Aligning Requirements and Testing - Current Challenges and Solutions

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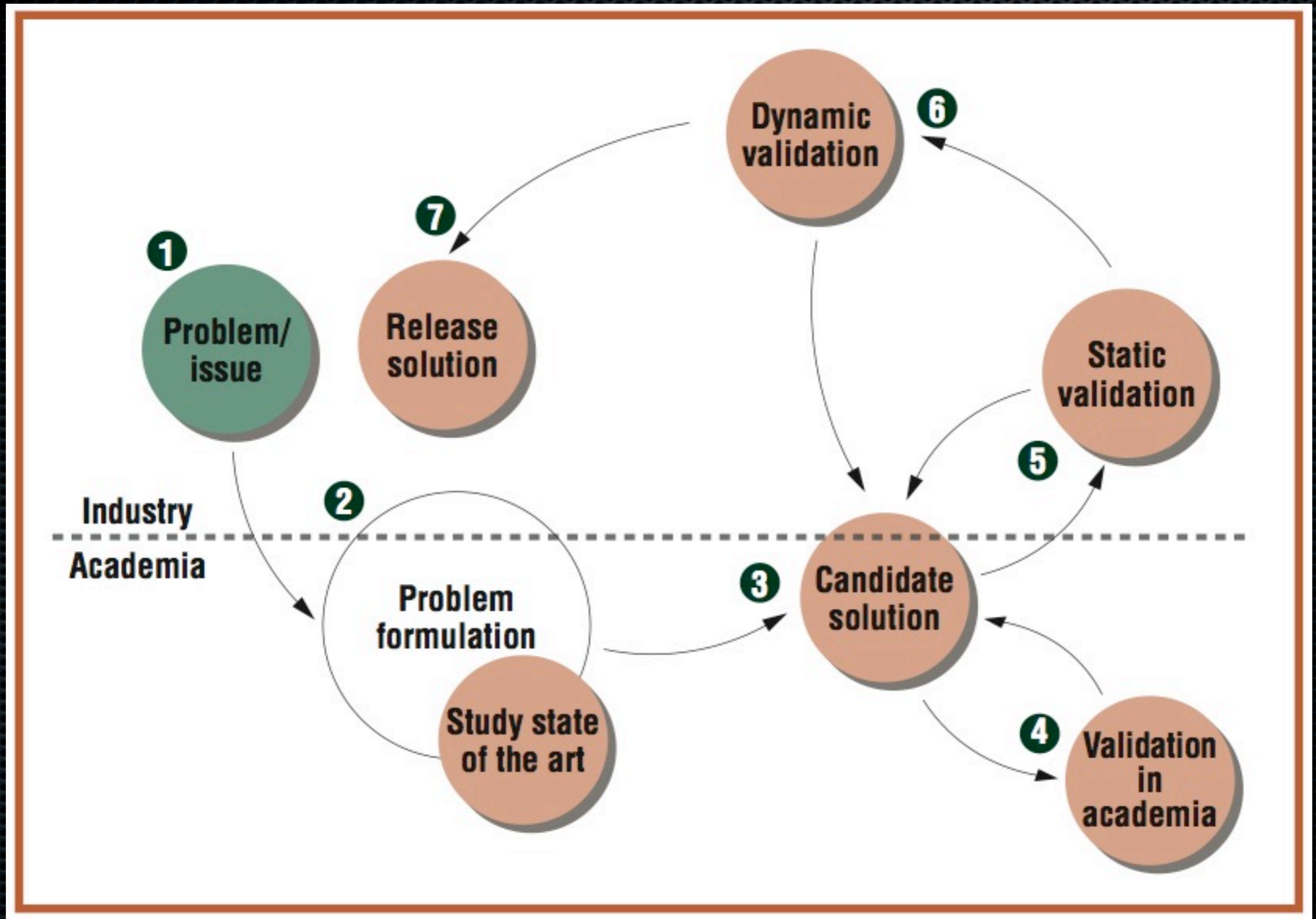
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How we often work (or try to work ;))

Trends

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Trends

Topic Keywords	2012	% 2012
Software Engineering	13,354	100 %
Requirements	2173	16 %
Design	4618	35 %
Programming	2760	21 %
Testing OR Verification	1349	10 %
Req AND Testing	289	2.2%
Human Factors	90	0.7%
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What is Alignment?

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Traditional view: Traceability

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Requirement Identifiers	Reqs Tested	REQ1 UC 1.1	REQ1 UC 1.2	REQ1 UC 1.3	REQ1 UC 2.1	REQ1 UC 2.2	REQ1 UC 2.3.1	REQ1 UC 2.3.2	REQ1 UC 2.3.3	REQ1 UC 2.4	REQ1 UC 3.1	REQ1 UC 3.2	REQ1 TECH 1.1	REQ1 TECH 1.2	REQ1 TECH 1.3
Test Cases	321	3	2	3	1	1	1	1	1	1	2	3	1	1	1
Tested Implicitly	77														
1.1.1	1	x													
1.1.2	2		x	x											
1.1.3	2	x											x		
1.1.4	1			x											
1.1.5	2	x												x	
1.1.6	1		x												
1.1.7	1			x											
1.2.1	2				x		x								
1.2.2	2					x		x							
1.2.3	2								x	x					
1.3.1	1										x				
1.3.2	1										x				
1.3.3	1											x			
1.3.4	1											x			
1.3.5	1											x			
etc....															
5.6.2	1														x

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Alignment = "*adjustment of RE and ST efforts for* **_coordinated functioning_** *& optimized product development*"

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We take a broader view and introduce:

Alignment = "*adjustment of RE and ST efforts for* ***coordinated functioning*** *& optimized product development*"

Alignment-as-activity = "***act of*** *adjusting/arranging efforts involved in RE & ST so they work better together*"

Alignment-as-state = "***condition of*** *RE & ST efforts having established a coordinated functioning*"

Previous work - in one page

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* **Model-based testing indirectly aligns**

  * Detailed Req models => automated testing, but costly

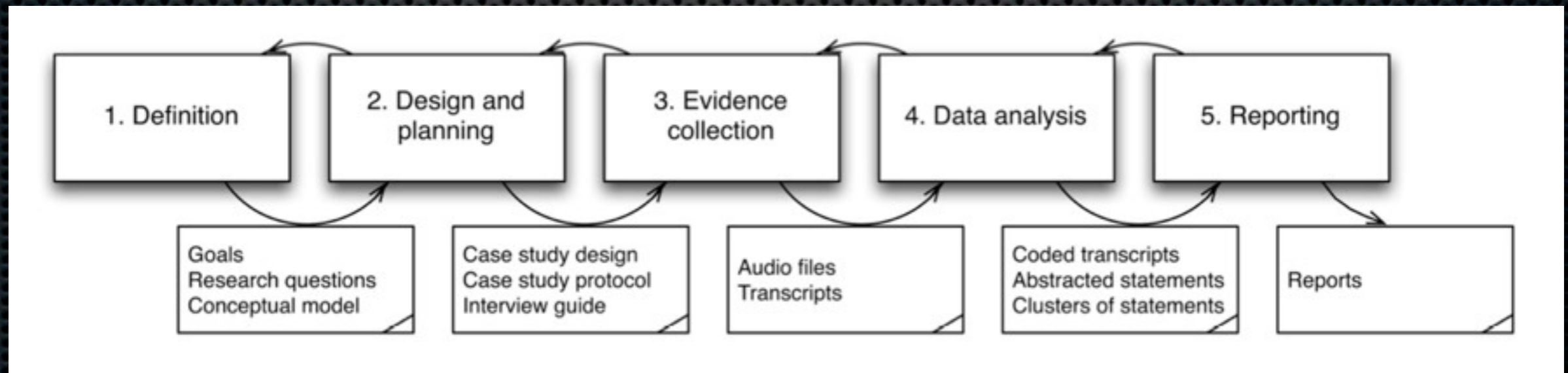# Ok, so what did we do?

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Main goals:
1. understanding challenges in REVV alignment
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1. understanding challenges in REW alignment
2. identify common practices used in industry

Six (6) companies involved

Company	A	B	C	D	E	F
Type of company	Software development, embedded products	Consulting	Software development	Systems engineering, embedded products	Software development, embedded products	Software development, embedded products
# employees in software development of targeted organisation	125-150	135	500	50-100	300-350	1,000
# employees in typical project	10	Mostly 4-10, but varies greatly	50-80	software developers: 10-20	6-7 per team, 10-15 teams	Previous process: 800-1,000 person years
Distributed	No	Collocated (per project, often on-site at customer)	Yes	Yes	Yes	Yes
Domain / System type	Computer networking equipment	Advisory/technical services, application management	Rail traffic management	Automotive	Telecom	Telecom
Source of requirements	Market driven	Bespoke	Bespoke	Bespoke	Bespoke and market driven	Bespoke and market driven
Main quality focus	Availability, performance, security	Depends on customer focus	Safety	Safety	Availability, Performance, reliability, security	Performance, stability
Certification	No software related certification	No	ISO9001, ISO14001, OHSAS18001	ISO9001, ISO14001	ISO9001, ISO14001 (aiming towards adhering to TL9000)	ISO9001
Process Model	Iterative	Agile in variants	Waterfall	RUP, Scrum	Scrum, eRUP, a sprints is 3 months	Iterative with gate decisions (agile influenced). Previous:

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						Waterfall
Duration of a typical project	6-18 months	No typical project	1-5 years to first delivery, then new software release for 1-10 years	1-5 years to first delivery, then new software releases for 1-10 years	1 year	Previous process 2 years
# requirements in typical project	100 (20-30 pages HTML)	No typical project	600-800 at system level	For software: 20-40 use cases	500-700 user stories	Previous process:14,000
# test cases in a typical project	~1,000 test cases	No typical project	250 at system level		11,000+	Previous process 200,000 at platform level, 7,000 at system level
Product Lines	Yes	No	Yes	Yes	Yes	Yes
Open Source	Yes	Yes. Wide use, including contributions	Yes, partly	No	No	Yes (with new agile process model)

Seven (7) roles involved

Role	A	B	C	D	E	F
Requirements engineer						F1 (senior), F6 (senior), F7 (senior)
Systems architect				D3 (junior)	E1 (senior)	F4 (senior)
Software developer		B1 (junior), B2 (senior), B3 (senior)				F13 (senior)
Test engineer	A2 (senior)		C1 (senior), C2 (junior)	D2 (senior)	E3 (senior)	F9 (senior), F10 (senior), F11 (junior), F12 (senior), F14 (senior)
Project manager	A1 (junior)		C3 (senior)	D1 (senior)		F3 (junior), F8 (senior)
Product manager	A3 (senior)				E2 (senior)	
Process manager						F2 (junior), F5 (senior), F15 (junior)

30 x 90mins semi-structured interviews
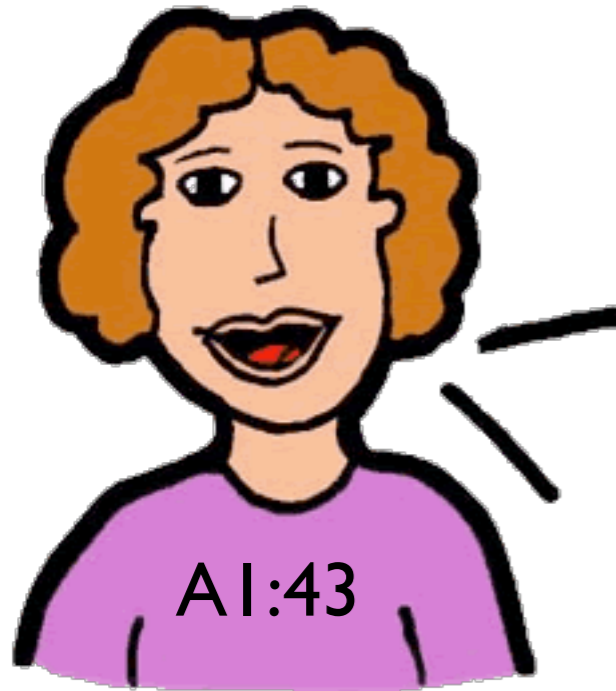
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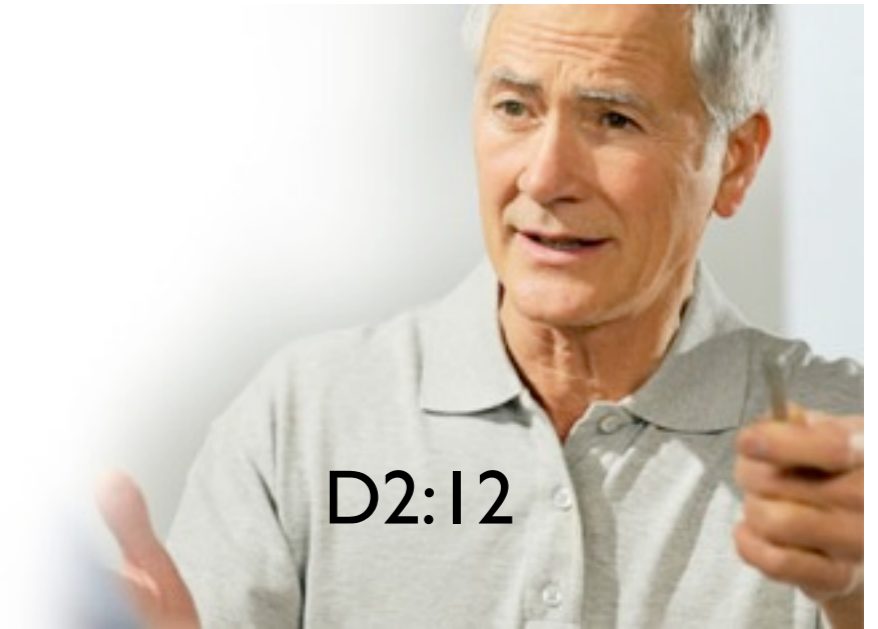
Results - in general
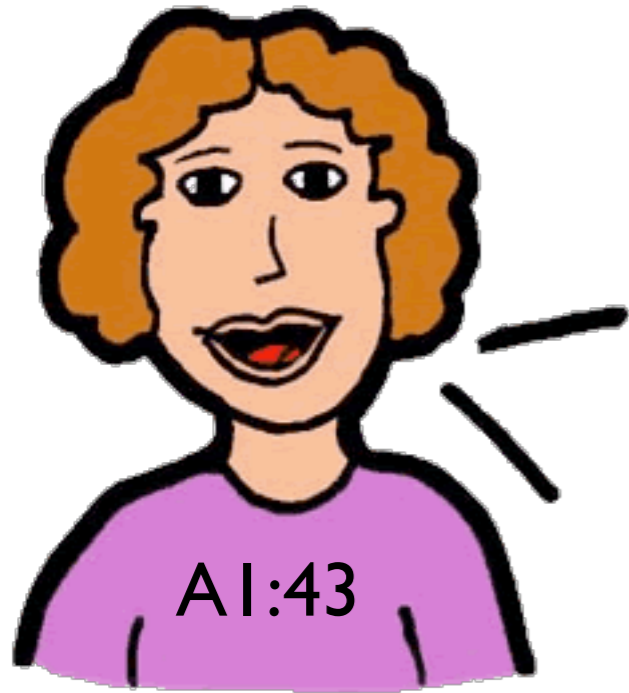
A1:43

Results - in general

AI:43

'[with misaligned requirements] there wasn't a bug, but the functionality was implemented in such a way that it was hard to do what the customer [originally] intended"

Results - in general

D2:12

Results - in general

D2:12

builds customer trust since good alignment allows the company to 'look into the customer's eyes and explain what have we tested... on which requirements'

Results - challenges

	Id	Challenge	Company					
			A	B	C	D	E	F
	Ch1	Aligning goals and perspectives within an organisation	X	X	X		X	X
	Ch2	Cooperating successfully	X		X	X	X	X
Req spec quality	Ch3.1	Defining clear and verifiable requirements			X	X	X	X
	Ch3.2	Defining complete requirements		X		X	X	X
	Ch3.3	Keeping requirements documents updated						X
VV quality	Ch4.1	Full test coverage	X	X	X	X		X
	Ch4.2	Defining a good verification process						X
	Ch4.3	Verifying quality requirements		X		X		X
	Ch5	Maintaining alignment when requirements change	X		X			X
Req's abstract levels	Ch6.1	Defining requirements at abstraction level well matched to test cases				X		X
	Ch6.2	Coordinating requirements at different abstraction levels	X					X
Traceability	Ch7.1	Tracing between requirements and test cases	X	X	X	X		X
	Ch7.2	Tracing between requirements abstraction levels		X	X	X		
	Ch8	Time and resource availability				X	X	X
	Ch9	Managing a large document space			X	X		X
	Ch10	Outsourcing of components or testing				X		X

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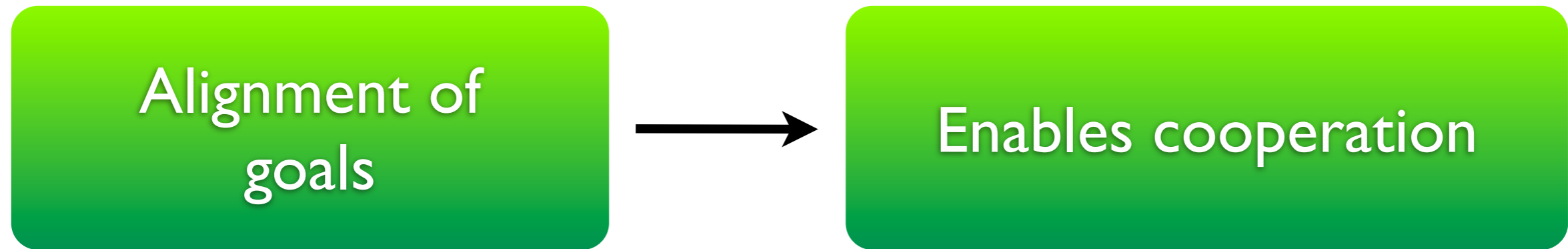|	Id	Challenge	Company					
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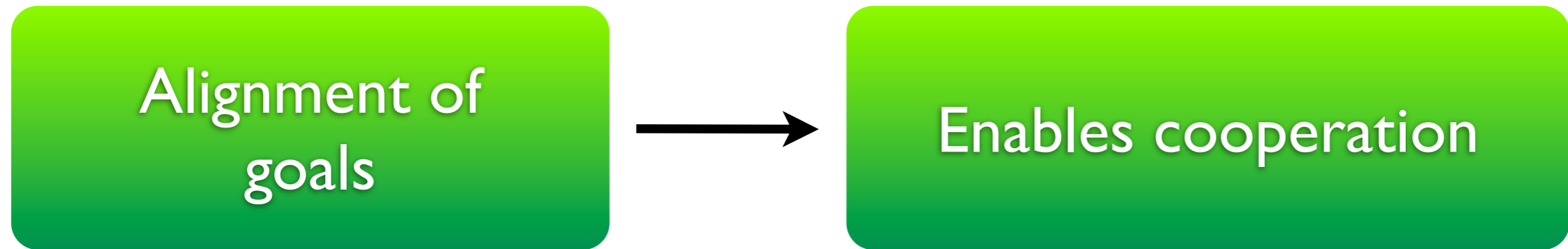
Alignment of goals
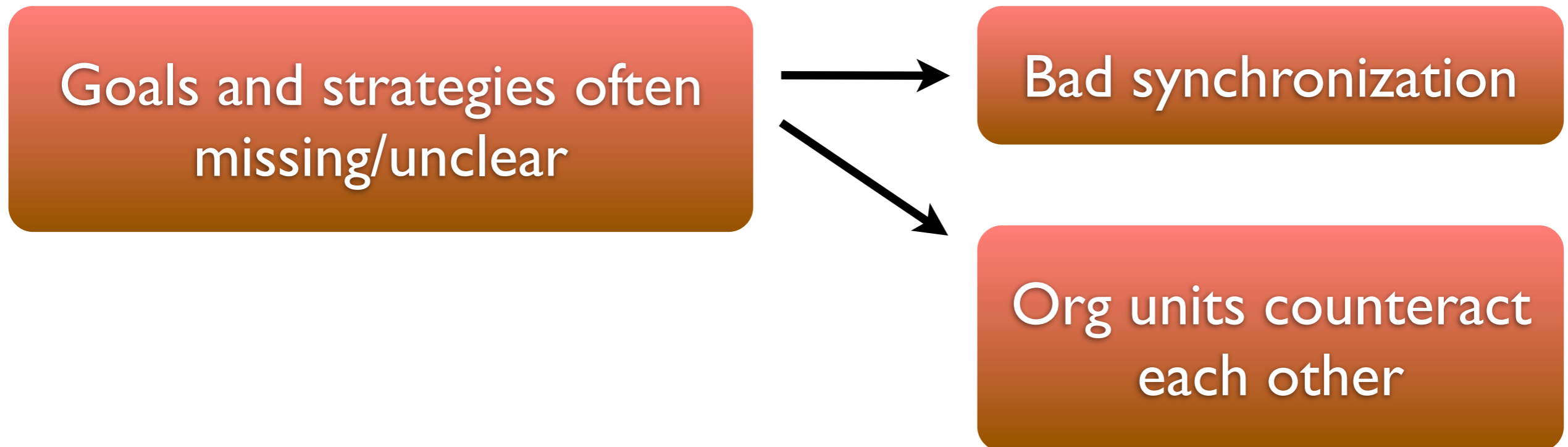
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Alignment of goals → Enables cooperation

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BUT:

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BUT:

Goals and strategies often missing/unclear → Bad synchronization
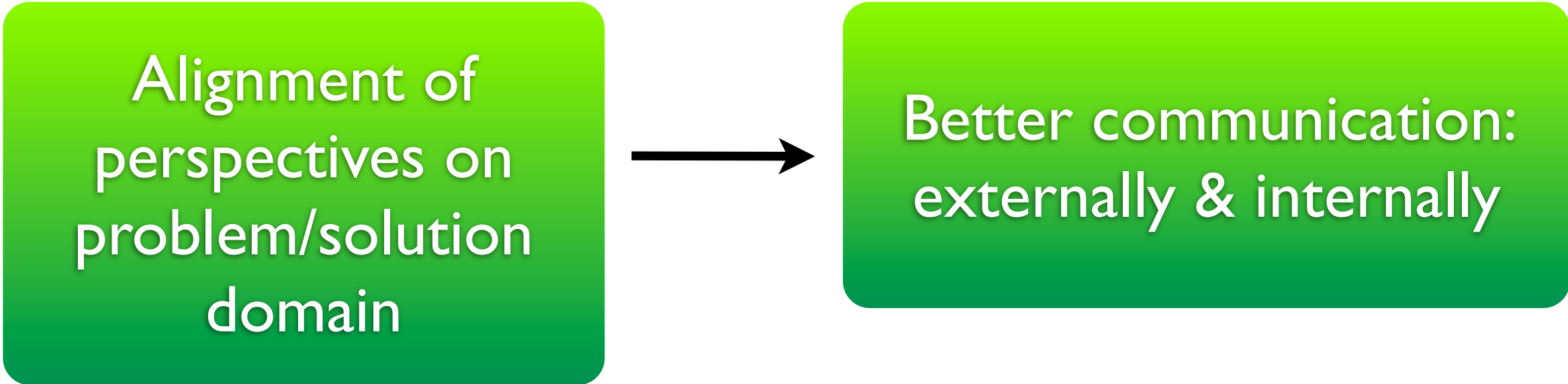
Org units counteract each other

C1: Aligning perspectives throughout org

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Alignment of perspectives on problem/solution domain

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Better communication: externally & internally

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BUT:

C1: Aligning perspectives throughout org

Alignment of perspectives on problem/solution domain → **Better communication: externally & internally**

BUT:

E1:20

Systems architect

when there is 'higher expectations on the product than we [systems architect] scoped into it' a lot of issues and change requests surface in the late project phases

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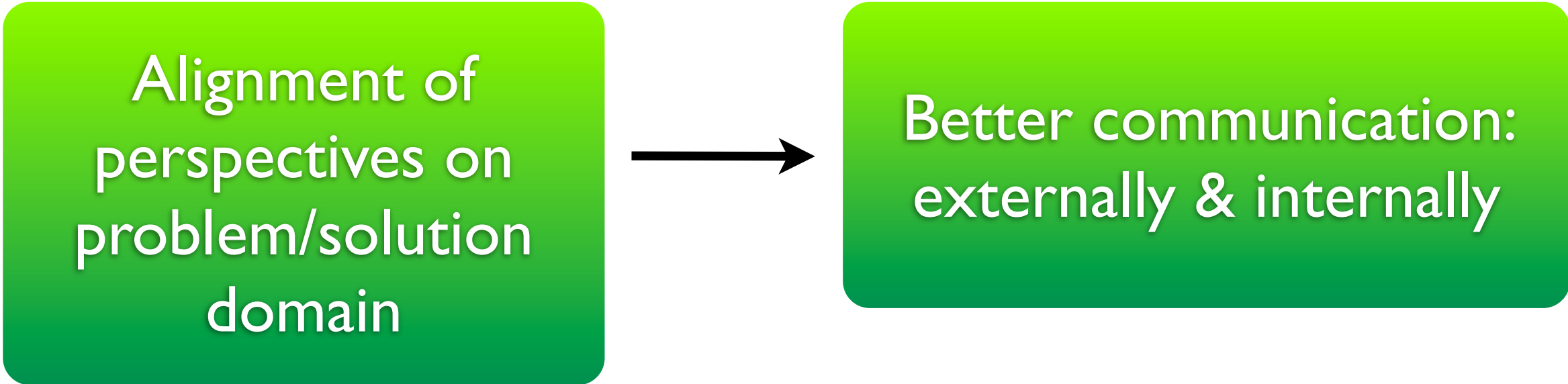**Better communication: externally & internally**

BUT:

A2:105

Test engineer

for higher abstraction levels there are no attempts to synchronize, for example, the testing strategy with the goals of dev projects to agree on important areas to focus on

C1: Aligning perspectives throughout org

Alignment of perspectives on problem/solution domain → **Better communication: externally & internally**

C1: Aligning perspectives throughout org

Alignment of perspectives on problem/solution domain

→

Better communication: externally & internally

F13:29

Software developer

'if both [Req eng & SW Dev] have a common perspective [of technical possibilities], then it would be easier to understand what [requirements] can be set and what cannot be set'

C2: Successful Co-op/communication

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Close co-op between roles and units

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Close co-op between roles and units → Less friction & better alignment

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Company F: lack of early co-op in validating reqs result in late discovery of failures to meet reqs. Dev project say: 'We did not approve these requirements, we can't solve it'

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Company B: 'We have succeeded with mapping requirements to tests since our process is more of a discussion'

Results - practices #1

Cat.	Id	Description	Company					
			A	B	C	D	E	F
Requirements	P1.1	Customer communication at all requirements levels and phases		X	X	X	X	X
	P1.2	Development involved in detailing requirements	X	X				X
	P1.3	Cross-role requirements reviews	X		X	X	X	X
	P1.4	Requirements review responsibilities defined					X	X
	P1.5	Subsystem expert involved in requirements definition				X		X
	P1.6	Documentation of requirement decision rationales					S	S
Validation	P2.1	Test cases reviewed against requirements						X
	P2.2	Acceptance test cases defined by customer		X				
	P2.3	Product manager reviews prototypes	X				X	
	P2.4	Management base launch decision on test report						X
	P2.5	User / Customer testing		X		X	X	X
Verification	P3.1	Early verification start					X	X
	P3.2	Independent testing			X	X	X	
	P3.3	Testers re-use customer feedback from previous projects					X	X	X
	P3.4	Training off-shore testers			X			

Results - practices #2

Change	P4.1	Process for requirements changes involving VV	X		X	X	X	X
	P4.2	Product-line requirements practices	X		X			
	P5	Process enforcement			X			S
Tracing	P6.1	Document-level traces	X					
	P6.2	Requirements-test case traces						X
	P6.3	Test cases as requirements	X					X
	P6.4	Same abstraction levels for requirements and test spec			X	X		
	P7	Traceability responsibility role			X	X	X	
Tools	P8.1	Tool support for requirements and testing	X		X	X	X	X
	P8.2	Tool support for requirements-test case tracing	X		X	X	X	X
	P9	Alignment metrics, e.g. test coverage			X	X	X	X
	P10	Job rotation				S		S

Results - practices #2

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Results - practices #2

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	P7	Traceability responsibility role			X	X	X	
Tools	P8.1	Tool support for requirements and testing	X		X	X	X	X
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	P9	Alignment metrics			X	X	X	X
	P10	Job rotation				S		S

Alignment metrics

Job rotation

onsdag 27 februari 13

P9: Measure alignment

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Company C: 'we measure how many requirements are already covered with test cases and how many are not' (through req and test management tool)

P9: Measure alignment

Company C: 'we measure how many requirements are already covered with test cases and how many are not' (through req and test management tool)

Company E & F: Also measure req coverage but say there is a lot of judgement involved and the metrics are only partial: "If you have one requirement, that requirement may need 16 test cases to be fully compliant. But you implement only 14 out of those. And we don't have any system to see that these 2 are missing.'

P10: Job Rotation

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Company D & F: Suggested as a way to increase contact network and experiences and over time create more aligned perspectives in the organisation. <u>Key for alignment is individuals and their experiences and willingness to communicate and align with others.</u>

Discussion and Analysis

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1. Human and organizational side of SW dev is at the core of industrial alignment practices

2. Requirements is the frame of reference for alignment; their quality is critical

3. Large variation in size between companies makes a difference for both challenges and practices

4. Incentives for investing in alignment varies between domains

Discussion and Analysis
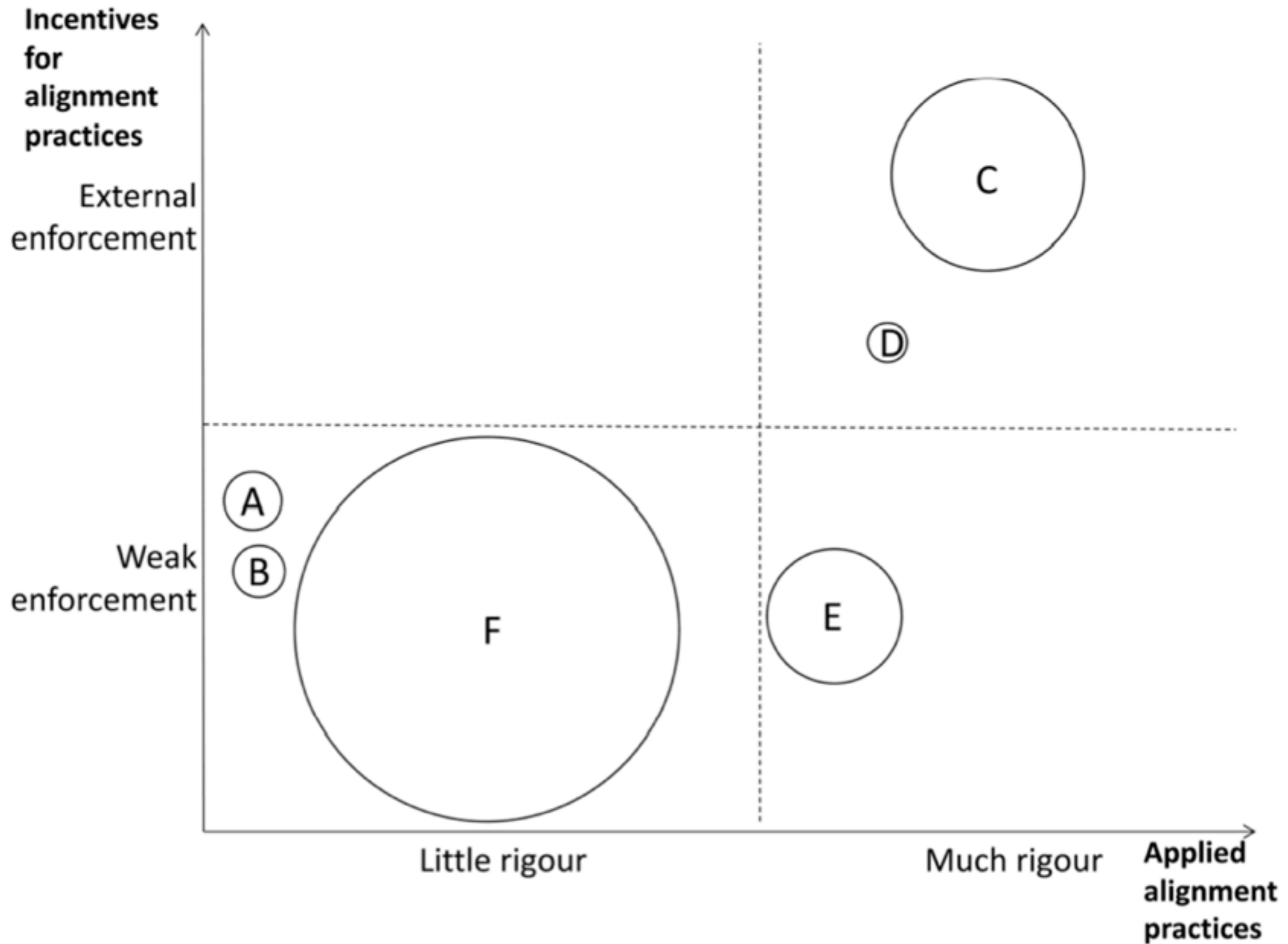
Acknowledgement

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Harmony?