CONSIDER THE DEFINITION OF SIMULATION

Explore the Universe for the Benefit of All Humankind
Priscilla Elfrey, NASA,KSC,IT/C1
Toward a Unified Theory of Simulation

Landscape of Consequential Complexity Requiring
NEW VISION:
Purpose, Perception ,Practice & Performance
NASA MISSION:
Explore the Universe for the Benefit of humankind

And share what we learn & Take on challenging issues
Daunting, daily reminder

• We know less than one millionth of one per cent about anything.

• Thomas. A. Edison
• We use Simulation in all professions, disciplines, & industries-- advanced manufacturing to zoo keeping

• Consequential, complex situations and behaviors involving: time, money, injury, life, death, missions, nations, the world

• Dense dynamic data can disguise what we need to know about situations-- systems, events, programs, phenomenon, accidents, catastrophe, missions.

• Simulation brings us beyond analytics to gain insight into difficult—even—wicked problems and critical challenges

• The mismatch-- **between the situation now and desired goal provides opportunity for simulation**
AT WORK

- For NASA -- **to go** where no one has gone before
- **Change** how we manufacture, communicate, travel and live
- **Take risks---responsibly---personal** to international
- **Respond to** hurricane, floods, fire and other natural disasters
- **Learn** to save lives and **do what seems impossible**
- **Push limits** of humans, machine and systems with no one or anything getting hurt
- **Solve** differences to give peace & harmony a chance
- **Create** a resilient teams
- **Prevent** and solve high crimes and other human-caused disasters
- **Clean up** after human and natural disasters
- **Save** the Planet
NOT EASY

• We have constructed a world in which the potential for technical catastrophe is embedded in the fabric of everyday life.

  • Malcolm Gladwell

• Richard Severinghaus, Policy Chair, National Modeling & Simulation Coalition, NMSC, adds, Not just ‘technical’ catastrophe-- True of social & political & economic issues as well.”
AND YET

- Despite this scope and value
- The Department of Labor denies it industry status
  - Says it is only software development
- The Meriam Webster Dictionary defines it as “imitation reality.”
  - Imitation means fake, cheap, copy as in imitation crabmeat, leather, diamonds
- Both are wrong!
  - Simulation predates computers by 1.4 million years, involves more than software and it is not imitation anything
- Simulation is serious problem solving technology
HUMANS CREATE TECHNOLOGY

• Simulation was invented and is constantly reinvented-- by and for us, a curious, questioning, fragile, often, adventurous, but “error-prone specie”. It both protects us from ourselves and helps us think, rethink and act more efficiently & effectively
MIND-SHIFTING

• Simulation models complex dynamic information about massive complexity, systematically impacts our blind spots & opens us to possibilities, so that individuals and teams can learn & work on consequential, even multi-decadal challenges.

• Requires education and skill...
BUT...

• “TOO FEW EXPERTS TEACH DISTRIBUTED SIMULATION”
  • Simon Taylor, Brunel University faculty advisor & SEE Honorary Executive Chair.

• Few people —if any?-- have the Big Picture of what simulation is or should, could or might be & do. And how to make that happen.

• SEE, like IMPET, is one step that seeks change to increase awareness of simulation’s educational & performance value
LANDSCAPE

• Simulation brings data, patterns, decisions, skills. learning, stories and and, more questions to life with

• PURPOSE
• PERCEPTION
• PRACTICE
• PERFORMANCE
#1. PURPOSE: DEFINE IT

• Identify both the problem or challenge and the desired outcome recognizing both complexity & consequences

• “Keep your eye on the Main event” -- the heart of the matter

• Start the correct story correctly
• Address uncertainty & ambiguity
• Ensure that everyone on the team can define the purpose of the simulation
• But be alert to change: the building, that should not, may crumble.

• Semi-jokingly but seriously--Simulation-- like Space-- is far too important to be left solely to scientists and engineers
PURPOSE: FOR SPACE EXPLORATION

• Safety first and always
• Address unknown to achieve success
• Life cycle design

• Concept to virtual prototype
• Development, practice, testing, training
• Performance, validation, review
• Operations to archive

• Shuttle engine lost in flight, “everyone knew what to do because of simulation training &” it came out all right.”

• When humans have to go where humans cannot go—simulation is the sole solution.

• Roy Bridges
PURPOSE: LIFE-LINE

- Filming Human Patient Simulator
- Programmed as male and female with differing life styles and medical issues
- Experience life and death situations but no one gets hurt or dies
- Trainees revived "patient" quicker (saving over 60 seconds in 3 repeated exercises) showing increased confidence & skill.
- "I was not afraid to try everything I had learned because in the back of my mind, I knew it was a simulator."

- When you need to be an expert, the first and every single time & lack 10,000 hours to become one.
#2. PERCEPTION: MINDSHIFT

- Recognize **need for best ideas from team**
- Surface **possibilities** for success
- **Design** simulation to surprise: the “AHA!” factor “I did not know that.” “Now, I see what I have to do”, “I get it.”
  - Surprise people with new story, new information, new perspectives

- **Benefit from diverse team offering different experience, knowledge and skills—different way of seeing the problem**
  - “It is difficult to think outside the box when everybody is in the box”
  - Natani Atkins
PERCEPTION: BLIND SPOTS

• Like being in the dark
• Unsure of what is there
• Not obvious what to do next
• Not know why.
IMPACT

- Design not happenstance
- Shift perspective
- No explanation needed
- Science, math, ethics, engineering sensory, systems, behavior, culture, arts, story,
- It takes a team with some outside the box

- “The purpose of a liberal arts education is to find the light switch in the dark.”
  - Horace Taft
#3 PRACTICE: TEST IT

• Question everything: models, decisions, answers
• Analogues -- Not always about computers:
  • Mental simulation (9/11),
  • Drawings, maps, stories, animation, film
  • Case studies, moot court, grand rounds, role play & psychodrama,
  • Adaptive tools, training vices, “props” test environments”,
    -- “hand holds” for Space,
  • Example: Apollo 13 fitting “square peg in round hole”.

• **Not what things—or people— designed to do but what they can do.**
PRACTICE: AN OLD SOUL

• Simulation is one of our first technologies --predates computers by 1.4 million years-- -- problem solving & survival..

• Symbol-ready ,pre-language ancestors developed and practiced mental & analogue simulation as life-saving learning & practices.

• Example: For tool acquisition and travel safety
  • Demonstrates obsidian tool superiority
  • Gestures, draws map in dirt to obsidian site
  • Others offer data to avoid danger

• New Perspectives & possibilities
• Problem solving
• Aid planning & performance
Our Ancestors knew their tools
PRACTICE: APPARATUS FOR TEACHING SWIMMING

• Called an oddity today but serious in 1874

• In 19th Century, swimming -- a new sport
• Frequency of drownings caused alarm
• Rescuers often drowned, unable to swim
• Dozens of inventors responded.
• This one based on mechanical loom
• Lessons at an indoor swimming school
• Patterned popular strokes
• : : breast, back and free-style
• “You get in and learn to swim, and then, go in the water”
A Patent for learning “instinct”

- **Inventor:** William Redfearn, Philadelphia, Pennsylvania
  **Date:** March 31, 1874
  **U.S. Patent Number:** 149,249

**Description:** Device for facilitating the teaching of swimming by accustoming the limbs of the learner to the several movements required, so that upon taking to the water, **the learner will instinctively make the same movements**, and will be enabled to swim perfectly **after comparatively little practice.**
PRACTICE : IT TOOK A WAR...

• WWI History of DeFlores & he Guggenheim estate—Technical Training Devices inspired by use in UK.

• Link “pilot-maker” the Blue Box” based on hydraulic technology -Flight System, 1929, Air mail, 1934—WWII trained 500,000 aviators

• In 1965, Military modeling, simulation training equipment moved to Orlando, 1965 followed shortly by building of Central Florida Research Park and University of Central Institute for Simulation & Training —Army, Navy, Marines, Air Force & Coast Guard and 140 companies.

• 1993, Technology Reinvestment Program ,TRP, Center for Simulation & NASA---

• 1996 to ITEC (First encounter Genoa University leading to: interns, exchange visits, Summer School in Bergeggi, IEPAL,SEE, IMPET...today!
#4 PERFORMANCE: MAKE IT WORK

• Simulation products & services are **never** complete until someone does something with them
• Demonstrate progress toward desired outcome, even, success
• Validate purpose, perception and practice with performance.
• Debrief and review
PERFORMANCE ANALOGY

• A play is a story performed by actors before an audience.

• Only a script until performed—Then and only then is it a play

• During performance, audience engages in change in story, character or themselves.
PURPOSE TO PERFORMANCE

• Simulation is a story, derived from dynamic data, designed, developed & shared by individuals and teams to illuminate something complex and consequential in order to understand complexity and consequences better:
  • See possibilities
  • Value and respect multi-disciplinary technologies & transdisciplinary teams
  • Recognize what is important and share that information with others
  • Make corrections faster, fewer errors and none where it counts
  • Be effective in new situations and better able to solve old problems and do things we could not do before.
  • Explore the Universe and save what is within—peacefully-- it as we are educated and inclined to do.
TAKES A TEAM

• A simulation is a transformative problem-solving experience in which mathematics, science, culture, engineering & tools, as well as the landscape interweaving purpose, perception, practice and performance play their parts.
FUTURE SIMULATION TOOLS?

• Over the millennia, simulation technology changes, using & integrating what is available:
• Role play, analogues, visuals & story evolve
• Gestures, stick and stones still sshape the interactive map
• Industrial age mechanics & hydraulics
• Today—computer, intelligent agents, virtual reality, artificial intelligence, mobile devices

• What is next? Holograms and holodecks? Or what?
  • “Forecasting is very difficult especially as regards the future”
Personal Note -- Connected Simulation Community

• Together, to addresses uncertainty, ambiguity, complexity, perception and consequences while representing dynamic data, integrating science, culture and art to create knowledge wisely, savor and save the world, achieve peace and explore the universe we are trained and inclined to do.

• Priscilla Elfrey

• priscilla.r.elfrey@nasa.gov

• www.exploresim.com