Classification For Decision Metrics

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Dr. Thomas Fehlmann

- 1981: Dr. Math. ETHZ
- 1982-89: Manager Software–Development
- 1990-95: Senior Consultant – Digital Equipment Corp.
- 1996-99: Sales Support Manager – Proposal Center
- 1999ff: Euro Project Office AG, Zürich
  - Akao Price 2001 for original contributions to QFD
  - Member of the Board of QFD Institute Germany – QFD Architect
  - SwiSMA: Software Metrics, Functional Sizing
- 2000ff: Six Sigma Black Belt for GMC Software AG
  - ISO 9001 Management System
  - CMMI for Software Development
  - QFD and New Lanchester Theory

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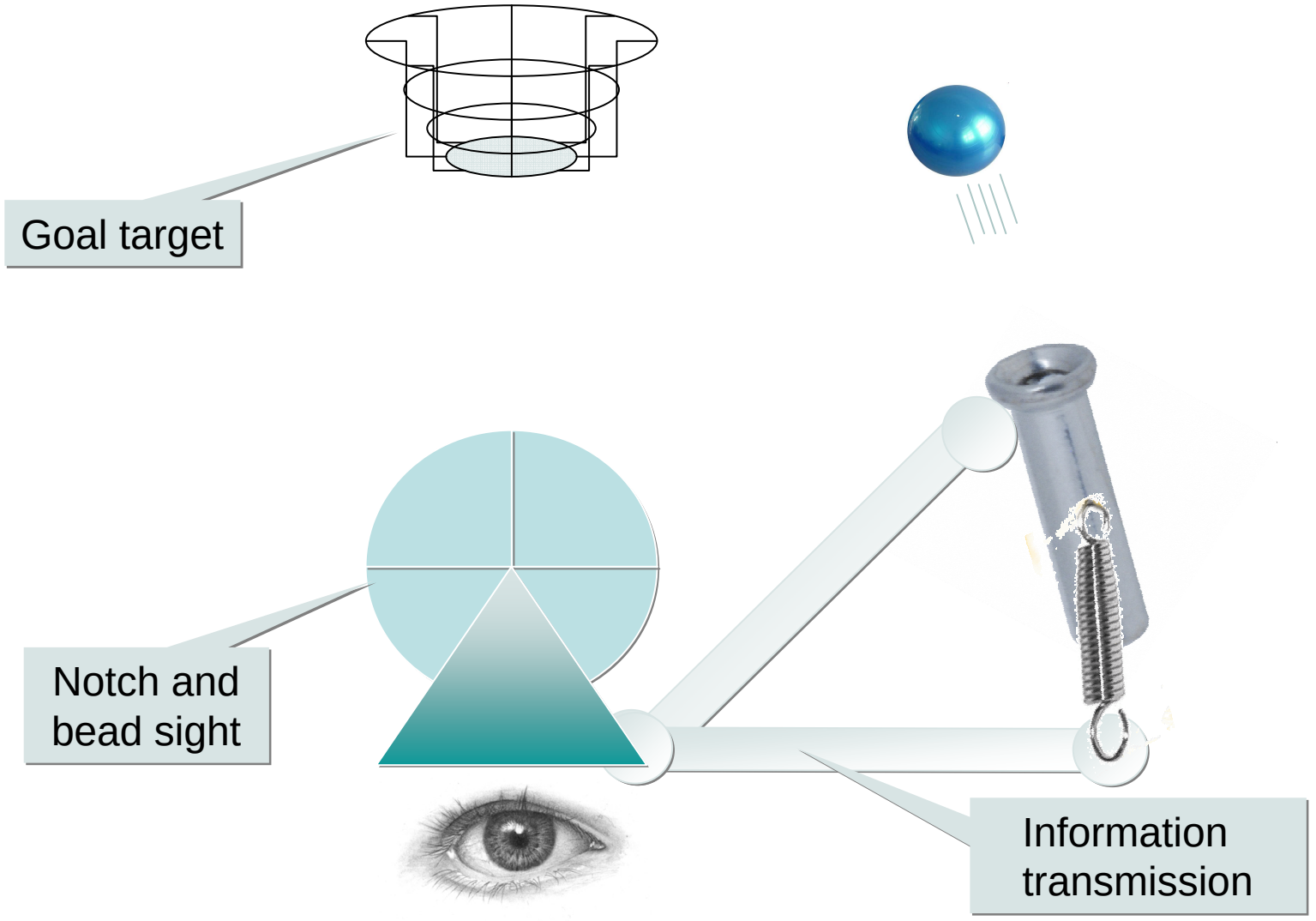
This was a Business Decision

The Inventor

- Alexandros Piridoros, Scientist at the University of Alexandria, developed in 298 a.D. a new device for a scientific variant of antique basket ball game
- He worked using analogous computers only…

Picture by courtesy of Römerstadt Augusta Raurica, © 2008

The Spring Canon – dated 298 a.D.



The Spring Canon

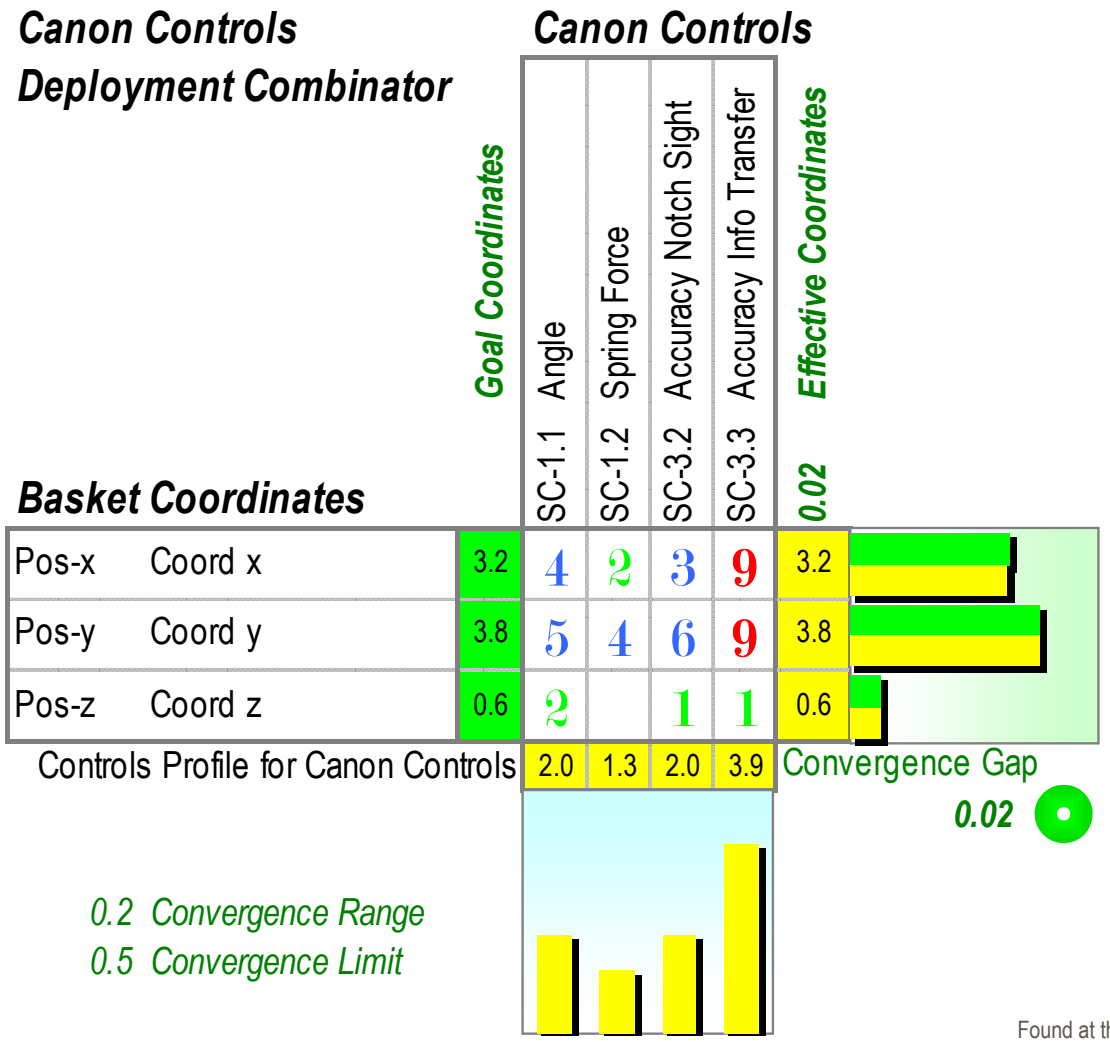
- Three degrees of freedom for the goal target (***Response***):
  - Height
  - Width
  - Distance
- Four degrees of freedom for the spring canon (***Controls***):
  - Angle of eject device
  - Spring force impact
  - Accuracy of notch and bead optical system
  - Accuracy of the information transmission system

The Spring Canon Transfer Function

4	2	3	9
5	4	6	9
2		1	1

Found at the sand beach of Alexandria, © -298

The Spring Canon Transfer Function



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Spring Canon Design Parameters

- How to determine what are the relevant controls?
  - Experience of experts
  - Technology Constraints
- How to adjust controls?
  - By trial and error
  - Linear Optimization
- Predicting the controls' profile
  - Looked trivial to most
  - But as soon somebody started replacing springs by gunpowder – paradigm changed!

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Time Jump

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Time Jump – All-Electric Cars in 2010

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Construction of a Car Door in 2010

- All-Electric Car
  - No longer mechanical but electronic controls
  - We'll construct software who's controls meet customer's needs
- Target goals become
  - ***Customer's Needs***
- Controls become
  - ***Use Cases***

Software Developers in a SCRUM team – NOOP.NL, © Jurgen Appelo 2010

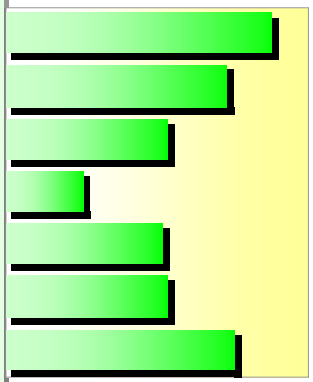
Car Door Design Parameters

- How to determine what are the relevant controls?
  - ***Prediction Functions*** for finding relevant Use Cases
- How to adjust controls?
  - By trial and error?
  - Linear Optimization?
  - ***Design for Six Sigma!***
- Design Decisions for the controls' profile – the technical solution
  - By ***Decision Metrics!***

Sample QFD: Car Door

Customer's Needs Profile

	Customer's Needs	*Combined Profile* Weight
CN-F Functional	CN-F.1 Open and Close	*2.6*
	CN-F.2 Anti-Trap Facility	*2.2*
	CN-F.3 Adjusts to User's Wishes	*1.6*
CN-Q Security	CN-Q.1 Knows Operational Status	*0.8*
	CN-Q.2 Security Lock	*1.5*
	CN-Q.3 User Friendliness	*1.6*
	CN-Q.4 Emergency Actions	*2.3*



- Assume: Customer's Needs analyzed and known
  - Kano Workshop
  - AHP approved

	A1	A2	A3	A4	A5	A6	A7		Profile	Ranking
A1	1.0	2.0	0.5	0.3	1.0	3.0	0.3	*0.11*	1.3	5
A2	0.5	1.0	3.0	0.5	0.3	3.0	0.3	*0.11*	1.3	6
A3	2.0	0.3	1.0	0.4	0.3	3.0	0.3	*0.09*	1.2	7
A4	3.0	2.0	2.5	1.0	1.0	1.0	0.3	*0.15*	1.9	3
A5	1.0	3.0	3.0	1.0	1.0	3.0	0.3	*0.16*	2.0	2
A6	0.3	0.3	0.3	1.0	0.3	1.0	3.0	*0.12*	1.5	4
A7	3.0	3.0	3.0	3.0	3.0	0.3	1.0	*0.26*	3.2	1
	10.8	11.7	13.3	7.2	7.0	14.3	5.7	1.00		

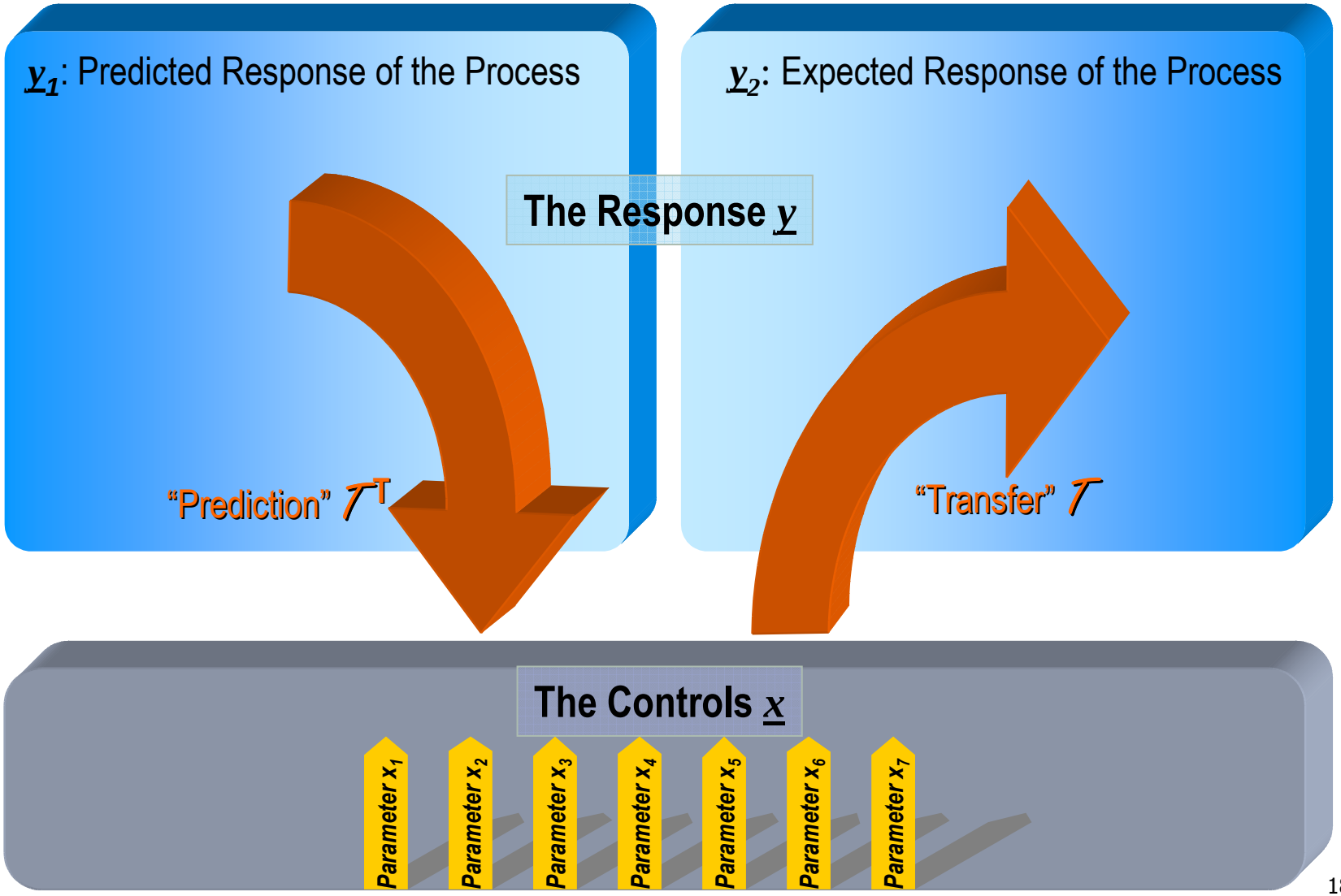
Enter ratios <1 for less important, >1 for more important, when compared with the alternative — *0.01*

Select Controls from Experience

Use Cases - Initial

	Topics
UC-1 Normal Functionality	UC-1.1 Open from Interior UC-1.2 Open from Exterior UC-1.3 Close from Interior UC-1.4 Close from Exterior
UC-2 Sensing	UC-2.1 Motor Start UC-2.2 Motor Stops
UC-3 Emergency	UC-3.1 Emergency: No Energy UC-3.2 Emergency: Collision Stop

Prediction and Transfer Function



Predict Weight of Controls

$\mathcal{T} =$

Use Cases - Initial
Deployment Combinator

Use Cases - Initial

The $\underline{y}$

		Target Response	UC-1.1 Open from Interior	UC-1.2 Open from Exterior	UC-1.3 Close from Interior	UC-1.4 Close from Exterior	UC-2.1 Motor Start	UC-2.2 Motor Stops	UC-3.1 Emergency: No Energy	UC-3.2 Emergency: Collision Stop
Customer's Needs										
CN-F.1	Open and Close	2.6	9	9	9	9				
CN-F.2	Anti-Trap Facility	2.2			9	9				
CN-F.3	Adjusts to User's Wishes	1.6	3	3	3	3	9	9		
CN-Q.1	Knows Operational Status	0.8	3	3						9
CN-Q.2	Security Lock	1.5		9		3				
CN-Q.3	User Friendliness	1.6	3	3	3	3				
CN-Q.4	Emergency Actions	2.3							9	9
Weighted Importance of Control			36	50	53	58	14	14	20	27
Controls Profile for Use Cases - Initial										

0.2 Convergence Range
0.5 Convergence Limit

The $\underline{x}$:
$\underline{x} = \mathcal{T}^{\mathsf{T}}(\underline{y})$

Validate Weight of Controls

$\mathcal{T} =$

Use Cases - Initial
Deployment Combinator

Use Cases - Initial

		Target Response	UC-1.1 Open from Interior	UC-1.2 Open from Exterior	UC-1.3 Close from Interior	UC-1.4 Close from Exterior	UC-2.1 Motor Start	UC-2.2 Motor Stops	UC-3.1 Emergency: No Energy	UC-3.2 Emergency: Collision Stop		*Response Achieved*
Customer's Needs											114	*0.68*
CN-F.1	Open and Close	2.6	9	9	9	9					82	3.6
CN-F.2	Anti-Trap Facility	2.2			9	9					47	2.0
CN-F.3	Adjusts to User's Wishes	1.6	3	3	3	3	9	9			40	1.7
CN-Q.1	Knows Operational Status	0.8	3	3						9	23	1.0
CN-Q.2	Security Lock	1.5		9		3					29	1.3
CN-Q.3	User Friendliness	1.6	3	3	3	3					27	1.2
CN-Q.4	Emergency Actions	2.3							9	9	20	0.9
Weighted Importance of Controls			36	50	53	58	14	14	20	27	107	Convergence Gap
Controls Profile for Use Cases - Initia			1.7	2.3	2.5	2.7	0.7	0.7	1.0	1.3		*0.68*

The $\underline{y'}$:
$\underline{y'} = \mathcal{T}(\underline{x}) = \mathcal{T}^{T}(\underline{y})$

0.2 Convergence Range
0.5 Convergence L

The $\underline{x}$

$\underline{y} \neq \underline{y'}$

Decision Metrics?

- Can we base Design Decisions on this Transfer Function $\mathcal{T}$?

$\mathcal{T}$ =

9	9	9	9				
		9	9				
3	3	3	3	9	9		
3	3						9
	9		3				
3	3	3	3				
						9	9

No!

Improve Controls with Prediction Function

Use Cases - Final

	Topics
UC-1 Normal Functionality	UC-1.1 Open from Interior UC-1.2 Open from Exterior UC-1.3 Close from Interior UC-1.4 Close from Exterior
UC-2 Sensing	UC-2.1 Motion Sensing UC-2.2 Power Supply Sensing
UC-3 Emergency	UC-3.1 Emergency: No Energy UC-3.2 Emergency: Collision Stop

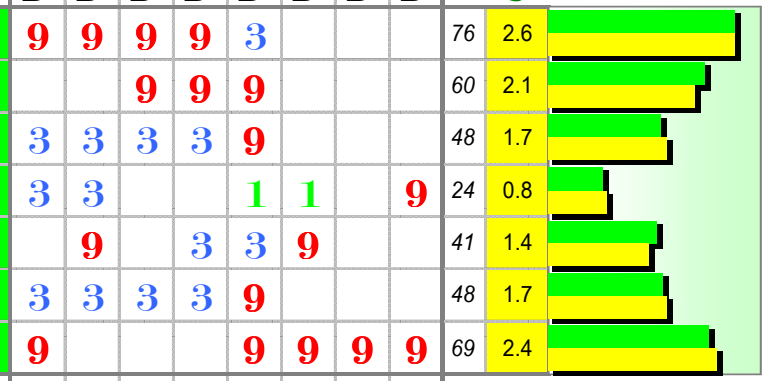
See how it works!

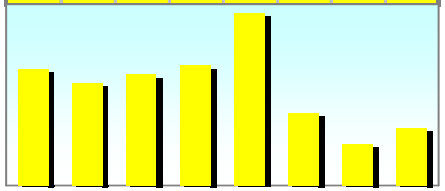
$\mathcal{T} =$

Use Cases - Final
Customer's Needs

Use Cases - Final

Customer's Needs		***Target Response***	UC-1.1 Open from Interior	UC-1.2 Open from Exterior	UC-1.3 Close from Interior	UC-1.4 Close from Exterior	UC-2.1 Motion Sensing	UC-2.2 Power Supply Sensing	UC-3.1 Emergency: No Energy	UC-3.2 Emergency: Collision Stop	145	***Response Achieved***
CN-F.1	Open and Close	2.6	9	9	9	9	3				76	2.6
CN-F.2	Anti-Trap Facility	2.2			9	9	9				60	2.1
CN-F.3	Adjusts to User's Wishes	1.6	3	3	3	3	9				48	1.7
CN-Q.1	Knows Operational Status	0.8	3	3			1	1		9	24	0.8
CN-Q.2	Security Lock	1.5		9		3	3	9			41	1.4
CN-Q.3	User Friendliness	1.6	3	3	3	3	9				48	1.7
CN-Q.4	Emergency Actions	2.3	9				9	9	9	9	69	2.4
	Weighted Importance of Controls		56	50	53	58	82	35	20	27	145	Convergence Gap
	Controls Profile for Use Cases - Final		1.9	1.7	1.8	2.0	2.8	1.2	0.7	0.9		*0.09*





The $\underline{y}'$:

$$\underline{y}' = \mathcal{T}(\underline{x}) = \mathcal{T}^{T}(\underline{y})$$

0.2 Customer's Needs
0.5 Customer's Needs

The $\underline{x}$

$\underline{y} \cong \underline{y}'$

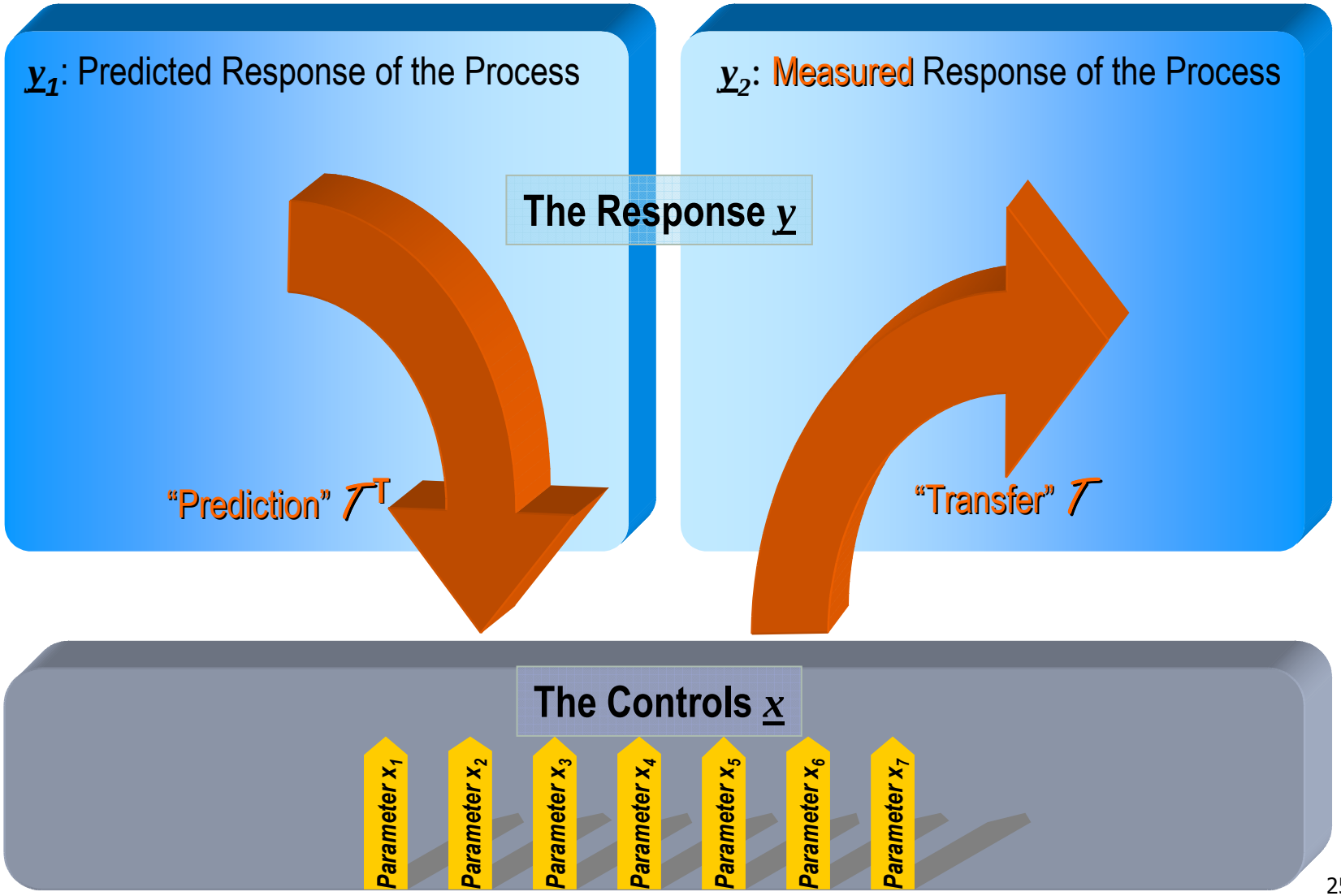
The Convergence Gap

- The ***Convergence Gap*** describes how much the achieved response from a Transfer Function $\mathcal{T}$ differs from the intended response

$$|| \ \underline{y} - \mathcal{T}(\mathcal{T}^{\mathsf{T}}(\underline{y})) \ ||$$

- The profile $\underline{y}$ is called a ***Decision Metrics*** for the Transfer Function $\mathcal{T}$ if there is an $\varepsilon > 0$ such that the vector distance $|| \ \underline{y} - \mathcal{T}(\mathcal{T}^{\mathsf{T}}(\underline{y})) \ || < \varepsilon$

Measuring Process Response

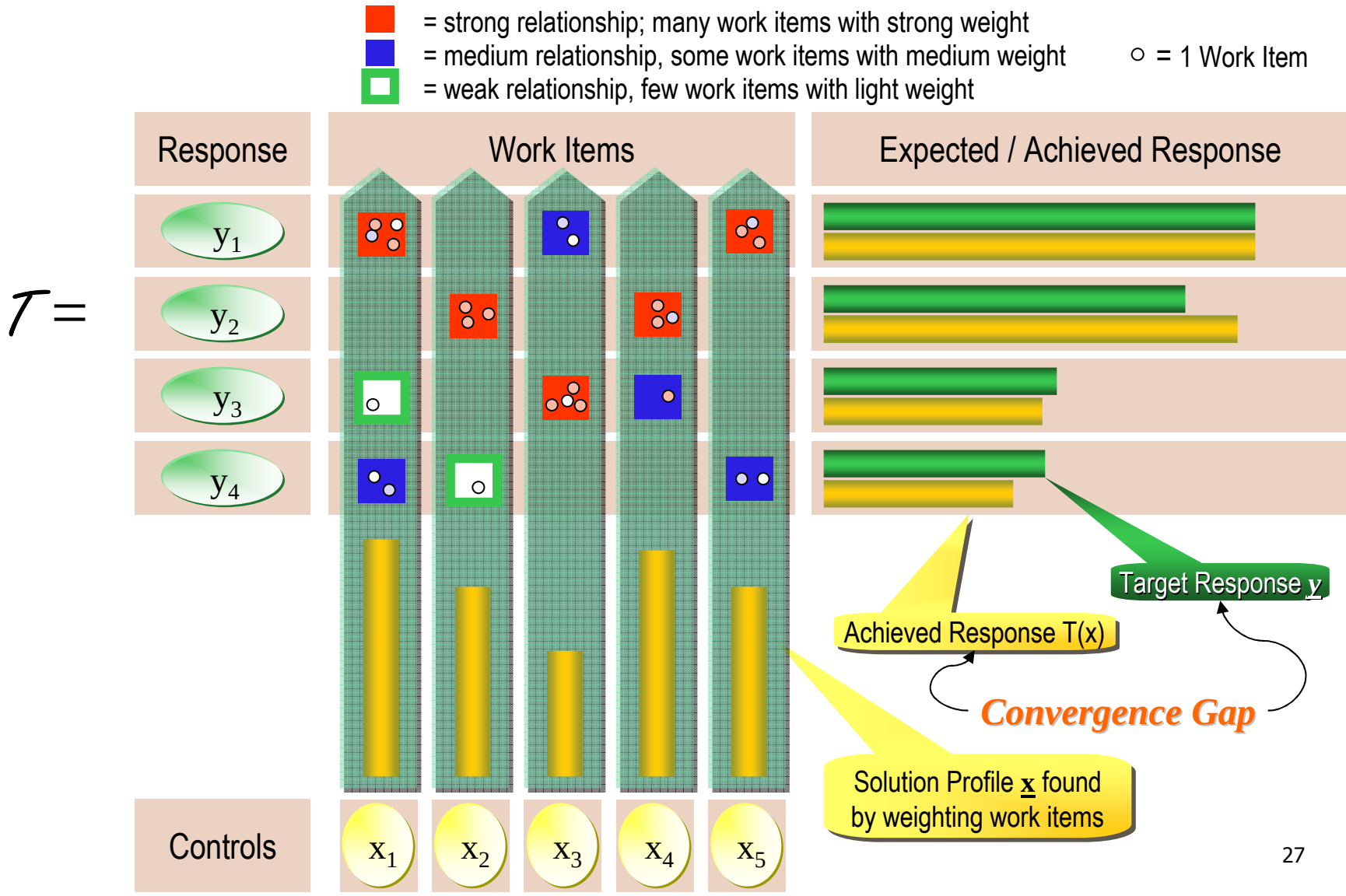


Measuring Process Response

- Developers identify
  - Work Items for the Use Case that they are working upon
  - Customer's Needs that receive some contribution
    - High:
    - Medium:
    - Low:

- And fill in the Transfer Matrix ↗ Use Cases vs. Customer's Needs
  - With small marker buttons or sticky notes
  - Containing reference to contributing Work Items

Achieved Response for Transfer Function T



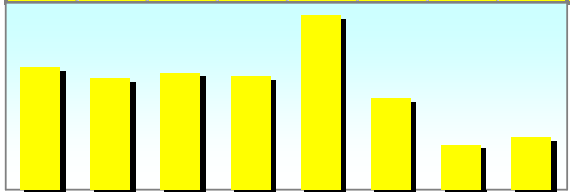
Measured Response

$\mathcal{T} =$

Use Cases - Final
Customer's Needs

Use Cases - Final

Customer's Needs		***Target Response***	UC-1.1 Open from Interior	UC-1.2 Open from Exterior	UC-1.3 Close from Interior	UC-1.4 Close from Exterior	UC-2.1 Motion Sensing	UC-2.2 Power Supply Sensing	UC-3.1 Emergency: No Energy	UC-3.2 Emergency: Collision Stop	150	***Response Achieved***
CN-F.1	Open and Close	2.6	8.3	9.2	8.7	8.7	5.2		1.2		80	2.7
CN-F.2	Anti-Trap Facility	2.2	2.0	1.1	9.7	7.9	8.7	2.1			66	2.2
CN-F.3	Adjusts to User's Wishes	1.6	3.0	3.3	5.0	2.3	6.8				44	1.5
CN-Q.1	Knows Operational Status	0.8	3.0	4.2			1.2	2.3	1.2	6.7	27	0.9
CN-Q.2	Security Lock	1.5		9.8		2.3	3.2	9.9			45	1.5
CN-Q.3	User Friendliness	1.6	3.0	2.0	2.2	4.5	9.0				47	1.6
CN-Q.4	Emergency Actions	2.3	9.0				8.7	9.8	7.8	8.8	69	2.3
	Weighted Importance of Controls		59	54	56	55	84	44	22	25	150	Convergence Gap
	Controls Profile for Use Cases - Final		2.0	1.8	1.9	1.8	2.8	1.5	0.7	0.8		***0.07***



0.2 Customer's Needs
0.5 Customer's Needs

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Questions?