Large-Scale RE, Creativity & Emotion in RE

Lecture 9, DAT230, Requirements Engineering
Robert Feldt, 2012-10-09

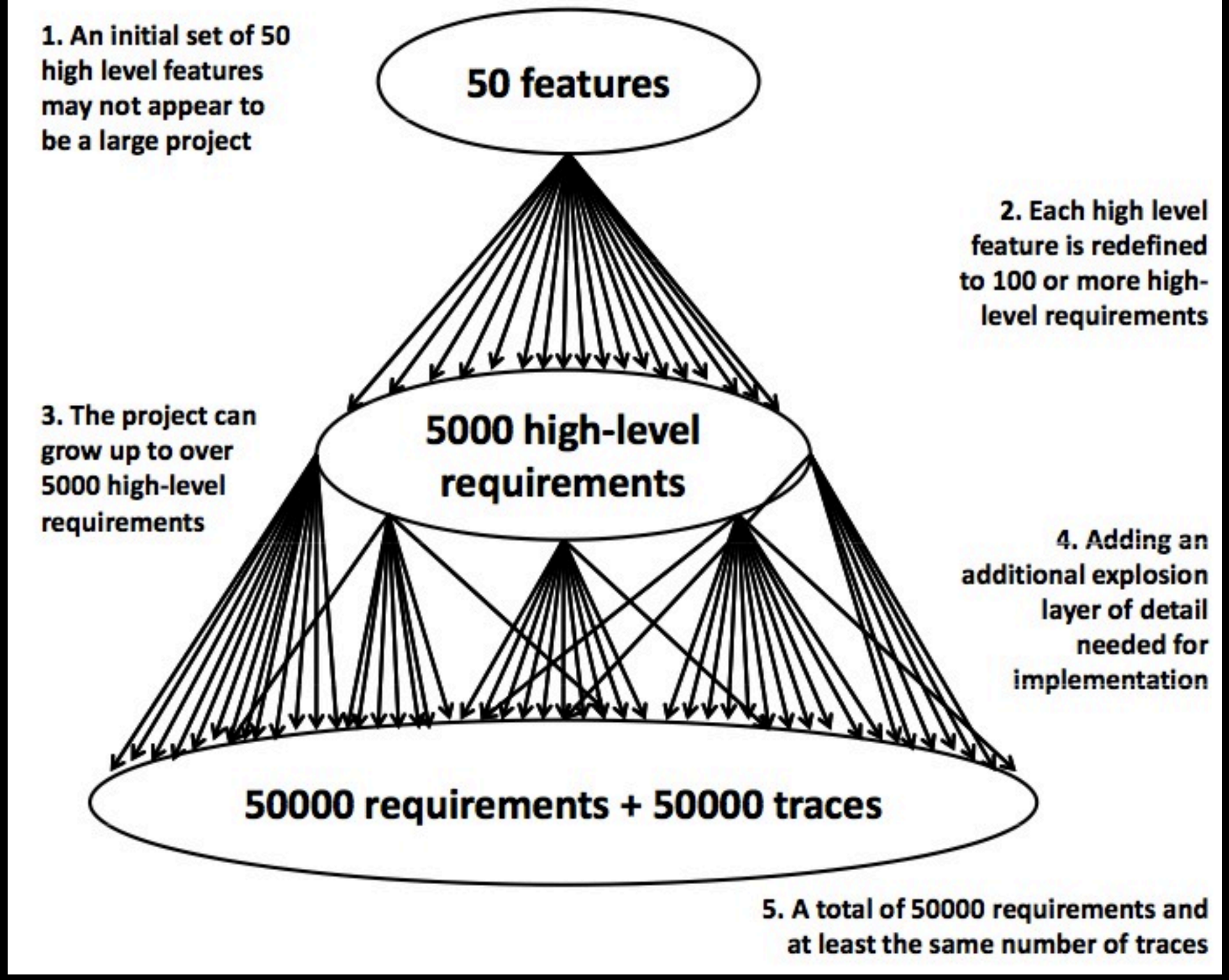
Table 1: Orders of magnitude in requirements engineering , based on Paper VI.

Abrev.	*Level*	*Order of magnitude*	*Sample empirical evidence*	*Interdependency management conjectures with current RE technology*
SSRE	Small-Scale Requirements Engineering	10 requirements		Managing a complete set of interdependencies requires small effort.
MSRE	Medium-Scale Requirements Engineering	100 requirements	(Feather et al. 2000)	Managing a complete set of interdependencies is feasible but requires large effort.
LSRE	Large-Scale Requirements Engineering	1000 requirements	(Park and Nang 1998)	Managing a complete set of interdependencies is practically unfeasible, but feasible among small bundles of requirements.
VLSRE	Very Large-Scale Requirements Engineering	10000 requirements	(Regnell et al. 2006)	Managing a complete set of interdependencies among small bundles of requirements is unfeasible in practice.

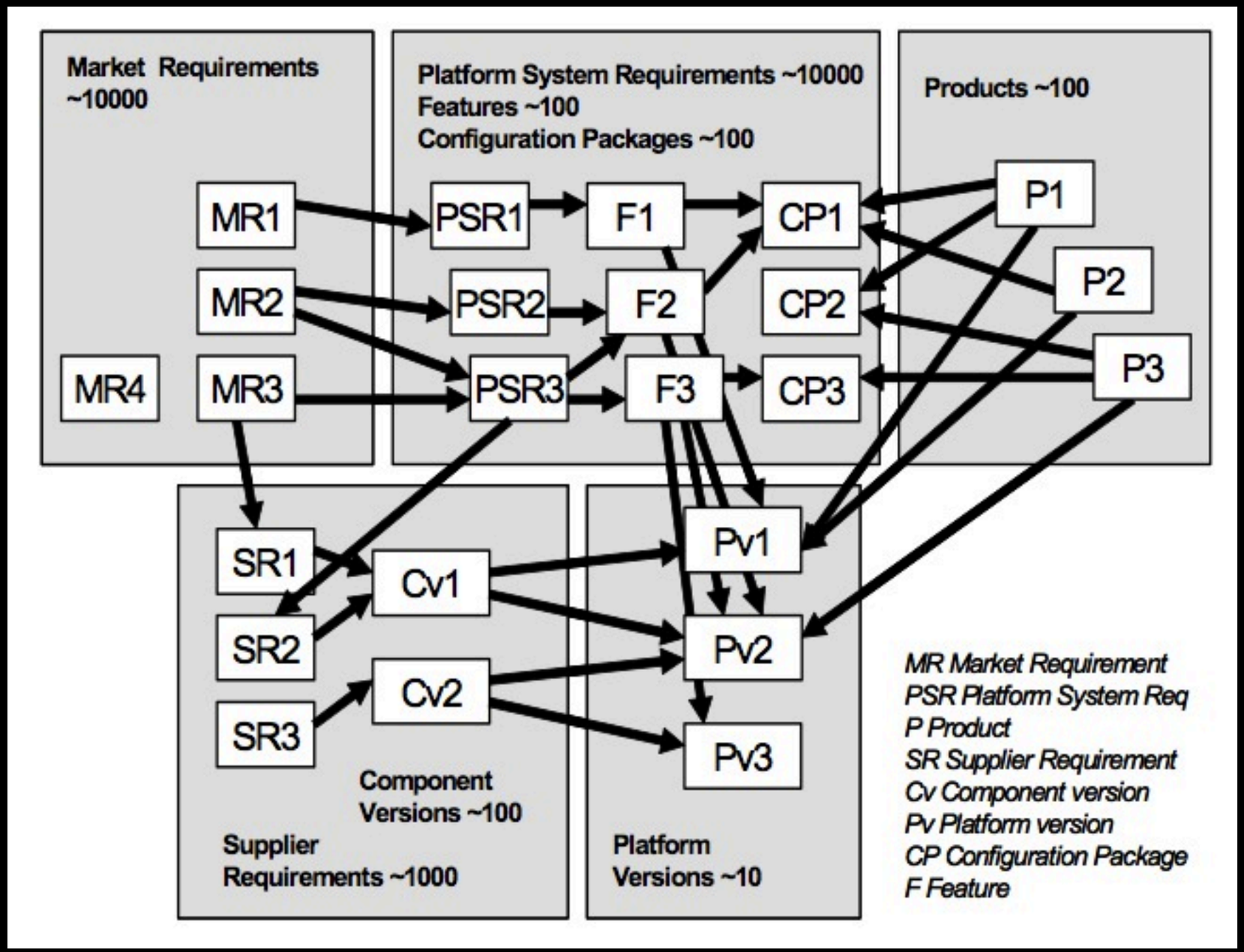
[Wnuk2009]

LSRE Challenges

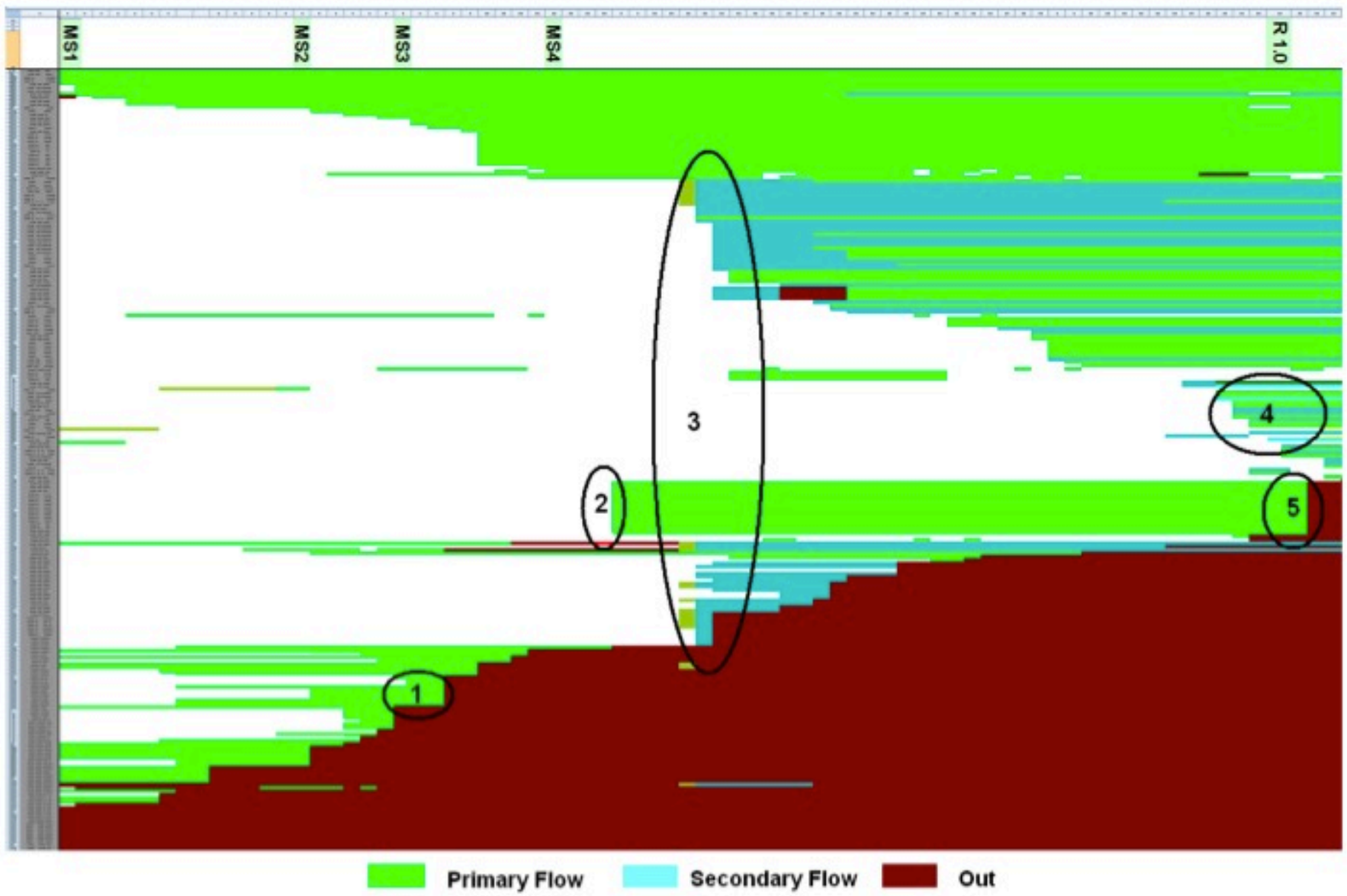
- Large number of customer requirements
- Formal interface to customer
- Management of customer expectations
- Changing technology
- Traceability
- Scope change and creep
- Resource fluctuation
- Prioritization


1. An initial set of 50 high level features may not appear to be a large project
50 features
2. Each high level feature is redefined to 100 or more high-level requirements
3. The project can grow up to over 5000 high-level requirements
5000 high-level requirements
4. Adding an additional explosion layer of detail needed for implementation
50000 requirements + 50000 traces
5. A total of 50000 requirements and at least the same number of traces

[Wnuk2009]

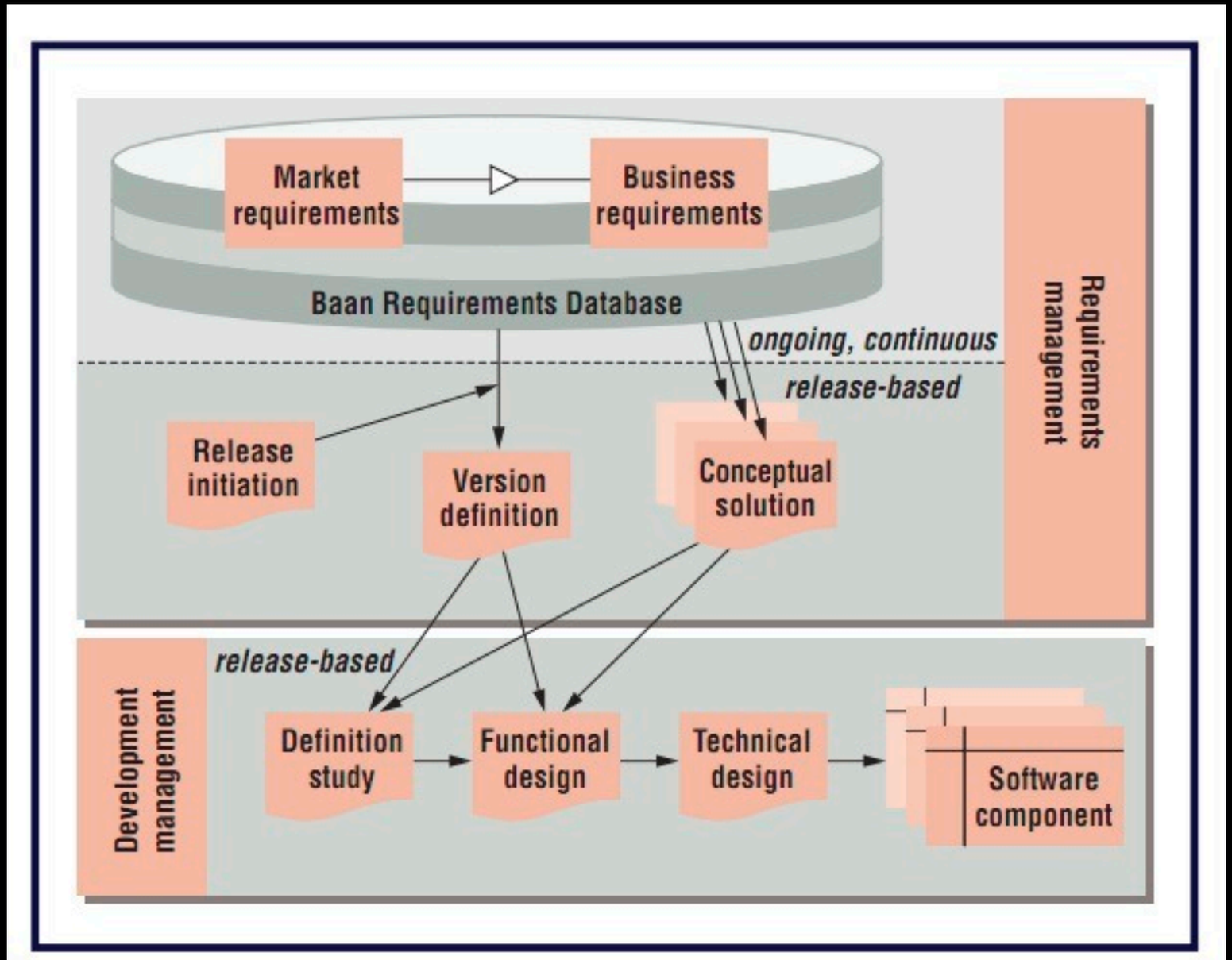

Market Requirements
~10000
Platform System Requirements ~10000
Features ~100
Configuration Packages ~100
Products ~100
MR1
MR2
MR3
MR4
PSR1
PSR2
PSR3
F1
F2
F3
CP1
CP2
CP3
P1
P2
P3
SR1
SR2
SR3
Cv1
Cv2
Component
Versions ~100
Supplier
Requirements ~1000
Pv1
Pv2
Pv3
Platform
Versions ~10
MR Market Requirement
PSR Platform System Req
P Product
SR Supplier Requirement
Cv Component version
Pv Platform version
CP Configuration Package
F Feature

[Wnuk2009]



[Wnuk2009]

“Linguistic” LSRE



time a new MR arrives into the BRD, they first check it by searching to find out whether one or more BRs already include the specified

Figure 1. The Baan requirements management process.

[NattoDag2005]

“Linguistic” LSRE

Stage 1: Flattened	Stage 2: Tokenized	Stage 3: Stemmed	Stage 4: Stop words removed
Pricing and Containerization Specifically what I am interested in is containerization and pricing. For a prospect I am working with (pretty much a distributor of *electonic* components) I need *pricng* by type of package by *cusotmer* type(wholesale or retail).	pricing and containerization specifically what i am interested in is containerization and pricing for a prospect i am working with pretty much a distributor of *electonic* components i need *pricng* by type of package by *cusotmer* type wholesale or retail	price and containerization specifically what i be interest in be containerization and price for a prospect i be work with pretty much a distributor of *electonic* component i need *pricng* by type of package by *cusotmer* type wholesale or retail	price containerization specifically containerization price prospect pretty distributor *electonic* component *pricng* type package *cusotmer* type wholesale retail

Figure A. Preprocessing part of our example market requirement.

[NattoDag2005]

“Linguistic” LSRE

The Vector-Space Model and the Cosine Measure

The vector-space model is a standard way of representing texts through the words they comprise. Each text is represented as a vector in the high-dimensional space corresponding to the vocabulary used, where each dimension represents a word. Parts of the market and business requirements in Table 1 would be represented by the word space and corresponding vectors shown in Table A (where the values represent the number of occurrences of each word).

Table A

Word space and vectors

	container	containerization	item	level	main	package	price	print	process	purchase	sale	sequence	statistics	type
r_m =	1,	2,	2,	0,	0,	1,	3,	0,	7,	0,	0,	0,	0,	2)
r_b =	6,	0,	5,	4,	2,	0,	1,	2,	0,	1,	1,	0,	8,	1)

The Cosine measure then takes the two vectors as input and returns a similarity value between 0 and 1, corresponding to the cosine of the angle between the vectors:

$$\sigma(r_m, r_b) = \frac{r_m \bullet r_b}{|r_m| \bullet |r_b|}$$

The $r_m \bullet r_b$ denotes the dot product of r_m and r_b, which is calculated by multiplying the corresponding frequencies of each word and then adding them together. However, as the number of times a word occurs is relevant, its relevance decreases as the number gets larger. One common approach is therefore to weight the term frequencies using the formula $1 + \log_2(\textit{term frequency})$. Thus, for the business and market requirements in our example, the similarity becomes

$$\sigma(r_m, r_b) = \frac{\sum_i \left[1+\log_2 r_m(i)\right] \bullet \left[1+\log_2 r_b(i)\right]}{\sqrt{\sum_i \left[1+\log_2 r_m(i)\right]^2} \bullet \sqrt{\sum_i \left[1+\log_2 r_b(i)\right]^2}} \approx 0.32.$$

[NattoDag2005]

ReqSimile 1.2

File Data View Report Help

Business Requirements | Market Requirements

Id	Label
MR1000731	Raw materials expiry date
MR1000732	Test Times in Quality
MR1000733	Test Procedure - Quality
MR1000734	Version control on the test procedure - Quality
MR1000735	Multi-Dimensional Inventory
MR1000736	TRADE SPENDING REQUIREMENTS
MR1000737	Quality - Selecting Inventories based on Customer Requirements
MR1000738	Configurator For Formulas
MR1000739	Pricing and Containerization
MR1000740	Yield, capacity, initial loss, and end items
MR1000741	Parameter for yield per order or yield per operation
MR1000742	Yield for end items
MR1000743	Yield dependant operation
MR1000744	Yield dependant materials
MR1000745	Yield calculation for material, capacity and cost price
MR1000746	Modifications on batches, addition of operation
MR1000747	Actual yield in pspmg001
MR1000748	Initial loss
MR1000749	Modification on released, active (and completed) batches
MR1000750	Cost Allocation for Co- / By-products (3.1)
MR1000751	Co- and by-products for end-items (3.2)
MR1000752	Inventory display on main item level (4.5)
MR1000753	Adjustment of process and containerised items (4.7)
MR1000754	Lot numbers automatically generated (5.1)
MR1000755	Lot numbers based on order numbers (5.2)
MR1000756	Modification of materials in relation to backflushing (7.1)

	Details
Id	MR1000739
Date	1996-05-26 00:00:00.0
Label	Pricing and Containerization
Description	Specifically what I am interested in is containerization and pricing. For a prospect I am working with (pretty much a distributor of electonic components) I need pricng by type of package by cusotmer type (wholesale or retail). I think pricing by container solves this problem, but I understand to use this feature the item must be a process item and I don't know if this is good or bad. If I must use process what do I gain or lose, like do I have to run a seperate MRP etc. Do I have to have one process company and one non-process company. They have mainly an assembly operation with no process involved. If process would be to cumbersome how difficut a mod would it be to disconnect containerzation from process.
Priority	Medium
Type	Functionality
Status	Closed/Completed
Comments	020699: functionality is available in BaanERP in the Pricing module
Agreement	None

Log | Candidate requirements

Search terms: statistics Only

Id	Label	Similarity	Link
BR1100450	Assembly: Surcharges related to assembly lines / final asse...	0,234	Link
BR1100493	Process Time Calculation	0,233	Link
BR1100474	Process dependant Cost Price Calculation	0,231	Link
BR1100422	LAC: Complex product engineering structures for mixed mod...	0,229	Link
BR1100661	Convert RFQ's towards Pricebooks	0,228	Link
BR1101416	LAC: Use WIP transfer price in case of multi-site assembly (fl...	0,227	Link
BR1103077	OWMA Process Engine Service: PE Instantiation of a process	0,225	Link
BR1101668	ERP Warehousing: item pricing per package (packed quantity)	0,225	Link
BR1100382	Macro Routing (Option 1: All using CF templates)	0,225	Link
BR2000336	Lifo by Year II	0,224	Link
BR2000587	Year end processing	0,223	Link
BR1100631	Recipe / Process definition	0,222	Link
BR1103298	OWMA Process Enginge Service: PE Process Patterns	0,219	Link
BR1000048	Pricing Criteria	0,217	Unlink
BR1000025	Statistics and Containers	0,216	Unlink
BR1000009	Changing Process/Containerized fields and flexibility in attrib...	0,216	Link
BR1101861	Separate Item Type for Non physical, Non warehousing, Non ...	0,216	Link
BR1100423	LAC: Assigning assembly level to engineering product struct...	0,215	Link
BR1000056	Subcontracting (process)	0,211	Link
BR1102825	Planner: respect Effectivity dates (Operations, Sourcing proce...	0,209	Link
BR1100926	Multi-site table sharing restrictions: Moving of warehouses to ...	0,208	Link
BR1102716	ERP LAC/ASC: Standard configurations	0,208	Link
BR1103444	ERP OrderMgt-SLS: Contract Management - Prices and Surc...	0,207	Link
BR1100621	Operation variant selection methods	0,205	Link
BR1100778	Process Validation Orders	0,205	Link
BR1100537	Merge Cost Component Solution (CCS) to Baan ERP 5.2 and...	0,204	Link

	Details
Id	BR1000025
Date	1998-01-27 00:00:00.0
Label	Statistics and Containers
Description	1. Container (end item) in statistics Purchase and sales statistics used to be maintained only at main item level. But now it has also become possible to build statistics at container level. There are two aspects: · printing statistics in the number of containers for a main item · selecting and/or printing statistics at container level 2. Displays in statistics Displays are compositions of end items (for example, an attractive display of different types of cake). The statistics will be updated at both the levels of display item and container (which is part of the display). Prevention of duplicate counting, and correct pricing must be arranged in a procedural manner.
Keywords	Process Industries
Type	Usability
Status	Assigned
Comments	Warehousing only

Idle. 100%

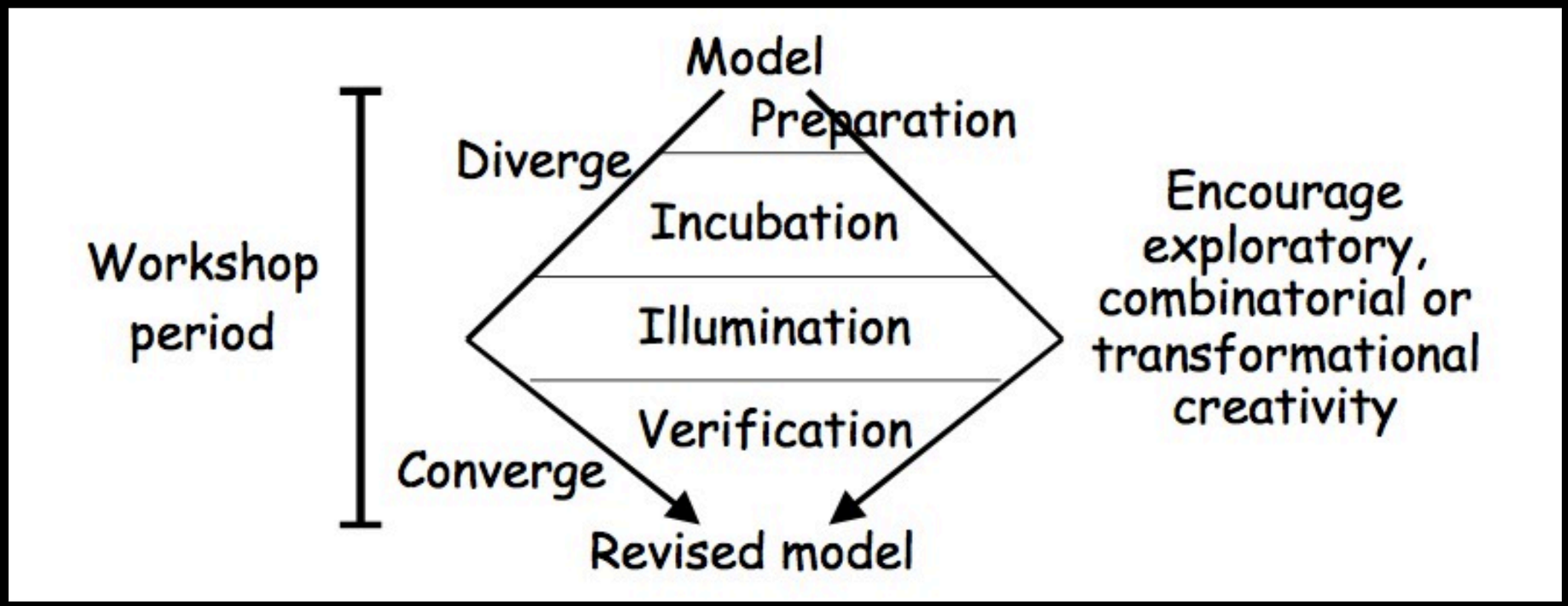
Figure 3. ReqSimile, an open source tool in Java.

Creativity in RE

Creativity = ability to produce work that is both novel (original, unexpected) and appropriate (useful, adaptive concerning task & constraints)

[Sternberg&Lubart1995]

Creativity Workshops for RE



[Maiden2007]

Divergent & Convergent Thinking

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Convergent thinking = select "correct" ideas among many alternatives

Divergent thinking

- Not correlated with IQ, but with:
  - nonconformity, curiosity, risk taking, persistence, musicians
- Can be promoted through:
  - creating lists of questions
  - time “off” to think and meditate
  - brainstorming
  - bubble mapping
  - keeping a journal, free writing (“stream of thought”)
  - artwork

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Transformational = deliberate transformation or transcendence of a conceptual space (rejects some constraints/assumptions of given space)

Combinatorial = novel combination of existing ideas as search through space

Four steps of creativity

- Preparation - research = collect information/data
- Incubation - percolation = milling over collected info
- Illumination - light bulb = aha moment
- Verification/Implementation - creation = check realism

Maiden Case Study

- Two-day workshop to create new reqs/ideas
- Product: Air Traffic Management system
- Process:
  - 2 system engineers + domain experts: 4 months to establish high-level spec with scope and goals
  - 2-day Creativity workshop = 2 facilitators + 2 scribes + 2 external experts + 19 stakeholders
    - Focus on use case models and texts + I* models

Maiden Case Study

- 4 half-day session in 2 days
- All ~20 people in one room
- Models & text printed on 1m2 pin boards around room
  - Physical and logical structure of ideas and reqs
- Rules: No criticism during divergent periods, time-boxing different topics strictly
- Post it notes, colored pens, idea cards at hand

Maiden Case Study

Day 1 morning	Day 1 afternoon	Day 2 morning	Day 2 afternoon
Brainstorming (system wide & use case specific) Constraint identification & removal Brainstorming given removed constraints	Expert pres: Design of museum exhibitions Analogy mapping to ATM & idea creation Reporting back	Reflection Expert pres: TV program scheduling Analogy mapping & idea creation Reporting back	Created Storyboards for high-prio use cases Combining ideas Revised use cases, models & texts

Analogical mapping/reasoning

- Can help Exploratory creativity
- Steps:
  - Find similar domain (source) to target domain
  - Identify and list mappings between
    - Agents, Objects, Actions, Constraints, Goals
  - Use each mapping in turn to create new idea by transforming solution between domains

Constraint removal

- Can help Transformational creativity
- Steps:
  - Identify constraints through brainstorming
  - Divide in small groups
  - Groups consider new ideas by consecutive removal of constraints until none remains
  - Report back and put on boards

Storyboarding

- Can help Combinational creativity
- Steps:
  - Divide in small groups
  - Groups have 1 A1 paper with 16 cartoon boxes to describe a scene of a use case
  - Report back

Case study results

Deliverable type	Number system-wide	Number use case-specific
Brainstormed ideas	16	12
EASM constraints	34	0
Ideas from EASM constraints	94	0
Ideas from analogical reasoning with museum exhibition	0	15
Ideas from analogical reasoning with TV program scheduling	0	8
Workshop1 storyboards	0	4 storyboards

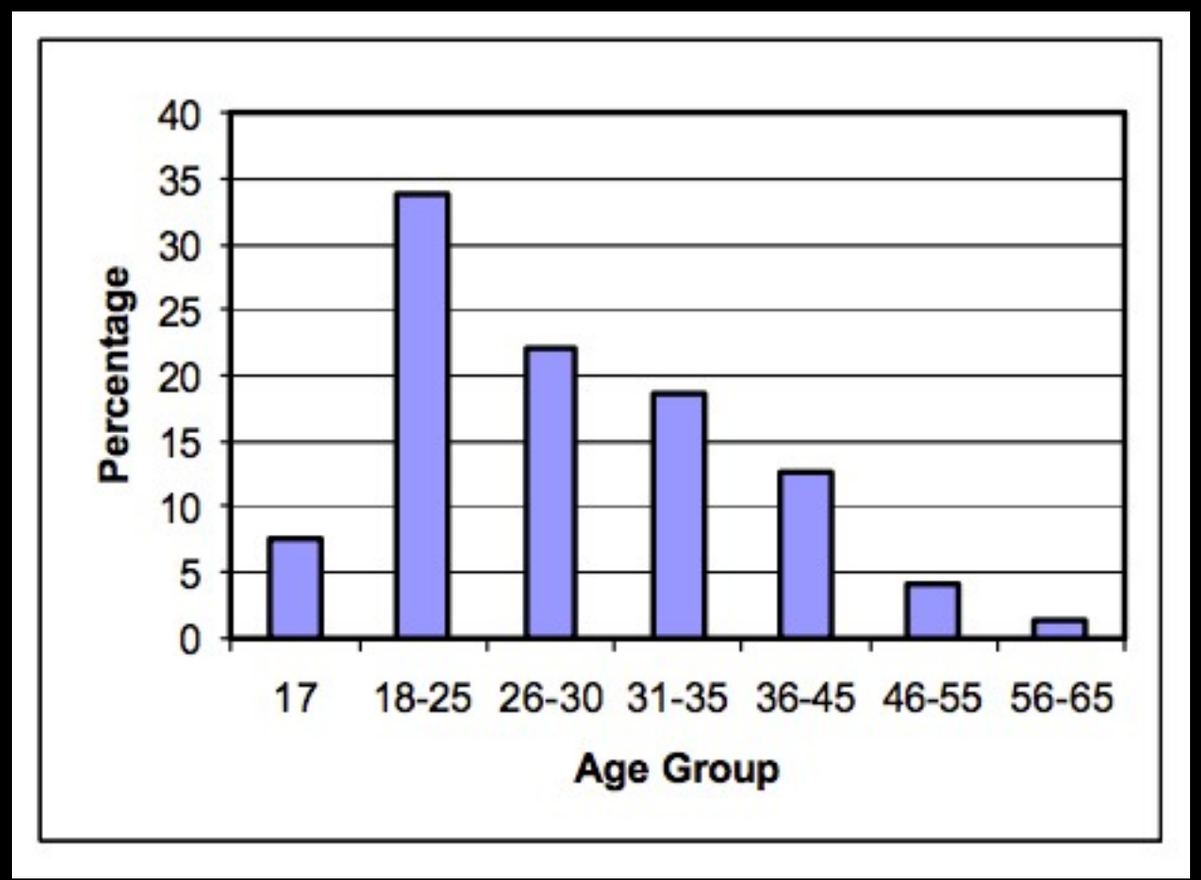
Technique	Novelty			Impact		
	1	2	3	1	2	3
Brainstorming	1	10	16	11	10	7*
Science Museum Analogy	0	7	8	7	5	3
Programme Scheduling Analogy	0	2	6	2	3	3
Constraint Removal	1	21	67	8	60	21
Totals	2	40	97	28	78	34

Summary of results

- Captured both novel and unoriginal ideas
  - that were useful and affected SRS
  - 106 of 140 ideas was useful
  - 42 of 139 ideas was novel
- More effect on abstract goals and concepts than actual reqs
- Constraint removal effective but needs more structure
- Sometimes hard to record all ideas (“idea blizzards”)
- Analogy techniques not very cost-effective

Survey on emotions in games

- [Bentley2002]
- 303 respondents recruited from gaming mailing lists and from post-grad alumni (no difference between groups)
- Younger people than who (in general) play games



Predictors of Enjoyment in games

	Unstandardized Beta	Standardized Beta	Sig.	Meaning
(Constant)	.452		.000	
Ability to Concentrate	.005	.013	.808	
Computer Competition	-.010	-.031	.542	
Clear Goals	-.023	-.072	.203	
Learnability	.047	.166	.002	Less learnable predicts increased enjoyment
Feedback	-.071	-.171	.001	More feedback predicts increased enjoyment
Distraction Element	-.021	-.059	.246	
Control over actions	-.029	-.085	.113	
Efficiency	-.009	-.029	.614	
Computer Recognition	.030	.104	.108	
Self Image	-.070	-.217	.000	Increased self image after use predicts increased enjoyment
Self Competition	.014	.049	.461	
Loss of Time	.029	.101	.043	Less 'Loss time' predicts increased enjoyment
Effectiveness	-.014	-.042	.396	
Curiosity	-.048	-.146	.004	More curiosity predicts increased enjoyment
Attribution	.003	.010	.850	
Fantasy	-.019	-.049	.342	
Challenge	-.031	-.059	.228	
Cooperation	-.034	-.117	.047	More cooperation predicts increased enjoyment
Peer Recognition	.000	.000	.999	

Table 2: Results of standard linear regression

Further analysis: Affect

- Harder to learn => more enjoyment!??
  - Real-time strategy+skill games => requires high levels of coordination+reaction speed => pride themselves with it => enjoy harder
  - Other games: Easier to learn => more enjoyment since mastery depends more on cognitive ability
  - So depends on system type, goals etc
- *"When I lost time in a computer game it is a game that I really enjoy. However I recognise losing time as 'bad' and therefore losing time itself does not increase my enjoyment, it is a side-effect of my enjoyment".*

How to elicit affective reqs?

Contrasting concepts relating to user experience:

Fun	|----|----|----|----|----|	Information Driven
Information Driven	|----|----|----|----|----|	Graphically Driven

Figure 4: Example of pseudo-repertory grid technique for affective requirement gathering

Emotion in RE

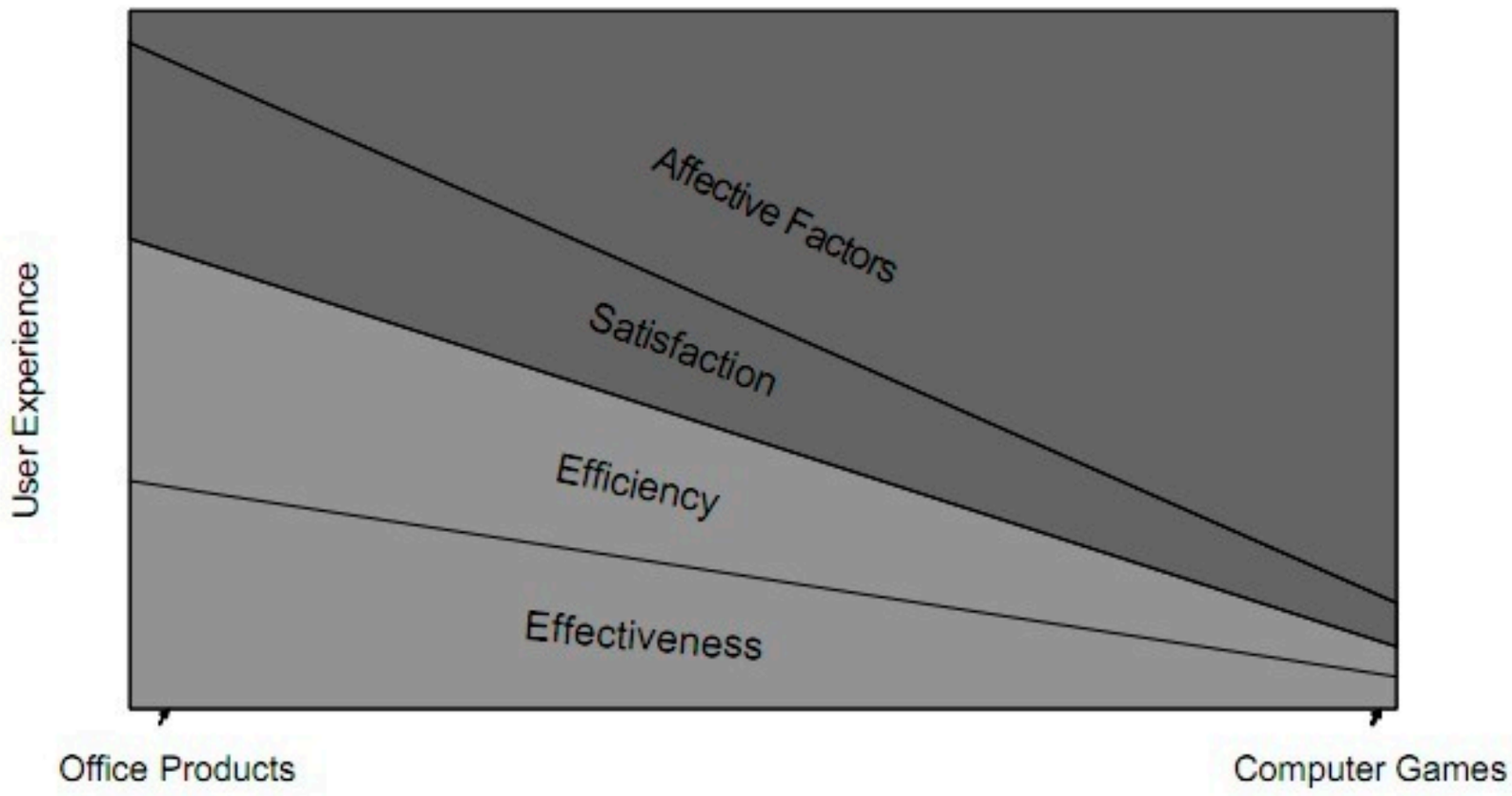


Figure 5: The model of user experience, with notional divisions for affective factors