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**Structured
Methods**

**Product
Development**

**Project
Office**

**Proposal
Management**

**Process
Metrics**

Six Sigma in Agile SW Development

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Thomas Fehlmann

What is Agile?

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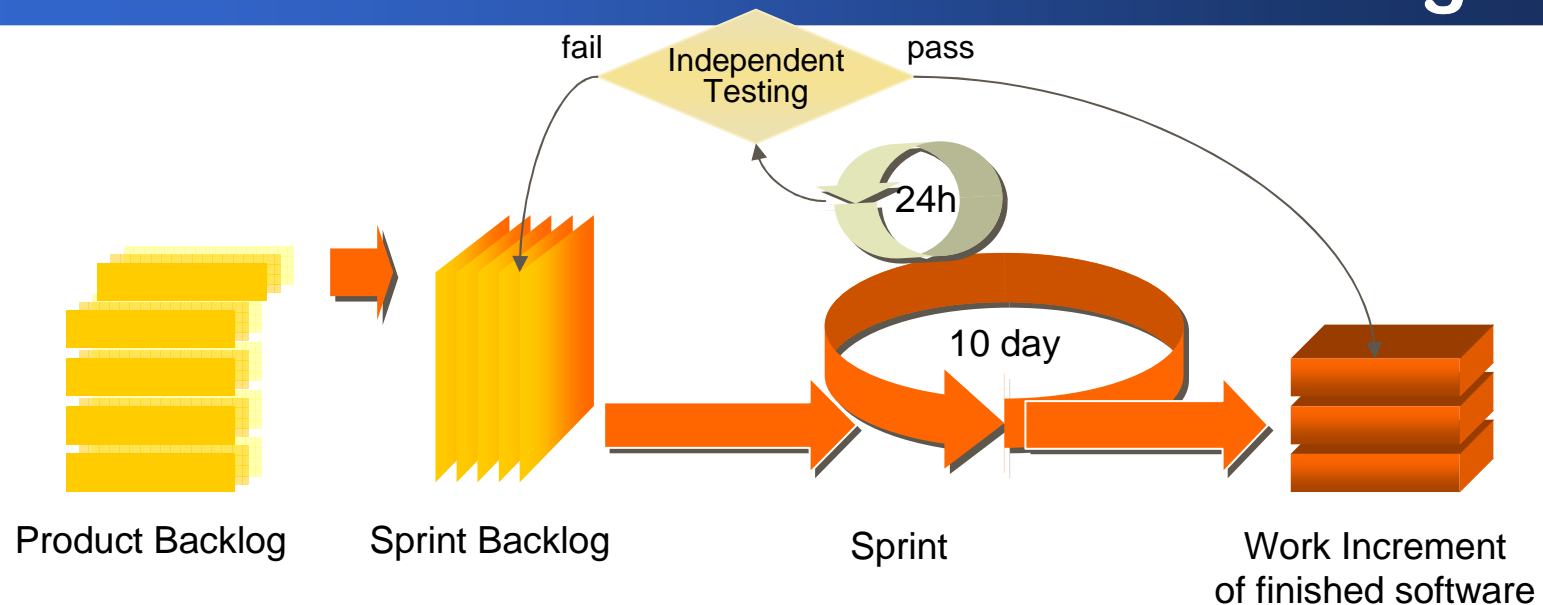
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fail   Independent   pass
            Testing

24h

10 day

Product Backlog   Sprint Backlog   Sprint   Work Increment
of finished software

- **Planning Session**
  - To select Work Items for the Sprint
- **Daily Scrum**
  - With Daily Stand-Up Meetings: *Achievements? Next Steps? Obstacles?*
- **Independent Testing**
  - "Green Bar" on JUnit
  - Create a Working System every day
  - Such that customer can provide feedback immediately

Agile – the Good Points and the Ugly Questions

- Embrace Change
  - ➡ SW development is not Civil Engineering
- Involve Stakeholders
  - ➡ Harvest on developer's experience and know-how
- Acquire Knowledge
  - ➡ Build up domain know-ledge as work progresses
- Communicate
  - ➡ Explain, discuss…
  - ➡ Reach consensus

- Pain Points
  - ➡ Sizing User Stories
  - ➡ Effort Estimation
- When is it finished?
  - ➡ What is finished?
  - ➡ What means "finished"?
- What are the priorities?
  - ➡ For the Product Backlog?
  - ➡ For the Sprint Backlog?
- Was the project successful?
  - ➡ Business goals reached?

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- **Communicate to your customer help desk**

- **Validate that help desk aligns with company strategy**

- **Spend help desk budget according company communication and strategy**

Planned Response for Transfer Function T

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Process Metrics

Response	Planned Contributions	Expected Response
y_1		
y_2		
y_3		

Expected Response $\underline{y}$

y_1: Friendliness
y_2: Response time
y_3: Accuracy

Planned Response for Transfer Function T

$\blacksquare$ = strong relationship; many contributions with strong weight

$\blacksquare$ = medium relationship, some contributions with medium weight

$\square$ = weak relationship, few contributions with light weight

Response	Planned Contributions	Expected Response

y_1
y_2
y_3

y_1: Friendliness
y_2: Response time
y_3: Accuracy

Expected Response $\underline{y}$

x_1: Training
x_2: IT performance
x_3: Salary & bonus
x_4: Work environment

Cost Profile $\underline{x}$ found by weighting contributions

Controls

x_1 x_2 x_3 x_4

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Effective Response for Transfer Function $\mathcal{T}$
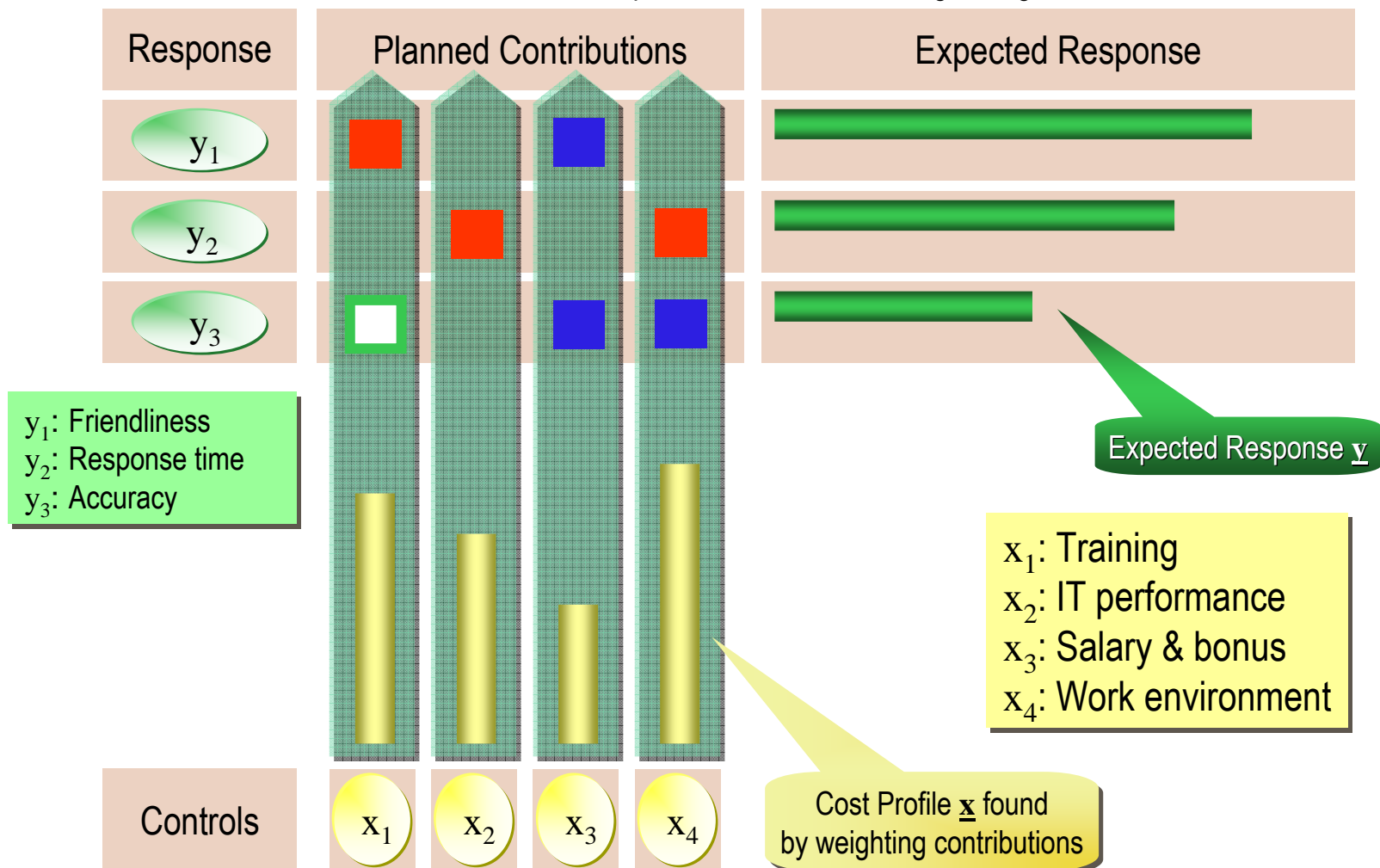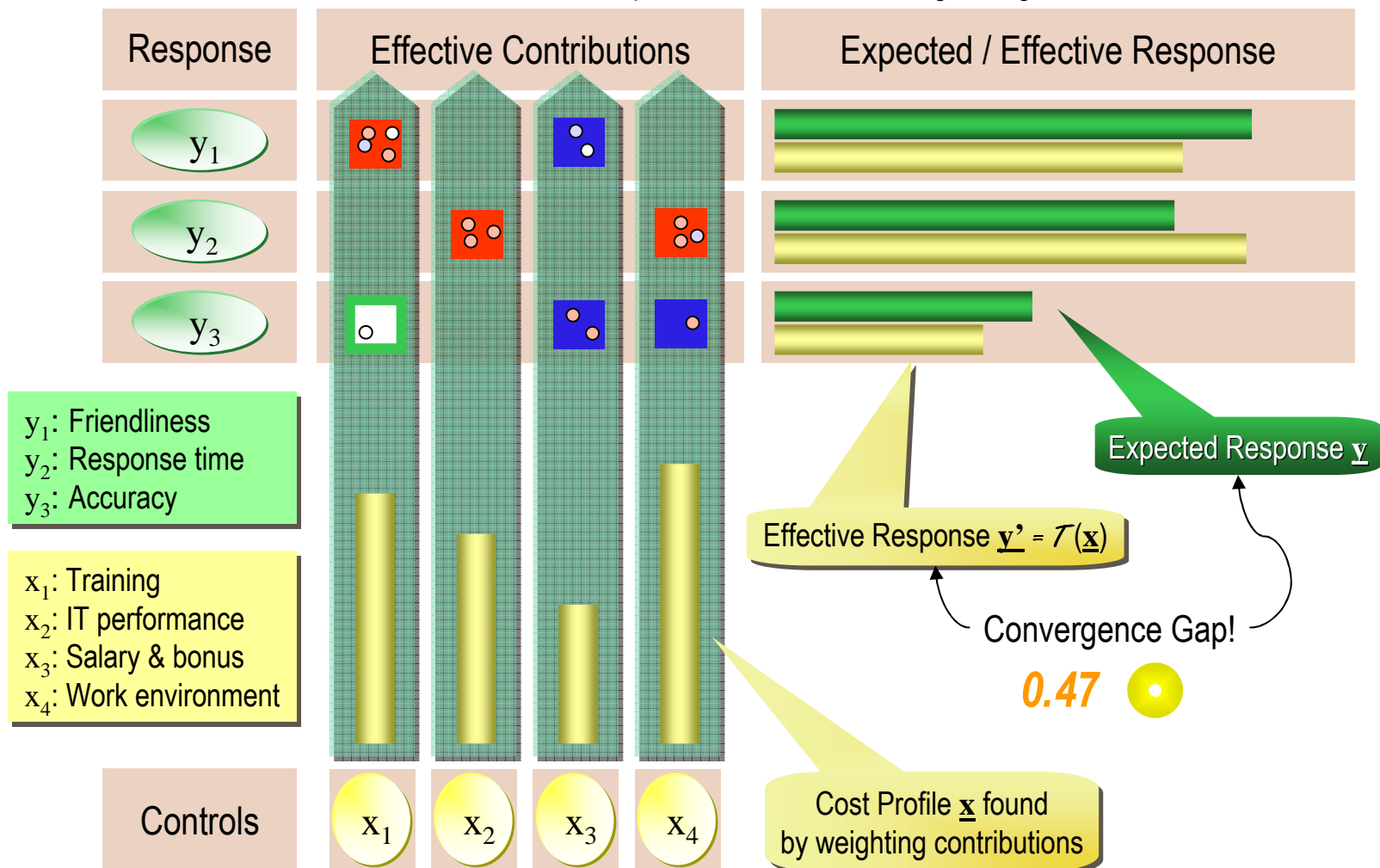
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■ = strong relationship; many contributions with strong weight
■ = medium relationship, some contributions with medium weight
□ = weak relationship, few contributions with light weight

Response | **Effective Contributions** | **Expected / Effective Response**

y_1

y_2

y_3

y_1: Friendliness
y_2: Response time
y_3: Accuracy

x_1: Training
x_2: IT performance
x_3: Salary & bonus
x_4: Work environment

Expected Response $\underline{y}$

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

Convergence Gap!

0.47

Cost Profile $\underline{x}$ found by weighting contributions

Controls | x_1 | x_2 | x_3 | x_4

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Process Metrics

Left Diagram

User Stories
Deployment Combinator

User Stories

Business Drivers

		Response Profile	Training x-1	IT Infrastructure x-2	Salary x-3	Work Place x-4	Effective Profile 0.47
y-1	Friendliness	3.5	9		3		3.0
y-2	Responsiveness	2.9		9		7	3.5
y-3	Correctness	2.1	1		5	3	1.8
	Control Profile for User Stories		3.1	2.4	1.9	2.5	Convergence Gap

Convergence Gap 0.47

0.2 Convergence Range
0.5 Convergence Limit

Right Diagram

User Stories
Deployment Combinator

User Stories

Business Drivers

		Response Profile	Training x-1	IT Infrastructure x-2	Salary x-3	Work Place x-4	Effective Profile 0.09
y-1	Friendliness	3.5	9		3		3.6
y-2	Responsiveness	2.9		7		6	2.8
y-3	Correctness	2.1	1		5	3	2.1
	Control Profile for User Stories		3.3	2.0	2.1	2.4	Convergence Gap

Convergence Gap 0.09

0.2 Convergence Range
0.5 Convergence Limit

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● The Response is known
  ➡ By measurement – customer preferences
  ➡ By business strategy decisions

● The Transfer Function is customizable
  ➡ Relationship corresponds to work effort
    o Up to constraints
  ➡ Is selectable for services
    o such as work instructions for software development
  ➡ Physical constraints play no big role for agile SW development
  ➡ Security constraints impact relationship $x_i \rightarrow y_j$

● The Controls are measurable
  ➡ Functional Size
  ➡ Total Effort
  ➡ Total Cost

$$\mathcal{T}(\underline{\mathbf{x}}) = \underline{\mathbf{y}}$$

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Process Metrics

- The goal profile $\underline{\mathbf{y}} = <y_1, y_2, \ldots y_m>$ describes business goals
- Solution with profile $\underline{\mathbf{x}} = <x_1, x_2, \ldots x_n>$ such that $\mathcal{T}(\underline{\mathbf{x}}) = \underline{\mathbf{y}}$ is requested
- *Quality is linear:*
  - Thus $\mathcal{T}$ can be written as an n x m matrix
  - The transpose $\mathcal{T}^{\mathbf{T}}$ is an m x n matrix
- Note $\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}$ is a square matrix (m x m); $[\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}](\underline{\mathbf{y}}) = \mathcal{T}(\mathcal{T}^{\mathbf{T}}((\underline{\mathbf{y}})), \forall \underline{\mathbf{y}}$
- Note that $\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}$ is not the Identity function!
  - Since cause/effect cannot be reversed!
- An *Eigenvector* $\underline{\mathbf{y}}$ fulfills the equation

$$[\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}](\underline{\mathbf{y}}) = \lambda \, \underline{\mathbf{y}}$$

  - λ is a scalar number; we can set it to $\lambda = 1$ by normalization
  - If $\underline{\mathbf{y}}$ is an Eigenvector then $\underline{\mathbf{x}} = \mathcal{T}^{\mathbf{T}}(\underline{\mathbf{y}})$ is the solution!
- We need to know how good the solution $\underline{\mathbf{x}}$ is for the goal $\underline{\mathbf{y}}$
- The vector distance $|| \mathcal{T}(\underline{\mathbf{x}}) - \lambda \, \underline{\mathbf{y}}||$ is called the *Convergence Gap*
- A small Convergence Gap means a good prediction, because
  - It can be repeated! $[\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}](\underline{\mathbf{y}}) = [\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}]([\mathcal{T} \bullet \mathcal{T}^{\mathbf{T}}](\underline{\mathbf{y}}))$ is decision metrics!

Eigenvector of a Transfer Function $\mathcal{T}$ – Easy!

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Process Metrics

- The customer knows what he wants: $\underline{y}$

  ➡ The goal profile

- Developers know their business domain

  ➡ They know how $\mathcal{T}$ works on solution $\underline{x}$!

  ➡ They know how $\underline{x}$ transforms into business benefits $\mathcal{T}(\underline{x})$

- Does $\mathcal{T}(\underline{x})$ meet customer's business goals $\underline{y}$?

  ➡ Look at the difference between $\underline{y}$ and $\mathcal{T}(\underline{x})$!

- This is the *Convergence Gap* $\|\underline{y} - \mathcal{T}(\underline{x})\|$

  ➡ This is a measurement for meeting requirements!

  ➡ This measurement *validates* the process

We can predict whether we will meet customer's business goal!

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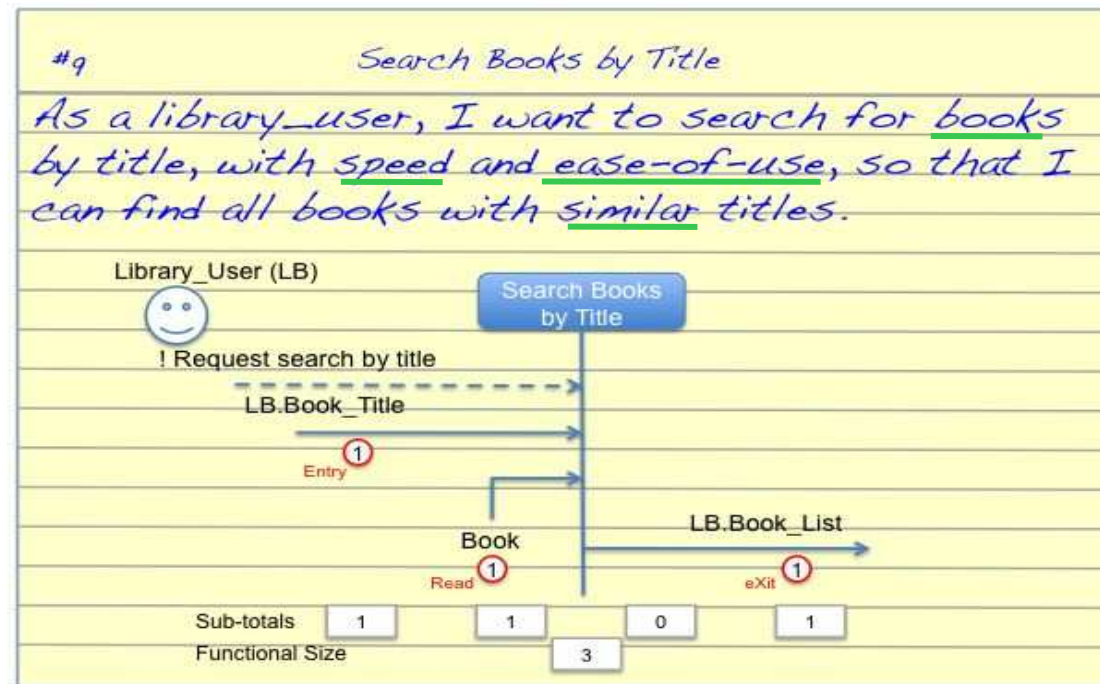
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- You can measure and validate well-structured processes only!

Sample User Story: Search Books by Title

#q Search Books by Title

As a library_user, I want to search for books by title, with speed and ease-of-use, so that I can find all books with similar titles.

- **Three functional Work Items:**
  - ➡ Enter Book Title
  - ➡ Read from Data Store
  - ➡ Present Book List

- **Four quality Work Items:**
  - ➡ Include Subtitle Search
  - ➡ Increased Search Speed
  - ➡ Forgiving Grammar Check
  - ➡ Pattern Matching Search

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1st Six Sigma Contribution to Agile

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● Functional Size

Functional Processes

ID	Process	Does it operate on a unique and ordered set of data movements performing a set of FURs?	Is it triggered by an event?	Does the triggering event occur outside the boundary of the software?	Does the process execute all that is required to be done in response to the triggering event?	Triggering Event		Sub-Process Description	Data Group	Entry (E)	Read (R)	Write (W)	Exit (X)	
X.1	Search Book by Title	Yes	Yes	Yes	Yes		f-1.1	Enter Book by Title		1				☑
		Yes	Yes	Yes	Yes		f-1.2	Read from Data Store			1			☑
		Yes	Yes	Yes	Yes		f-1.3	Present Book List					1	☑
		No	Yes	Yes	No		q-1.1	Include Subtitle search						☑
		No	No	No	No		q-1.2	Increase Search Speed						☑
		No	Yes	Yes	Yes		q-1.3	Forgiving Spell Check						☑
		No	Yes	No	Yes		q-1.4	Pattern Matching Search						☑
								Cfsu per Data Movement Type		1	1	0	1	
								Total Cfsu					**3**	

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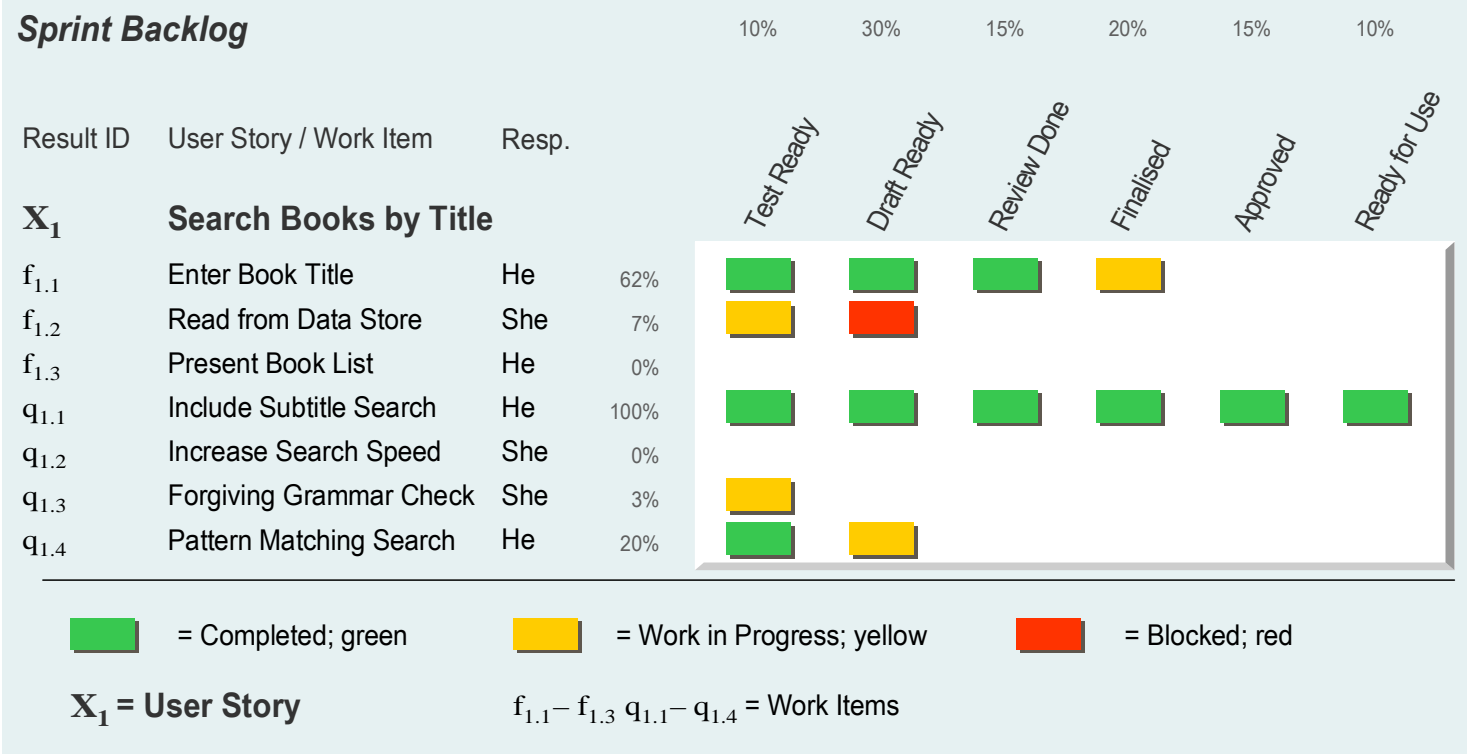Success with your projects

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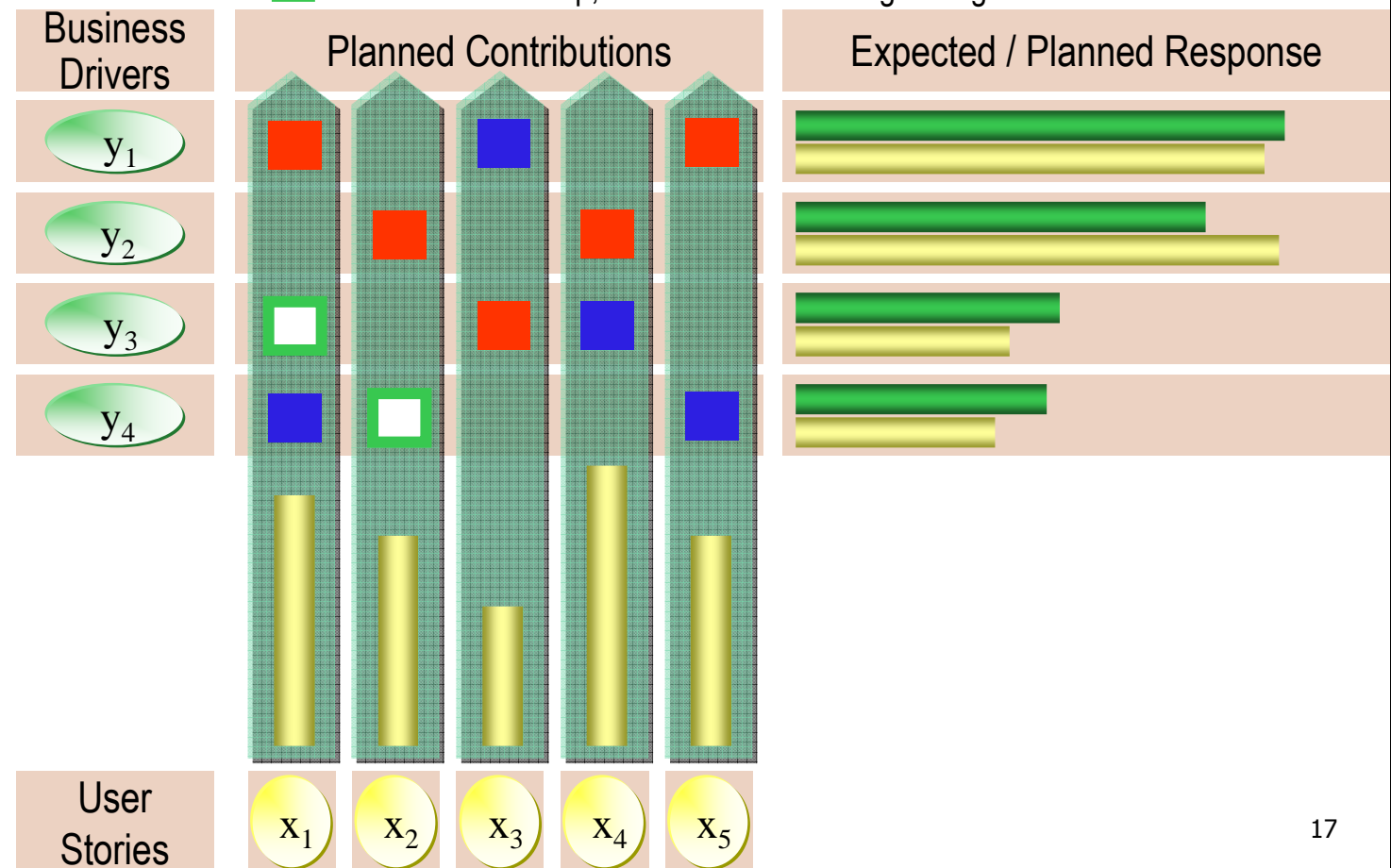
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Process Metrics

● Six Steps to Completion

Sprint Backlog			10%	30%	15%	20%	15%	10%
Result ID	User Story / Work Item	Resp.	Test Ready	Draft Ready	Review Done	Finalised	Approved	Ready for Use
X_1	**Search Books by Title**							
$f_{1.1}$	Enter Book Title	He	62%	🟩	🟩	🟩	🟨		
$f_{1.2}$	Read from Data Store	She	7%	🟨	🟥				
$f_{1.3}$	Present Book List	He	0%						
$q_{1.1}$	Include Subtitle Search	He	100%	🟩	🟩	🟩	🟩	🟩	🟩
$q_{1.2}$	Increase Search Speed	She	0%						
$q_{1.3}$	Forgiving Grammar Check	She	3%	🟨					
$q_{1.4}$	Pattern Matching Search	He	20%	🟩	🟨				

🟩 = Completed; green   🟨 = Work in Progress; yellow   🟥 = Blocked; red

X_1 = **User Story** $f_{1.1} - f_{1.3}$ $q_{1.1} - q_{1.4}$ = Work Items

The Buglione–Trudel Matrix

6 = Non-functional Work Item with **strong** impact on Business Driver
3 = Non-functional Work Item with medium impact on Business Driver
1 = Non-functional Work Item with weak impact on Business Driver
= Functional Work Item with no impact on any particular Business Driver

Business Drivers

Work Items

Expected / Achieved Response

y_1
y_2
y_3
y_4

User Story Priorities

Functional Work Items

User Stories

x_1 x_2 x_3 x_4 x_5

Convergence Gap!
0.04

Functional Size:
23 Csfu

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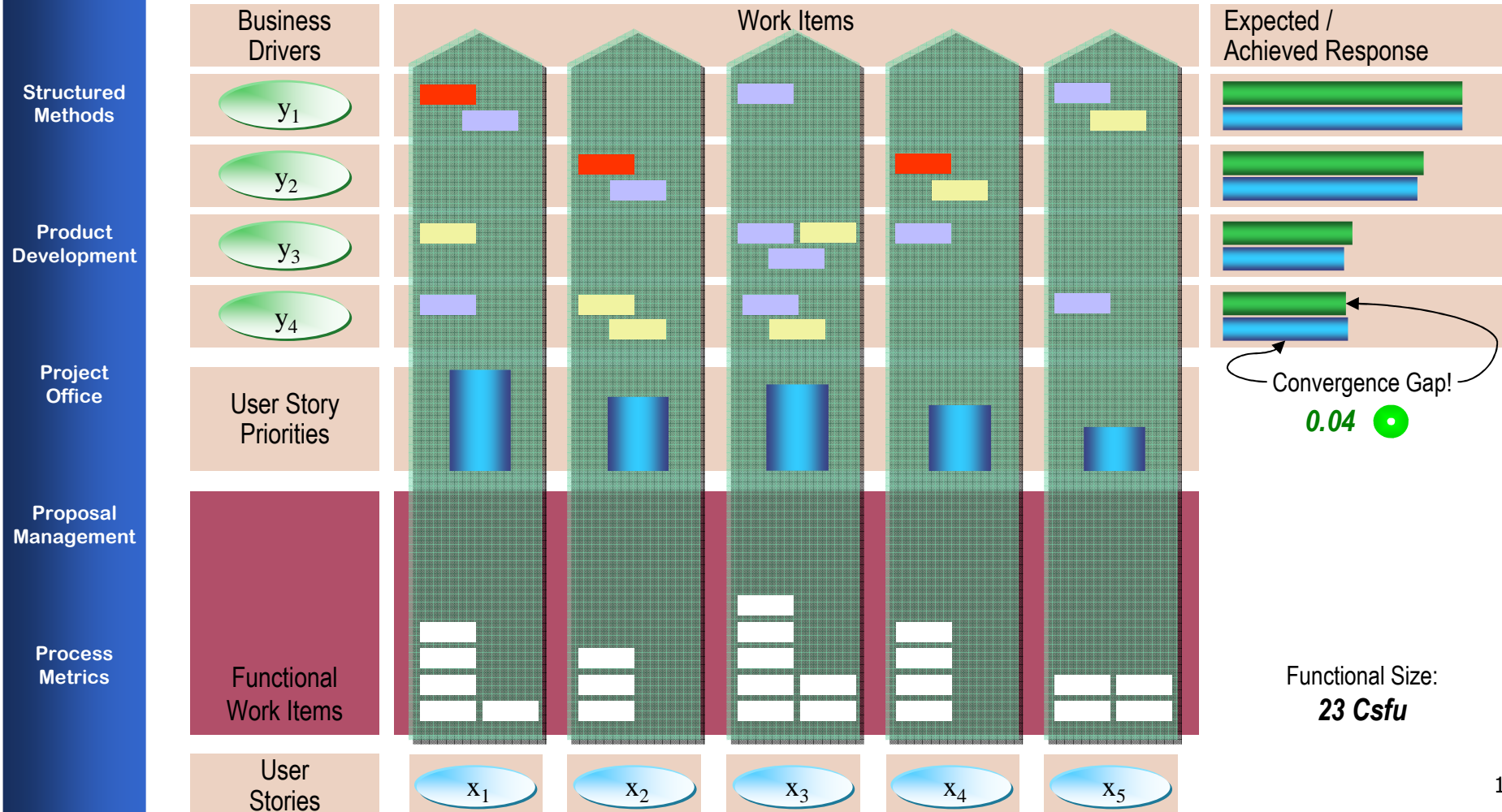
Planned Functional Work Item

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Work Item for User Story x_1 *(planned)*

0 x refactored

$f_{1,1}$: **Enter Book Title**

Functional ✓ Size: **1**   Workdays

Quality ◯ Impact: _____   Planned: **11**

Description

Create input form for entering
- Book Title
- Author
- Publisher
- ISDN
- Media type
- Maximum number of matches

and start search using search book API of library service

● Functional Work Item
  ➡ Related to some data movement, or
  ➡ To some persistent data store

● Quality Work Item ("Non-Functional")
  ➡ Related to some desired quality – depends on identified Business Drivers
  ➡ With high, medium, or low impact (**6** – **3** – **1**) on one or more Business Drivers
  ➡ Has different levels of impact on specific Business Drivers, e.g., Impact = $y_1,\mathbf{6}; y_4,\mathbf{3}$

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- Refactoring Count:

  ➡ Can be increased only when all stages are marked green

  ➡ Whenever a defect is encountered while already Ready for Use – the Six Steps to Completion count is reset to all yellow! Or to red, if issue is blocker.

- Refactoring counts the Failures

  ➡ MTBF – Mean Time Between Failures – means

Work Item for User Story x_1 *(tracked)*   **1** x refactored

	Test is Ready	Draft is Ready	Review Done	Final-ised	Appro-ved	Ready for Use
	🟩	🟩	🟩	🟨	⬜	⬜

$f_{1,1}$: **Enter Book Title**

Functional ✅   Size: **1**   Workdays
Quality ⚪   Impact: ____   Planned: **11**   Actual: **10**   Change: **3**

Description

Create input form for entering
- Book Title
- Author
- Publisher
- ISDN
- Media type
- Maximum number of matches

and start search using search book API of library service

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Work Item for User Story x_1 (tracked)

0 x refactored

Test is Ready	Draft is Ready	Review Done	Final-ized	Appro-ved	Ready for Use

$q_{1,2}$**: Increase Search Speed**

Functional ○ Size: **0** Workdays

Business ✔ Impact: y_1,**6**; y_4,**3** Planned: **11** Actual: ___ Change: ___

Description

Find a method to increase search speed, e.g.
- Indexing
- Frequent search hash table
- Others

- The Hen and Egg Dilemma:
  - ➡ How much impact does a Work Item have?
  - ➡ Impact is always relative – left to the developers to decide
- Priority set by Quality Impact does not necessarily match effort!
  - ➡ Impact Priority profile and effort profile can differ
  - ➡ *Does transfer function applied to effort profile still match goals?*
- Result: Total Impact of User Story $\neq$ Total Effort spent!

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● Now we can start measuring SW processes

● Only now!

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Questions?

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