelling" mode and an interactive mode, where the participant controls his or her navigation/actions during and in the aftermath of a simulated earthquake. An interface is being developed to allow the researcher to observe and record the users' actions as they navigate through the VE during training trials and these components are currently under construction.

CONCLUSION

The use of VR as a tool for assessment, therapy, and rehabilitation is expected to grow as the medical and psychological sciences evolve in the digital age. As with any technology applied in these areas, both challenges and opportunities will emerge in how virtual reality is usefully applied and validated.[34] The application of the Virtual Classroom scenario for attention process assessment in children with ADHD illustrates one area where this technology can add value over existing traditional methods. As well, the retooling of this VR system for other clinical purposes demonstrates one approach for how this technology can be applied in a cost-effective manner. The development of such archetypical VEs (ie, offices, homes, social environments, etc.) will likely continue as VR is applied to a wider range of clinical and scientific research questions in the future. ***CNS***

REFERENCES

1. Glantz K, Rizzo AA, Graap K. Virtual reality for psychotherapy: current reality and future possibilities. *Psychotherapy: Theory, Research, Practice, Training.* 2003;40:55-67.
2. Rizzo AA, Schultheis MT, Kerns K, Mateer C. Analysis of assets for virtual reality applications in neuropsychology. *Neuropsychol Rehabil.* 2004;14:207-239.
3. Weiss P, Jessel AS. Virtual reality applications to work. *Work.* 1998;11:277-293.
4. Pugnetti L, Mendozzi L, Motta A, Cattaneo A, Barbieri E, Brancotti S. Evaluation and retraining of adults' cognitive impairments: which role for virtual reality technology? *Comput Biol Med.*1995;25:213-227.
5. Rizzo AA. Virtual Reality applications for the cognitive rehabilitation of persons with traumatic head injuries. In: Murphy HJ, ed. *Proceedings of the 2nd International Conference on Virtual Reality And Persons With Disabilities.* Northridge, Calif: California State University, Northridge; 1994:1-8.
6. Rizzo AA, Wiederhold M, Buckwalter JG. Basic issues in the use of virtual environments for mental health applications. In: Riva G, Wiederhold B, Molinari E, eds. *Virtual Reality in Clinical Psychology and Neuroscience.* Amsterdam, Netherlands: IOS Press; 1998:21-42.
7. Rizzo AA, Buckwalter JG, van der Zaag C. Virtual environment applications for neuropsychological assessment and rehabilitation. In: Stanney K, ed. *Handbook of Virtual Environments.* New York, NY: L.A. Earlbaum; 2002:1027-1064.
8. Rose FD, Attree EA, Johnson DA. Virtual reality: an assistive technology in neurological rehabilitation. *Curr Opin Neurol.* 1996;9:461-467.
9. Rose FD, Brooks BM, Rizzo AA. Virtual reality in brain damage rehabilitation: review. *Cyberpsychol Behav.* 2005;8:241-262.
10. Krueger MW. The experience society. *Presence Teleoper Virtual Environ.* 1993;2:162–168.
11. Neisser U. Memory: what are the important questions? In: Gruneberg MM, Morris PE, Sykes RN, eds. *Practical Aspects of Memory.* London, UK: Academic Press; 1978:3-24.
12. Wilson BA. Cognitive rehabilitation: how it is and how it should be. *J Int Neuropsychol Soc.* 1998;3:487-496.
13. Christiansen C, Baum C. Person-environment occupational performance: a conceptual model for practice. In: Christiansen C, Baum C, eds. *Occupational Therapy: Enabling Function and Well-Being.* 3rd ed. Thorofare, NJ: SLACK; 2004:46-71.
14. Barkley RA. *Attention Deficit Hyperactivity Disorder: A Handbook for Diagnosis and Treatment.* New York, NY: Guilford Press; 1990.
15. Colegrove R, Homayounjam H, Williams J, Hanken J, Horton NL. The problem of overreliance upon behavioral checklists in the diagnosis of ADHD. Paper presented at:: The 107th Annual Conference of the American Psychological Association; August 4-8, 2001; Washington, DC.
16. *Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: American Psychiatric Association; 1994.
17. Greenhill LL. Diagnosing attention-deficit/hyperactivity disorder in children. *J Clin Psychiatry.* 1998;59(suppl 7):31–41.
18. Virtual Research Systems, Inc. Web site. V8 Head Mount Display page. Available at: http://virtualresearch.com/products/v8.htm. December 9, 2005.
19. Ascension Technology Corporation Web site. Flock of Birds product page. Available at: http://ascension-tech.com/products/flockofbirds.php. Accessed December 9, 2005.
20. Hix D, Gabbard JL. Usability engineering of virtual environments. In: Stanney K, ed. *Handbook of Virtual Environments.* New York, NY: L.A. Earlbaum; 2002:681-700.
21. Brown DJ, Standen PJ, Proctor T, Sterland D. Advanced design methodologies for the production of virtual learning environments for use by people with learning disabilities. *Presence Teleoper Virtual Environ.* 2001;10:401-415.
22. Kennedy RS, Lane NE, Berbaum KS, Lilienthal MG. Simulator sickness questionnaire: an enhanced method for quantifying simulator sickness. *Int J Aviation Psychol.* 1993;3:203-220.
23. Rizzo AA, Bowerly T, Buckwalter JG, et al. The virtual classroom: a virtual reality environment for the assessment of attention deficit hyperactivity disorder. *The ADHD Report.* 2001;9:9-13.
24. Rizzo AA, Bowerly T, Buckwalter JG, et al. Virtual environments for the assessment of attention and memory processes: the virtual classroom and office. In: Sharkey P, Lanyi CS, Standen P, eds. *Proceedings of the 4th International Conference on Disability, Virtual Reality and Associated Technologies.* Reading, UK: University of Reading; 2002:3-12.
25. Randall K, Kerns KA, Rizzo AA, Yeh S. The Stroop in a virtual reality: is it virtually the same? *J Int Neuropsychol Soc.* 2005;11(S1):9.
26. Stroop JR. Studies of interference in serial verbal reactions. *J Exp Psychol.* 1935;18:643-661.
27. Adams R, Finn P, Flannery K, Moes L, Matano B, Rizzo A. A virtual reality ADD classroom and the BASC: a preliminary investigation of convergent validity. *J Int Neuropsychol Soc.* 2005;11(S1):151.
28. Duchowski A, Medin E, Cournia N, et al. 3-D eye movement analysis. *Behav Res Methods Instrum Comput.* 2002;34:573-591.
29. Lavine RA, Sibert JL, Gokturk M, Dickens B. Eye-tracking measures and human performance in a vigilance task. *Aviat Space Environ Med.* 2002;73:367-372.
30. Sneed SJ. Eye response assessment of selective attention in adolescents with attention deficits [dissertation]. *Diss Abstr Int.* 1999;2963:AAI9930088.
31. Kamphaus RW, Reynolds CR. BASC Monitor for ADHD Manual and Software Guide. Circle Pines, Minn: American Guidance Service, Inc; 1998.
32. Ollendick TH, Hirshfeld-Becker DR. The developmental and psychopathology of social anxiety disorder. *Biol Psychiatry.* 2002;51:44-58.
33. Hofmann SG, Albano AM, Heimberg RG, Tracey S, Chorpita BF, Barlow DH.. Subtypes of social phobia in adolescents. *Depress Anxiety.* 1999;9:15-18.
34. Rizzo AA, Kim G. A SWOT analysis of the field of Virtual Rehabilitation and Therapy. *Presence Teleoper Virtual Environ.* 2005;14:1-28.

Presentations

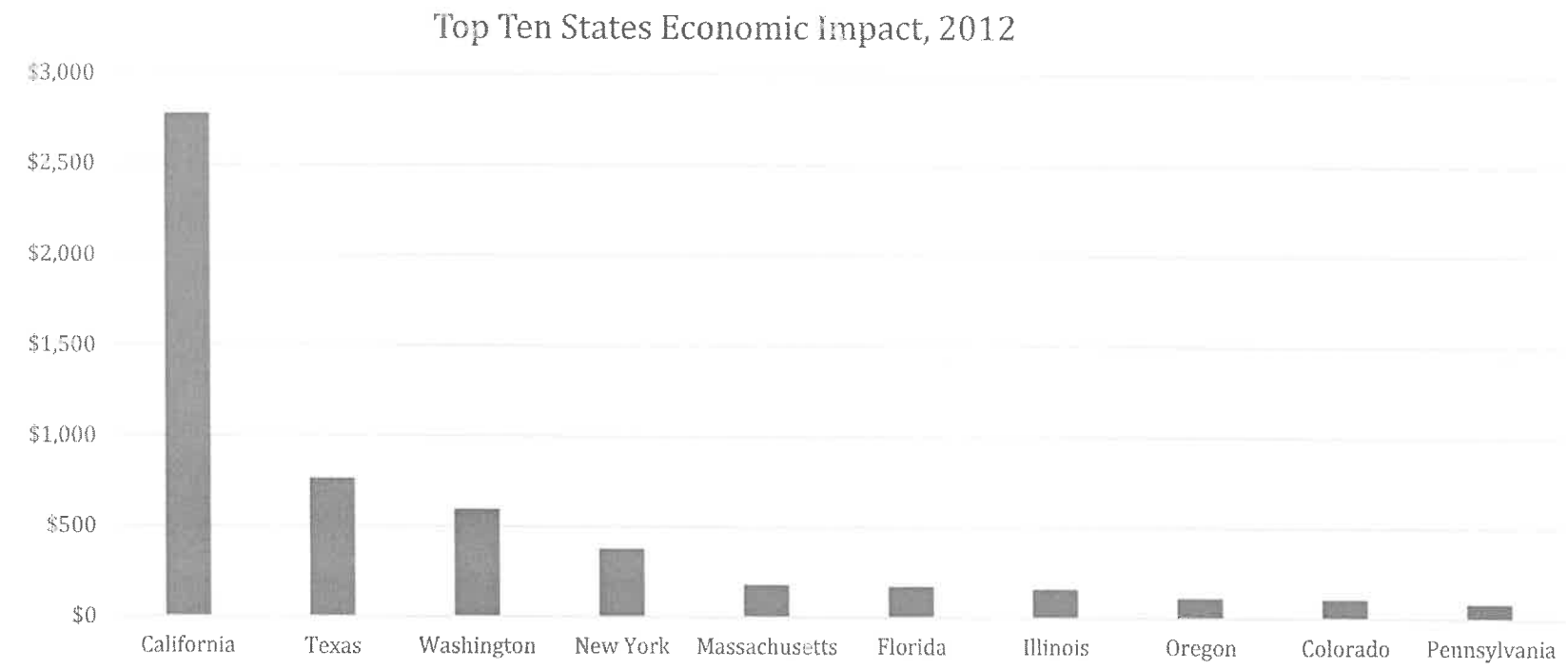
- Kevin Klowden, Milken Institute Presentation
- Will Kock, California Competes Tax Credit Program Presentation

Kevin Klowden

Managing Director, California Center and Managing Economist
California, Entertainment & Sports, Global Economy, Regional Economics, Technology

PowerPoint Presentation Slides

California leads the nation in the economic impact of the video game industry



Source: Fortune.

Several U.S. states offer video game production incentives

State	Program	Tax credit for qualifying costs
Alabama	Entertainment Industry Incentive Act	Up to 25%
Arkansas	Digital Product and Motion Picture Industry Development Act	Up to 20%
Colorado	Colorado Film Incentives	Up to 20%
Connecticut	Connecticut Digital Media and Motion Picture Tax Credit	Up to 20%
Florida	Earmarks, amount varies annually	Up to 20%
Georgia	Entertainment Industry Investment Act	Up to 30%
Hawaii	Motion Picture, Digital Media, and Film Production Income Tax Credit	Up to 15%
Kentucky	Kentucky Film Office Tax Credit	Up to 20%
Louisiana	Louisiana Digital Media Act	Up to 25%
Maine	Certified Media Production Credit/Certified Media Wage Reimbursement	Up to 5%/ Wages: Up to 12%
Michigan	Film and Digital Media Production Assistance Program	Wages: Up to 32% Production: Up to 27%
Mississippi	Mississippi Motion Picture Production Incentive Program	Wages: Up to 30%
Nevada	Nevada Tax Credit	Wages: Up to 12% Production: Up to 15%
New Jersey	Digital Media Tax Credit	Up to 20%
New Mexico	Refundable Film Production Tax Credit	Up to 25%
Ohio	Motion Picture Tax Incentive	Wages: Up to 35% Production: Up to 25%
Oregon	Oregon Production Investment Fund/Indigenous Oregon Production Investment Fund	Wages: Up to 10% Production: Up to 20%
Rhode Island	Motion Picture Production Company Tax Credit	Up to 25%
Texas	Moving Image Industry Program/Additional exemptions	Up to 20%
Virginia	Virginia Motion Picture Tax Credit	Wages: Up to 10% Production: Up to 20%

Source: Frankfurt Kurnit Klein + Selz, PC.

Canada is also a leader in regional digital media tax incentives

Province	Program	Tax credit for qualifying costs
British Columbia	British Columbia Interactive Digital Media Tax Credit	Up to 17.5%
Manitoba	Manitoba Interactive Media Tax CreditDigital	Up to 40%
New Brunswick	New Brunswick Digital Media Development Program	Up to 30%
Nova Scotia	Nova Scotia Digital Media Tax Credit	Wages: Up to 50% OR Production: Up to 25%
Quebec	Quebec Computer Animation and Special Effects Tax Credit	Wages: Up to 20% OR Production: Up to 20%
Ontario	Ontario Computer Animation and Special Effects Tax Credit	Up to 20%

Source: RDP.

Government programs or grants are also available in several other nations and territories

Country/Territory	Program
United Kingdom	Tax credit incentives up to 25% of cost for "culturally British" developers
France	Tax credit incentives up to 20% of cost
Puerto Rico	Tax credit incentives up to 40% of cost
New Zealand	Annual grants
South Korea	Korea Creative Content Agency provides loans to companies producing cultural products, including video games
Singapore	Annual grants
Norway	Annual grants

Source: GamaSutra, Gameindustry.biz., TechNZ.

GOVERNOR'S OFFICE OF BUSINESS AND ECONOMIC DEVELOPMENT

STATE OF CALIFORNIA • OFFICE OF GOVERNOR EDMUND G. BROWN JR.

California Competes Tax Credit

Governor's Economic Development Initiative (GEDI)

Hiring Tax Credit (New Employment Credit)

- Started January 1, 2014
- Administered by Franchise Tax Board
- FAQs at www.ftb.ca.gov

Manufacturing Partial Sales Tax Exemption

- Started July 1, 2014
- Administered by Board of Equalization
- FAQs at www.boe.ca.gov

California Competes Tax Credit

- Started March 2014
- Administered by GO-Biz

The California Competes Tax Credit

California Competes Tax Credit:

- Credit against the income tax due the Franchise Tax Board
- Non-refundable
- 6 tax year carryover
- Legislation signed by Governor Brown in September 2014 allows the credit to offset Alternative Minimum Tax (AMT)

Accountability:

- Tied to achieving contractual (hiring / investment) milestones
- Recapture provisions

California Competes Tax Credit Availability

Tentative Amount of Credits Available:

- $200 million in each fiscal year 2015/16 – 2017/18

Note:

- No more than 20% may go to any one applicant per fiscal year
- 25% of total amount each fiscal year reserved for small businesses

Application Periods

The Director of GO-Biz sets the application periods each fiscal year

Fiscal Year 2015-2016:

July 20, 2015 – August 17, 2015

- $75 million available

January 4, 2016 – January 25, 2016

- $75 million available

March 7, 2016 – March 28, 2016

- $50.9 million plus unallocated amounts from previous application periods

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Award Factors

Credit awards are based on 11 factors:

- Number of jobs created or retained
- Compensation paid to employees
- Amount of investment
- Extent of unemployment or poverty in business area
- Other incentives available in California
- Incentives available in other states
- Duration of proposed project and duration of commitment to remain in this state
- Overall economic impact
- Strategic importance to the state, region, or locality
- Opportunity for future growth and expansion
- Extent the benefit to the state exceeds the amount of the tax credit

Evaluation and Approval Process

PHASE I

- Quantitative analysis
- Cost-benefit ratio

$$\frac{\text{Amount of Credit Requested}}{\text{Aggregate Employee Compensation} + \text{Aggregate Investment}}$$

PHASE II

- Qualitative analysis
- Evaluates applicants based on eight additional factors plus Phase I ratio

AGREEMENTS

- Agreements include: credit distribution period, recapture provisions, minimum employee compensation
- Must be approved by the California Competes Tax Credit Committee

POST COMMITTEE APPROVAL

GO-Biz is required to post:

- Name of each awardee
- Number of jobs to be created
- Amount of investment
- Amount of credit allocated
- Amount of credit recaptured

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Oversight / Accountability

Franchise Tax Board (FTB)

- Access to application and all documentation
- Will review books/records for agreement compliance unless the recipient is a small business
- May review books/records for agreement compliance if the recipient is a small business

Material Breach

- FTB informs GO-Biz
- Committee approves or denies recapture

Awardees

Nearly $180 Million in tax credits awarded to date

- 35,000 jobs and $9 billion in investments
- Awardees include:

California Competes Tax Credit

Questions?

Apply: www.CalCompetes.ca.gov
Email: CalCompetes@gov.ca.gov
Phone: (916) 322-4051

Governor's Office of Business & Economic Development
1325 J Street, Suite 1800
Sacramento, CA 95814
www.business.ca.gov/CalCompetes.aspx

Hearing Participants' Biographies

- Erik Huey, Senior Vice President, Government Affairs
  Entertainment Software Association
- Tracy Fullerton, Director, University of Southern California Games
- Kevin Klowden, Managing Director, California Center and Managing Economist
  Milken Institute
- Peter Marx, Chief Technology Officer, Los Angeles Mayor's Office of Innovation
- Will Koch, Deputy Director, California Competes Tax Credit Program,
  Governor's Office of Business and Economic Development (GO-Biz)
- Craig Hagen, Director, Global Government Affairs, Electronic Arts, Inc.
- Walt Scacchi, PhD., Director of Research, Institute for Virtual
  Environments and Computer Games, University of California, Irvine

Erik Huey

Since 2009, Erik Huey has served as the Senior Vice President for Government Affairs at the Entertainment Software Association (ESA), the trade association representing the business interests of interactive entertainment software publishers and console makers. In this capacity, Erik manages a team of seven employees and fifty outside consulting firms and oversees all federal and state government relations as well as strategic partnerships for the $21 billion U.S. video game industry.

For nearly two decades, Huey has been at the center of high profile and controversial policy debates affecting the technology, media and telecommunications industries, including issues like combating digital theft of copyrighted content, media ownership, expanding broadband deployment, and preserving creative freedom and First Amendment rights.

In recent years, Huey has helped successfully guide the videogame industry through two major challenges by orchestrating the government affairs campaign in support of its historic free speech victory in the Supreme Court, and by developing the strategy and managing the day-to-day response to numerous legislative efforts to restrict the industry's creative expression and distribution model.

In addition to his direct advocacy work, Huey has been instrumental in developing and launching numerous strategic initiatives and public-private partnerships of importance to ESA and the industry, including:

- The Congressional Caucus for Competitiveness in Entertainment Technology (E-TECH Caucus);

- The National STEM Video Game Challenge (with the White House and Sesame Workshop);

- GlassLab (an education software studio in collaboration with Electronic Arts and the MacArthur and Gates Foundations);

- Project A-Game (a partnership with the California Endowment to teach at-risk youth coding skills); and

- The Higher Education Video Game Alliance (a consortium of the top university video game design programs, as ranked by the Princeton Review).

Prior to joining ESA, Huey was a partner at Kilpatrick Stockton LLP where he specialized in public policy advocacy for the entertainment, communications, and media sectors. In 2007, his efforts on behalf of clients, including the Screen Actors Guild, Creative Coalition, AFTRA and the Recording Artists Coalition, earned him recognition by The Hollywood Reporter has named him one of the "100 Most Influential Media & Entertainment Lawyers" in its annual "Power Lawyer" issue.

Huey also remains active in the Democratic Party and helped oversee voter mobilization and

protection in Western Pennsylvania for the Obama-Biden campaigns and the 2004 Kerry-Edwards campaign. Born outside Pittsburgh, Pennsylvania and raised in Morgantown, West Virginia, Huey graduated with Honors from the University of Miami and received his J.D. from the University of Notre Dame Law School.

Outside of work and politics, Erik pursues two creative passions as a screenwriter and as the lead singer of The Surreal McCoys, his Americana rock band, which recently put out its second, original full-length album and regularly performs live.

Tracy Fullerton, M.F.A.

Director, Game Innovation Lab
University of Southern California

Tracy Fullerton, M.F.A., is a game designer, educator and author with twenty years of professional experience. She is currently Director of the joint USC Games Program, which is a collaboration between the School of Cinematic Arts and the Viterbi School of Engineering. She is also an Associate Professor and Chair of the Interactive Media & Games Division of the USC School of Cinematic Arts. In December 2008, she was installed as the holder of the Electronic Arts Endowed Chair of Interactive Entertainment.

Tracy is the author of *Game Design Workshop: A Playcentric Approach to Designing Innovative Games*. This design textbook is in use at game programs worldwide. Her research lab, the Game Innovation Lab, is a leading center for game design research. Recent credits include faculty adviser for the award-winning student games *Cloud*, and *flOw*; and game designer for *The Night Journey*, a unique game/art project with media artist Bill Viola. She is currently designing a game based on Henry David Thoreau's experiment in living at Walden Pond. Also, she is leading a team of designers to create a suite of college knowledge games collectively known as FutureBound Games.

Prior to joining the USC faculty, she was president and founder of the interactive television game developer, Spiderdance, Inc. Spiderdance's games included NBC's *Weakest Link*, MTV's *webRIOT*, The WB's *No Boundaries*, History Channel's *History IQ*, Sony Game Show Network's *Inquizition* and TBS's *Cyber Bond.* Before starting Spiderdance, Tracy was a founding member of the New York design firm R/GA Interactive. As a producer and creative director she created games and interactive products for clients including Sony, Intel, Microsoft, AdAge, Ticketmaster, Compaq, and Warner Bros. among many others. Notable projects include Sony's Multiplayer *Jeopardy!* and Multiplayer *Wheel of Fortune* and MSN's*NetWits*, the first multiplayer casual game. Additionally, Tracy was Creative Director at the interactive film studio Interfilm, where she wrote and co-directed the "cinematic game" *Ride for Your Life*, starring Adam West and Matthew Lillard. She began her career as a designer at Bob Abel's company Synapse, where she worked on the interactive documentary *Columbus: Encounter, Discovery and Beyond* and other early interactive projects.

MILKEN INSTITUTE

Changing the World in Innovative Ways

Kevin Klowden

Managing Director, California Center and Managing Economist

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Kevin Klowden is managing director of the Milken Institute's California Center and a managing economist at the Institute. He specializes in the study of demographic and spatial factors (the distribution of resources, business locations, and movement of labor) and how these are influenced by public policy and in turn affect regional economies. His key areas of focus include technology-based development, infrastructure, the global economy, media and entertainment.

Klowden was the lead author of "Strategies for Expanding California's Exports," which focused on the vital role trade and exports play in the state economy and its underperformance relative to the country over the past decade. He has also written on the role of transportation infrastructure in economic growth and job creation in reports such as "California's Highway Infrastructure: Traffic's Looming Cost" and "Jobs for America: Investments and Policies for Economic Growth and Competitiveness," as well as in publications including The Wall Street Journal.

He has addressed the role of technology-based development in publications such as the "2014 State Technology and Science Index," "North America's High-Tech Economy" and location-specific studies on Arkansas and Arizona. In addition, Klowden was the lead author of several studies on the economics of the entertainment industry, including "A Hollywood Exit: What California Must Do to Remain Competitive in Entertainment—and Keep Jobs, "Fighting Production Flight: Improving California's Filmed Entertainment Tax Credit Program, "Film Flight: Lost Production and Its Economic Impact in California" and "The Writers' Strike of 2007-2008: The Economic Impact of Digital Distribution," each of which analyzes the changing dynamics of the entertainment industry.

Additionally, he coordinated the Milken Institute's two-year Los Angeles Economy Project, seeking public-policy and private-sector solutions to challenges the region faces amid a growing unskilled labor

pool. Klowden is a frequent speaker on state fiscal issues and has served on multiple advisory boards on business growth, economic development and infrastructure. He holds graduate degrees from the University of Chicago and London School of Economics.

Peter Marx

Mayor Garcetti appointed Peter Marx as the city's first Chief Technology Officer. A key part of Mayor Garcetti's back to basics agenda, Marx will oversee the implementation of new tools and technologies across L.A. city government better solve problems for residents and make City Hall work more efficiently and effectively. In addition, he will partner with L.A.'s growing tech industry to deploy innovative technology and promote local job creation.

Before joining the Mayor's Office, Marx served as the Vice President of Business Development at Qualcomm Labs, Inc., commercializing a variety of emerging technologies. Previously, Marx was the Vice President of the Technology and Digital Studio at Mattel, Inc. where the company received a Webby award, the highest award for excellence in online content. Marx managed Analog Protocol, a media-technology consultancy; served as the Chief Technology Officer for Vivendi-Universal Games and Vice President of Emerging Technologies for Universal Studios; and held engineering and producer positions at Electronic Arts. Early in his career, he served as an engineer on a variety of telemedicine, digital video, radiological imaging, and biomedicine applications for UCLA and 3M Company.

This appointment is the latest in Mayor Garcetti's efforts to reform and reorganize City Hall to make it more efficient and effective in serving the people of Los Angeles.

Will Koch

Deputy Director
California Competes Tax Credit Program
Governor's Office of Business and Economic Development (GO-Biz)

Will Koch was appointed by Governor Brown as Deputy Director of the California Competes Tax Credit Program at the Governor's Office of Business and Economic Development (GO-Biz) in May 2014.

To date, the California Competes Tax Credit program has awarded over $179 million in tax credits to California businesses to create a projected 35,000 jobs and make over $9 billion in investments. As Deputy Director for legislative affairs at GO-Biz from 2012 to 2014, Mr. Koch had an instrumental role in the development and enactment of Governor Brown's Economic Development Initiative.

From 1998 to 2012, Mr. Koch held multiple positions at the California Franchise Tax Board, including legislative analyst, personal income tax technical advisor, and tax compliance specialist. He earned a bachelor's degree in accounting from California State University, Sacramento.

Craig Hagen
Electronic Arts, Inc
Global Government Affairs

As the global head of government affairs, Craig Hagen, is responsible for the management of all government relations and public affairs for Electronic Arts Inc. This includes EA's interaction with federal and state governments on a wide range of policy issues including restrictions on game content and retail sales, game ratings, tax and economic incentives, labor standards, immigration, talent development and many other issues.

Craig is the company's liaison with numerous industry trade associations around the world and works closely with EA's CEO, General Counsel and Vice President of Public Policy on the implementation of key public affairs objectives. He currently serves as Chairman of the Board of Directors of the Entertainment Software Association of Canada and is on the Board of Directors of the Foreign Direct Investment Association.

Craig joined Electronic Arts in 2003. He was formerly a Director of Human Resources for America Online, Inc., (AOL) where he led that function for South America within AOL's international subdivision.

He served two terms as the elected Commissioner of Labor for his home state of North Dakota.

Craig received a Bachelor of Arts degree in history and political science from Jamestown College in Jamestown, ND.

Craig and his husband, Ben Arvizo, make their home in Orlando, FL.

Walt Scacchi, PhD.

Director of Research, Institute for Virtual Environments and Computer Games
Senior Research Scientist, Institute for Software Research
University of California, Irvine

Walt Scacchi is Director of Research at the Institute for Virtual Environments and Computer Games, and also Senior Research Scientist and research faculty member in the Institute for Software Research, both at University of California, Irvine.

He received a Ph.D. in Information and Computer Science at UC Irvine in 1981. From 1981-1998, he was a professor at the University of Southern California. Dr. Scacchi returned to UC Irvine in 1999.

His research interests include computer game technology and culture, open source software development, virtual worlds for modeling and simulating complex engineering and business processes, and software acquisition. Dr. Scacchi is an active researcher with more than 170 research publications, and has directed more than 65 externally funded research projects. His most recent book is *Computer Games and Software Engineering* (2015), CRC Press, Francis & Taylor Publications.

He also has had numerous consulting and visiting scientist positions with more than 40 firms or institutes, including five start-up ventures. He served as General Co-Chair for the 8th. International Conference on Open Source Systems in 2012, Co-Chair of the 4th. Games and Software Engineering Workshop at the 2015 International Conference on Software Engineering, and UCI Distinguished Alumnus in Information and Computer Science, in 2012. His recent activities and research publications can be found at http://www.ics.uci.edu/~wscacchi