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Deconstructing Game-based Systems: What are They? What Really Matters?

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Deconstructing Game-based Systems: What are They? What Really Matters?

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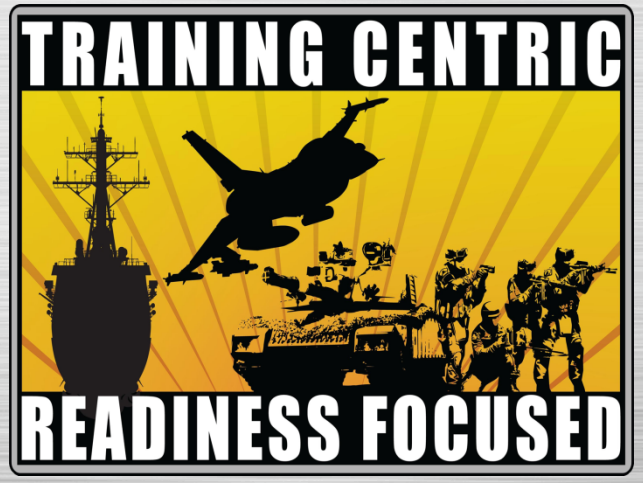

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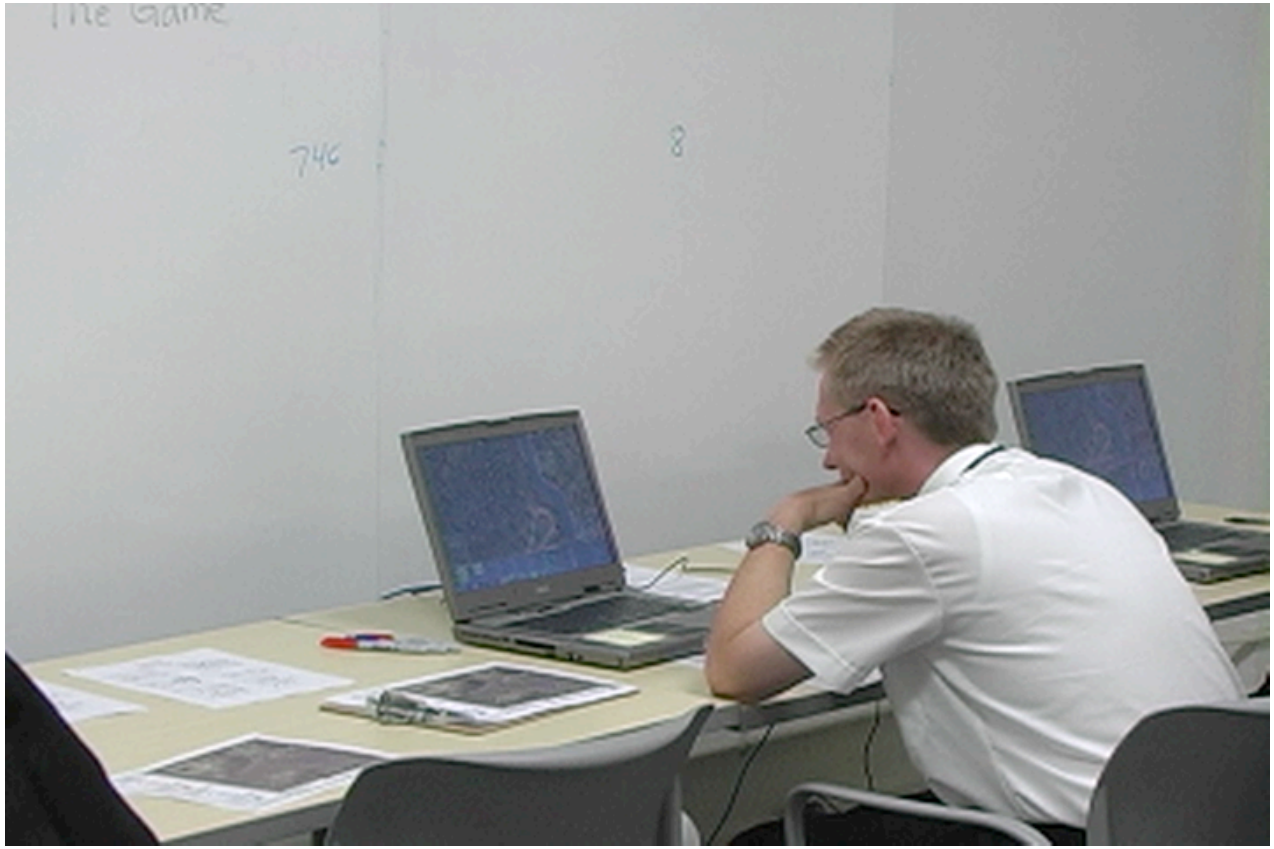


User study, Marine Victory in CCM

Learning Objectives: You Will…

1. **Understand training needs & a role of game-based systems in satisfying them**
2. **Learn the basic postulates of game-based systems and know to differentiate them for other computer supported environments**
3. **Acquire clear understanding about major structural components in game-based systems, and how they relate to user's experience.**
4. **Get acquainted with several examples of game-based systems & research studies**
5. **Acquire basic understanding about the large scale adoption issues**

Audience: military personnel, acquisition specialists, instructors and managers in simulation centers, and other people who currently provide or plan to provide training using game-based systems.

Tutorial Outline

1. **Let's start with the needs & current practices**
2. **Define the world of computer assisted training environments**
   - Simulations, virtual reality systems, virtual environments, game-based systems
3. **Game-based systems: the main structural components**
   - Hardware and software
   - Human factors
   - Training methodologies & pedagogies
4. **Examples of game-based systems used in training**
5. **Examples of research studies & their findings**
6. **Situations to consider in training context:**
   - Using off-the-shelf games for training
   - Negative training transfer
7. **Large scale adoption issues**
8. **Summary**
9. **Bibliography**

What are they?

What really matters?

1. Military Training: Needs & Current Practices

<u>Situation</u> that military community deals with:

- changes of doctrinal teachings & mission objectives
- operational tempo changes dramatically
- unsatisfactory retention rate for the servicemen and servicewomen
- … but no performance drop-off is allowed!

<u>Training needs</u>:

- train a large number of skills
- train a large number of people
- involve fewer instructors
- train in novel ways & motivate learners
- train in novel places & under novel conditions
- acquire new skills, learn & do novel tasks
- save material and logistical resources

… and achieve all that in a shortest period of time possible!

1. Military Training: Needs & Current Practices

Can the computer-supported training environments, including game-based systems, be a solution?

- Trey are not a panacea
- They are not the only solution
- They will not provide a complete solution
- … but most likely they will be a good part of that solution

1. Military Training: Needs & Current Practices

Why should we use them? Today they are:

- mature enough (robust, reliable, enable more intuitive interaction…)
- affordable
- they have a potential ** to:

1. Enable more effective learning/training:
   - learn more, quicker, retain skills and knowledge longer, less cost involved
2. Increase interest and motivate learners/trainees
3. Enable learning/training situations that would not be possible otherwise
4. But also, very importantly, they correspond with contemporary lives of its users

** 'have a potential' NOT EQUAL to 'will' or 'always'

1. Military Training: Needs & Current Practices

<u>Other reasons</u> to use game-based systems in training & learning:

- Provide rich visual and spatial representations
- Simulate rich environment with multiple sensory information coupled together in an organized way - video, audio and other stimuli in a sync
- Provide immediate feedback to learner's actions, and enable a creation process (constructivist approach to learning)
- Include the elements of storytelling and narration. Enable role-playing and experimentation
- Engage user in active learning process and enhance experiential learning - users are no longer passive observers

1. Military Training: Needs & Current Practices

<u>Other reasons</u> to use game-based systems in training & learning (...cont):

- Engage people in most intuitive way (as compared to some other media) - they provide life-size and life-like communication and interaction
- Can be fun and motivate users for learning (training)
- Adaptable for different skill levels and learning styles
- Enable high level of presence (this may influence performance)
- Immerse users in problem-solving activities
- Easy to play out a number of different situations and what-if scenarios → perfecting skills
- Self-selection of the level of difficulty → ownership over the learning process

1. Military Training: Needs & Current Practices

Caveats:

- Simulations & game-based systems (technology in general) are only the tools - not a goal and not a 'full' package, just one segment of that package
- They are not the ultimate replacement for current / traditional training approaches
- They should be employed when they represent a better solution for a given training / learning objective. NOTE: need to define the meaning / metrics for 'better' in a given training context

Efforts should be directed towards coupling of learning & training objectives and goals with right approaches, right tools, having in mind a specific audience one deals with, and a specific point/place they are in their training regimen.

1. Military Training: Needs & Current Practices

Current practices: <u>Modes of use</u>

a) **Mandatory use**:

- Pilots: 40% of flying hours on flight simulators
- Highly specialized skill set: ship, submarine & tank navigation; missile engagements, vehicle rollover

Common denominator: Results were substantial, tangible, clearly visible, with high relative advantage and immediate results

b) **Optional use**:

- All other domains (e.g. tactical decision-making skills, language skills)

Common denominator: Relative advantage visible only after a long term use

1. Military Training: Needs & Current Practices

Current practices: Perceived trends

Expectations vs Reality:

- Black-box solution… just a wishful thinking
- One time exposure only + short exposure
- Unrealistic expectations on learning results and timing: more complex & more expensive solution → higher the expectations

Attitude:

- Training or 'fun'?
- Lack of evaluation of training effectiveness
- Lack of accountability for achieved training results & skill transfer

Misplaced Motivations:

- Motivation: "Checking the 'technology' box"
- Hope for BIG savings - "This will help us reduce the number of our instructors"
- "This system is all you will ever need"
- "These systems will (should) sell themselves"
- "It will be a 'pull' process only, no need for 'push' strategies"

1. Military Training: Needs & Current Practices

Current practices: Perceived trends (… cont.)

Curriculum Issues:

- Absence of 'full package' solutions
- Wrong order of skill mastery
- No syllabus, no high-quality scenarios
- Not matching system capabilities and levels with users
- Missing training relevance (need for continuous updates)
- Rigid definition of what it means to 'use the technology': 100%, 50% or 3% of training time?

Issues in Delivery:

- Lack of formal training for instructors
- Timing not appropriate
- Disconnect between the systems and (right) users
- Time to get acquainted with the system not calculated in
- "We will start preparing for deployment once the training system is acquired

Missing validation of game-based systems!

2. Definitions

Simulation: a computer supported dynamic representation of world phenomena. Involves complex mathematical models. Generates visual, auditory, haptic / tactile and/or olfactory sensory stimuli.

- Examples: simulation of weather changes, wind and fluid flow, weapon ballistics, animal or human skeleton & muscle movement, facial animation, aircraft flight, crowd movement, material damage

"Don't think of that thing as a screen, think of it as a window, a window through which one looks into a virtual world. The challenge to computer graphics is to make that virtual world look real, sound real, move and respond to interaction in real time, and even feel real."

(Dr. F. Brooks paraphrasing the ideas presented in Ivan Sutherland's essay "The Ultimate Display")

2. Definitions

Virtual Reality (VR): a system technology, hardware & software. Interactive computer-simulated 3D world through which a user can advance/move and interact, and images of that world being changed accordingly.

Virtual Environment (VE): a simulation, a totality of different sensory information coupled together in an organized way providing a meaningful context for human action and collaboration.

Virtual Environments (VEs) or Immersive Virtual Reality (IVR) (definition by Dr. Fred Brooks).

Ingredients:

- Real immersion – world is life size, the rest of blocked out
- Real time – viewpoint changes as head moves
- Real space – 3D worlds, concrete or abstract
- Real interaction – one manipulates virtual objects

2. Definitions

Game-based system: computer-supported real-time system that couples multiple sensory information (visual, auditory, haptic and /or olfactory) in an organized way providing a meaningful context for human action and collaboration. Also includes the elements of:

1. **Content**: representation of environment, actors and characters (one or many). Typically 3D world, but it can be 2D or 2.5 D
2. **Storyline** / plot / scenario
3. **Roles** that all actors and characters have
4. **Tasks & goals**
5. **Dynamics**: set of rules, behaviors and interaction modalities
6. **Elements of competition**: levels, teams, results

2. Definitions

Games → entertainment domain. Emphasis: players having fun!



Smart games → training & learning domains

- Concerned with validity, correct simulation of physical phenomena and human behaviors, metrics and measurements
- Other application domains: advertizing, politics



3. Game-based Systems: Components

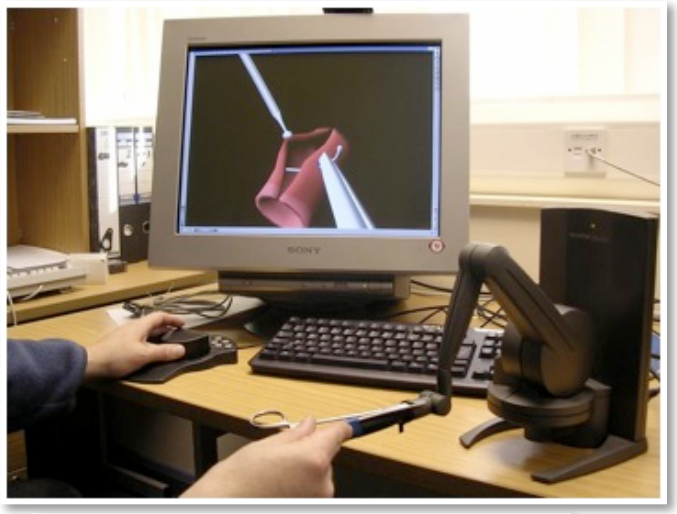
1. **Technology (hardware and software):**
   - hardware and software platforms
   - input and output devices
   - game engines (proprietary and open source), DIS, HLA
2. **Human factors**
   - sensory modalities
   - usability issues
   - representation of terrains/environments and humans
   - interaction techniques
   - navigation and locomotion, spatial awareness
   - object manipulation
   - health and safety issues
   - immersion and presence
   - performance evaluation
3. **Training methodologies & pedagogies**
   - timing and frequency of using training environments
   - role of instructors
   - trainees' motivation and involvement
   - peer review and peer pressure
   - trainees as computer specialists (support)
   - training the trainers

3. Game-based Systems: Technology

Displays

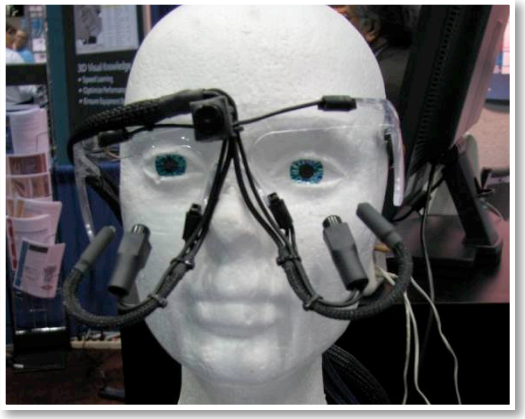
3. Game-based Systems: Technology

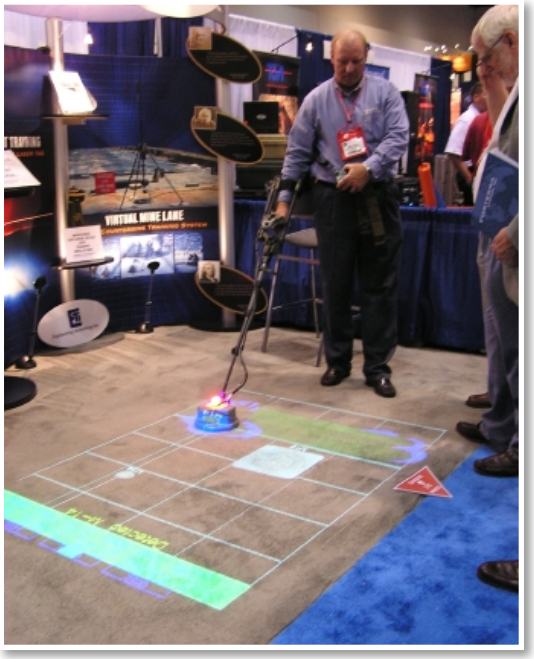
Input devices



3. Game-based Systems: Technology

Input devices





3. Game-based Systems: Technology

Hardware platforms:

- off-the-shelf: typically PC platforms
- specialized: custom made with special features (haptics, motion platforms)

Software platforms & Game engines:

- proprietary: RenderWare, Truevision 3D, Unreal Engine, Vengeance Engine, …
- free or open source: Arianne, Axiom Engine, Delta3D, RealmForge, Panda3D, …

Standards:

- scene representation: objects, characters/actors, terrain
- animation, physics
- networking
- data archiving & exchange, DIS, HLA

3. Game-based Systems: Human Factors

Definition of HF: The field involving research into human psychological, social, physical and biological characteristics, and applying those results with respect to the design, operation or use of products or systems for optimizing human performance, health, safety and habitability

Interdisciplinary study:

- psychology (cognitive, social, industrial, perceptual, organizational, experimental)
- engineering
- sociology
- computer science
- anthropology
- anthropometry
- design (industrial, interaction, graphics)
- environmental medicine
- statistics

3. Game-based Systems: Human Factors

Areas of interest:

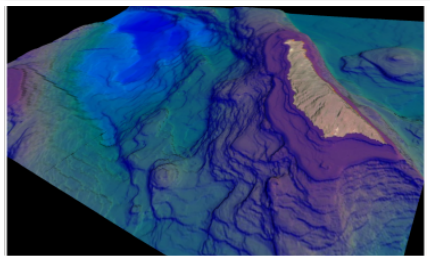
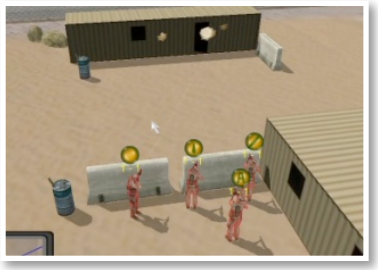
- workload
- fatigue
- situational awareness
- usability
- user interface
- learnability
- attention
- vigilance
- human performance
- control and display design
- stress
- visualization of data
- human comfort
- ease of use
- reliability
- system performance
- maintainability
- user acceptance
- economy of production
- accessibility
- individual differences
- cultural and group differences
- organizational culture
- social interactions
- aging
- shift work
- work in extreme environments
- human error
- ethics

3. Game-based Systems: Human Factors

- **Sensory modalities**: visual, aural (2D and 3D), vestibular, kinesthetic, tactile/ haptic & force feedback, olfactory

- **Usability issues**: The effectiveness, efficiency, and satisfaction with which specified users can achieve specified goals in a particular environment

- **Realistic representation of terrains, environments, human appearance & behaviors**

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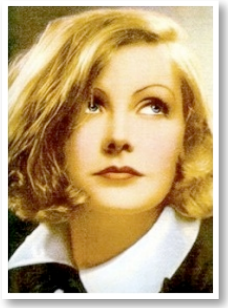

3. Game-based Systems: Human Factors

- **User interaction**: navigation, object selection & manipulation, system control

User navigation:
- pressing a button vs
- walking in place vs
- real walking?

- **Health and safety issues**: avoid, minimize and eliminate human discomfort harm and injury

- **Immersion** (system characteristic) & **Presence**: the extent to which a user feels present in virtual / simulated environment as opposed to his immediate physical environments

- **Performance evaluation & efficiency:** build a system that minimize a learning (on how given system works) but maximize the information yield

Now that you know what game-based systems are, it's time to look at **what matters to the users:**

Who, How, Why and When to use them.

3. Game-based Systems: Training Methodologies & Pedagogies

Some issues to consider:

- **Start** with defining your training objective(s). Only THEN look for:
  - the best / optimal training approach, and then
  - the best / optimal training environment(s)
- Consider optimal **timing** and **frequency** of using training environment(s)
- Consider **a combination** of different training approaches and training environments
- What **role** should the **instructors** have? Do you expect them to be the instructors and tech. experts and moderators and …
- Set the right framework for **trainees' motivation** and **involvement**. Could they also be your computer specialists (support)?
- Make an **introduction**, provide a **context**; training does not start when the trainees sit at the computers
- Consider using **motivation tools** like peer review and peer pressure
- **Training the trainers** is different from training the trainees. Also, do not consider the trainers will automatically know how to use game-based systems in training

3. Game-based Systems: Training Methodologies & Pedagogies

More issues to consider:

Q1: Do my trainees need any prep time before they engage in active learning/training?

- Absolutely!

Q2: Do I need to bring any aids? Cards? Projector? Recording devices? And how about the use of headphones?

- Most likely

Q3: What should I do when the trainees start gaming (playing around, using non-doctrinal tactics)?

- Example of one solution: peer pressure as motivation tool

Q4: How should I arrange my computers (I need to organize a session for an entire group)?

- If possible, match that arrangement with potential operational situation

Q5: Should I think about introducing elements of a challenge or competition?

- Possibly. You know your audience/trainees best, so make the most appropriate decision

4. Examples of Game-based Systems

1. **Tactical decision making:** CCM, VBS, America's Army

America's Army

- It is a **game**. Started as a recruitment tool, not as training system
- Substantial promotional efforts invested
- Has active support: support forums, organized events for peers (gamers) and chat networks
- Professional web-site with expected segments focused on engaging new players: expanding user base is their mission
- No user ('transfer of training') studies done
- No validation done

4. Examples of Game-based Systems

2. Language and tactical cultural skills:

Tactical Iraqi

- It is a **game-based system**. Has integrated a training management segment.
- Part of Deployable Virtual Training Environment DVTE suite (USMC)
- Use not mandatory
- Not widely known among intended users
- Word of mouth ‘promotion and advertising’
- Ongoing user studies

4. Examples of Game-based Systems

3. **Flight simulators:** Microsoft Flight Simulator
4. **Convoy courses:**

Virtual Combat Convoy Trainer - VCCT

- Special platform: 360 wrap-around imagery, mock-up vehicles
- Team performance
- Individual Marines not tracked (position in space); weapons actions recognized
- Good combination: training with VBS, then in VCCT
- No user ('transfer of training') studies done
- No validation done




5. **Call for fire:** FOPCSim

5. Examples of Research Studies

Topics explored:

1. **Different human factors issues:** display size, input devices, user interfaces, representation of humans and environments, team collaboration, situation awareness, cybersickness
2. **Validity of simulations**
   - Goerger, S.R., McGinnis, M.L., and Darken, R.P. (2005). A Validation Methodology for Human Behavior Representation Models. The Journal of Defense Modeling and Simulation: Applications, Methodology, technology 2005, 2(39). pp. 39-51
3. **Efficiency of different systems and approaches in training the same skill set:**
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4. **Training transfer effectiveness:**
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   - Brown, B. (2010). A Training Transfer Study of Simulation Games. Master thesis, NPS
5. **Possibility of using off-the-shelf solutions in training**
   - Nolan, Joseph M. and Jones, Jason M. (2005). Games For Training: Leveraging Commercial Off The Shelf Multiplayer Gaming Software For Infantry Squad Collective Training, Master Thesis, NPS.

Common denominator: very few (if any) large scale studies with domain / end users

6. Situations to Consider

1. **Using off-the-shelf games for training**
   - Nolan, Joseph M. and Jones, Jason M. (2005). Games For Training: Leveraging Commercial Off The Shelf Multiplayer Gaming Software For Infantry Squad Collective Training, Master Thesis, NPS.

2. **Beware of possible negative training transfer**

   Reasons:
   - imperfect and not validated simulations - incorrect mathematical or behavioral models
   - wrong perception of time
   - lack of important stimuli when learning a new skill (audio, force feedback)
   - system used in a wrong way
   - system provides more than what will be available in relevant operational context

3. **Alienation of user population:**
   - Should learners' working hours (school, unit) be as contemporary as their free-time?
   - Is the alienation from a 'clunky' & 'old' segment of learner's life possible to happen, and how can one address it?

7. Large Scale Adoption Issues

A paradigm shift - truly and successfully enabling novel training practices, and achieving significant results, happens only when:

- large majority (ideally everyone) uses those solutions
- they do it methodically and consistently
- they have those solutions available 24 / 7

What is the problem?

- Affordable solutions, substantial and continuing investments, fairly well recognized and acknowledged potential do exist nowadays…
- … yet still no evidence of large scale adoption of technology-based solutions and their effective and systematic use for learning and training purposes
- Return of investment (ROI) & accountability … anyone?

Large scale: > 80 % users

7. Large Scale Adoption Issues

Diffusion of innovation:

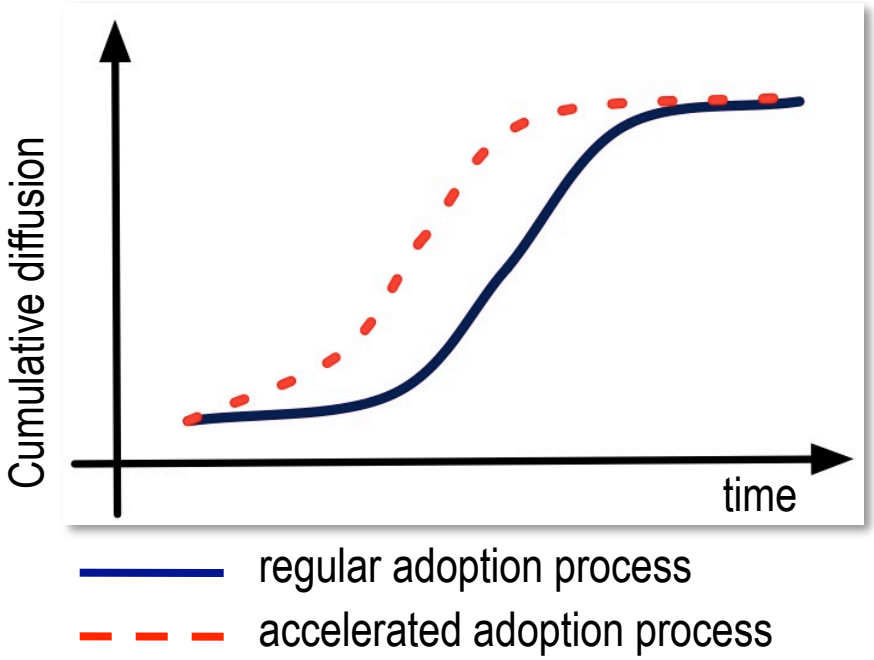
- It is a technical issue AND social process.
- Important message: Innovations do NOT sell themselves.
- Our focus: what happens AFTER a system is acquired
- Our goal: maximize the return of investment (ROI)

Categories of adopters

1. Innovators
2. Early adopters
3. Early majority
4. Late majority
5. Laggards

Special roles:

- opinion leaders
- change agents
- change agent aide



[Everett M. Rogers, Diffusion of Innovation]

7. Large Scale Adoption Issues

Parameters influencing adoption rate:

1. **Relative advantage**: benefits over current solution
   - Bigger the benefits → faster the adoption
2. **Compatibility**: degree of being consistent with current system of values
   - New system more compatible with current system → easier to adopt new system
3. **Complexity**:
   - Simpler to understand & simpler to use → faster the adoption
4. **Trialability**:
   - Adoption possible in an incremental fashion → easier to adopt new system
5. **Observability**:
   - Results being visible to other adopters → best 'advertizing' and faster adoption

and also:

6. **Users' attitude:**
   - Unfunded and unrealistic expectations → slower the adoption

7. Large Scale Adoption Issues

Affecting (accelerating!) adoption rate

Practical considerations and techniques for successful adoption:

Q: Is it realistic to expect that all instructors will have necessary technical expertise and experience?

Possible solution: Trainees acting as (occasional) technical support:

- active involvement vs. 'being served' approach - instills a sense of ownership over the process
- great opportunity to learn more about technology - they may need those skills in a very near future
- recognition of their current (highly valuable) skills
- higher appreciation for instructor's efforts
- more forgiving when technical difficulties get experienced

7. Large Scale Adoption Issues

Affecting (accelerating!) adoption rate

Practical considerations and techniques for successful adoption:

Q: (Valid concern): Certain tasks represent considerable cognitive load for an individual - do I add to that by asking them to control an input device in addition to their already complex tasks?

Q: Could the experience of watching someone use the system be another form of learning?

Possible solution: Consider different combinations and arrangements with some people using the system and some not using it (second group perhaps using it later on).

The goal: **ALL** trainees should benefit from that arrangement and that session.




7. Large Scale Adoption Issues

Affecting (accelerating!) adoption rate

Practical considerations and techniques for successful adoption:

Q: How beneficial is it to use a combination of new and old tested instructional approaches? What is a potential this combination may bring?

- They work (quite often very successfully)
- This combination may be the best fit for training objective; make appropriate combinations for beginning, intermediate, advanced levels
- 'Old' approaches serving as 'suspenders' in case of hasty behaviors while training with simulations
- Instructors are familiar with 'old' approaches – they may be more inclined to accept a combination then simulation-only approach

7. Large Scale Adoption Issues

Affecting (accelerating!) adoption rate

Practical considerations and techniques for successful adoption:

Knowing the characteristics of military as a social system:

1. **Introduce mandatory** deployment and **use** of simulations

   If you do, make sure there is a strong and valid rationale for such decision. Also, make sure it is accepted on ALL levels

2. **Increase a number of agents of change**:

   Create new billets dedicated to dissemination and use of simulations + make the simulation focus be the main focus (primary MOS)

3. **Create more active and changed role for simulation centers**
4. **Introduce challenge programs & competitions**

8. Summary

What did we learn about today?

1. Military training needs & current practices
2. Definitions: simulations, virtual reality systems, virtual environments, game-based systems
3. Game-based systems: the main structural components
4. Examples of game-based systems used in training
5. Examples of research studies & their findings
6. Situations to consider in training context
7. Large scale adoption issues

8. Summary

Messages at the end:

1. Technology is only a tool, not the ultimate goal
2. Game-based systems are only a part of the solution, not the entire solution
3. Game-based systems, like any innovation, will NOT sell itself. A considerable effort needs to be invested so they do get adopted and used by masses
4. Efforts should be directed towards coupling of learning & training objectives and goals with right approaches, right tools, having in mind a specific audience one deals with, and a specific point/place they are in their training regiment

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Shameless advertising:

Paper session: S 320A, Tuesday, 16:00

"Validating Visual Simulation of Small Unit Behavior"

Q & A