

## Webinar

# Agile Systems and Processes 104: Quality Fundamentals – The Art of Agile Systems Engineering

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(updated asynchronously from time-to-time)

# Agile Systems & Processes 104: Quality Fundamentals – The Art of Agile Systems Engineering

**Abstract:** Agility is enabled and maintained by a fundamentally necessary and sufficient common structural architecture and ConOps in systems of all kinds; from agile development and deployment processes, to the agile systems and products that are deployed. This webinar will focus on sustaining system and SE process agility in operational environments that are Capricious (Unpredictable), Uncertain, Risky, Variable, and Evolving (CURVE). Sustainability is shown as enabled by an architecture and a Concept of Operations based on design-quality principles of Requisite Variety, Parsimony, and Harmony. Examples will be drawn to exhibit these design-quality principles.

**Presenter Bio:** Rick Dove, INCOSE Fellow, was co-PI on the original work which identified Agility as the next competitive differentiator, in a 3-month industry-collaborative workshop funded by the US Office of the Secretary of Defense through the Navy in 1991 at Lehigh University. He went on to organize and lead the US DARPA-funded industry collaborative research at Lehigh University's Agility Forum, developing fundamental understandings of what enables and characterizes system's agility. He authored *Response Ability – The Language, Structure, and Culture of the Agile Enterprise* (Wiley, 2001). He has employed these agile concepts in both system architecture and program management for large enterprise IT systems, for rapid manufacturing systems and services, and for self-organizing security strategies. Through Stevens Institute of Technology he teaches two 40-hour graduate courses in basic and advanced agile-systems and agile systems-engineering, at client sites. He is CEO/CTO of Paradigm Shift, an applied research firm specializing in agile systems concepts and education. He chairs the INCOSE working groups on Agile Systems and Systems engineering, and on Systems Security Engineering.

# Goals

**Appreciation for:**

**the quality of experiential system-engagement**

**the factors that encourage engagement behavior**

**the necessity of engagement for system/process agility**

# Why This Matters

***“Quality is practical, and factories and airlines and hospital labs must be practical. But it is also moral and aesthetic. And it is also perceptual and subjective.”***

**-- Tom Peters (1989: 83). *Thriving on chaos*, London, UK: Pan Books.**

**The quality of systems and processes is measured in user engagement.  
Engagement may be enforced, entrapped, or embraced.**

**Enforced: This is what I am required to use, damn it!**

**Entrapped: This is the best I can get, alas!**

**Embraced: This is a joy to use, I love it!**

**Agile systems require high user engagement,  
because agility-sustaining active responsibilities are necessary.**

**Agile systems engineering requires high user engagement,  
because it is dependent on active awareness, learning, action.**

# Webster Sets the Context

**Agile: adjective.**

- 1) quick and well coordinated in movement; nimble.**
- 2) active, lively.**
- 3) marked by an ability to think quickly; mentally acute or aware.**

**Agility: noun.**

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**Agile Manifesto authors are upset with the noun usage of *Agile*, which refers to a family of software development procedures that have little to do with agility, by their now-vocal reckoning.**

Dave Thomas. 2014. [Agile is dead \(long live agility\)](http://pragdave.me/blog/2014/03/04/time-to-kill-agile/).  
<http://pragdave.me/blog/2014/03/04/time-to-kill-agile/>

Andy Hunt. 2015. An Experiment: The GROWS Method.  
[www.infoq.com/articles/grows-method-experiment](http://www.infoq.com/articles/grows-method-experiment)

# The CURVE Environment Drives Need for Agility for both agile systems and agile systems engineering

Agile systems have effective situational response options, under:

- Capriciousness: randomness among unknowable possibilities.
- Uncertainty: randomness among known possibilities with unknowable probabilities.
- Risk: randomness among known possibilities with knowable probabilities.
- Variation: randomness among knowable variables and knowable variance ranges.
- Evolution: gradual (relatively) successive developments.

But agility doesn't occur unless someone actively:

- is aware that a situation warrants a response
- has options appropriate for a response
- selects and affects an appropriate response

**Minds-on hands-on full and timely engagement.**

# American Football is Agility in Action

## Operational Environment

- Capriciousness (injury)
- Uncertainty (composition of opposing team on game day)
- Risk (impaired team-work day)
- Variation (weather)
- Evolution (team competencies)

Dynamic game situations require certain response capabilities, e.g.

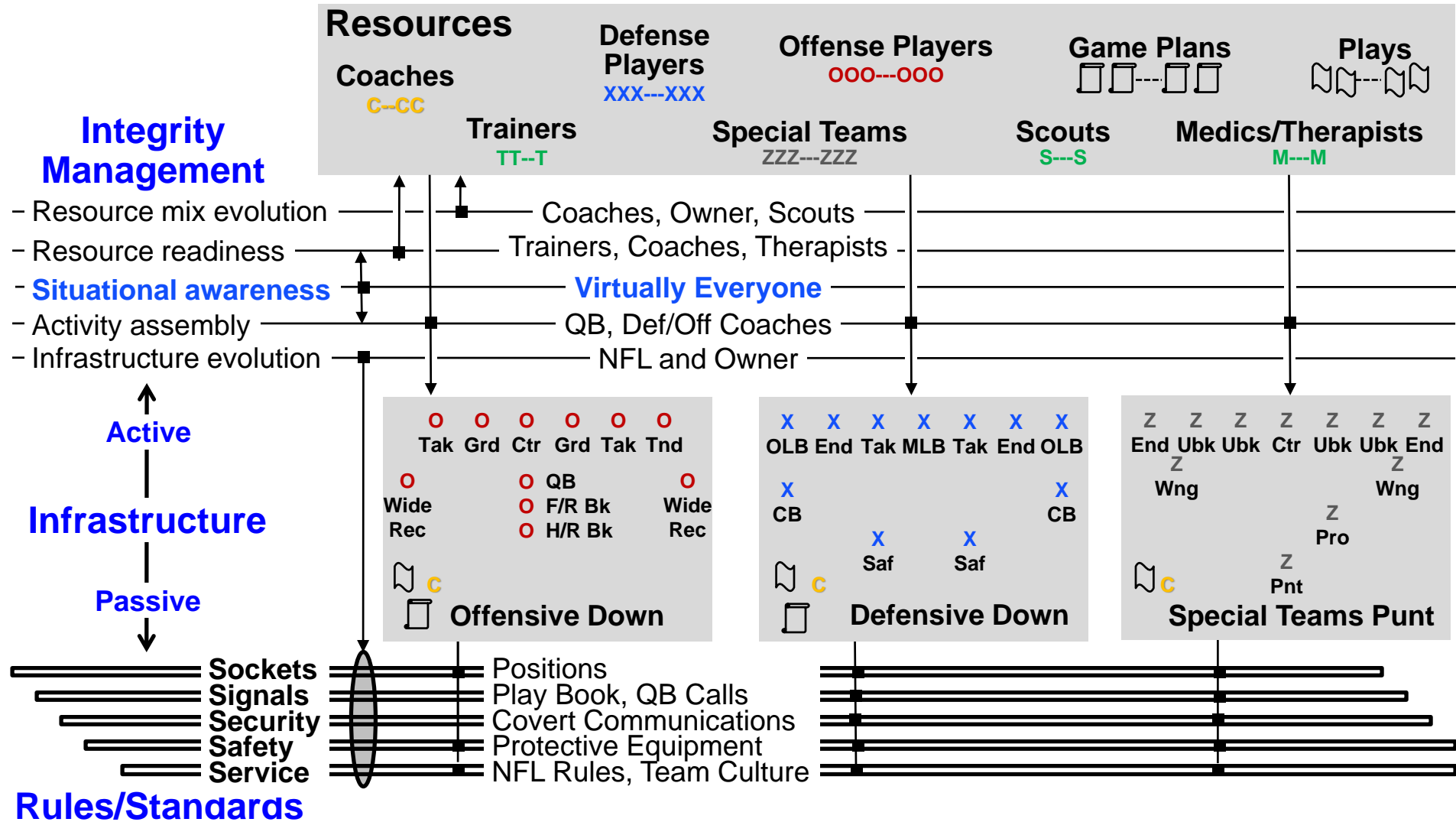
- Creating a tailored game plan for each game
- Improving opponent-evaluation accuracy
- Migrating pre to post salary cap rule
- Modifying game plan strategy, replacing Troy Polamalu (Steelers)
- Correcting on-field competitive mismatch in specific position.
- Varying defense-offence competitive strength balance
- Expansion/contraction range of player-position depth of 2-4 minimum
- Reconfiguring mix of 11-on-field frequently

**Performance quality is determined  
by degree of engagement of every team member at every moment**

# Fundamental Agile Architecture Pattern (AAP)

## Drag-and-drop resources in a plug-and-play infrastructure

Details in [www.parshift.com/s/140630IS14-AgileSystemsEngineering-Part1&2.pdf](http://www.parshift.com/s/140630IS14-AgileSystemsEngineering-Part1&2.pdf)





# Process Agility is Sustained by Four Active-Engagement Responsibilities

## Resource Mix Evolution Responsibility:

- Timely awareness of new/pending needs.
- Effective modification/augmentation of drag-and-drop asset resources.

## Resource Readiness Responsibility:

- Effective maintenance of resources ready for use when needed.

## Response-System Assembly:

- Effective configuration/reconfiguration of response-system resources.

## Infrastructure Evolution:

- Effective modification/augmentation of plug-and-play interface rules.
- Effective modification/augmentation of Concept of Agile Operations.

# Design Quality Principles

## Harmony/Delight (Emotional Quality)

- Positive impact on personal productivity and goal priorities.
- Positive impact on org's productivity and goal priorities.
- Synergistic fit with natural human and org behavior.
- Engenders feelings of user Compatibility, Trust, Respect, Synergy.

## Parsimony (Economic Quality)

- Occam's Razor: Given a choice between two ... choose the simplest.
- Unintended consequences are the result of complexity.
- Bounded rationality (Herb Simon), humans simplify decision-making knowledge.
- (Human brains can only deal with 5-9 items simultaneously.)
- (Humans brains have 2 simultaneous-attention centers.)

## Requisite Variety (Functional Quality)

- Ashby's Law: “The larger the variety of actions available to a control system, the larger the variety of perturbations it is able to compensate....variety must match variety.”

# Bikes Engage Users

## Harmony

- Affordable acquisition/operation
- Minimal learning
- Intuitive operation
- User maintainable
- Unobstructed awareness
- Bike/biker become one in operation



## Parsimony

- Minimal controls
- Minimal parts



## Requisite Variety

- City use
- Country use
- Sports use
- Carries stuff
- Carries multiple people



# Cars Engage Users

## Harmony

- Affordable acquisition/operation
- Minimal learning
- Intuitive operation
- User-maintenance facilitated
- Facilitated driver awareness
- Car/driver become one in operation



## Parsimony

- Minimal controls
- No frills basic factory models



## Requisite Variety

- City use
- Country use
- Sports use
- Carries stuff
- Carries multiple people



# Fighter Planes Engage Users



## Swedish Saab Gripen

### Combat performance

Gripen is a true multirole fighter, designed as such from the very beginning. This means it can **perform missions in all the three roles: air-to-air, air-to-surface and reconnaissance.** It can change role while airborne, and it can even act in multiple roles simultaneously.

### Low life cycle cost

Gripen has stable, **affordable acquisition and low life cycle costs.** This gives air forces a reliable basis on which to budget for operations and fleet sustainment over the long term. Gripen's inherent reliability and **low maintenance footprint** boosts force levels and operational effectiveness.

# Gripen NG Performance Facts & Figures

2015: [http://saab.com/%2Fglobalassets/commercial/air/gripen-fighter-system/gripen-ng/technical-brochure-gripen-ng-english-ver.2-jan-2015\\_low.pdf](http://saab.com/%2Fglobalassets/commercial/air/gripen-fighter-system/gripen-ng/technical-brochure-gripen-ng-english-ver.2-jan-2015_low.pdf)

**Easy maintenance and reconfiguration** was also vital, as it would need to be performed by Swedish **conscripts with only 10 weeks' training** – usually outdoors in freezing, isolated conditions.

A fundamental aspect of this approach is Gripen's modular and open avionics architecture. This enables the integration of off-the-shelf products wherever possible, as well as **continuous development of new functions to meet future needs**.

**Instead of conducting major and costly mid-life upgrades**, Saab uses a short [6 month] upgrade cycle which provides step-wise improvements.

Throughout design and construction Saab has ensured that the aircraft is **easy to service and repair – even outdoors, by conscript soldiers with minimum resources**.

Cost is also a design parameter in the sense that every detail is **created for maximum ease of use and low cost to maintain, and the whole lifecycle is taken into consideration when these prioritisations are made**.

-----From: [http://www.business-standard.com/article/economy-policy/brazil-chooses-gripen-over-rafale-114103000027\\_1.html](http://www.business-standard.com/article/economy-policy/brazil-chooses-gripen-over-rafale-114103000027_1.html) -----

Saab's maintenance philosophy made the Gripen the world's most **easy-to-maintain** fighter. Gripen requires three to five man-hours of maintenance per flight hour. That means, after an hour-long mission, **6-10 technicians require only 30 minutes to put the fighter back in the air**.

# Gripen Operational Cost Lowest of All

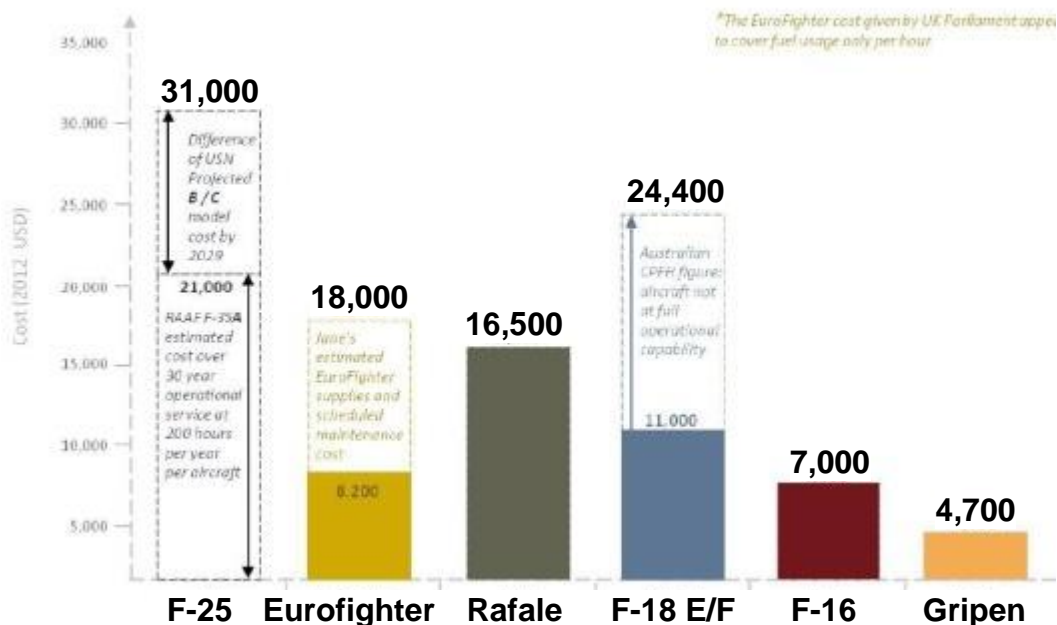
Saurabh Joshi. 2013. [www.stratpost.com/gripen-operational-cost-lowest-of-all-western-fighters-janes](http://www.stratpost.com/gripen-operational-cost-lowest-of-all-western-fighters-janes)

The operational cost of the Swedish Saab Gripen aircraft is the lowest among a flightline of modern fighters, confirmed a White Paper submitted by the respected international defense publishing group IHS Jane's.

The paper says that in terms of 'fuel used, pre-flight preparation and repair, and scheduled airfield-level maintenance together with associated personnel costs', "The Saab Gripen is the least expensive of the aircraft under study in terms of cost per flight hour (CPFH)."

From Jane's: the performance of the aircraft is only one factor in success; the capabilities of the air and ground crews married to the weapons carried are of equal importance.

For performance see: Saab Gripen vs F-35, <https://defenseissues.wordpress.com/2013/03/16/saab-gripen-vs-f-35/>



# THE GRIPEN

<http://saab.com/air/gripen-fighter-system/gripen/gripen/downloads/>

## HUMAN MACHINE INTERFACE

### FLIGHT DATA DISPLAY

Provides flight data and system status information about engine, fuel and external stores. Also serves as Electronic Warfare Display.

### HEAD UP DISPLAY

Look ahead and see flight data, steering commands, aiming info, etc. All superimposed on the outside world at all altitudes.

### UP FRONT CONTROL PANEL

Provides the pilot with access to decision support data, navigation data and target acquisition data. It is also the primary communications panel.



**Hans Einerth,  
Saab Chief Wing  
Commander:**

**“Gripen is a lovely plane to fly. The flight control system is simply terrific and the performance is outstanding.**

<http://www.gripenblogs.com/Lists/Tags/Tag.aspx?TagId=28&Name=Farnborough+International+Airshow>

### HANDS ON THROTTLE AND STICK (HOTAS)

HOTAS is used to fly the fighter and control displays and weapon systems during flight and combat.

### HORIZONTAL SITUATION DISPLAY

Directly in front of you, the Horizontal Situation Display provides navigation & tactical mission data superimposed on an electronic map of selected scale.

### MULTI SENSOR DISPLAY

Here you see information from radar and other sensors. Flight and fire control data are superimposed



# Expectation Consistency: Evolutionary, Not Revolutionary Change

The conundrum facing **fighter planners** is that, however smart your engineering, these aircraft are expensive to design and build, and have a cradle-to-grave product life that is far beyond either the political or technological horizon.

Software comes first: the new hardware runs the latest Mission System 21 software, the latest **roughly-biennial release** in the series that started with the earlier, A and B models of the aircraft.

Long life requires adaptability, both across missions and through-life. The Gripen was designed as a small aircraft with a relatively large payload. And **by porting most of the software to the new version, the idea is that all of the C and D models' weapons and capabilities, and then some, are ready to go on the E.**

The Planet's Best Stealth Fighter Isn't Made in America. Bill Sweetman, *March 24*, Aviation Week & Space Technology.  
[www.thedailybeast.com/articles/2014/03/24/the-planet-s-best-stealth-fighter-isn-t-made-in-america.html](http://www.thedailybeast.com/articles/2014/03/24/the-planet-s-best-stealth-fighter-isn-t-made-in-america.html)

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**Pilots and maintenance crew are working with an evolving/modified/augmented operational environment, rather than a completely new generation each time – so base-line system structure and concepts are familiar.**

# Fighter Planes Engage Users

## Harmony

- Affordable acquisition/operation
- Minimal learning
- Intuitive operation
- Simplified maintenance
- Facilitated pilot awareness
- Pilot/plane become one in operation

## Parsimony

- Minimal controls
- Minimal maintenance

## Requisite Variety

- Air-to-air
- Air-to-surface
- Reconnaissance
- Competitive avionics
- Carries large variety of deadly stuff
- 1 and 2 pilot versions
- Continuous upgrade for new needs



Designed to ensure **outstanding combat agility**. Gripen features a delta-canard configuration with relaxed aerodynamic stability. The delta wing and canards, along with the digital Fly-By-Wire Flight Control System, give the fighter an **optimum combination of maneuverability, acceleration, top speed and short-field performance**.

# Factors Affecting Engagement

# Becoming One With The System/Process

**You “live” in a house experientially every moment – if it is really your joy of a house. Frank Lloyd Wright built houses to invoke the emotional engagement of the user.**

**You crawl inside a painting and explore its subtle and collective emotion-generation – because the sensory input is focused and the mind is intensely engaged in experiencing the effect and nuance. Not to be confused with training in art appreciation, which is a cognitive-reasoning analysis.**

**You ride a bike and are focused totally in the experience rather than on the operational aspects of balance and locomotion and steering – because the operation has become intuitive and needs no high level cognitive attention.**

**In all cases you have become one with the “system” – you are a part of the system – and your focus is on the experiential rather than the operational.**

# Becoming One With The System/Process

Full engagement is unconscious personal behavior.

It occurs without cognitive reasoning.

One engages fully when there is

**personal motivation,  
compatibility with the unconscious mind,  
continued joy in the experience.**

There is too much in support of these assertions to address here.

The support is rooted in cortical neuro-science and psychology.

A few threads are in undiscussed background slides.

# Behavior is Primarily Unconscious

**The human cortex is a pattern learning and pattern prediction engine.**

**Intuitively it connects incoming patterns to outgoing actions immediately – for energy and time conserving action, rather than cognitive reasoning.**

**Harmony: Cortex can biologically extend existing patterns of expectation more readily than it can develop completely new patterns of expectation.**

- **Modify/extend the familiar, rather than introduce completely new.**
- **Make evolutionary rather than revolutionary upgrades.**
- **Communicate with all “users” in terms they already understand.**

**Parsimony: Cortex structure and performance optimizes energy and resource usage, minimizing memory-pattern features, maximizing re-use of pattern structures.**

- **Keep it simple and familiar.**
- **Pattern symmetry and pattern fractals are comfortably assimilated.**

**Cognitive dissonance is the state of having conflicting memory patterns. Input that triggers conflicting patterns generally result in the most emotionally-comfortable action at the moment.**

**Know that the brain has only two simultaneous attention centers.**

# Brain-Synergistic Engagement Principles

## SW-Scrum “Alignment-Potential” Example

**Cognitive-Pattern Symmetry** – Intent: Harmony and Parsimony.  
Examples: Learning loops, sprints, story format

**Cognitive-Pattern Fractals** – Intent: Harmony and Parsimony.  
Examples: Scrum of Scrums, hierarchical learning loops, hierarchical iterations.

**Cognitive-Pattern Simplicity** – Intent: Harmony and Parsimony.  
Examples: Self organizing, individual responsibility, optimal information flow.

**Cognitive-Pattern Familiarity** – Intent: Harmony and Parsimony.  
Examples: Requirements-stories, sprint regularity, consistent team size.

**Cognitive-Pattern Evolution** – Intent: Requisite Variety  
Examples: Retrospectives, iterations, OO development platform employment.

**Experiential Stability** – Intent: Harmony and Parsimony.  
Examples: Customer/user involvement, integrated testing, short sprints, long-term teams, DevOps.

**Experiential Predictability** – Intent: Harmony and Parsimony.  
Examples: Standard Scrum-process architecture and ConOps

**Experiential Awareness/Intelligence** – Intent: Harmony and Parsimony.  
Examples: All-hands frequent meetings, story boards, release-often feedback.

These are only potentials – value comes from execution effectiveness.

# Take Away Wrap Up

High human engagement is critical to agile system/process operation,  
because agility manifests as effective minds-on human activity.

Human engagement is encouraged when **cognitive dissonance is minimized**,  
because competition for human attention is removed.

Human engagement is embraced when **cognitive synergy is maximized**,  
because system/process employment creates productive joy.

Design quality manifests as a user emotional response,  
because depth of user engagement is the measure of purpose.

Design attention to H-P-RV quality elements yields value,  
because operational costs are minimized and effectiveness is maximized.

Great artists are made by emotionally engaging the user:

*"There are painters who transform the sun to a yellow spot, but there are others who, with the help of their art and their intelligence, transform a yellow spot into sun."* ~Pablo Picasso [on functional vs. emotional quality]

Some Full-Engagement Open Challenges:

- Engaging customers and users
- Engaging systems engineering and management
- Engaging HW engineering with an agile SW development activity
- Engaging HW engineering in an agile SE process



# Unpresented Background of Interest

# Sweet Anticipation: Music and the Psychology of Expectation

David Huron. 2006. The MIT Press.

[www.researchgate.net/profile/David\\_Huron/publication/209436188\\_Sweet\\_anticipation\\_Music\\_and\\_the\\_psychology\\_of\\_expectation/links/0c96052e02be139f9f000000.pdf](http://www.researchgate.net/profile/David_Huron/publication/209436188_Sweet_anticipation_Music_and_the_psychology_of_expectation/links/0c96052e02be139f9f000000.pdf)

[Excerpts from the book]

...emotions provide the intimate experiences that define our personal lives. Emotions add depth to existence; they give meaning and value to life.

...the performing arts have figured prominently in attempts to understand the dynamics of emotion. Of the many arts, music has perhaps faced the most onerous challenges.

In the 1950s, the renowned musicologist Leonard Meyer [in his] seminal book, *Emotion and Meaning in Music*, argued that the principal emotional content of music arises through the composer's choreographing of expectation.

Of course, expectations are not the province of music alone; expectation is a constant part of mental life.

# Sweet Anticipation: Music and the Psychology of Expectation

David Huron. 2006. The MIT Press.

[www.researchgate.net/profile/David\\_Huron/publication/209436188\\_Sweet\\_anticipation\\_Music\\_and\\_the\\_psychology\\_of\\_expectation/links/0c96052e02be139f9f000000.pdf](http://www.researchgate.net/profile/David_Huron/publication/209436188_Sweet_anticipation_Music_and_the_psychology_of_expectation/links/0c96052e02be139f9f000000.pdf)

**Expectations are not the province of music alone; expectation is a constant part of mental life.**

**In attempting to understand expectation, it is essential to take both biology and culture seriously.**

**The capacity to form accurate expectations about future events confers significant biological advantages. Those who can predict the future are better prepared to take advantage of opportunities and sidestep dangers.**

**Accurate expectations are adaptive mental functions that allow organisms to prepare for appropriate action and perception.**

**But what about the emotional “feelings” that are often conjured up as a result of expectations? What gives *anticipation* or *surprise* their distinctive phenomenological characters? The story of emotion is intertwined with the psychology of behavioral motivation. Emotions encourage organisms to pursue behaviors that are normally adaptive, and to avoid behaviors that are normally maladaptive.**

**The emotions accompanying expectations are intended to reinforce accurate prediction, promote appropriate event-readiness, and increase the likelihood of future positive outcomes.**

**The biological purpose of expectation is to prepare an organism for the future.**

# Sweet Anticipation: Music and the Psychology of Expectation

The ITPRA theory is intended to provide a general theory [of expectation]. The theory aims to account for all of the main psychological phenomena related to expectation.

**ITPRA Theory of Expectation – 5 emotion response systems.**

***Imagination* response** motivates an organism to behave in ways that increase the likelihood of future beneficial outcomes.

***Tension* response** prepares an organism for an impending event by tailoring arousal and attention to match the level of uncertainty and importance of an impending outcome.

***Prediction* response** provides positive and negative inducements that encourage the formation of accurate expectations.

***Reaction* response** addresses a possible worst-case situation by generating an immediate protective response.

***Appraisal* response** provides positive and negative reinforcements related to the biological value of different final states.

# Attractive Things Work Better

Norman, D. A. (2004). Emotional Design: Why We Love (or Hate) Everyday Things. Basic Books.  
[www.jnd.org/dn.mss/CH01.pdf](http://www.jnd.org/dn.mss/CH01.pdf)

From Chapter 1:

Two Japanese researchers, Masaaki Kurosu and Kaori Kashimura, developed two forms of automated teller machines. Both forms were identical in function, the number of buttons, and how they worked, but one had the buttons and screens arranged attractively, the other unattractively. **Surprise! The Japanese found that the attractive ones were easier to use.**

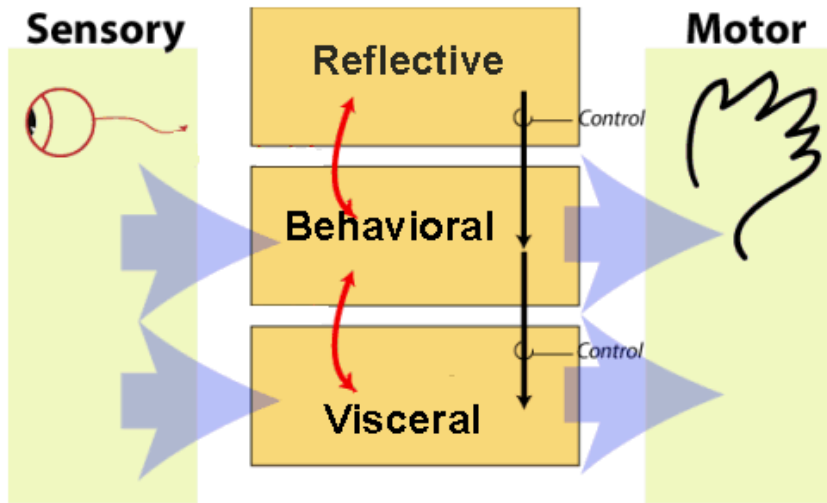
But Israelis? Nah, Israelis are action oriented—they don't care about beauty. So Noam Tractinsky, an Israeli scientist, redid the experiment. He got the ATM layouts from Kurosu and Kashimura, translated them from Japanese into Hebrew, and designed a new experiment, with rigorous methodological controls.

**Not only did he replicate the Japanese findings, but the results were stronger in Israel than in Japan, contrary to his belief that beauty and function “were not expected to correlate.”**

This is a surprising conclusion. In the early 1900s, Herbert Read, who wrote numerous books on art and aesthetics stated that “it requires a somewhat mystical theory of aesthetics to find any necessary connection between beauty and function,” and that belief is still common today. **How could aesthetics affect how easy something is to use?**

# Emotional Design: Why We Love (or Hate) Everyday Things

Norman, D. A. (2004). New York: Basic Books. <http://www.jnd.org>



Three levels of processing:  
Visceral,  
Behavioral, and  
Reflective.

See TED Talk at:

[www.ted.com/talks/don\\_norman\\_on\\_design\\_and\\_emotion](http://www.ted.com/talks/don_norman_on_design_and_emotion)

**The visceral level is fast: it makes rapid judgments of what is good or bad, safe or dangerous, and sends appropriate signals to the muscles (the motor system) and alerts the rest of the brain. These are biologically determined and can be inhibited or enhanced through control signals from above.**

**The behavioral level is the site of most human behavior. Its actions can be enhanced or inhibited by the reflective layer and, in turn, it can enhance or inhibit the visceral layer.**

**The highest layer is that of reflective thought. It does not have direct access either to sensory input or to the control of behavior. Instead it watches over, reflects upon, and tries to bias the behavioral level.**

# Happiness is Remembered Experience

Daniel Kahneman. The riddle of experience vs. memory. TED2010, February  
[www.ted.com/talks/daniel\\_kahneman\\_the\\_riddle\\_of\\_experience\\_vs\\_memory.html](http://www.ted.com/talks/daniel_kahneman_the_riddle_of_experience_vs_memory.html)

**Happiness has two completely different aspects: experienced happiness and remembered happiness.**

**Remembered happiness dominates, and what is remembered are just a few moments of the experienced full story that are distinguished as changes, surprises, and endings.**

**Remembered happiness is projected forward in decision making about future choices – the choices you make are determined by what you expect to remember rather than what you expect to experience.**

**In reflecting on an experience, the ending emotion will dominate the remembrance – a bad experience at the end and the whole experience will be remembered as bad, even if 95% of the preceding experience had high experiential happiness.**

## **Lessons:**

**Make sure agile-process activity ends on an experiential (emotional) high. This can simply be an end accomplishment of perceived value. e.g,**

- an effective agile system/process response to a situation**
- an insightful and meaningful learning experience in a retrospective.**

**Provided ... operational surprises were not excruciating ordeals.**

# The Correlation Between Arts and Crafts and a Nobel Prize

Slashdot September 12, 2015

*The stereotype of the scientist or engineer is that he prefers facts, reason, and objectivity over more artistic pursuits. But the Priceonomics blog points out an interesting correlation: "the more accomplished a scientist is, the more likely they are to have an artistic hobby." <http://priceonomics.com/the-correlation-between-arts-and-crafts-and-a/>*

*It continues, "The average scientist is not statistically more likely than a member of the general public to have an artistic or crafty hobby.*

*But members of the National Academy of Sciences and the Royal Society — elite societies of scientists, membership in which is based on professional accomplishments and discoveries — are 1.7 and 1.9 times more likely to have an artistic or crafty hobby than the average scientist is.*

*And Nobel prize winning scientists are 2.85 times more likely than the average scientist to have an artistic or crafty hobby."*

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**Appears to be evidence that brain-patterns built from practice in the arts get unconsciously employed in same-brain science and technology endeavors.**

**Success in artistic endeavor is measured solely by the engagement of the artist's "users".**



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