INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

Systems Engineering Implications of Neuroscience Discoveries

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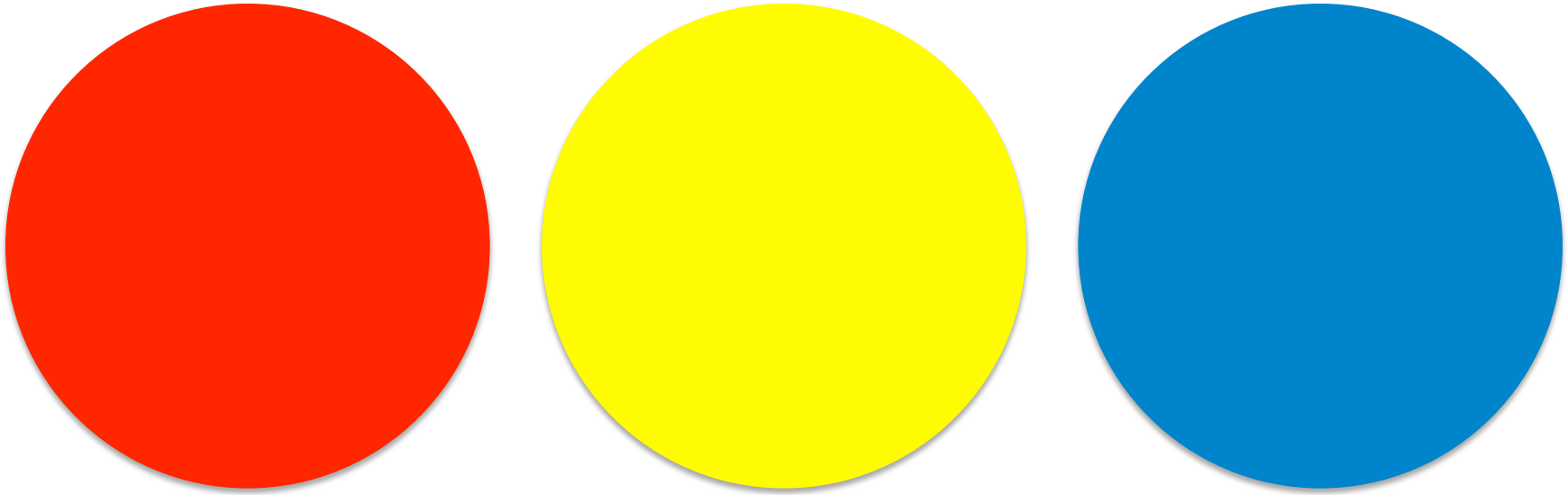
Topics

- The problem
- Discoveries in Neuroscience and Behavioral Economics
  - What are cognitive biases?
  - Why do they matter?
  - Some examples
- Implications for Systems Engineering

The Problem

- SE practices/heuristics assume:
  - participants behave rationally
  - communications work effectively
- Sometimes . . . . . success
- Often intended results are **not** obtained, even with practitioners' & stakeholders':
  - **good intentions**
  - **extensive knowledge**
  - **impressive skills**

How Many Dots?



“So What” for Systems Eng

- Assume we all have filters
- Vary communications with stakeholders, and probe to identify their filters, especially:
  - Success criteria from their perspective
  - Risks from their perspective and their risk tolerance

Rescue Mission Decision

Situation: one astronaut is stranded in orbit on a failed space ship

1. Do you want to send two astronauts on a risky rescue mission with a 20% chance that both they and the stranded astronaut will perish?

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2. Do you want to send two astronauts on a rescue mission with an 80% chance they will succeed in bringing the stranded astronaut safely back to earth?

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Rescue Mission Decision

- Same facts, different decision!

Decision 1 **Decision 2**

“So What” for Systems Eng

- Communicate using multiple “frames”
  - Frame with payoff/benefits of each choice
  - Frame with risks of each choice
- Encourage stakeholders to identify
  - Worst possible consequences
  - Positive outcomes

Choosing a Car

My requirements for a car

- Good gas mileage
- Low cost
- Easy to repair anywhere in the U.S.
- Able to transport 2 grandchildren

Choosing a Car

My requirements for a car

- Good gas mileage
- Low cost
- Easy to repair anywhere in the U.S.
- Able to transport 2 grandchildren
- **Toyota Prius meets your requirements**

Hmmm . . .

But I Really Want . . .

The Prowler

Violation of Utility Theory

“So What” for Systems Eng

Violations of Utility Theory

- Look for unstated requirements (e.g. the car makes me look sexy)
- Relative priority of different requirements – look for multiple ways to assess/confirm
- Consider possibility requirements may have changed since project inception

Al Gore's Sound Bite

- When Al Gore was asked on October 3, 2000 in a Presidential debate for his plan on Social Security, he said "I will keep it in a lockbox. The interest savings, I would put right back into it. That extends the life for 55 years."

➢ "Keep it in a lock box" was a sound bite

The Reality

- Social Security is a pay-as-you-go system: taxes paid by today's workers are immediately sent out to pay the benefits of today's retirees. The government does not save our Social Security taxes. Congress borrows any extra money and uses it to make up for deficits elsewhere. Thus the Social Security trust fund contains nothing but IOUs the government has written to itself.

Cognitive Fluency bias is accepting the message easiest to understand

Two Project Histories

- Agree on require-ments & design
- Prototype fails – **customer distress!**
- **Recriminations**
- New design approach
- Program goes over budget & schedule

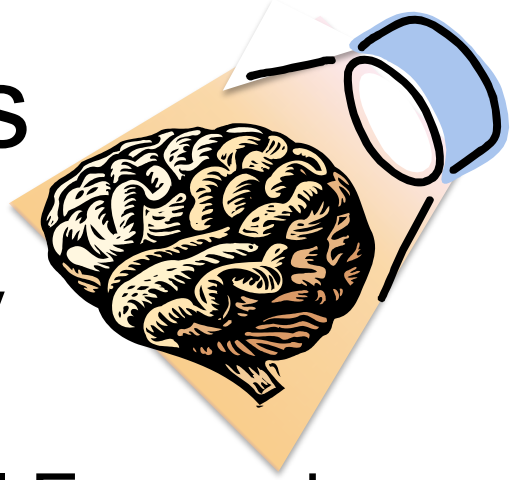
- Agree on require-ments & design
- Prototype fails – support continues
- Refine design
- Meet budget & schedule

Win-stay Lose-shift bias leads us to abandon a winning strategy

“So What” for Systems Eng

- Anticipate possible failures
- Shape customer expectations

Conclusions



- Human nature includes many built-in biases and quirks
- Neuroscience and Behavioral Economics provide insights into how these biases and quirks operate
- Systems Engineering activities can be adapted to take these biases & quirks into account, thus increasing the likelihood of success

Questions?