



SINGAPORE UNIVERSITY OF  
TECHNOLOGY AND DESIGN

Established in collaboration with MIT



# Idea Matrix and Creativity Operators

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# Operationalize Creativity for Individuals

- How to **represent** an idea using a consistent, but general, specification;
- How to use existing ideas to systematically **generate** new and potentially creative ideas;
- How to rigorously **evaluate** and **rank** competing ideas.
- How to **improve** ideas in a repeatable way, based on **evaluation and analysis** of them;

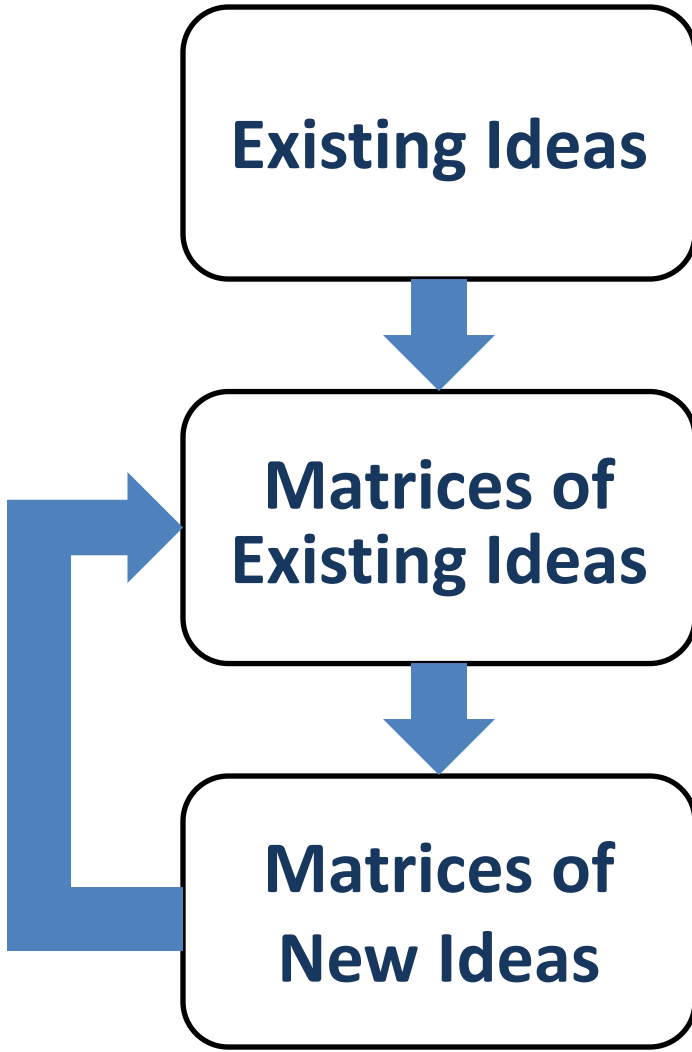
**Existing Ideas**

Identify key features and attributes and their correlations.  
**represent ideas as matrices**

**Matrices of Existing Ideas**

**Matrices of New Ideas**

Use generative algebraic analysis of matrices and  
**Creative Operations**



# What Describe an Idea/Design

- **Features**

- Inherent, inextricable, and inseparable of an idea
- Features serve to identify an idea

- **Attributes**

- Qualities are associated with novelty and usefulness of an idea
- Socially attributed and determined

- Attributes depend on features

# Matrix Representation of An Idea

## Feature-Attribute Matrix of An Idea

	Feature 1	...	Feature j	...	Feature q
Attribute 1					
...					
Attribute i					
...					
Attribute p					

# Intensity Measures

Contribution Intensity	Definition	Explanation
0	No contribution	
1	Weak	Barely perceptible
3	Moderate	
5	Average	Neither weak nor strong
7	Strong	Readily perceptible
9	Very strong	
10	Dominant	Governing
2, 4, 6, 8	Intermediate values	

# Novelty Matrix [ $N^{iPad}$ ]



## Features

	Front lid	Magnetic hinge	Magnetic closing	3-level folding	Multiple colors
Screen protection	7	2	0	2	0
Thin covers	3	0	0	3	0
Light weight covers	1	0	0	0	0
Easy installation	2	5	2	2	0
Hands-free reading	3	1	0	6	0
Hands on reading	1	1	0	0	0
Sleep and wake-up	0	0	7	3	0
Looks attractive	1	1	0	4	4

## Attributes

Novelty = Norm of matrix  $N$

# Usefulness Matrix [ $U^{iPad}$ ]



## Features

	Front lid	Magnetic hinge	Magnetic closing	3-level folding	Multiple colors
Screen protection	9	0	1	2	0
Thin covers	9	1	0	3	0
Light weight covers	8	1	0	0	0
Easy installation	9	0	0	0	0
Hands-free reading	3	3	0	9	0
Hands on reading	1	1	0	0	0
Sleep and wake-up	0	0	9	4	0
Looks attractive	7	2	2	1	4

## Attributes

Usefulness = Norm of matrix  $U$



# Compare, Rank, and Select

iPad Smart Cover

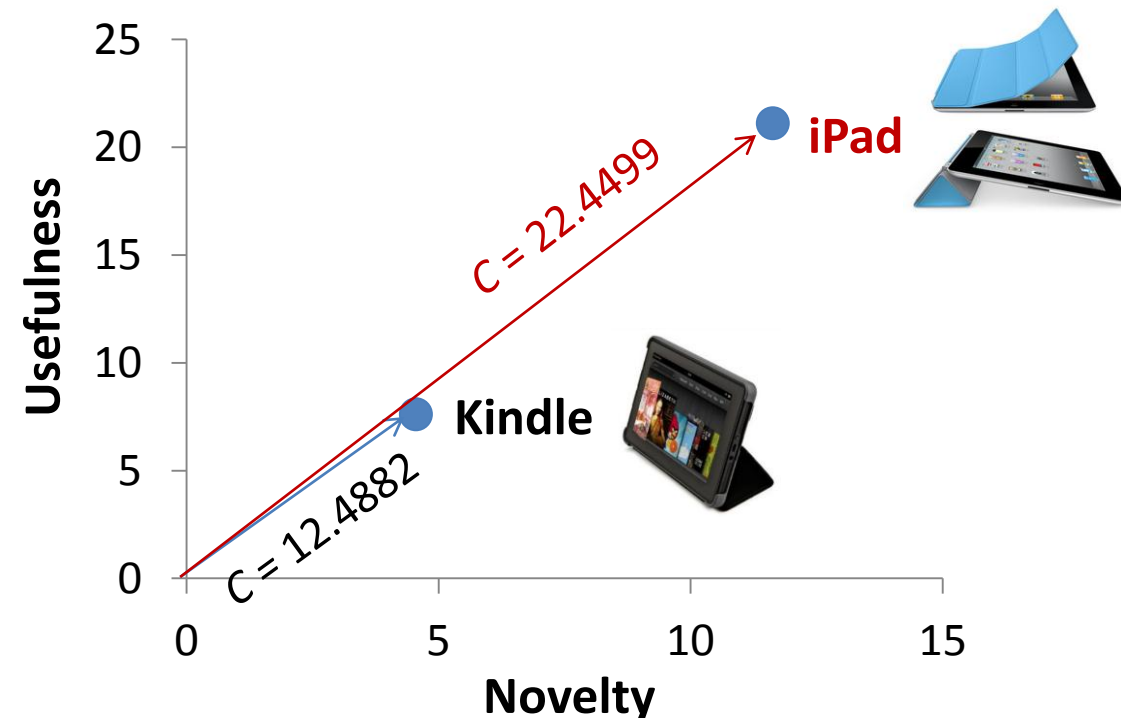


Kindle Fire  
Lightweight MicroShell Folio



# Proposed Metric of Creativity

Norms	iPad Cover	Kindle Folio
Novelty ( $n$ ) = Norm of matrix $\mathbf{N}$	11.6274	4.5561
Usefulness ( $u$ ) = Norm of matrix $\mathbf{U}$	21.1209	7.6096
Creativity ( $c$ ) = $\sqrt{n^2 + u^2}$	22.4499	12.4882



Assuming Novelty and Usefulness have equal weight in creativity.

Consider weighting:

$$\text{Creativity } (c) = \sqrt{(\lambda n)^2 + [(1 - \lambda)u]^2}$$

# Creativity Matrix $[C^{iPad}] = [N^{iPad}] * [U^{iPad}]$

*Hadamard Multiplication*

	Front lid	Magnetic hinge	Magnetic closing	3-level folding	Multiple colors
Screen protection	63	0	0	4	0
Thin covers	27	0	0	9	0
Light weight covers	8	0	0	0	0
Easy installation	18	45	4	0	0
Hands-free reading	9	3	0	54	0
Hands on reading	1	1	0	0	0
Sleep and wake-up	0	0	63	12	0
Looks attractive	7	2	0	4	16

# Which Feature is Most Important?

- Importance Index of feature  $i$ ,  $x_i$ , is proportional to the sum of the importance of associated features:

$$x_i = \frac{1}{\lambda} \sum_{j=1}^q f_{ij} x_j$$

matrix form  $\lambda \mathbf{x} = \mathbf{F} \mathbf{x}$

- Solution  $\mathbf{x}$  is the eigenvector corresponding to the dominant eigenvalue.

# Rank Features and Attributes for Improvement Opportunities



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## Ranking of Features

- 1 Front lid
- 2 3-level folding
- 3 Magnetic hinge
- 4 Magnetic closing
- 5 Multiple colors

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## Ranking of Attributes

- 1 Screen protection
  - 2 Hands-free reading
  - 3 Thin covers
  - 4 Easy installation
  - 5 Sleep and wake-up
  - 6 Looks attractive
  - 7 Light weight covers
  - 8 Hands on reading
-

# **Creative Operations**

# Use Matrix as Operand for Generative Operations

$$\omega(\mathbf{C}^l_{pq}) \Rightarrow \mathbf{C}^k_{pq}$$

	Feature 1	...	Feature j	...	Feature q
Attribute 1	$c^k_{11}$	...	$c^k_{1j}$	...	$c^k_{1q}$
...	...	...	...	...	...
Attribute i	$c^k_{i1}$	...	$c^k_{ij}$	...	$c^k_{iq}$
...	...	...	...	...	...
Attribute p	$c^k_{p1}$	...	$c^k_{pj}$	...	$c^k_{pq}$

# Creative Operators

## Examples

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Synthesis

$\omega_s$

(Phone, Email, Computer, Camera, ...)  $\Rightarrow$  Smart Phone  
(Programming, Evolution)  $\Rightarrow$  Genetic Programming

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Fractionation

$\omega_f$

Monolithic Products  $\Rightarrow$  Modular Platform Products  
Fluid Dynamics  $\Rightarrow$  Hydrodynamics, Aerodynamics

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Reversal

$\omega_r$

Proprietary Software Development  $\Rightarrow$  Open Source  
Empire and Dictating  $\Rightarrow$  Republic and Election

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Analogy

$\omega_a$

Bird  $\Rightarrow$  Airplane  
Auction Place  $\Rightarrow$  Online Auction Space, e.g. eBay

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etc

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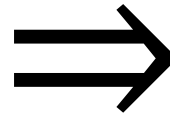
# Creativity Operators

## Fractionation

$\omega_f$

Existing Idea 1

	$F^1_1$	$F^1_2$	$F^1_2$
$A^1_1$	6	0	0
$A^1_2$	7	1	0
$A^1_3$	8	1	0
$A^1_4$	0	0	2



### Idea 2 (new)

	$F^1_1$	$F^1_2$
$A^1_1$	6	0
$A^1_2$	8	2
$A^1_3$	9	1

### Idea 3 (new)

	$F^1_2$
$A^1_4$	9

# Synthesis

Existing Idea 1

	$F^1_1$	$F^1_2$	$F^1_3$
$A^1_1$	9	0	1
$A^1_2$	9	1	0
$A^1_3$	8	1	0
$A^1_4$	9	9	2

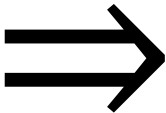
Existing Idea 2

	$F^2_1$	$F^2_2$	$F^2_3$
$A^2_1$	8	2	0
$A^2_2$	3	0	0
$A^2_3$	1	0	0

Idea 3 (new)

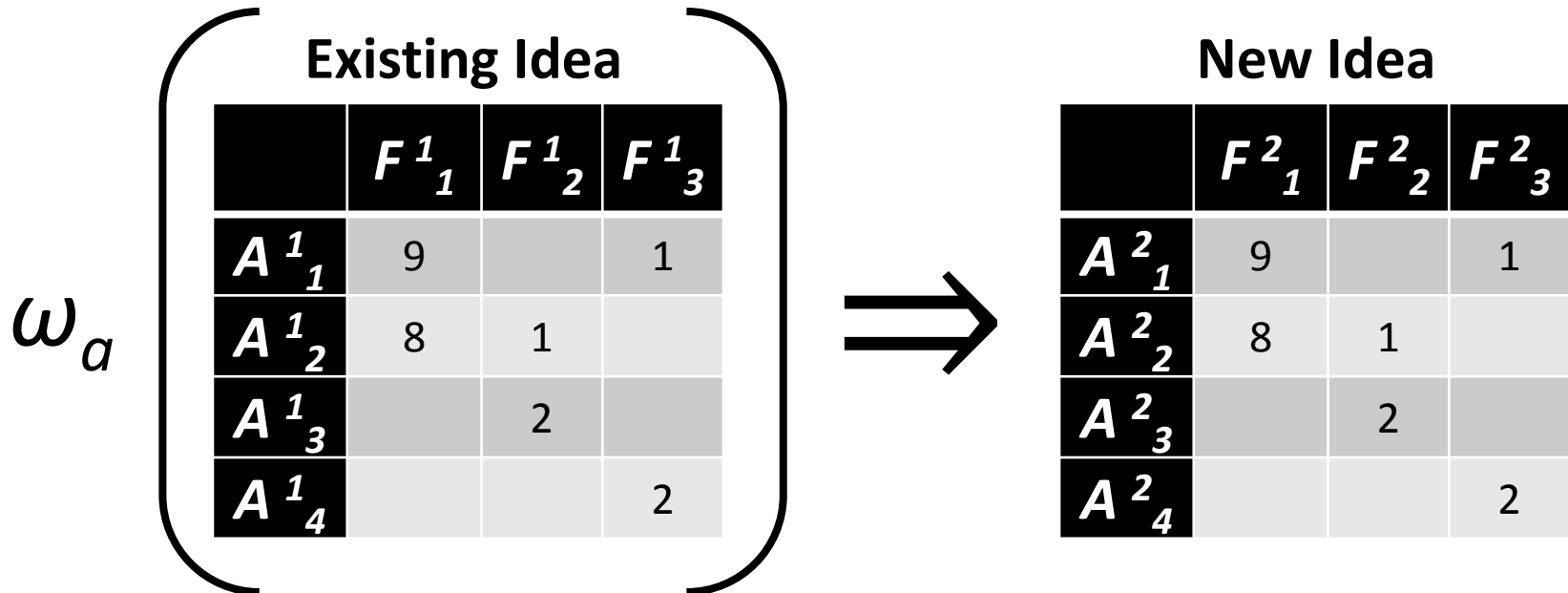
	$F^1_1$	$F^1_2$	$F^1_3$	$F^2_1$	$F^2_2$	$F^2_3$
$A^1_1$	9	0	1	0	1	0
$A^1_2$	2	1	0	0	3	0
$A^1_3$	8	3	0	4	0	2
$A^1_4$	9	9	2	0	9	0
$A^2_1$	0	3	0	8	2	0
$A^2_2$	1	1	0	3	3	5
$A^2_3$	1	0	2	1	0	0
$A^3_1$	4	3	0	0	9	0

$\omega_s$



# Creativity Operators

Analogy



# Composite Operation

- A **composite operation** is the nested use of more than one operators.

Two operations

$$\omega_p(\omega_i(I^j)) = \omega_p(I^k) \Rightarrow I^w, \text{ i.e. } \omega_i(I^j) \Rightarrow I^k$$

Finite operations

$$\prod_{i=1}^n \omega_i(I^k) = (\omega_n(\omega_{n-1}(\omega_{n-2}(\dots(\omega_1(I^k)))))) \Rightarrow I^z$$

# Thank You



**P.S. we are hiring postdocs, faculty, PhD students etc.  
at SUTD to study creativity and design methods**