Creativity in RE and Its Measurement

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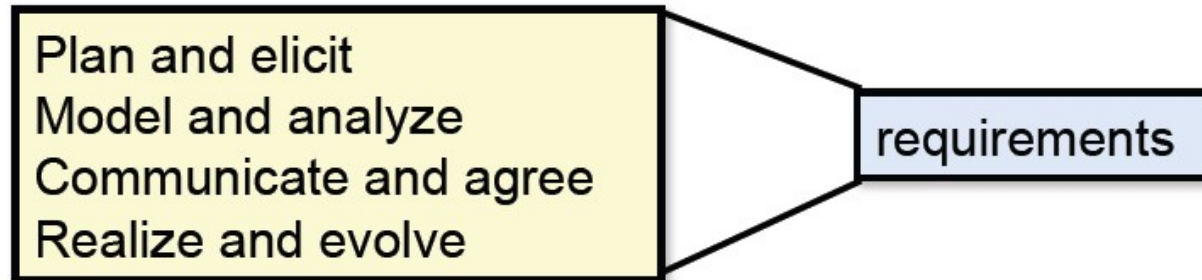
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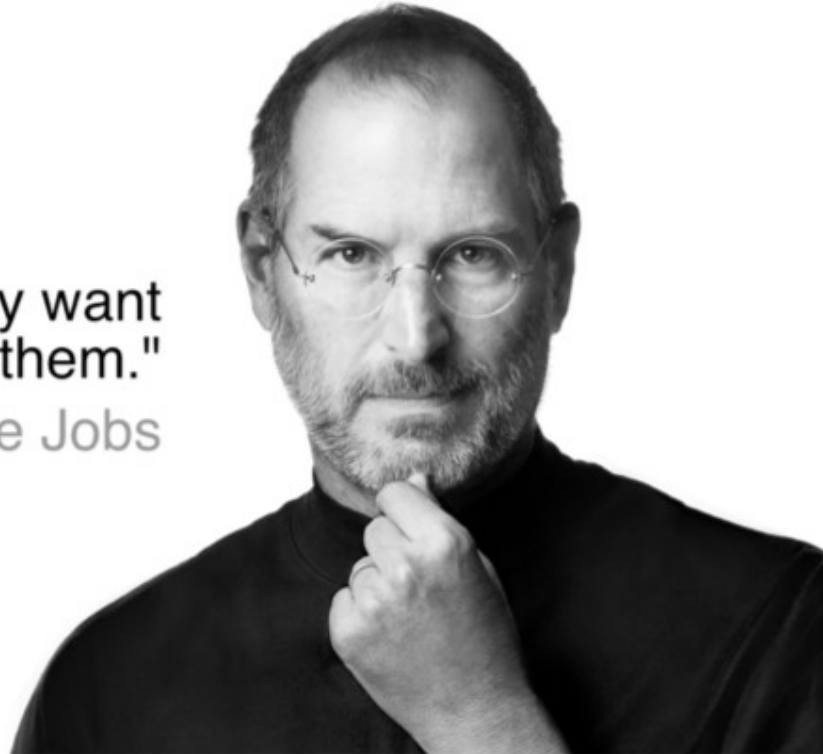
Requirements engineering (RE)

- **Requirements** engineering (RE)

- Involves interaction among multiple stakeholders

- Traditional RE

  - Requirements exist in the stakeholders' minds in an implicit manner [Lemos *et al.,* 2012]
  - Customer driven

"People don't know what they want until you show it to them."
- Steve Jobs

Picture source: Internet

Requirements engineering (RE)

Picture source: Internet

Creativity in RE

Picture source: Internet

Creativity in RE

- More critical in modern software industry
  - Competition in the industry
  - Multiple system in the same application domain

- Modern RE
  - **Creative requirements**
  - **Improve sustainability**

Creativity in RE

- ## Creativity [Sternberg, 1999]
  - Ability to produce work that is both
    - Novel
      - original and unexpected
    - Appropriate
      - useful and adaptive to task constraints

Creativity in RE

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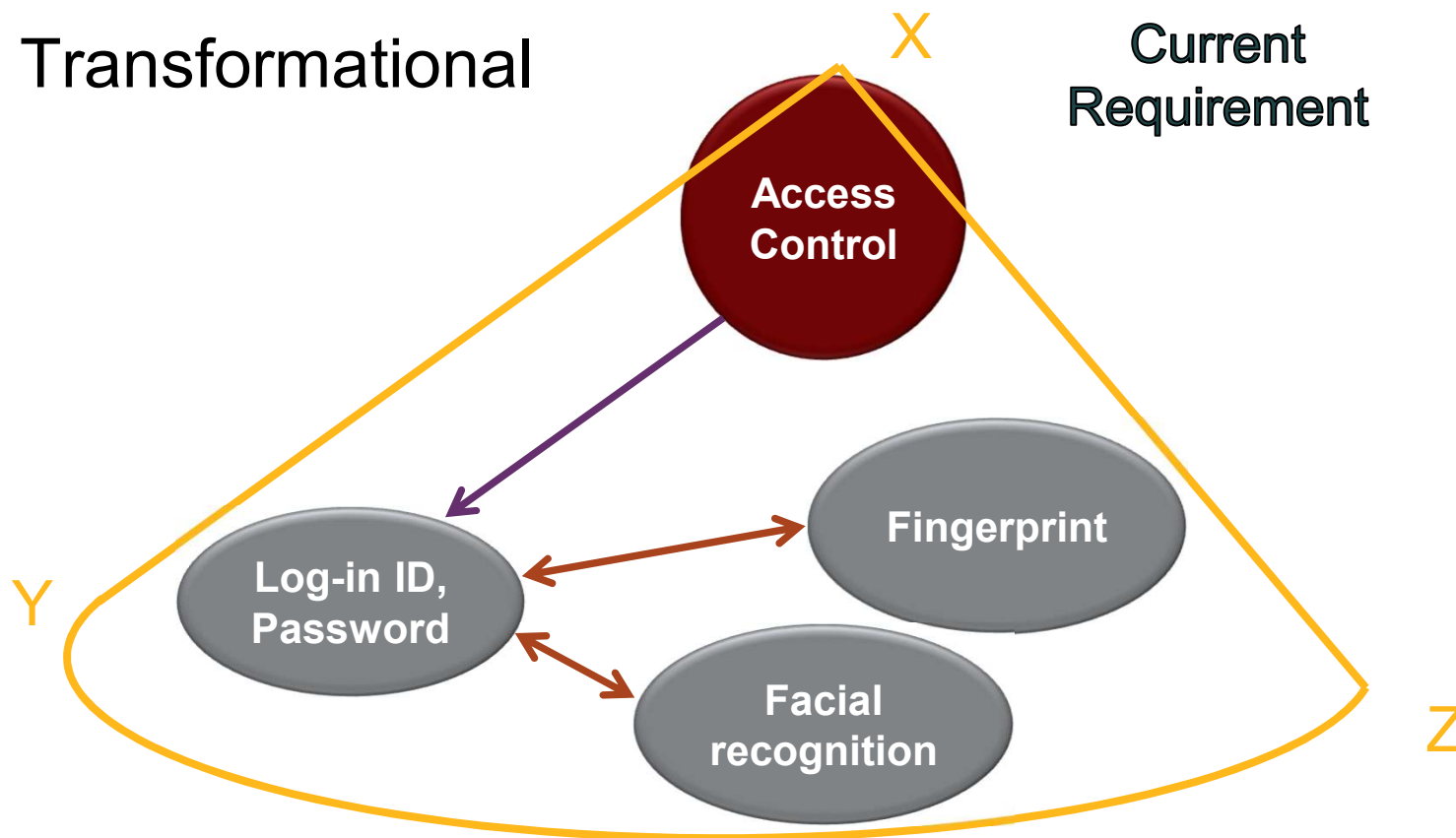   - useful and adaptive to task constraints

- ## In RE [Maiden *et al.,* 2010]
  - Capture of requirements
    - New to the stakeholders
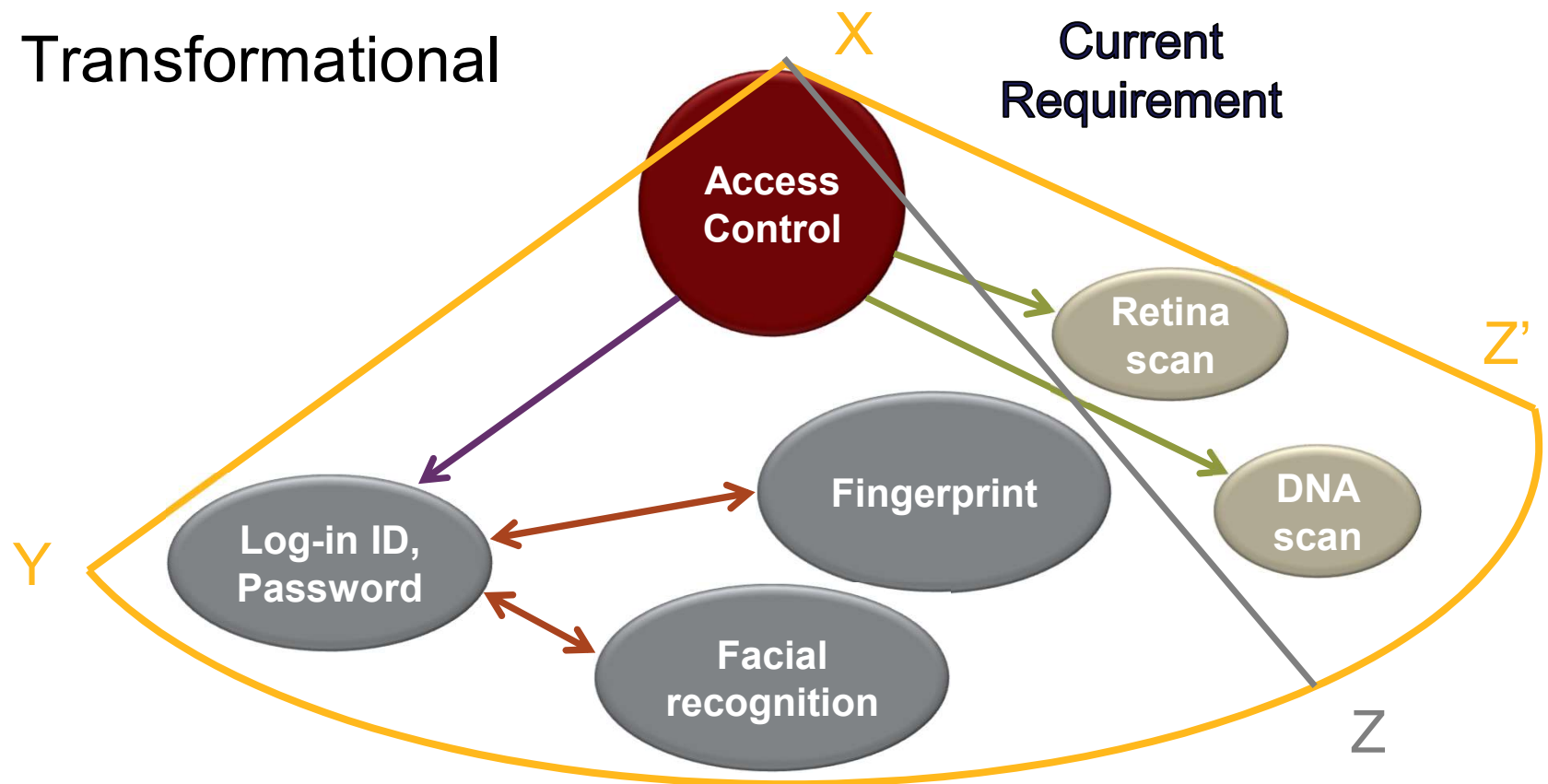   - May not be historically new to humankind

Creativity in RE

- Categories of Creativity [Boden, 2003]
  - Exploratory
  - Combinational
  - Transformational

X

Current
Requirement

Access Control

Fingerprint

Log-in ID, Password

Y

Facial recognition

Z

Creativity in RE

- Categories of Creativity [Boden, 2003]
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Creativity in RE

System	New Requirement
Firefox	F1: Firefox should provide **floating** tab-**view**
	F2: Firefox should provide **button** for **saving** all tabs
	F3: Firefox should **inform** users the **count** of open tabs
	F4: Firefox user can **select** text **saving** directly into files
	F5: Firefox should provide **arrow** to **browse** tabs
	F6: Firefox users can **zoom** in/out by a **dragging** slider
	F7: Firefox user can **text** phone **number** from the web page
	F8: Firefox can **parallel** tab-**view**

Source: Bhowmik et al., 2020

Creativity in RE

Creativity in RE

How to measure creativity in RE?

- Creativity [Sternberg, 1999]
  - Ability to produce work that is both
    - Novel
      - original and unexpected
    - Appropriate
      - useful and adaptive to task constraints

- Rate the requirements at a 5-point Likert Scale

  1 = least innovative

  2 = not innovative

  3 = neutral

  4 = innovative

  5 = most innovative

How to measure creativity in RE?

- Kappa statistic is used to show the level of agreement among participants [Manning *et al.* 2008]
  - Firefox: 0.79

Firefox: Avg. Rating

Source: Bhowmik et al., 2020

How to measure creativity in RE?

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	F8: Firefox can **parallel** tab-**view**

Is such a single rating sufficient?

How to measure creativity?
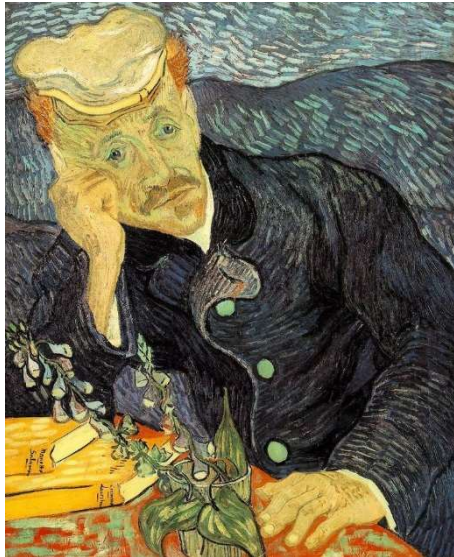
$149.7 M

$119.9 M

$103.4 M

$300 M
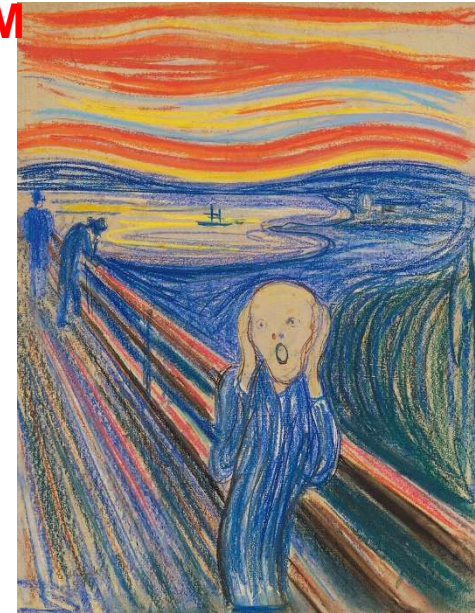
$112.5 M

Picture source: Internet

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How to measure creativity in RE?

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How to measure creativity in RE?

- **In Recent Years**
- Clarity
  - Unambiguous, provides an appropriate level of detail
- Novelty
  - Users find it original and unexpected
    - something that is not common place, mundane, or conventional
- Usefulness
  - Useful & implementable
  - Provides value or utility to the users

How to measure creativity in RE?

- Clarity

- Novelty

- Usefulness

- Rate the requirements at a 5-point Likert Scale

  1 = very low

  2 = low

  3 = medium

  4 = high

  5 = very high

How to measure creativity in RE?
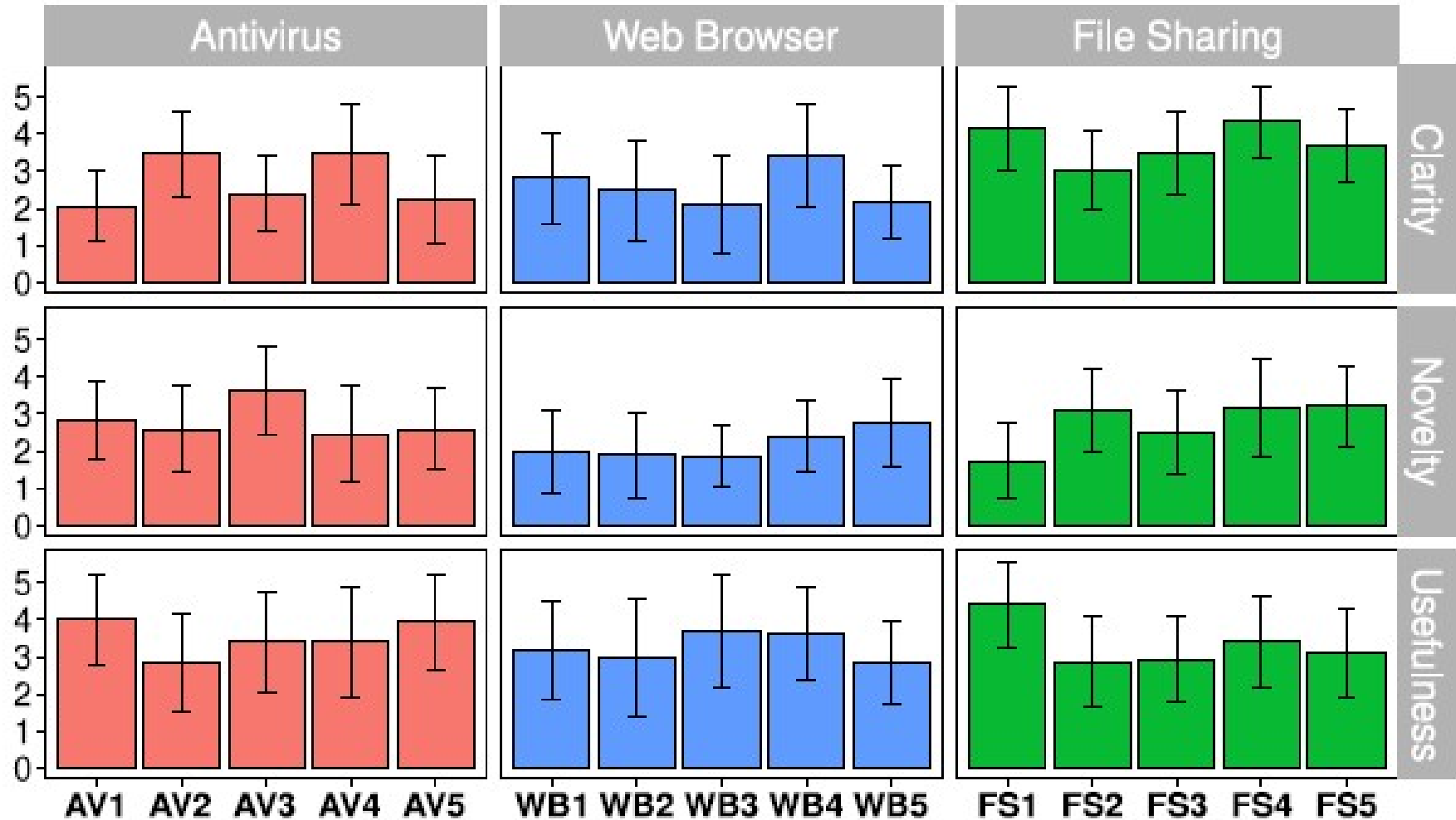
Picture source: Do et al., 2020

How to measure creativity?

- Facet-Level-Measurement Approach [Batey, 2012]

- Facet: What is being measured?
  - The 4 Ps
    - Person (trait)
    - Process
    - Press (environment)
    - Product

Person X Process X Press = Product

How to measure creativity?

- Level: We are measuring the facet at what level?
  - The 4 levels
    - Culture
    - Organization
    - Team
    - Individual
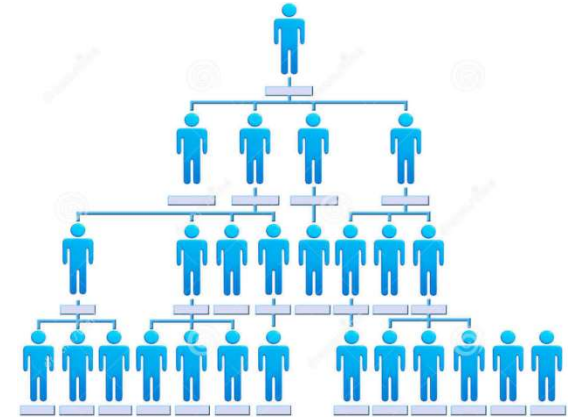
Picture source: Internet

How to measure creativity?

- **Measurement Approach: How to measure a facet at a specific level?**
  - Objective measure
    - # of patents for an inventor, # of exhibitions for an artist
  - Subjective measure
    - From the focal point of analysis, done internally
    - E.g., self-rating, rating from the team members about the product they built
  - Other-ratings
    - Rating provided by an external subject matter expert

How to measure creativity in RE?

- A three dimensional heuristic framework by Mark Batey [Batey, 2012]
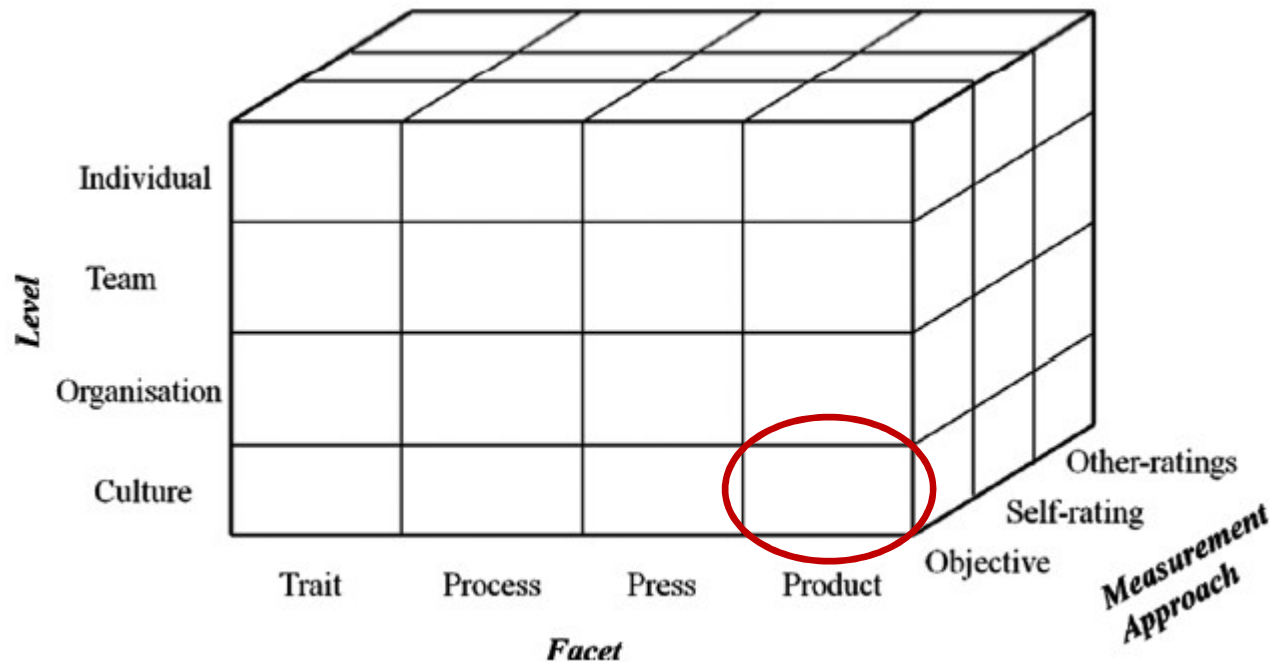
Product = Requirement
Ratings: Objective, Expert

How to measure creativity in RE?

- Levels and kind of creativity in products [Cropley & Cropley, 2005]

Criterion	Kind of Product				
	Routine	Original	Elegant	Innovative	Aesthetic
Effectiveness	+	+	+	+	-
Novelty	-	+	+	+	+
Elegance	-	-	+	+	?
Genesis	-	-	-	+	?

How to measure creativity in RE?

- The Creative Solution Diagnosis Scale (CSDS) with 30 attributes [adapted from Cropley et al., 2011]

Relevance & Effectiveness	Novelty			Elegance		Genesis
	Problematization	Existing Knowledge	New Knowledge	External	Internal	
Correctness	Diagnosis	Replication	Redirection	Recognition	Completeness	Foundationality
Performance	Prescription	Combination	Reconstruction	Convincingness	Gracefulness	Transferability
Appropriateness	Prognosis	Incrementation	Reinitiation	Pleasingness	Harmoniousness	Germinality
Operability			Redefinition		Sustainability	Seminality
Safety			Generation			Vision
Durability						Pathfinding

27 different attributes

How to measure creativity in RE?

- The question we would like to ask

Can we adapt CSDS to measure creativity in RE?

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Defining the attributes in RE

Attribute	General Definition	Redefine in RE
Correctness	The solution accurately reflect conventional knowledge and/or technique	The requirement accurately reflects conventional knowledge and/or technique about the application domain
Appropriateness	The solution fits within task constraints	The requirement fits within the task constraints. That is, given the constraints/limitations of resources (e.g., time, money, technology, etc.) in hand, a successfully implementation of the requirement is possible.

adapted from Cropley et al., 2011

How to evaluate creativity in RE?

- 27 creativity attributes that should be used to assess creativity merit of a requirement
    - **Correctness:** The requirement accurately reflects conventional knowledge and/or technique about the application domain
    - **Operability:** The requirement is easy to use. That is, the requirement does not have any negative effect on the usability of the software system (it can be implemented in such a way)
    - **Prognosis:** The requirement helps the requirements engineer (or stakeholder) anticipate likely effects of changes that will take place in the software
    - ……..

Exercise

<table>
<tr><td colspan="2">Firefox can parallel tab-view</td></tr>
<tr><td>Attribute</td><td>Rate
5-Strongly Agree
4-Agree
3-Neutral
2-Disagree
1-Strongly disagree</td></tr>
<tr><td>1. Correctness: The requirement accurately reflects conventional knowledge and/or technique about the application domain.</td><td></td></tr>
<tr><td>2. Performance: The requirement does what it is supposed to do. That is, the requirement has a positive impact on the overall functionality of the software system. Or, the requirement improves the overall functionality (or, performance) of the software system. In other words, the requirement makes the software more attractive to the users.</td><td></td></tr>
<tr><td>3. Appropriateness: The requirement fits within the task constraints. That is, given the constraints/limitations of resources (e.g., time, money, technology, etc.) in hand, a successfully implementation of the requirement is possible.</td><td></td></tr>
</table>

Summary

- ## Creativity in RE
  - Why it is important?

- ## How to measure creativity?

- ## How to measure creativity in RE?
  - Do we need a more sophisticated measurement approach?

- ## Next
  - Requirements-Based Testing

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