Tutorial Human Side of Systems Architecting

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Abstract

Architects play a crucial role in creating systems that fit well in the human needs. The creation of these systems requires many human interactions between all stakeholders. The background of architects, however, is completely different, mostly technical. We bring insight in the human aspects of systems architecting and we provide an approach with related tools to address the human aspects.

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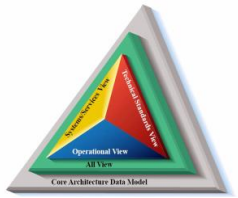
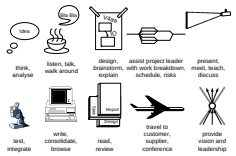
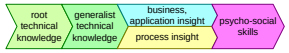
Figure Of Contents™

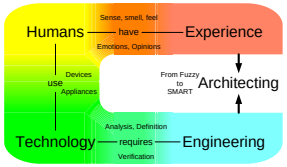
1. brainstorm human characteristics

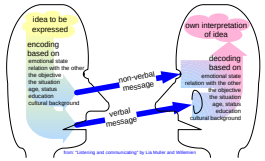


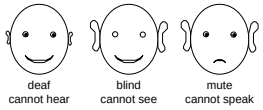




2. HFI in Defense → 3. Role Architect → 4. Growth

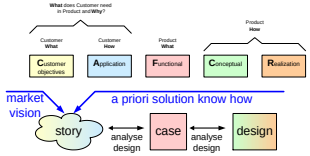


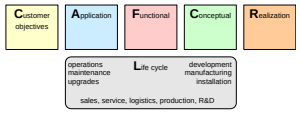


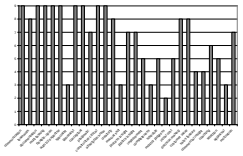


but in the team two can hear, two can see, and two can speak

5. Experience Transfer → 6. Interpersonal Skills → 7. Team Work







provocation	when in an impasse: provoke effective when used sparsely
facilitation	especially recommended when new in a field: contribute to the team, while absorbing new know how
leading	provide vision and direction, make choices risk: followers stop to give the needed feedback
empathic	take the viewpoint of the stakeholder acknowledge the stakeholders feelings, needs, concerns
interviewing	investigate by asking questions
whiteboard simulation	invite a few engineers and walk through the system operation step by step
judo tactics	first listen to the stakeholder and then explain cost and alternative opportunities

11 Story Telling ← 10 CAFCR model ← 9. Profile ← 8. Styles

summary

What human characteristics

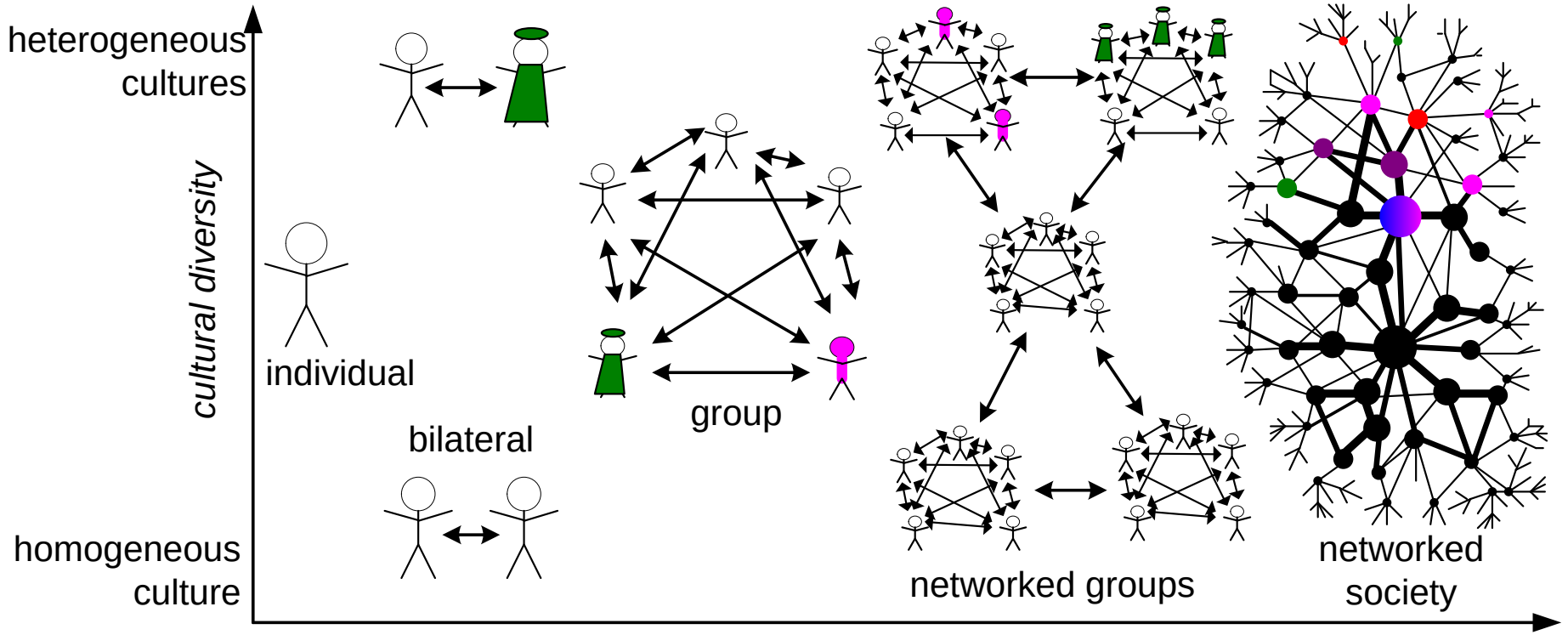
do you know

that impact the

use, specification and design

of systems?

Overview of Human Aspects



psychology

psychiatry

physiology

pedagogy

ergonomics

medicine

group dynamics

didactics

cultural anthropology

political science

sociology

criminology

Human Factors in Defense

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Abstract

The defense industry has recognized the importance of human factors for system design. Some processes and procedures are available to address these needs. In this paper we provide a brief overview of ongoing *Human Factors* or *Human Systems Integration* activities in Defense.

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Human Systems Integration DoD Acquisition

Human Systems Integration in DoD Acquisition by Ms. Nancy Dolan CNO N125
https://acc.dau.mil/GetAttachment.aspx?id=25755&pname=file&aid=3181&lang=en-US

Human Engineering from Naval Perspective

1. Mission Analysis
2. Requirements Analysis
3. Function Analysis
4. Function Allocation
5. Task Design and Analysis
6. Human Interface and Team Development
7. Performance, Workload, and Training Level Estimation
8. User and Requirements Reviews

from ONR (Office of Naval Research)/SC-21 Manning Affordability Initiative
www.hf.faa.gov/docs/508/docs/Human_System_Engineering_(NSWC).pdf

Human Views for MODAF

HV-A: Personnel Availability

HV-B: Quality Objectives and Metrics

HV-C: Human Interaction Structure

HV-D: Organisation

HV-E: Human Functions and Tasks

HV-F: Roles and Competencies

HV-G: Dynamic Drivers of Human Behaviour

from The Human View Handbook for MODAF
www.hfidtc.com/MoDAF/HV Handbook First Issue.pdf

The Role and Task of the System Architect

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Abstract

The role of the system architect is described from three viewpoints: deliverables, responsibilities and activities. This description shows the inherent tension in this role: a small set of hard deliverables, covering a fuzzy set of responsibilities, hiding an enormous amount of barely visible day-to-day work.

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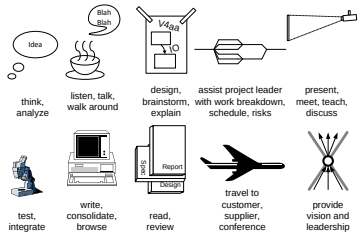
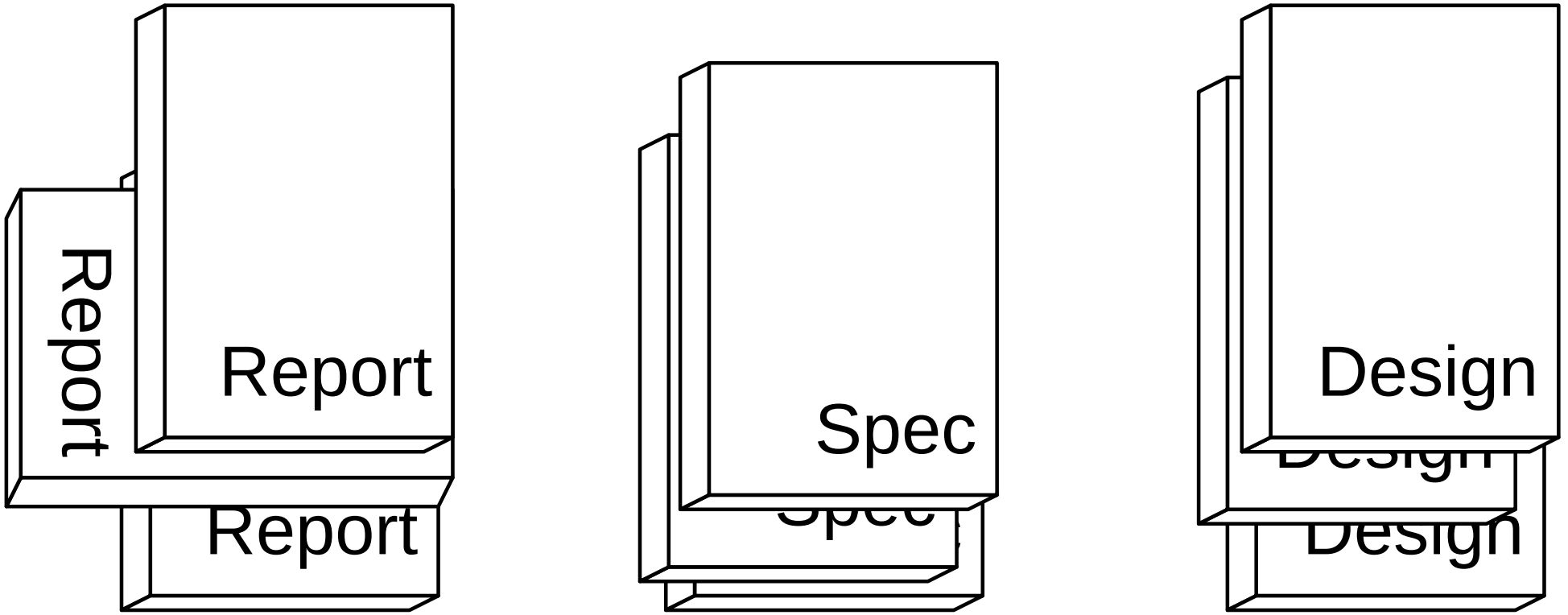


Deliverables of the System Architect



List of Deliverables

Customer and Life-Cycle Needs *(what is needed)*

System Specification *(what will be realized)*

Design Specification *(how the system will be realized)*

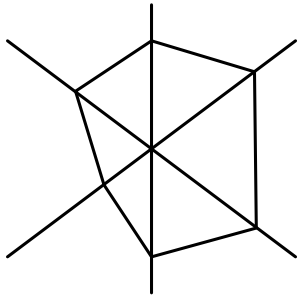
Verification Specification *(how the system will be verified)*

Verification Report *(the result of the verification)*

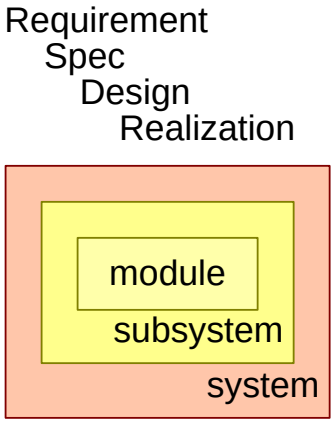
Feasibility Report *(the results of a feasibility study)*

Roadmap

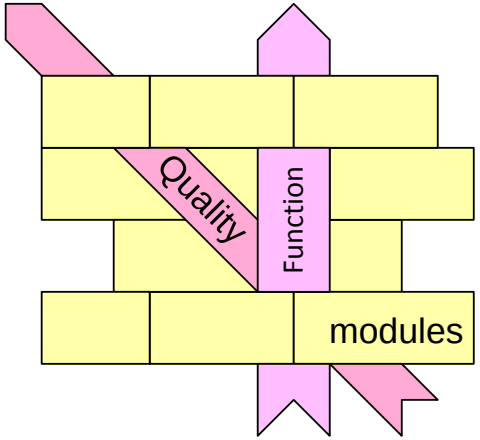
Responsibilities of the System Architect



Balance

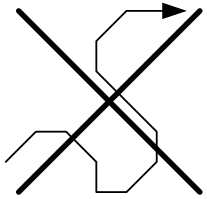


Consistency



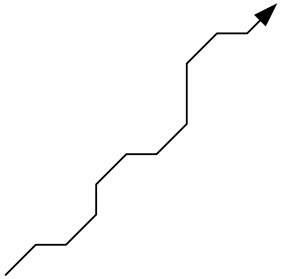
Decomposition
Integration

Overview

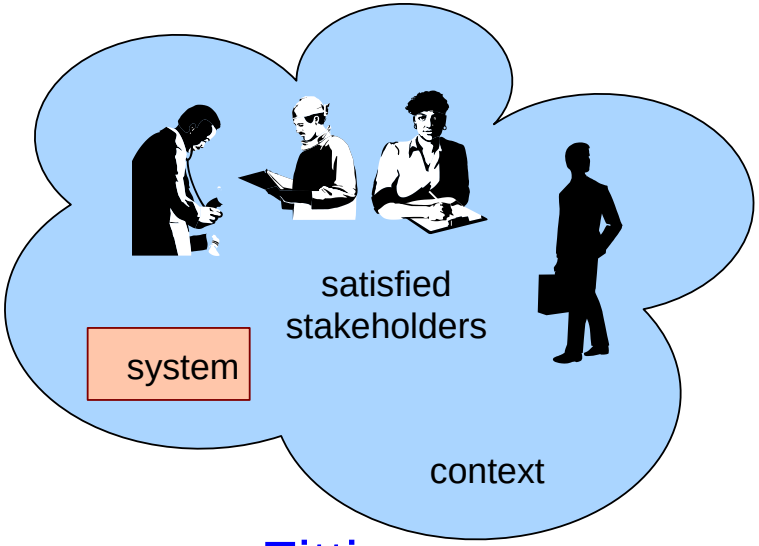


KISS

Elegance
Simple



Integrity

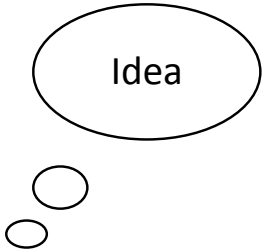


Fitting

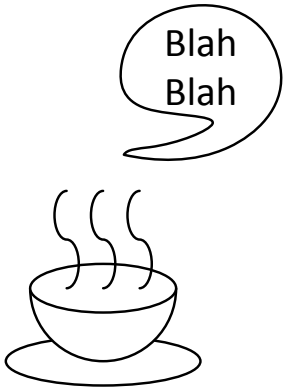
Examples of Secondary Responsibilities

responsibility	primary owner
business plan, profit	business manager
schedule, resources	project leader
market, saleability	marketing manager
technology	technology manager
process, people	line manager
detailed designs	engineers

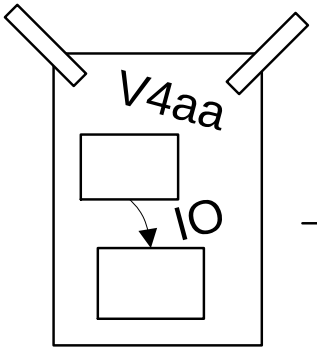
What does the System Architect do?



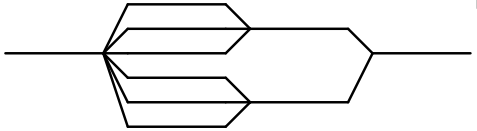
think, analyze



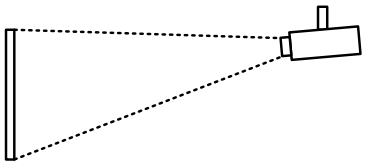
listen, talk, walk around



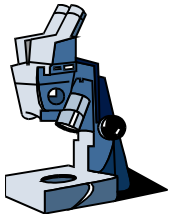
design, brainstorm, explain



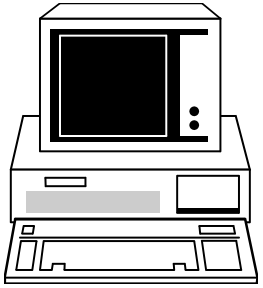
assist project leader with work breakdown, schedule, risks



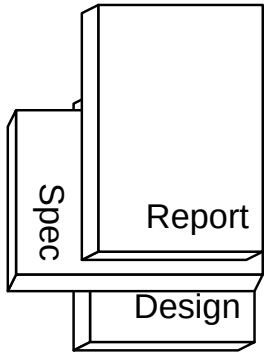
present, meet, teach, discuss



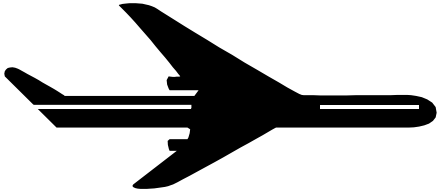
test, integrate



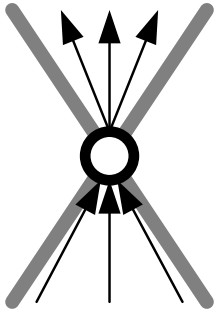
write, consolidate, browse



read, review

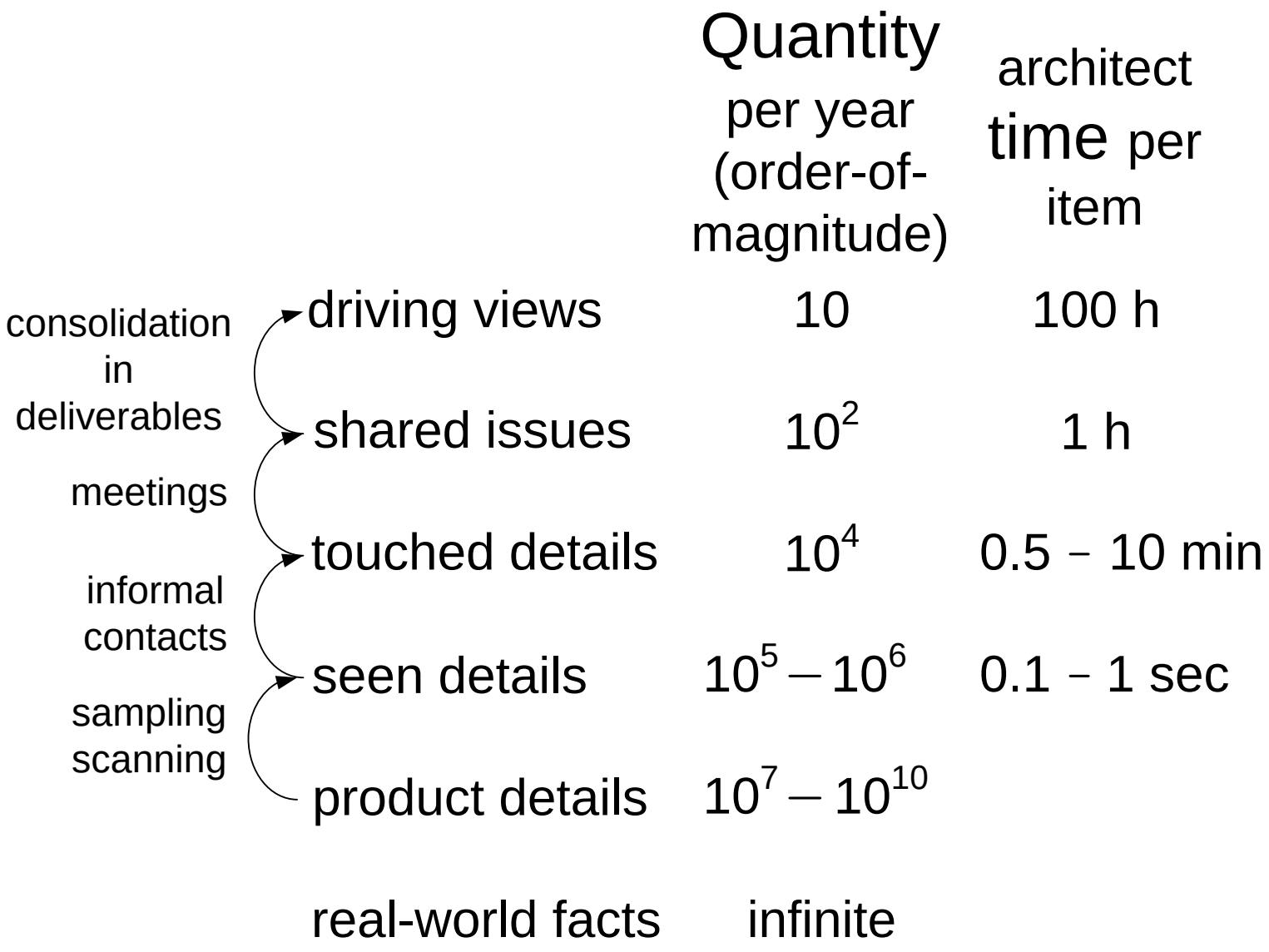


travel to customer, supplier, conference



provide vision and leadership

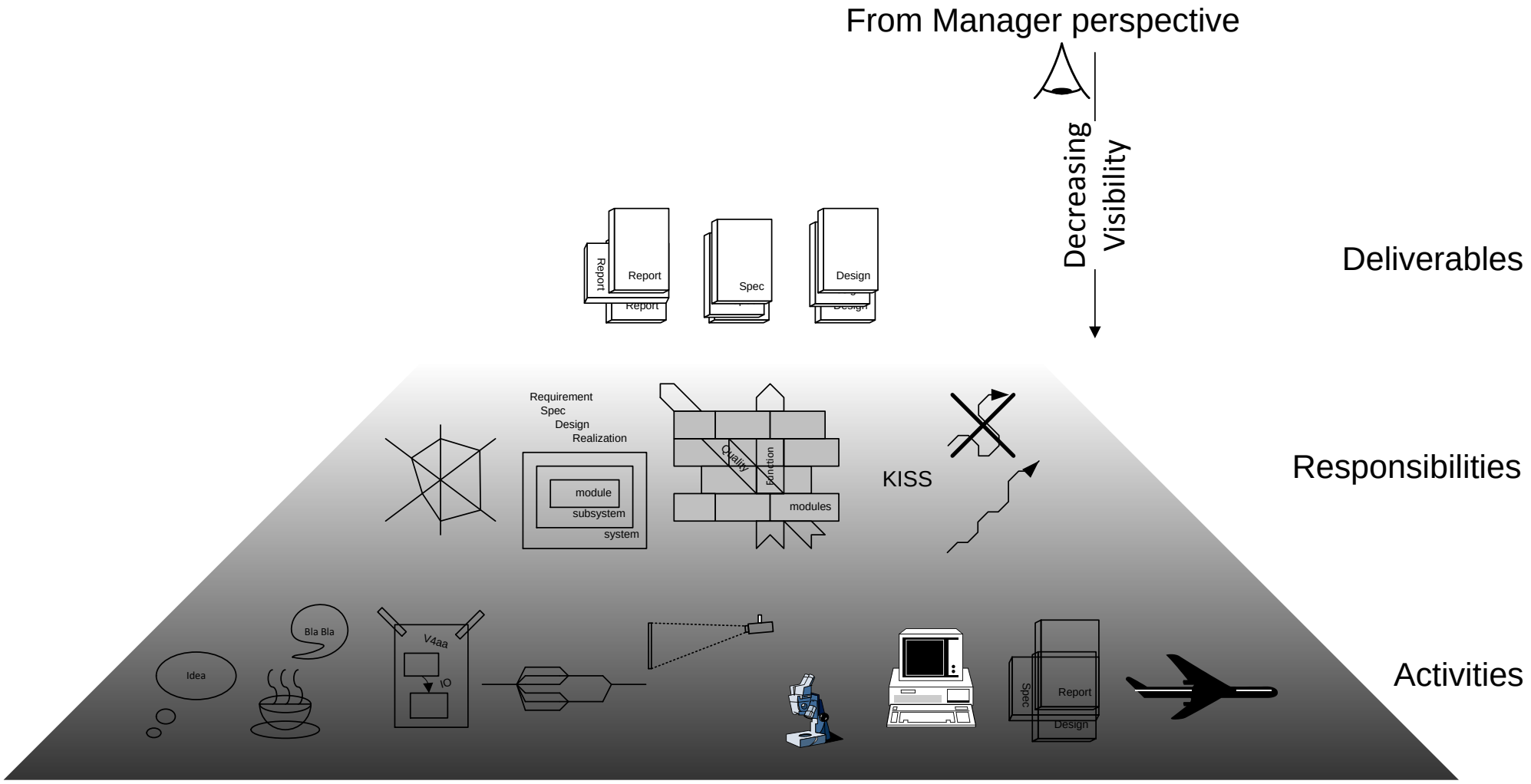
From Detail to Overview



Reality or Virtuality?

Abstractions only exist for concrete facts.

Visible Output versus Invisible Work



The Awakening of a System Architect

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Abstract

The typical phases of a system architect development are described, beginning at the fundamental technology knowledge, with a later broadening in technology and in business aspects. Finally the subtlety of individual human beings is taken into account.

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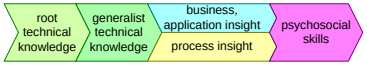
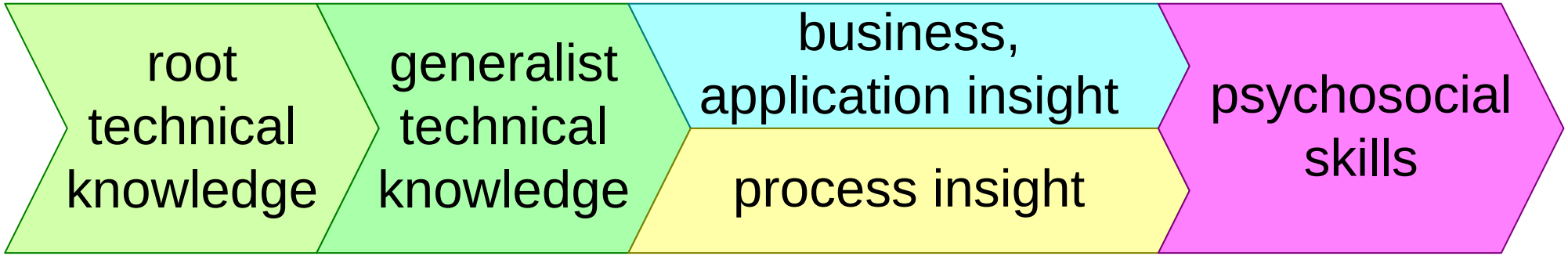
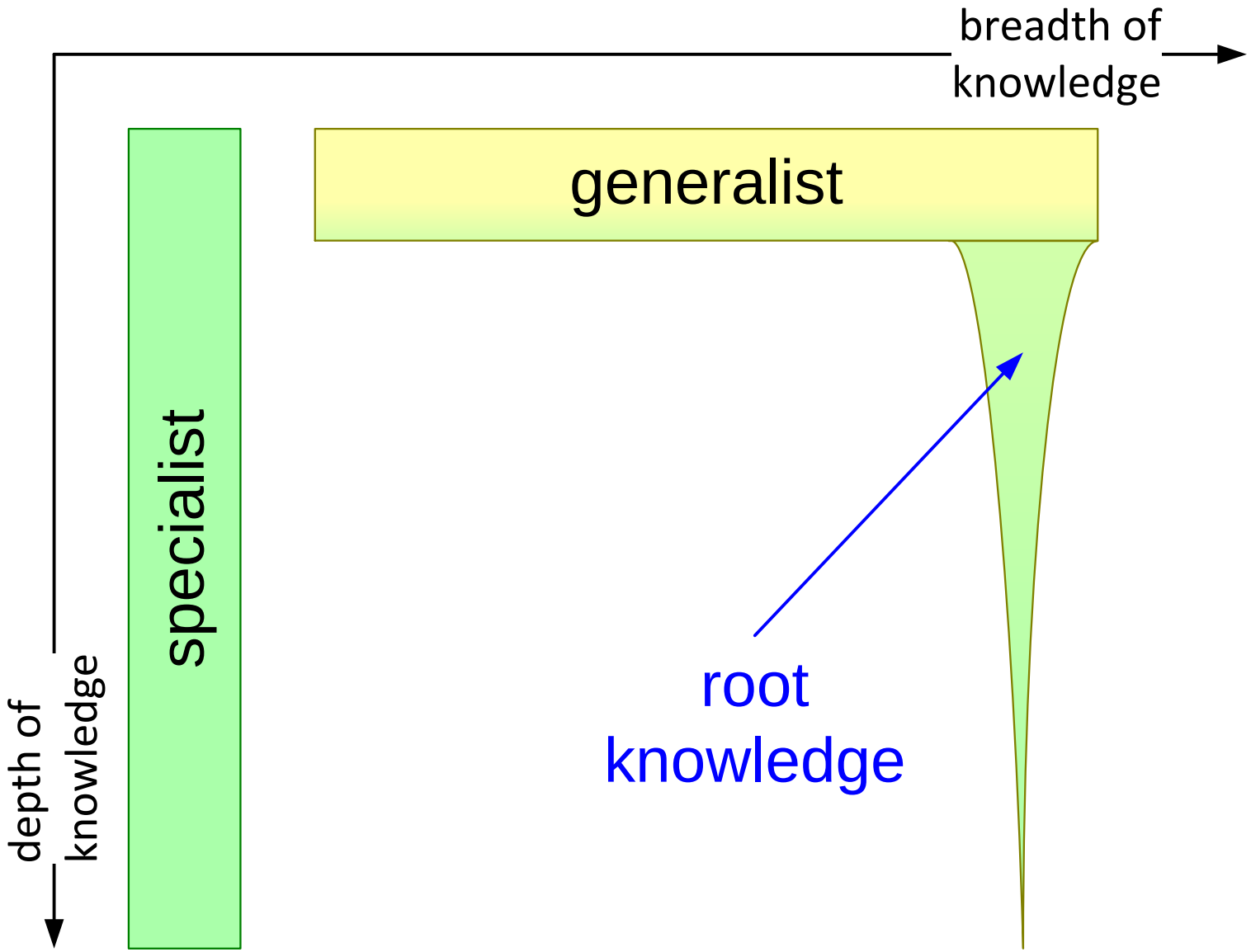


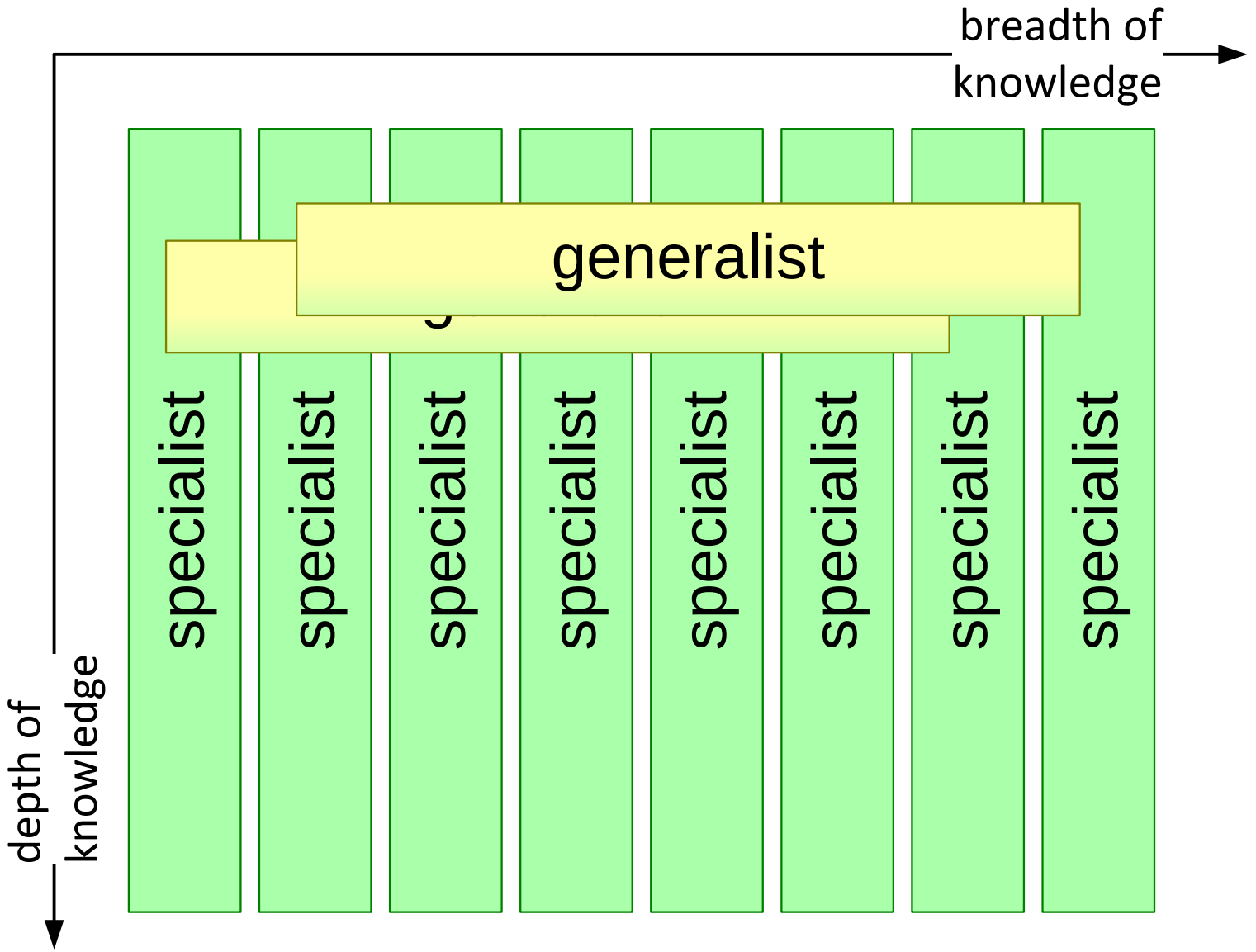
Typical Growth of a System Architect



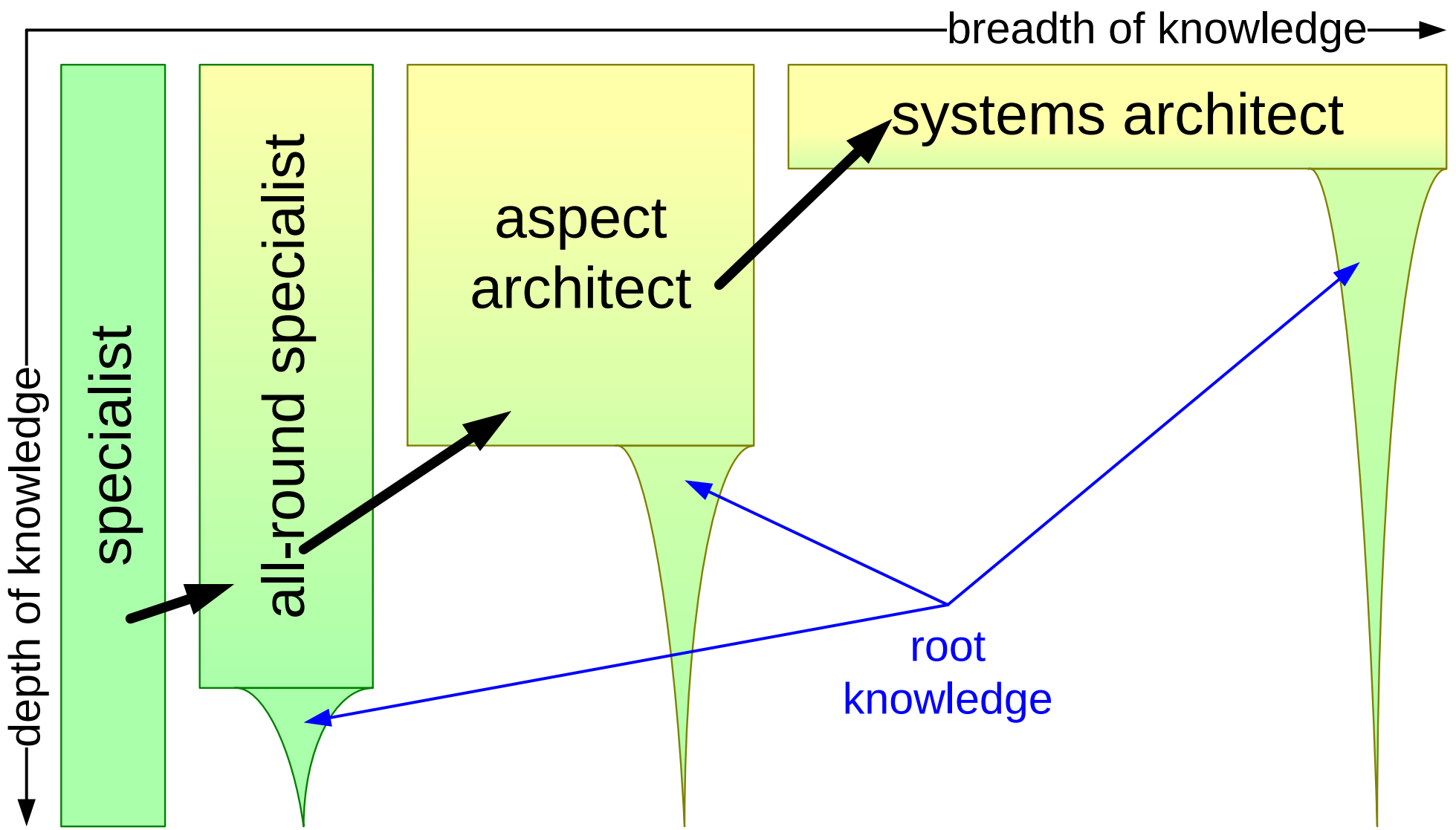
Generalist versus Specialist



Generalists and Specialists are Complementary



Spectrum from Specialist to System Architect



Architecting for Humans; How to Transfer Experience?

by *Gerrit Muller* University of South-Eastern Norway-NISE
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Abstract

The ultimate goal of Product Creation is to create products which give the user a great experience. User experience is very intangible. Product engineering focuses on tangible requirements. Successfull product require both sound engineering as well as creative design. The question is how to obtain a workforce, which is capable of both activities?
The education of successfull engineers is limited to engineering methods. Additional skills are acquired by experience. Unfortunately experience cannot be transfered from one engineer to the next. Such a transfer is approximated by active personal development.

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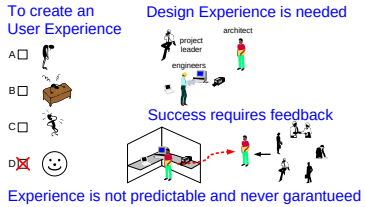
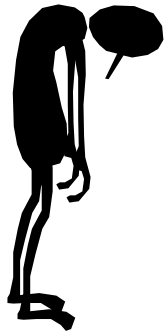
version: 1.3



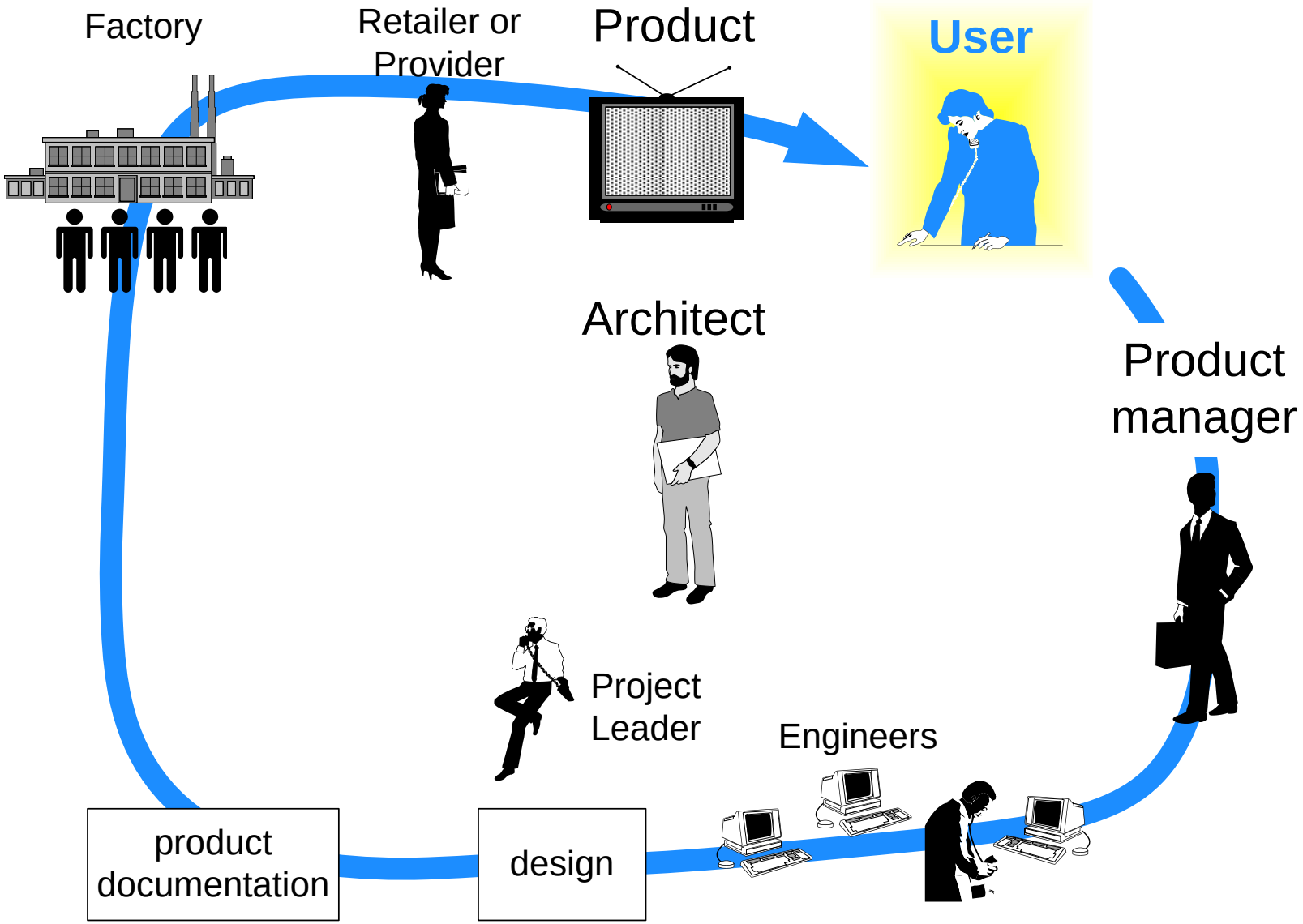
Did you ever program a VCR or PVR?

A ☐  depressed

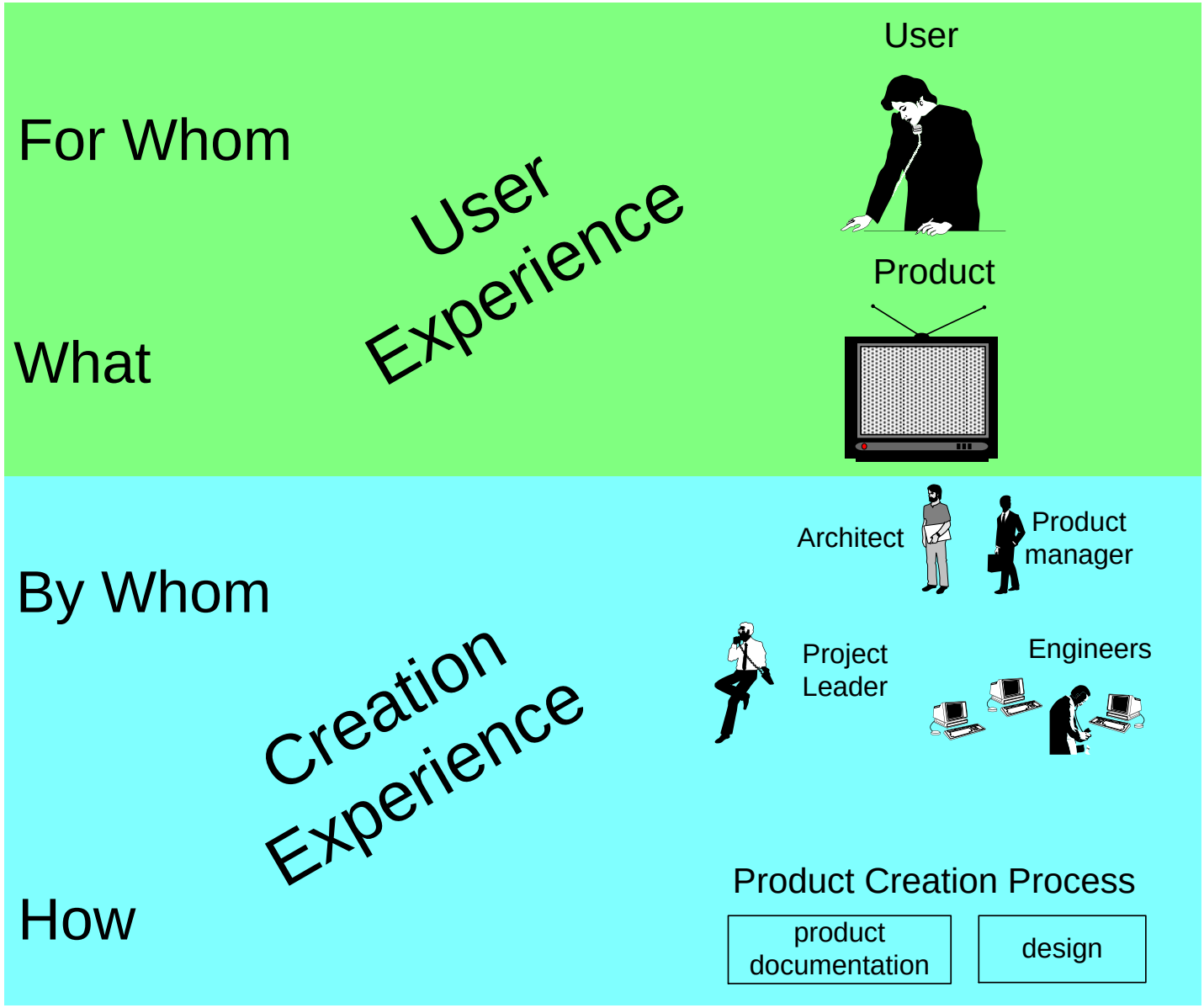
B ☐  desparate

C ☐  hysteric

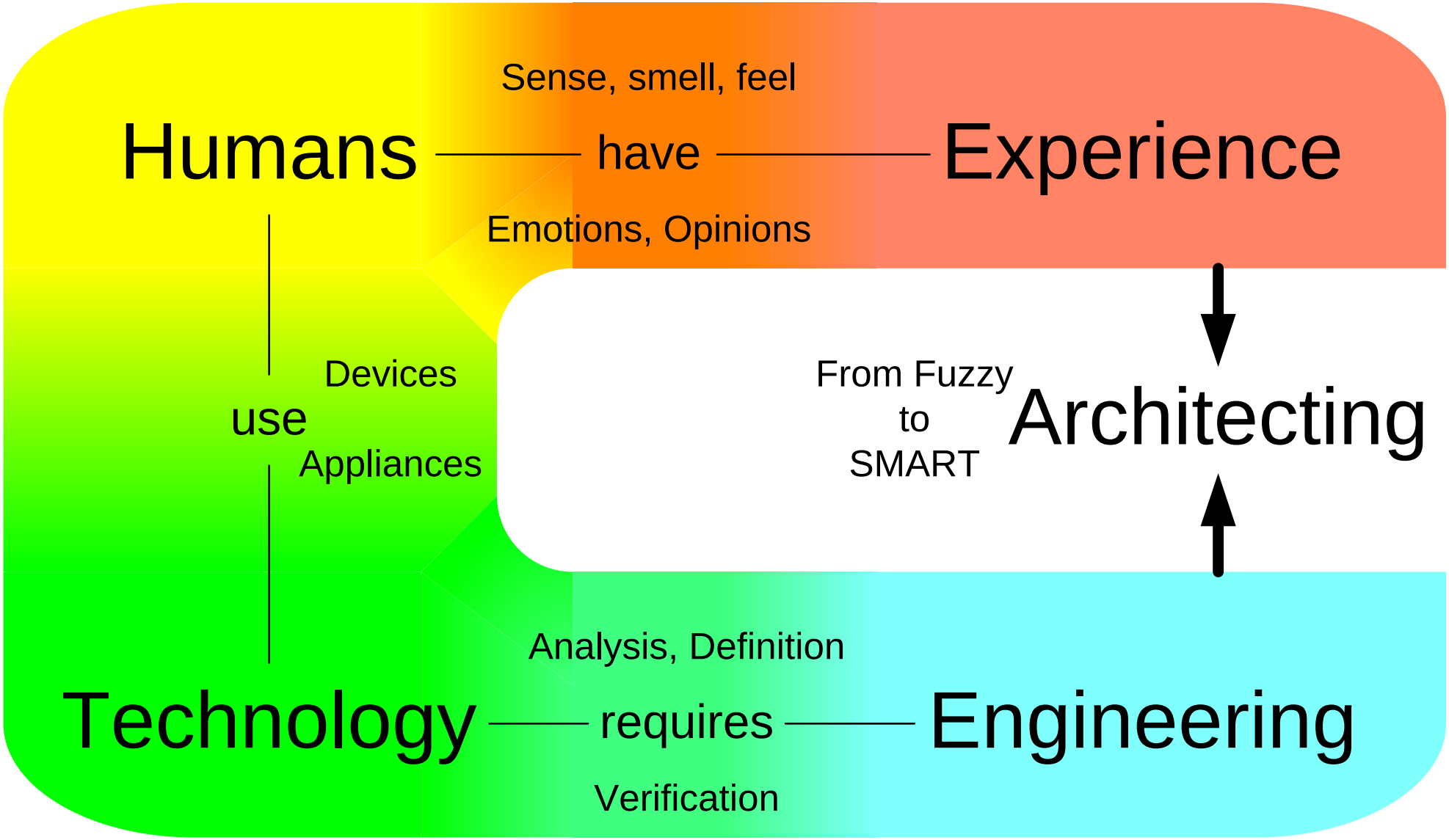
Product Creation Cycle



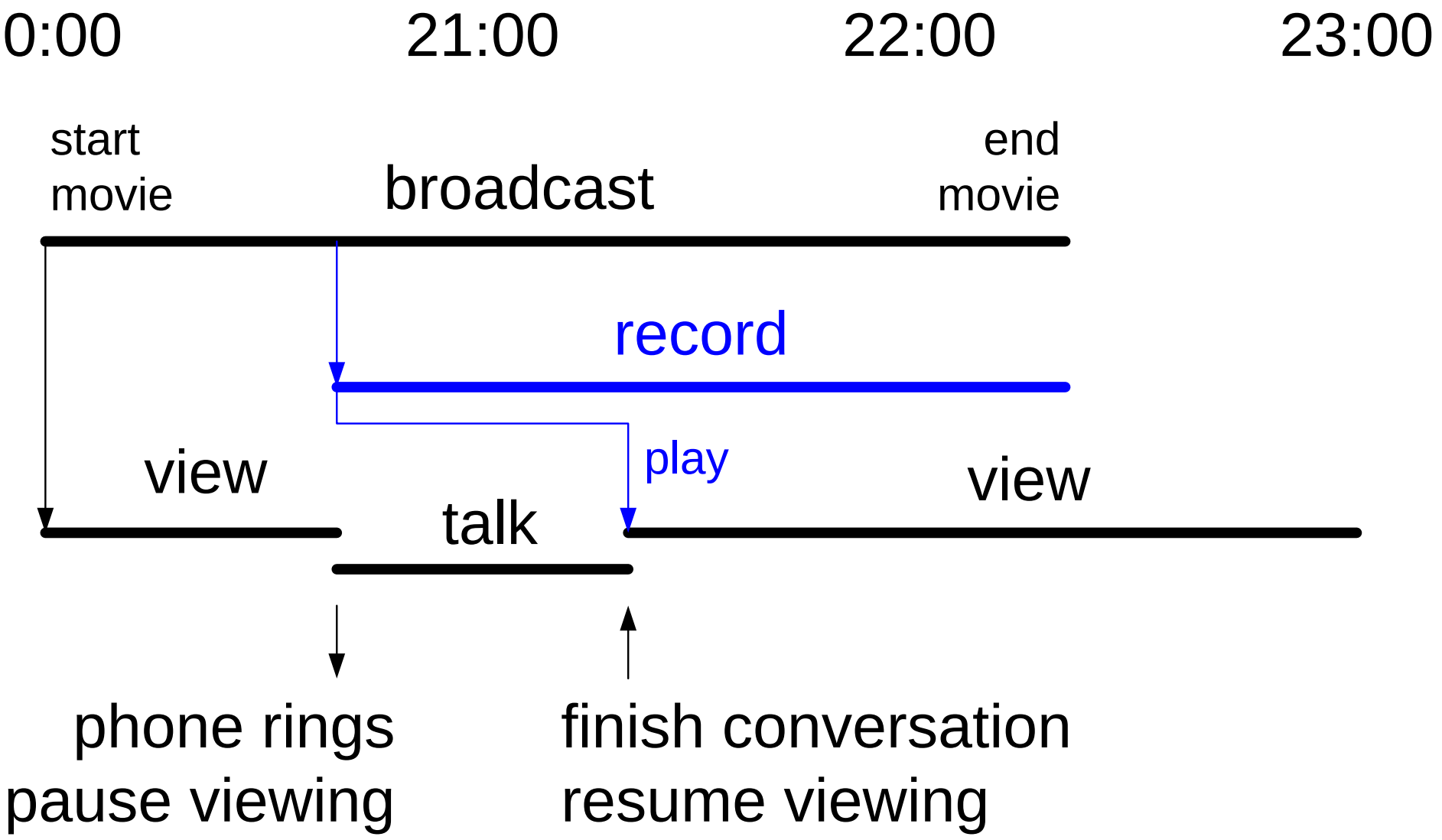
2 Levels of Experience



Bridging the gap between Experience and Engineering



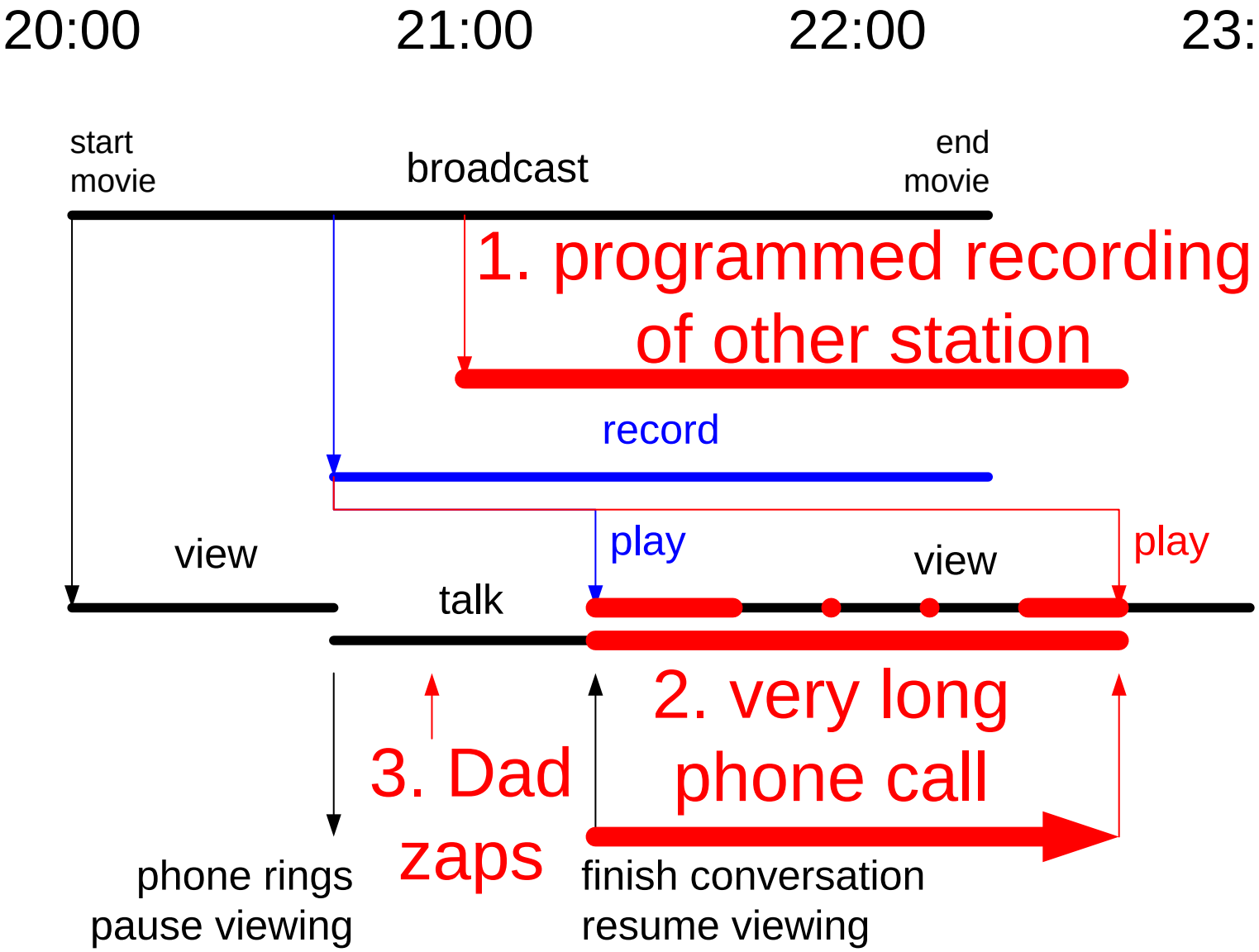
Example Time Shift recording



Construction limits intrude in Experience

- number of tuners
- number of simultaneous streams (recording and playing)
- amount of available storage
- management strategy of storage space

What if?


20:00
21:00
22:00
23:00
start movie
broadcast
end movie
1. programmed recording of other station
record
view
play
view
play
talk
2. very long phone call
3. Dad zaps
phone rings
pause viewing
finish conversation
resume viewing

Visual Basic Prototype:

enables "experiencing"

- play
- pause
- record
- EPG

Requirements specification

Many tables, mostly addressing details

2.1.1 Real-time data requirements

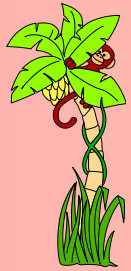
2.1.2 Implementation detail

2.1.3 Non-real time data requirements

1.1	**Software Requirements**		
1.1.1	Real-time data requirements	*1.1.1.1 Access to the non-real-time data must be done in such a way that it does not interfere with the real-time data* *1.1.1.2 There must be no disruptions in output of video signal during the operation of VCR* 1.1.1.3 *Responsiveness for non real-time data is less then 150ms (the time for writing a block on HDD) for 2KB of non-video data*	
1.1.2	Implementation detail	*1.1.2.1 Management of HDD content must only be possible through the TOC in order to prevent unauthorized access to content of HDD* *1.1.2.2 Visual feedback is provided to the user via On-Screen Display* 1.1.2.3 *User input is provided via the RC*	
1.1.3	Non-real time data requirements	*1.1.3.1 User must be able to pause and unpause a title, played from HDD, while (s)he is watching it* *1.1.3.2 User can jump forward and backward in a title, from HDD, during watching of this title* *1.1.3.3 Names of titles should be derived from the information from the EPG (name of the program to be recorded, time and date of registration)*	

Factors influencing the User Experience

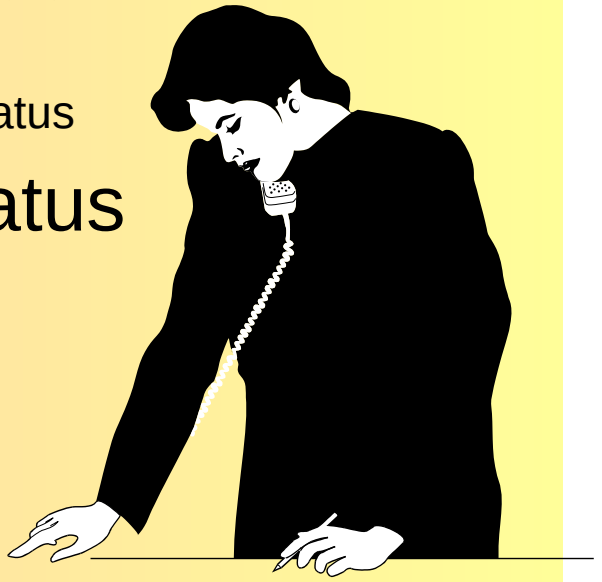
environmental factors



- social status
  - relation
  - family
- group influence
  - fashion
- culture
  - taboo
  - cultural
- location
- time

personal factors

- education
- mental status
  - trauma
  - emotional status
- physical status
  - allergy
  - handicap
- religion
  - taboo
- preferences
  - taste



How to ”SMART”en Experience?

- define
- measure
- predict
- verify

Infinite Experience Space

People	Number of People on earth	$O(10^9)$
		*
Time	Human lifespan in seconds	$O(10^9)$
		*
Location	Square meters of planet earth	$O(10^{14})$
		*
...	...	...

Size of experience space ∞

It is not that bad :-)

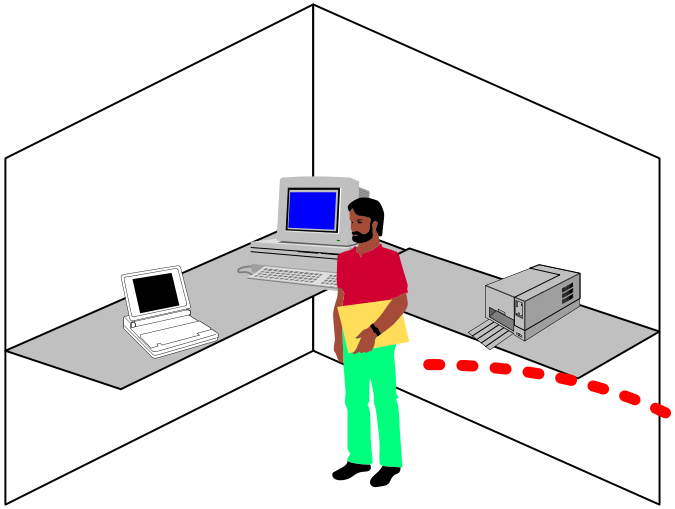
Many nice and successfull products exist!

Key Success Factor: Feedback

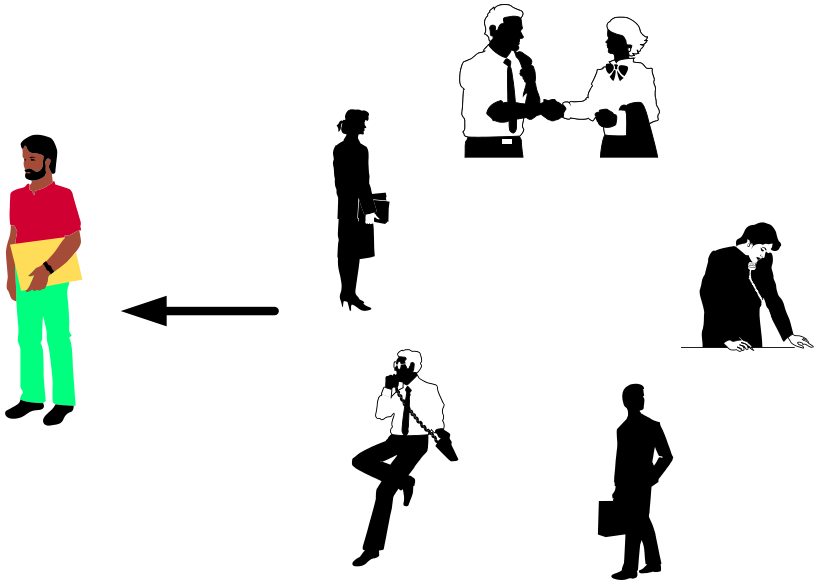
Obtain feedback from real users:

- Observe
- (Dare to) Listen

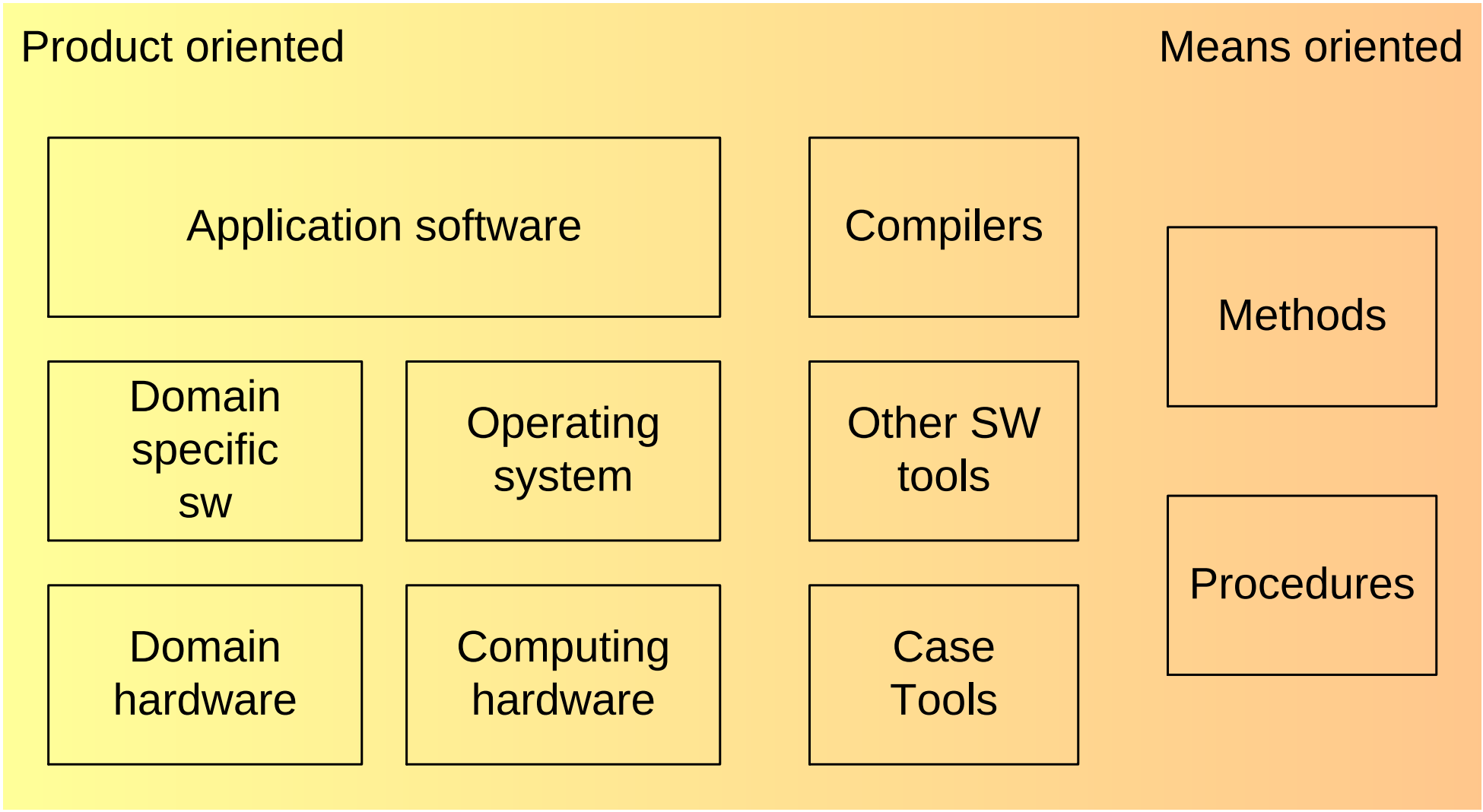
- Experiment
- Use short development cycles



Don't stay in the development lab



The world of the construction



Engineers are educated in construction disciplines

- Programming languages
- Operating systems
- Algorithms
- Data structures
- Formal specification and verification techniques
- Analysis, simulation techniques

Product Creation is much more than Engineering

Product Creation = Engineering + Creativity

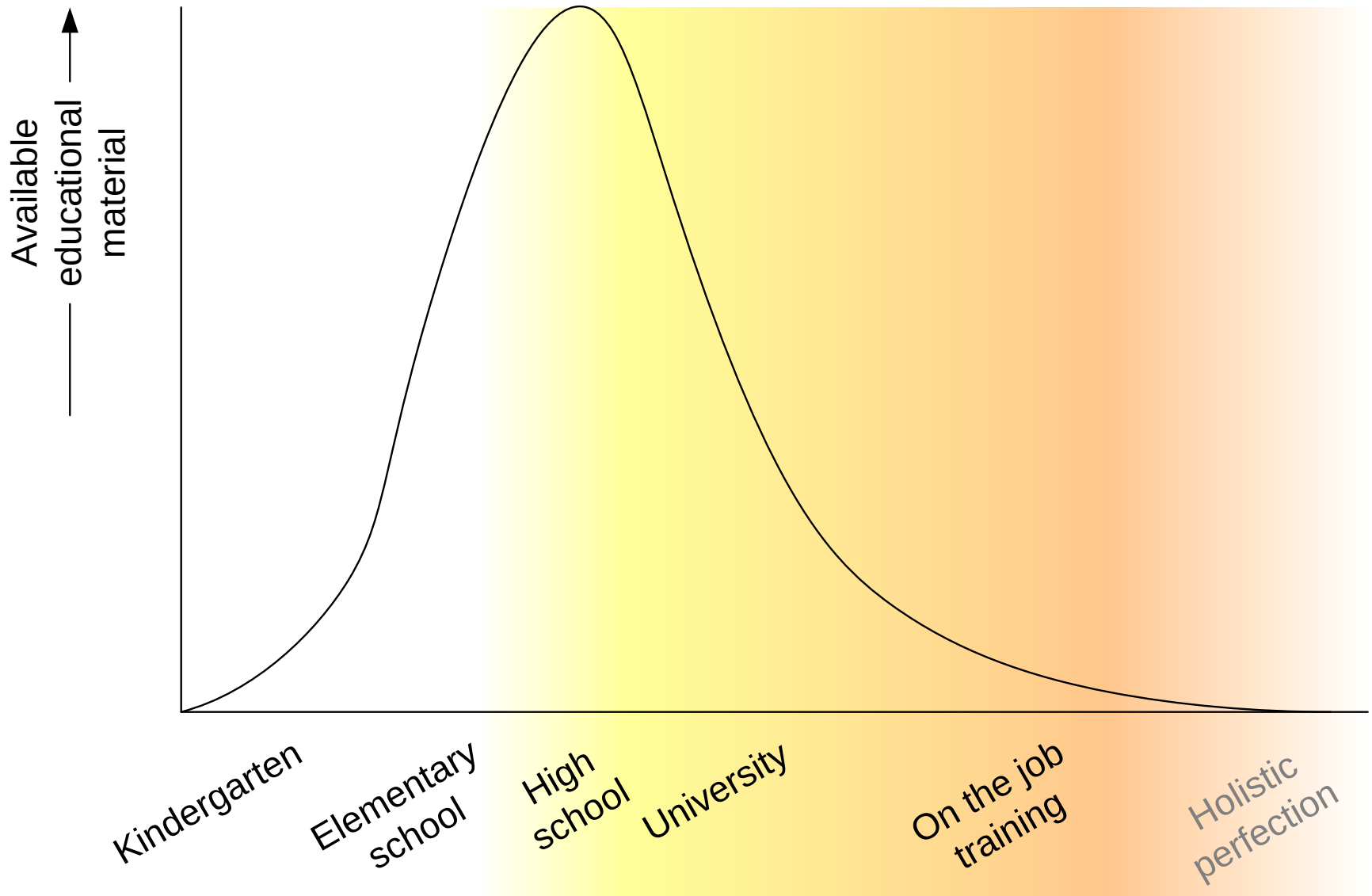
Known:

- Facts
- Notations
- Methods
- Tools
- Patterns

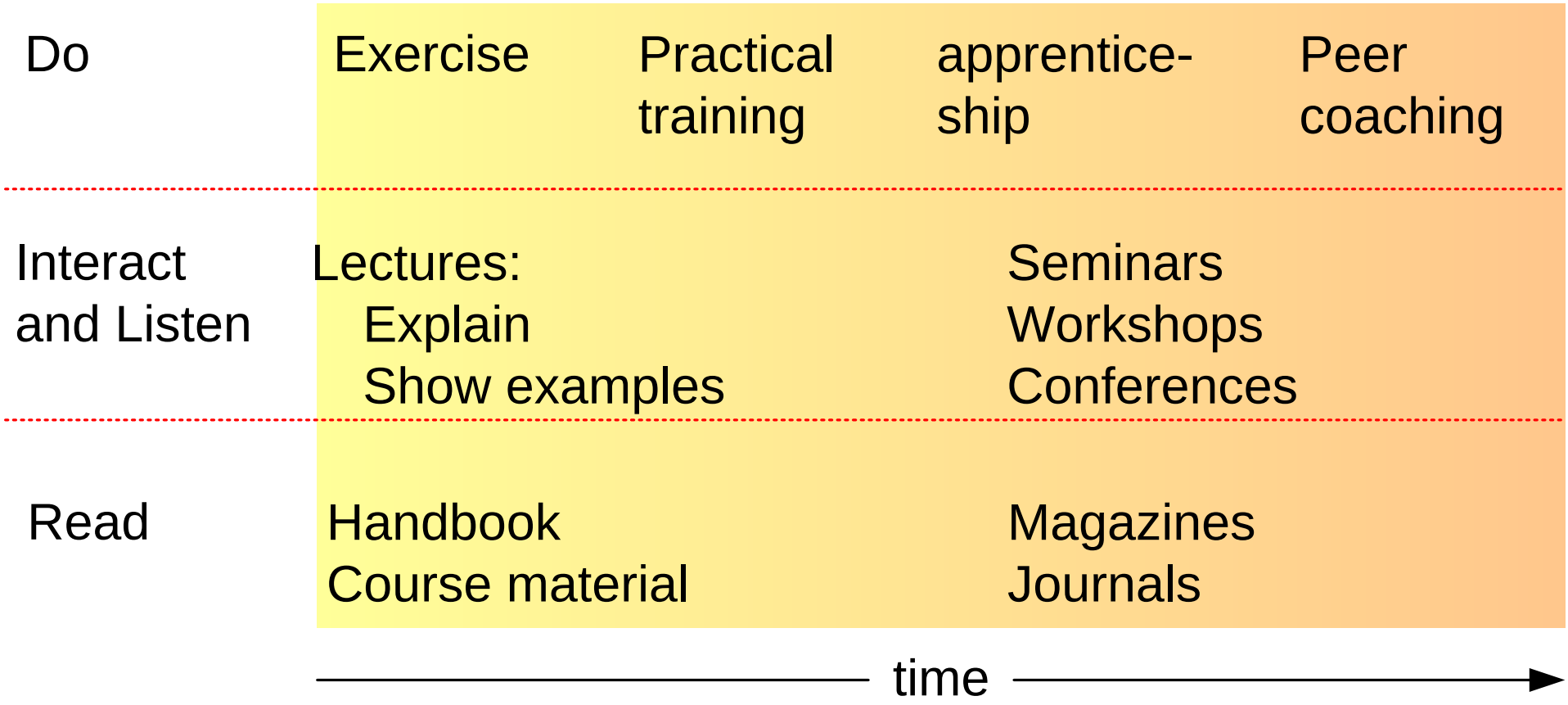
- Intuition
- Observation
- Trial and error
- Lateral thinking
- Collection of references

Education ⟷ Experience

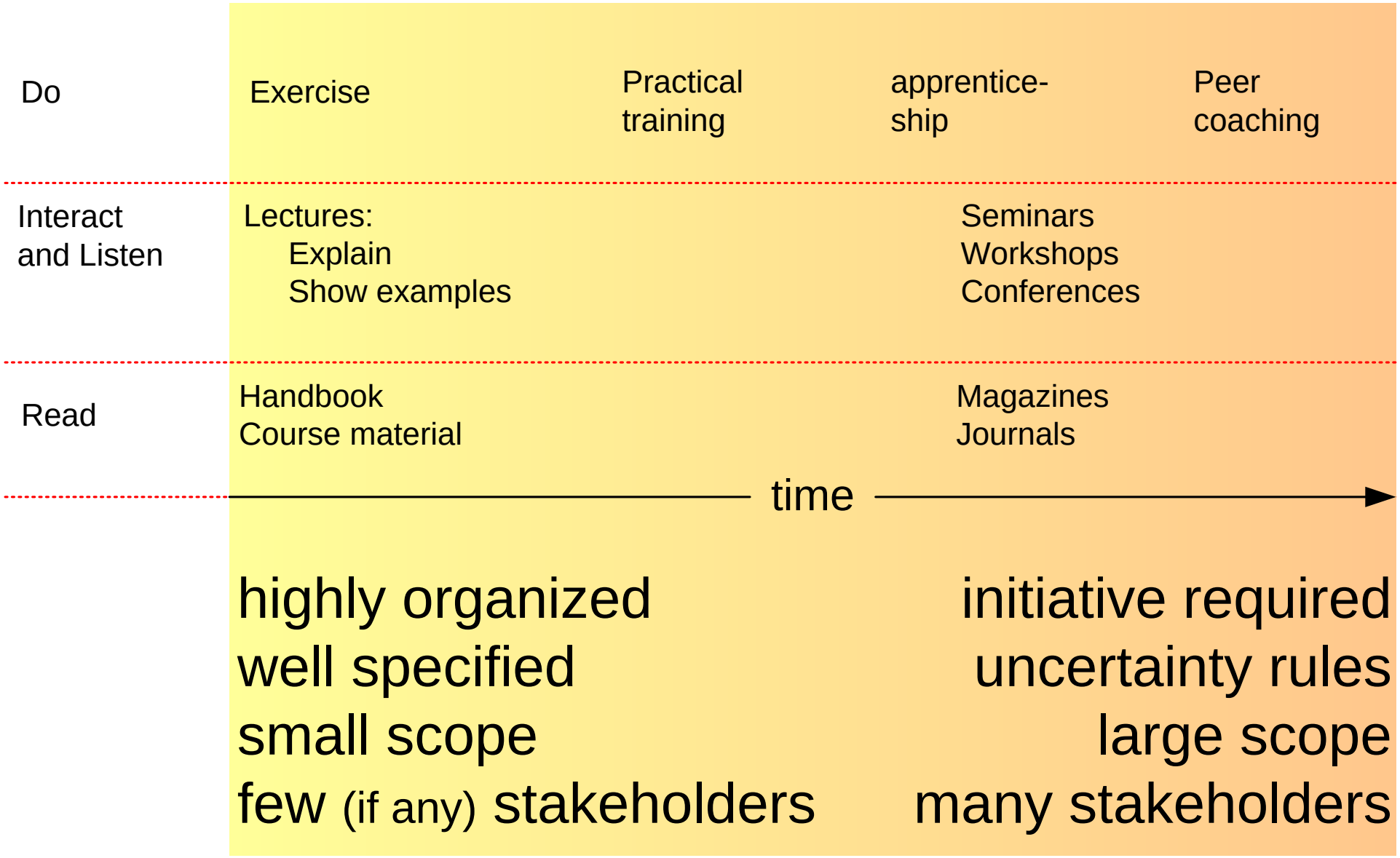
Educational Material per education stage



Changing Education model in time



Increasing Initiative required



Prerequisites for continuous successfull product creation

- Awareness of engineers of human aspects
- Active personal development drive of engineers
- Awareness of managers of education models
- Active motivation by managers

To create an User Experience

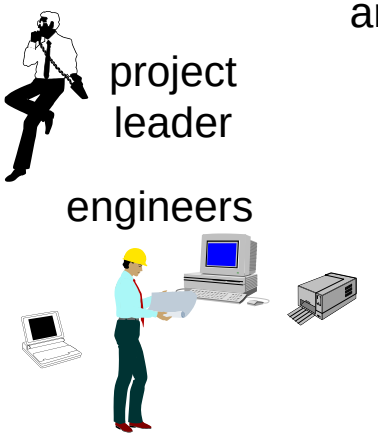
A ☐ 

B ☐ 

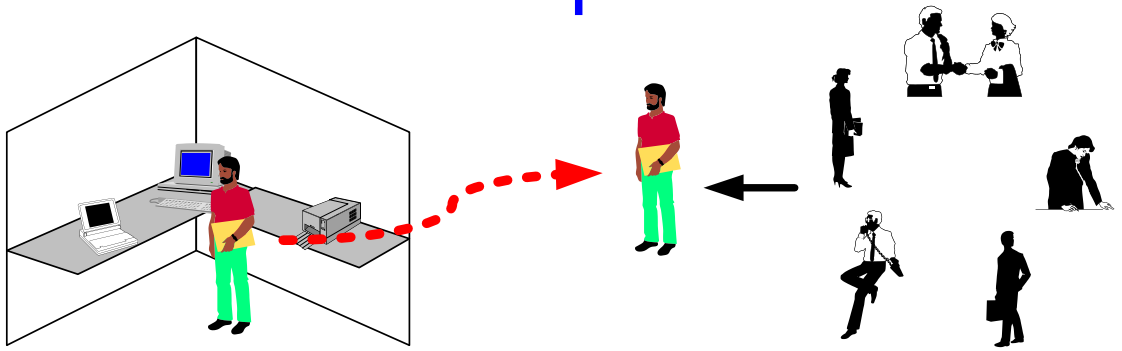
C ☐ 

D ☒ 

Design Experience is needed



Success requires feedback



Experience is not predictable and never garantueed

Design experience is not transferable
education is no substitute

Regular education =
Transfer of Engineering methods
+ Training

Transfer is approximated by
personal development

Personal Development =
On the job training
+ feedback
+ continuous personal education

Human Side: Interpersonal Skills

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

We discuss in this paper a set of skills and techniques to cooperate effectively between two individuals. We show the wonders of communication and then we address techniques such as investigation and acknowledgement, constructive feedback, conflict management, appraisal, good practices in a conversation, searching for ideas.

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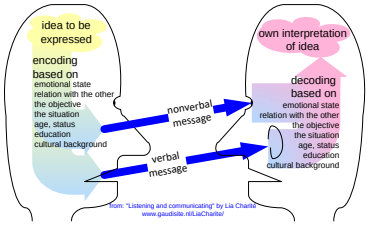
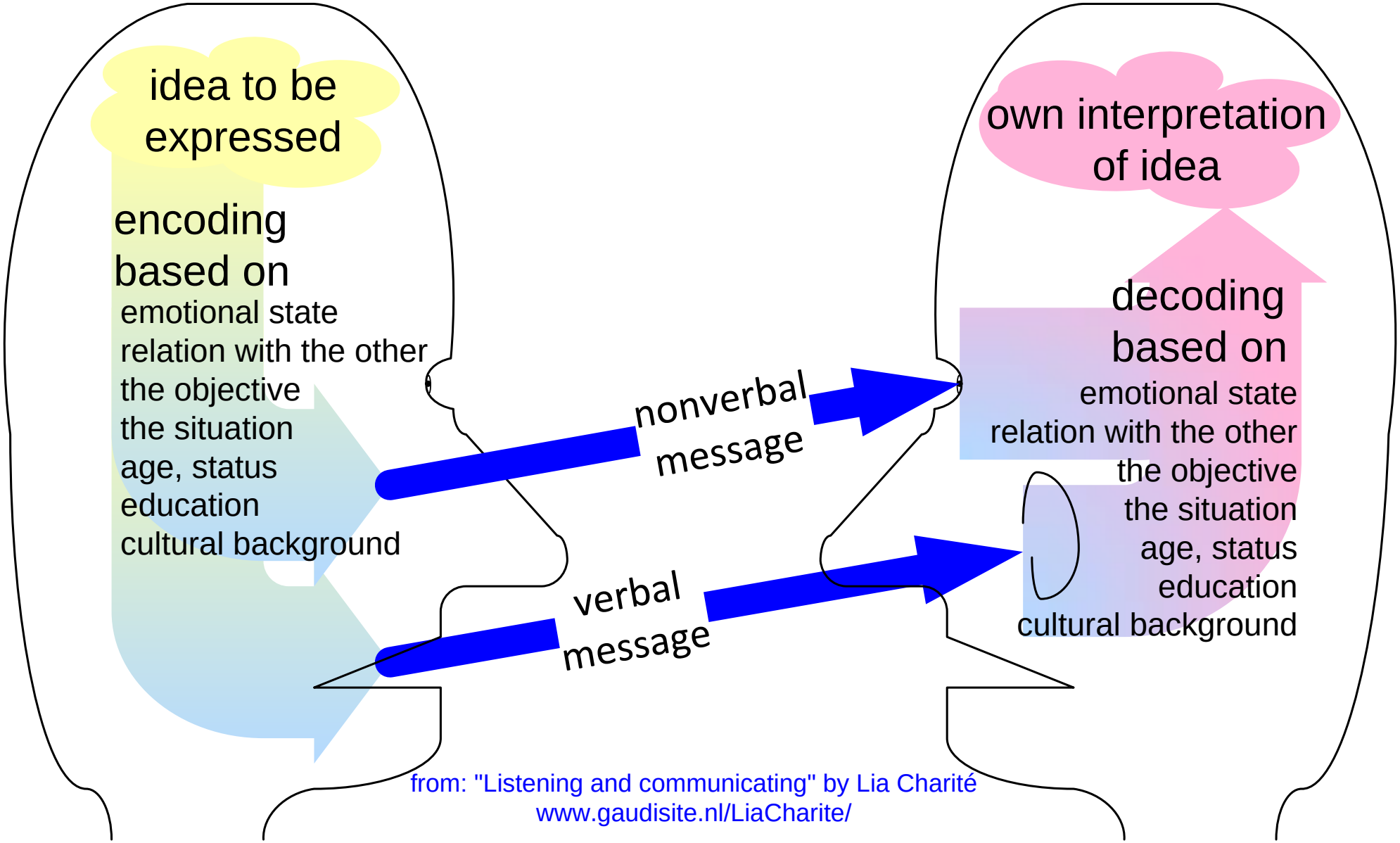


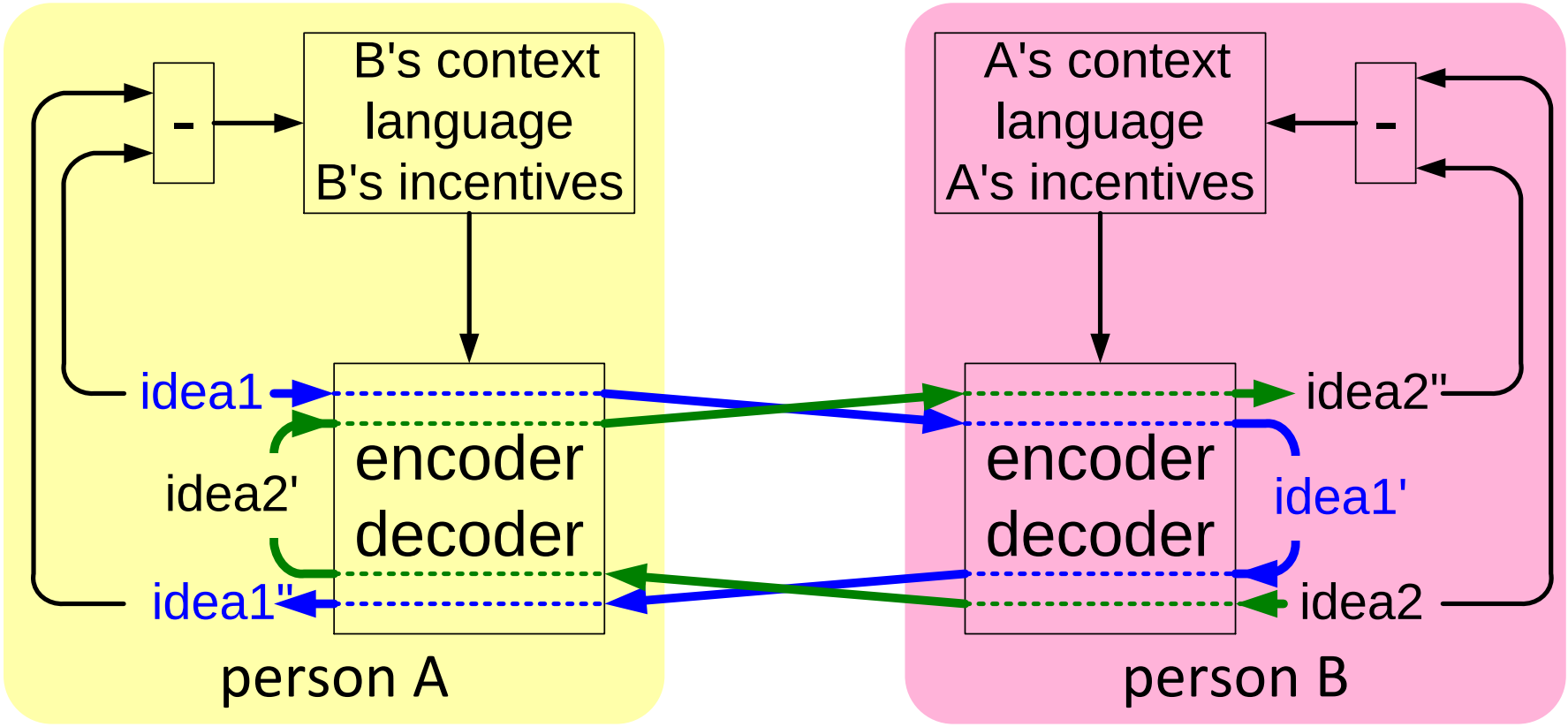
Active listening: the art of the receiver to decode the message



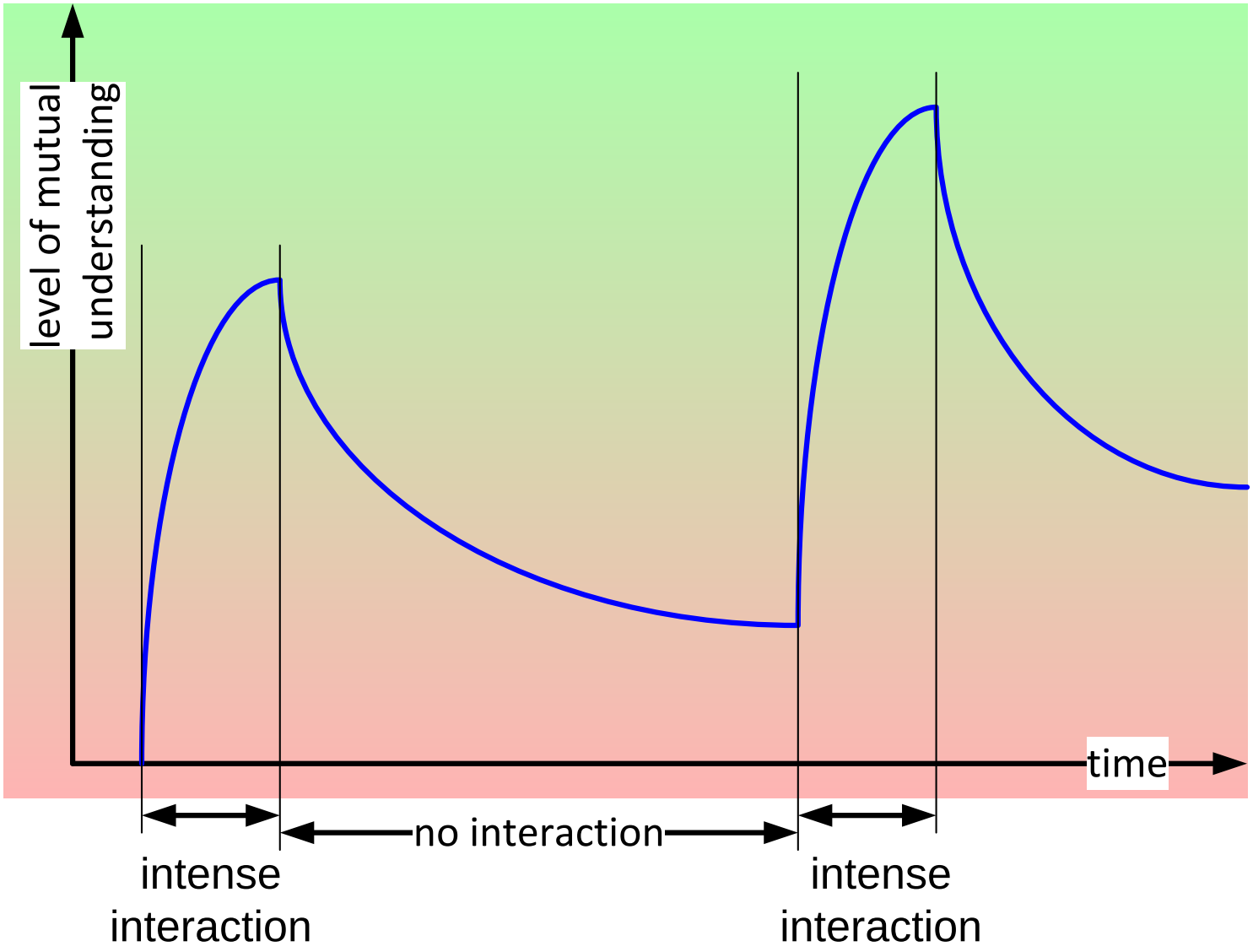
from: "Listening and communicating" by Lia Charité
www.gaudisite.nl/LiaCharite/

Intense interaction needed for mutual understanding

to calibrate:
repeat many times with different
examples, illustrations, and explanations



Mutual understanding as function of time



The material for interpersonal skills

is based on a set of techniques

from a course

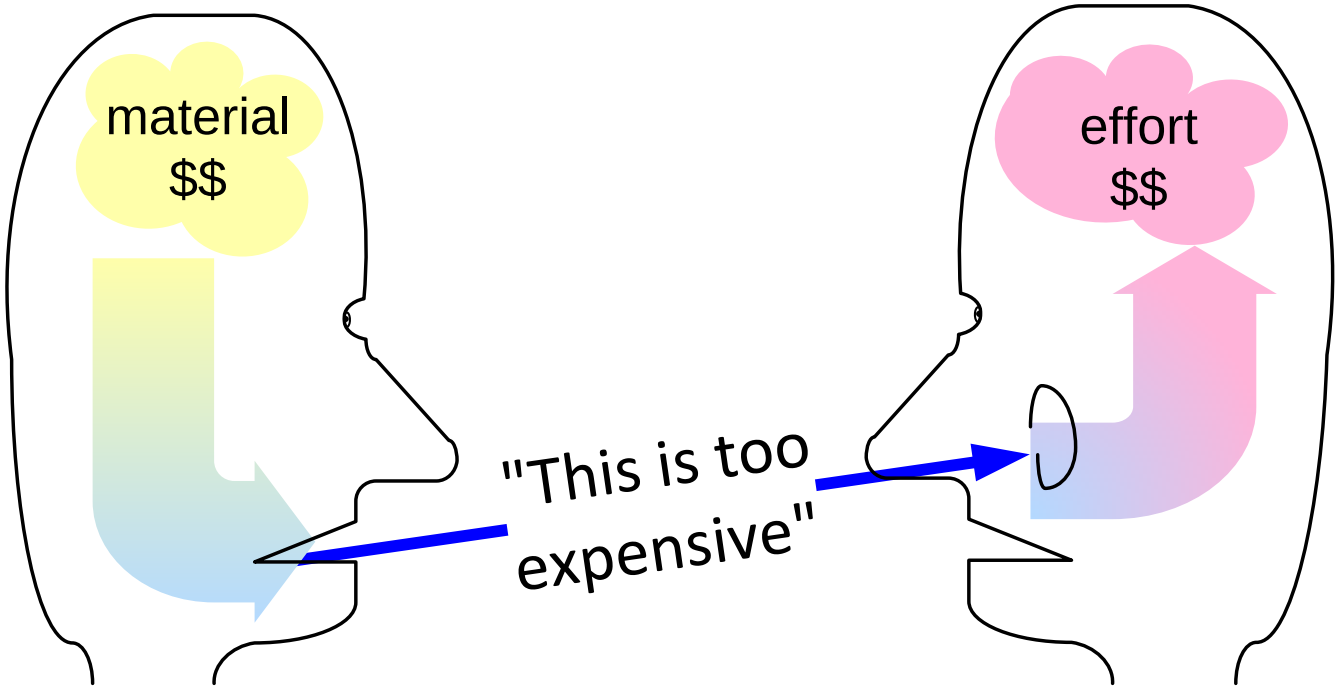
"Interpersonal Management Skills"

by

Hay Management Consultants

in 1998

Investigate and Acknowledge



investigate:
What has been said and why?

acknowledge:
Paraphrase what has been said and why?
i.e. use your own words

When a decision will be taken or an action will be started on the basis of exchanged information, opinions or suggestions
or
when the first reaction is to reject, ignore or contradict what you just heard.

Constructive Feedback

How

+ Indicate the strong points to be kept

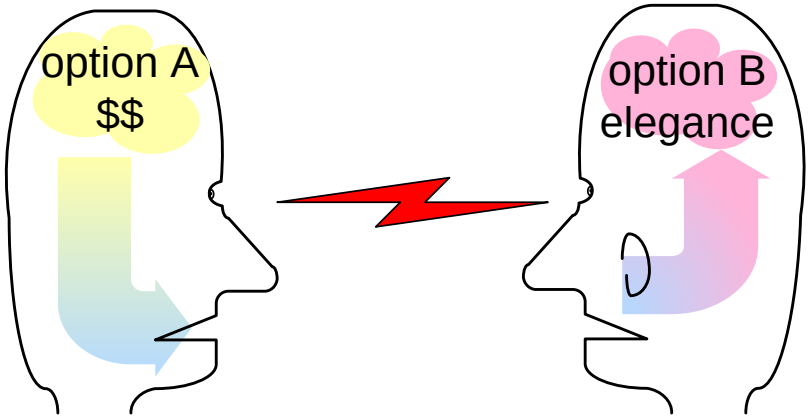
+ Indicate the points to be improved

+ Search for solutions which build upon the strong points and improve the weak points

When

You want to facilitate someone to improve his/her performance

Conflict Management



When

in case of conflict

How?

define the positions:

* indicate what is important for you and why
* investigate and acknowledge what is important for the other and why

If you are willing and able to consider alternatives:

IF

If you are not willing and able to consider alternatives, or no acceptable solution for both parties can be found:

Search for alternative solutions

Finish the conversation:

* acknowledge the right to have a different opinion
* indicate your decision and why

Appraisal

When

Someone's performance is important for you

* exceeding the expectations
* meets expectations continuously
* meets expectations, which exceed the normal performance level of this person

Appraise only when authentic!

How

+ Mention the performance very specific.
+ Mention the personal qualities which lead to this performance.
+ Describe which advantages arise for you, the department or the organization.

Conversation Good Practices

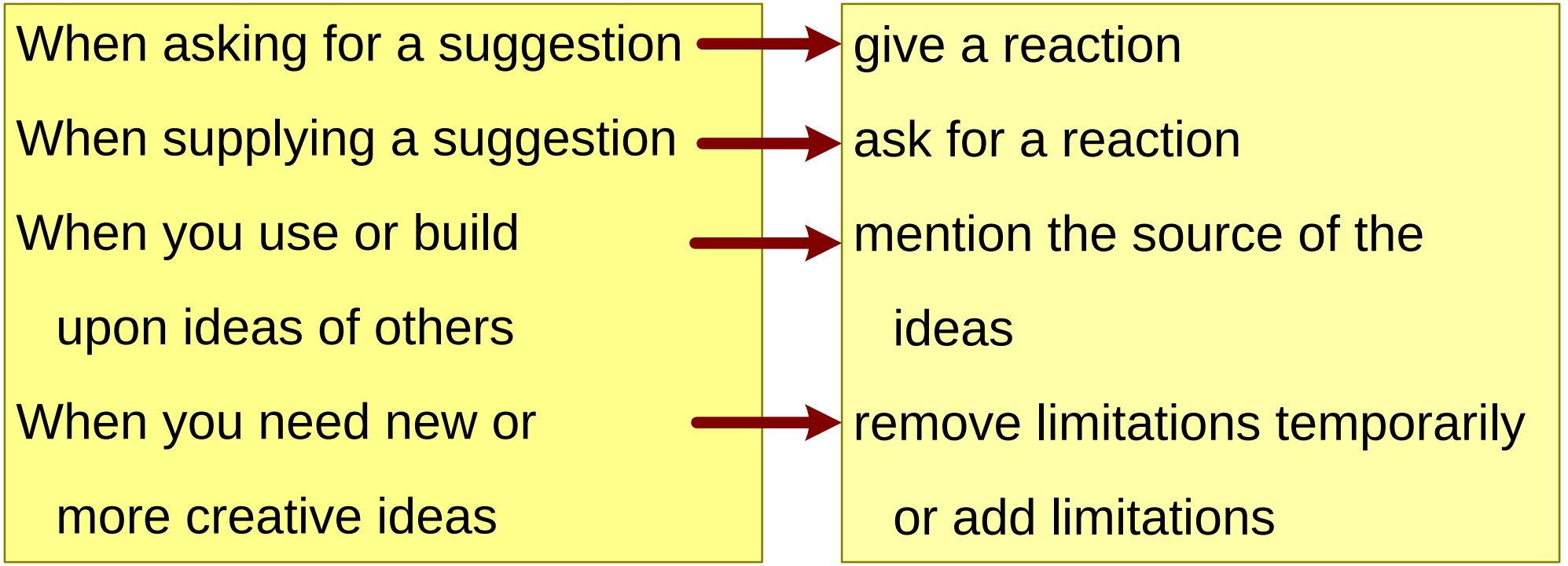
When you open a conversation

formulate the purpose

When you finish the conversation

summarize the agreements and the actionplan

Searching for Ideas



Human Side: Team Work

by *Gerrit Muller* USN-SE
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www.gaudisite.nl

Abstract

The creation of products requires many different people to cooperate. The work is often organized in teams. The team members have complimentary skills and knowledge. In many management courses the need to design teams is emphasized. Unfortunately, often these recommendations are ignored. We re-iterate in this paper the rationale for teams and the recommendations for designing the team itself.

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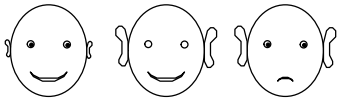
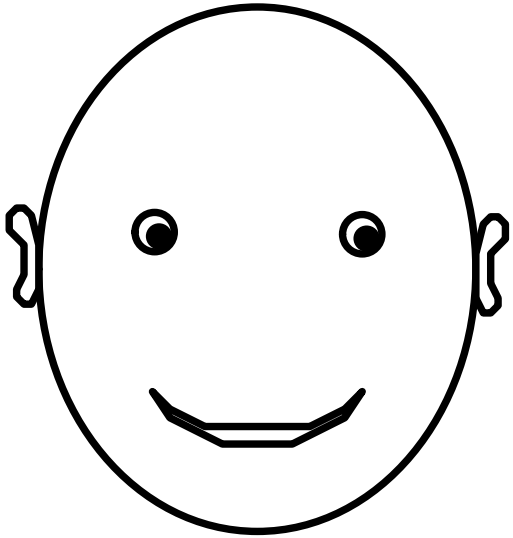
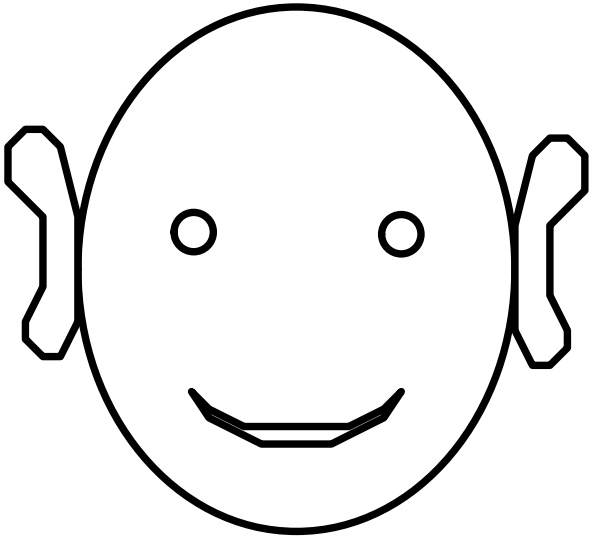


but in the team two can hear,
two can see, and two can speak

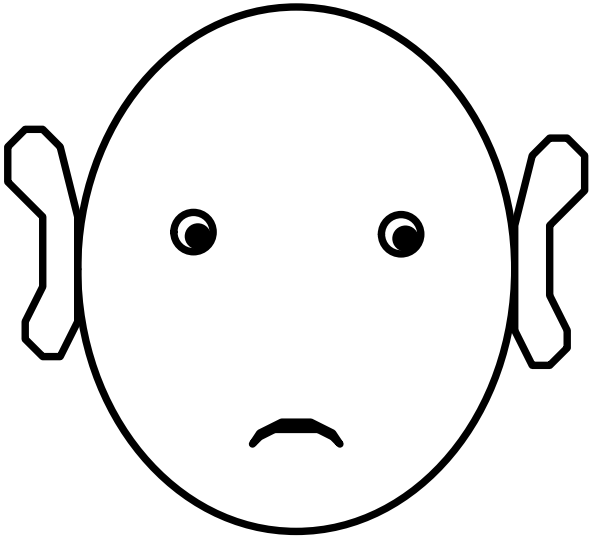
Teams consist of complementary people



deaf
cannot hear



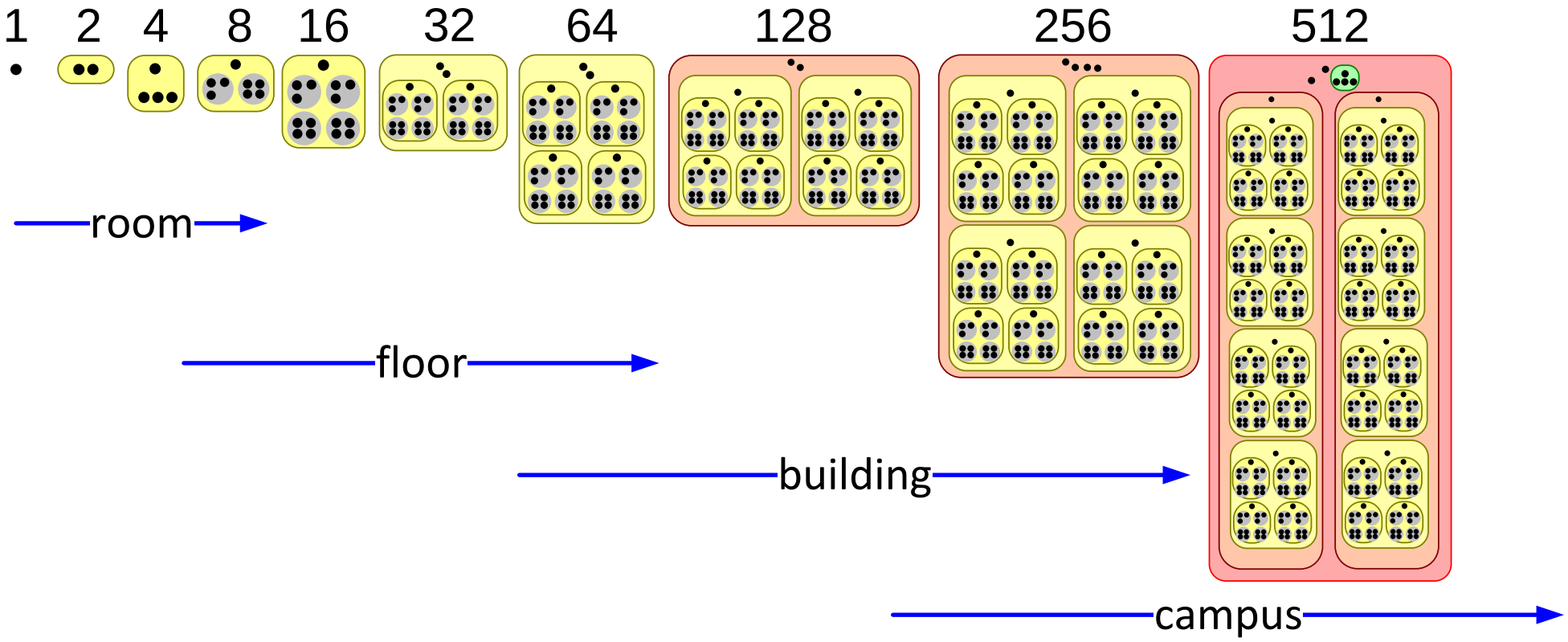
blind
cannot see



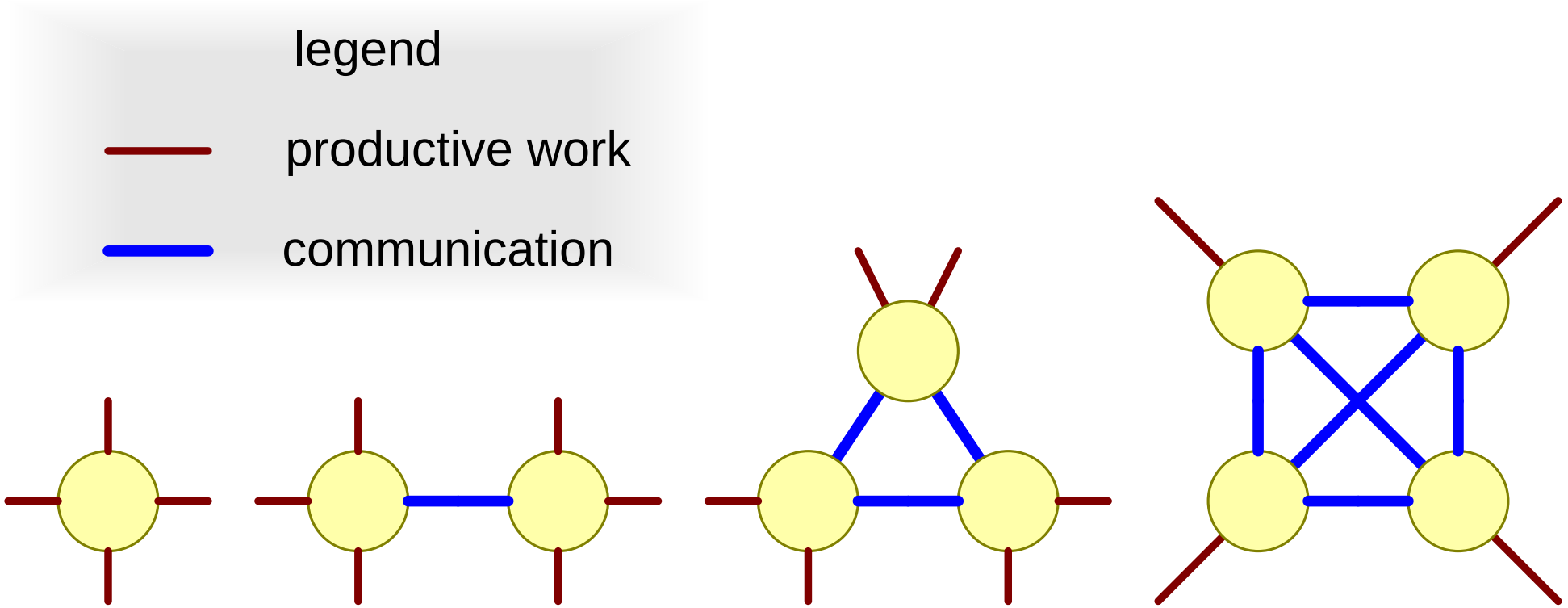
mute
cannot speak

but in the team two can hear,
two can see, and two can speak

Organization size and teams



Very simplistic team model



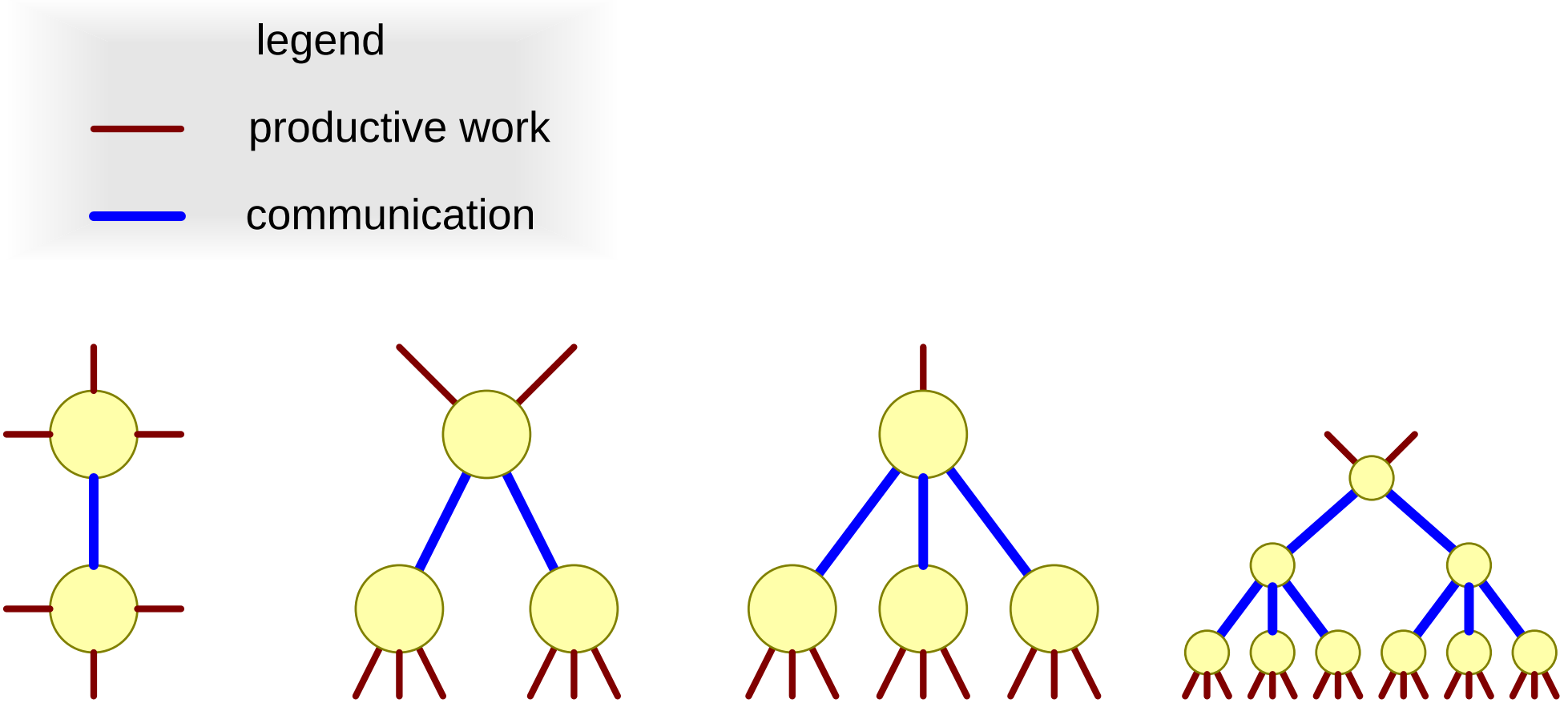
1-person team
eff = 100%

2-person team
eff = 75%

3-person team
eff = 50%

4-person team
eff = 25%

Hierarchical simplistic team model



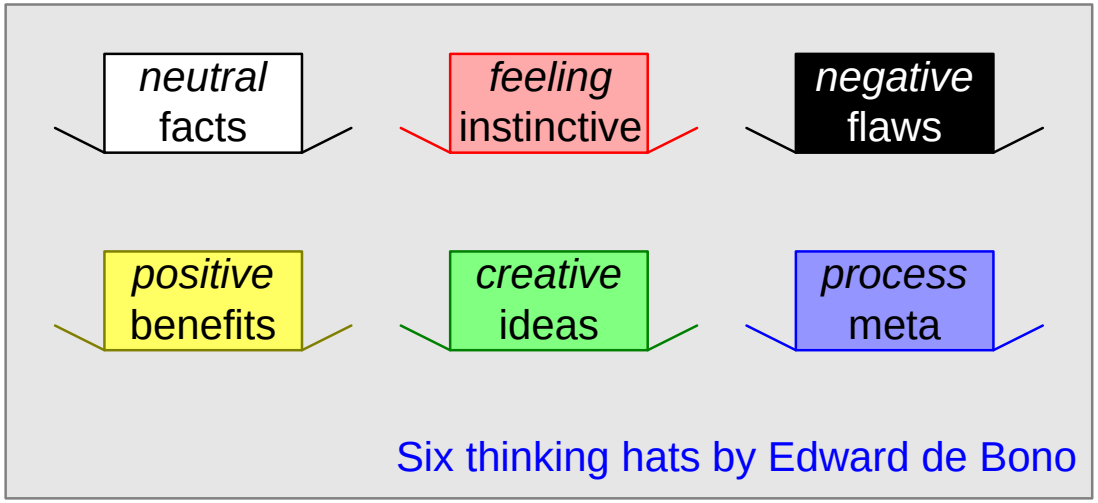
2-person team
eff = 75%

3-person team
eff = 66%

4-person team
eff = 62.5%

9-person team
eff ~= 56%

Many personality and role models are available



Six thinking hats by Edward de Bono

E Extraversion ⟷ Introversion **I**

S Sensing ⟷ iNtuition **N**

T Thinking ⟷ Feeling **F**

J Judging ⟷ Perceiving **P**

Myers-Briggs Type Indicators

plant
creative

team worker
co-operative,
averts friction

implementer
disciplined, conservative,
do-er

resource investigator
enthusiatic
communicator

shaper
driver, dynamic

completer finisher
conscientious, painstaking

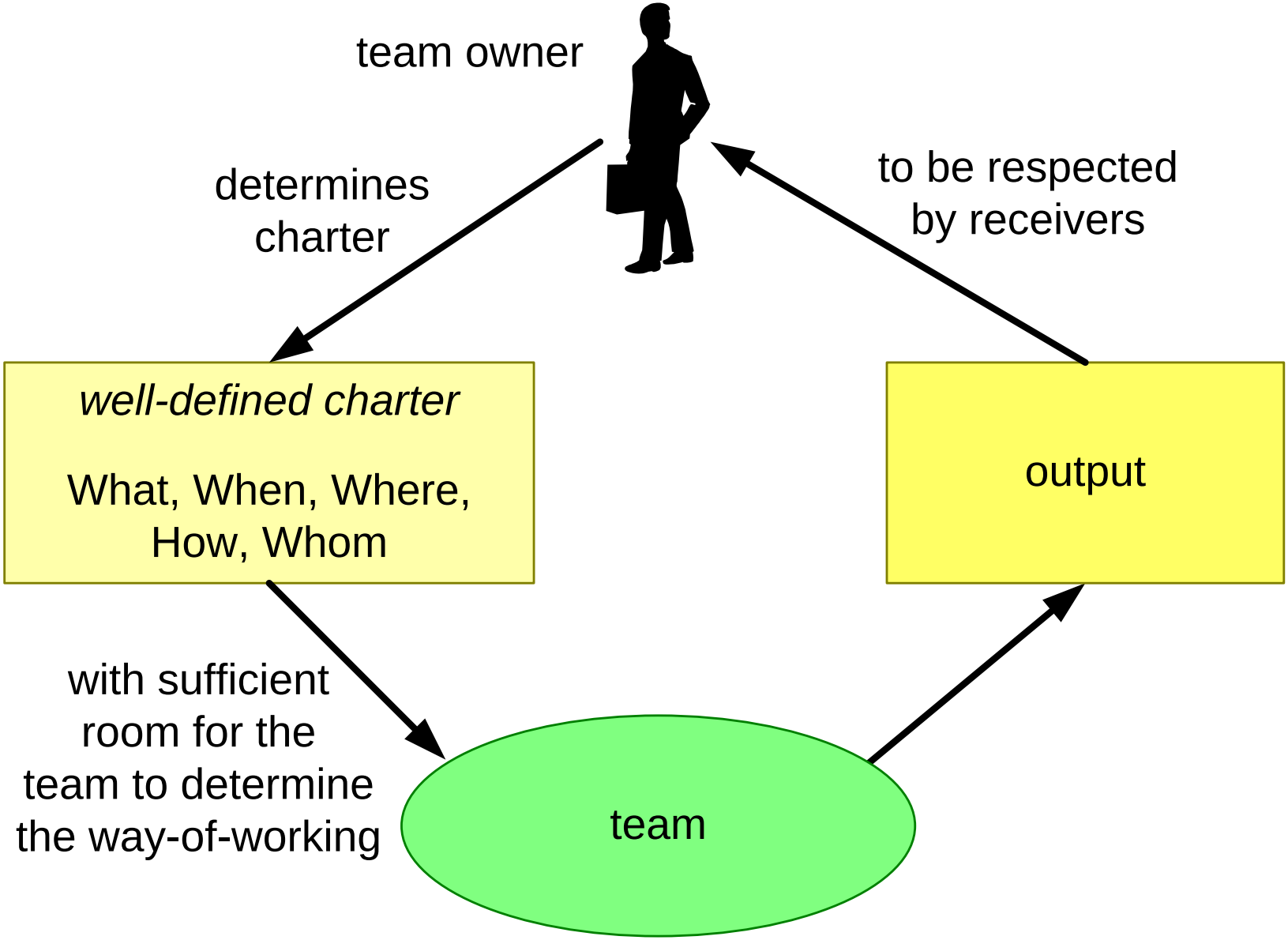
co-ordinator
mature, chairman

monitor evaluator
sober, analytical

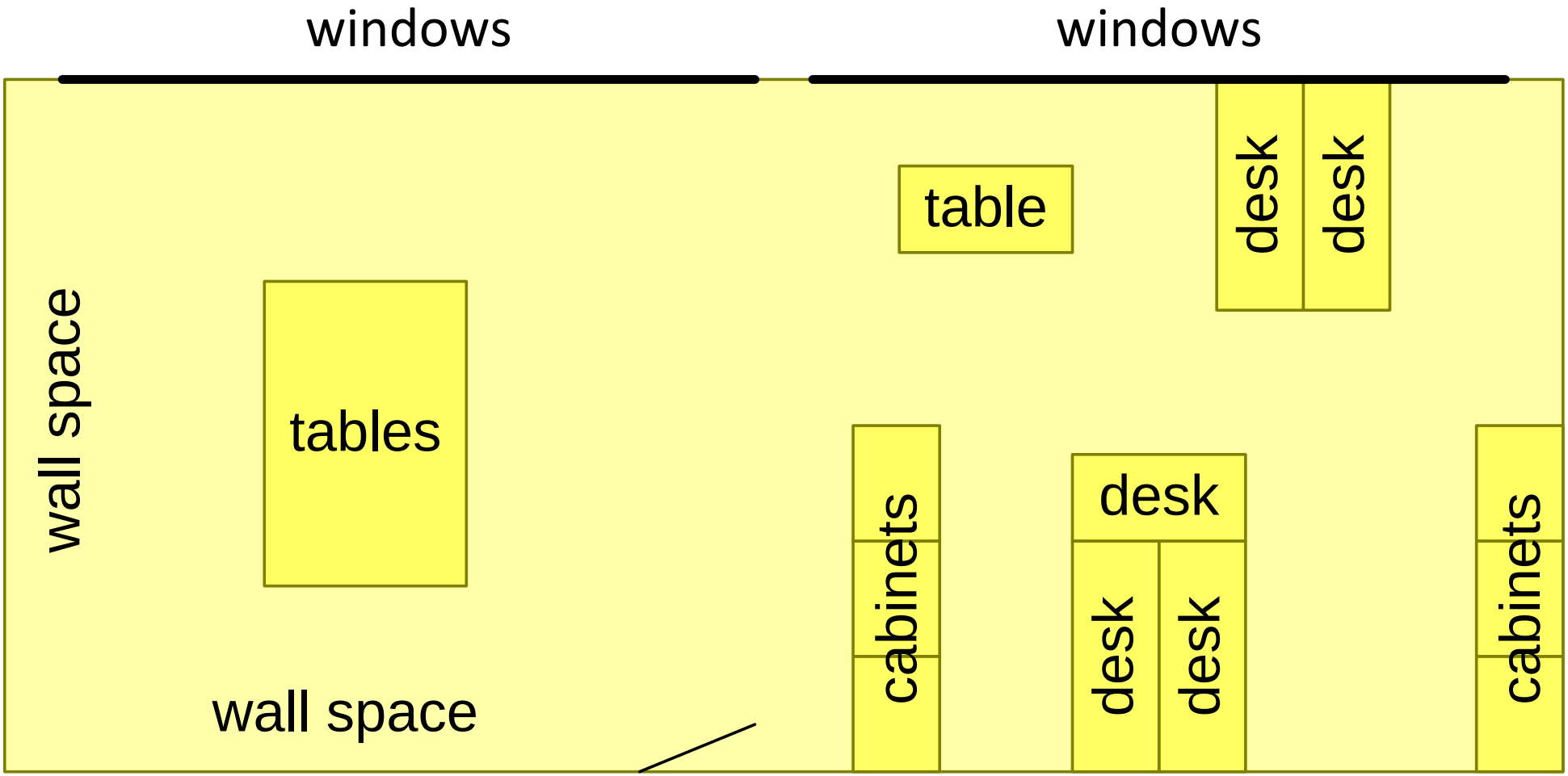
specialist
single-minded, rare skills

Belbin's team roles

Process of creating and using a team

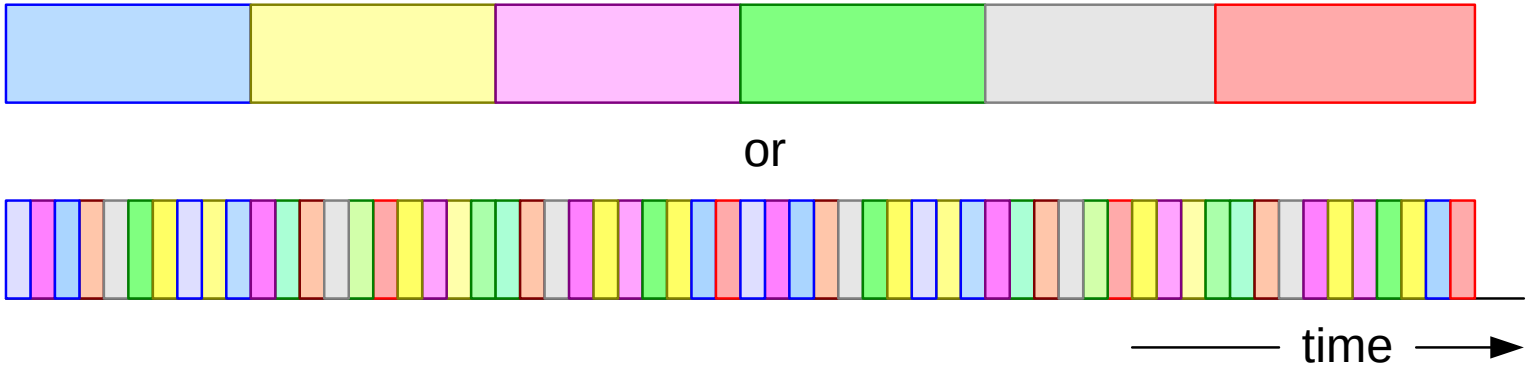


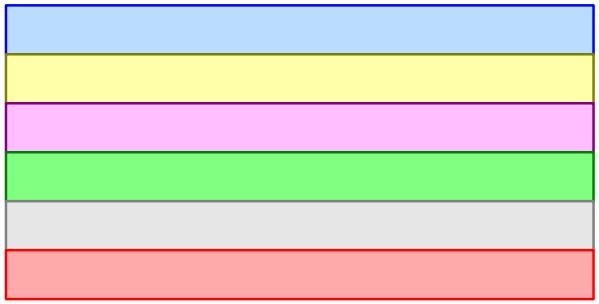
“War Room” is very effective



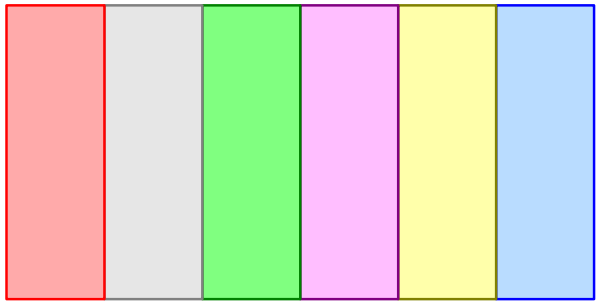
Concurrency and Fragmentation lower efficiency

How many (semi-)concurrent tasks can a person handle?
Working in burst-mode (concentrating on one task for one day, week or month) can increase efficiency.



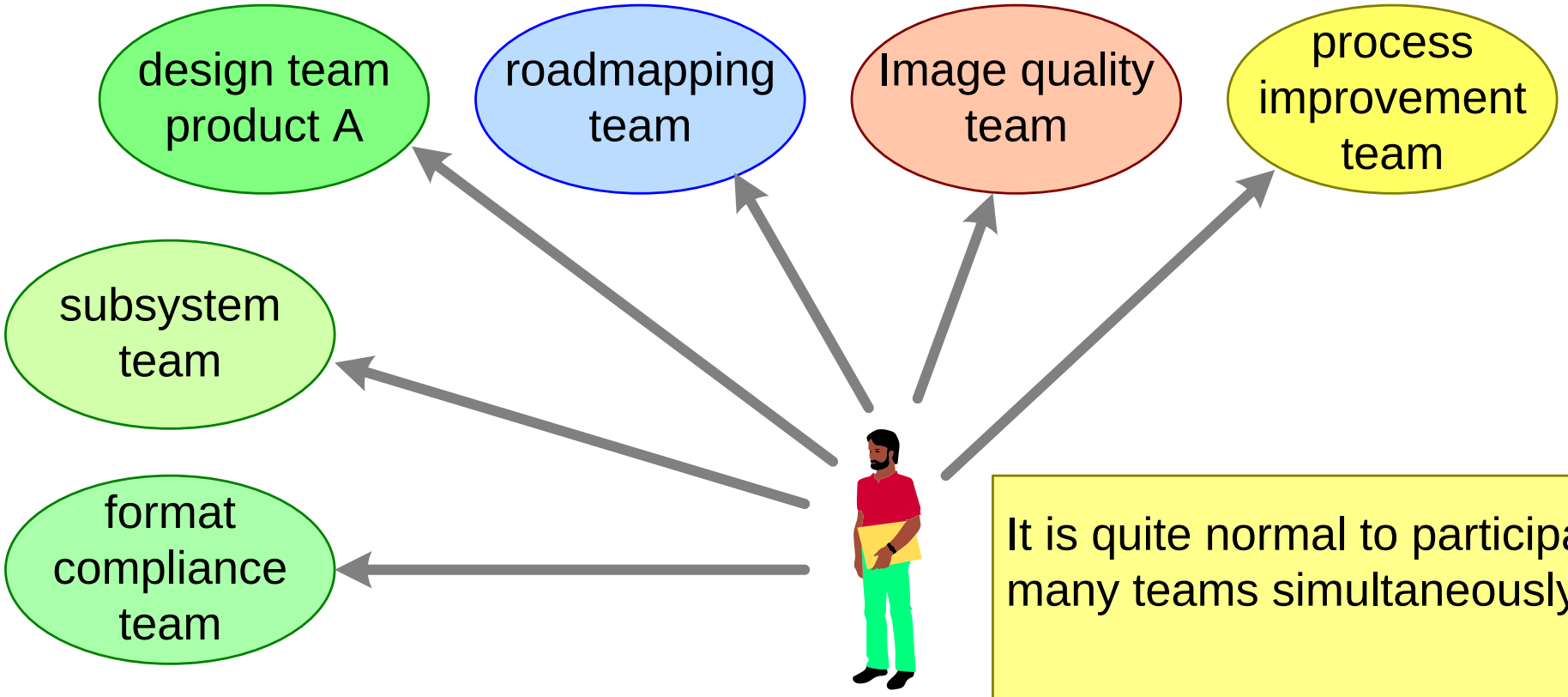


six tasks in parallel:
all results are late



six tasks sequential
first result in 1/6 of time!

One person will be member of multiple teams



It is quite normal to participate in many teams simultaneously.

However, a team can only function if the members are sufficiently available!

Critical Success Factors for teams

well defined charter

clear owner of the result

respect for the output of the team

freedom of way-of-working

housing and location

availability of team members

complementary roles

diversity, pluriformity

Architecting Interaction Styles

by *Gerrit Muller* USN-SE
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www.gaudisite.nl

Abstract

A system architects needs skills to apply different interactions styles, depending on the circumstances. This document discusses the following interaction styles: provocation, facilitation, leading, empathic, interviewing, white board simulation, and judo tactics.

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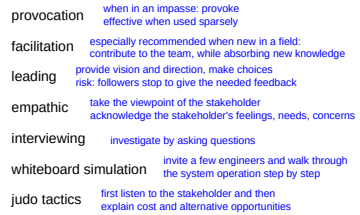

Architecting Styles

provocation	when in an impasse: provoke effective when used sparsely
facilitation	especially recommended when new in a field: contribute to the team, while absorbing new knowledge
leading	provide vision and direction, make choices risk: followers stop to give the needed feedback
empathic	take the viewpoint of the stakeholder acknowledge the stakeholder's feelings, needs, concerns
interviewing	investigate by asking questions
whiteboard simulation	invite a few engineers and walk through the system operation step by step
judo tactics	first listen to the stakeholder and then explain cost and alternative opportunities

Function Profiles; The Sheep with Seven Legs

by *Gerrit Muller* USN-SE
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Abstract

The profile of a system architect is quantified for a large list of system architect related characteristics. For comparison the function profiles of related functions are given as well. This profile is based on personal observations and experience.

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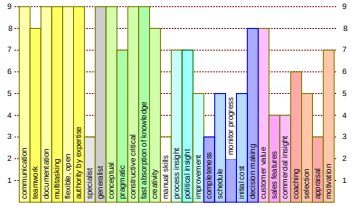
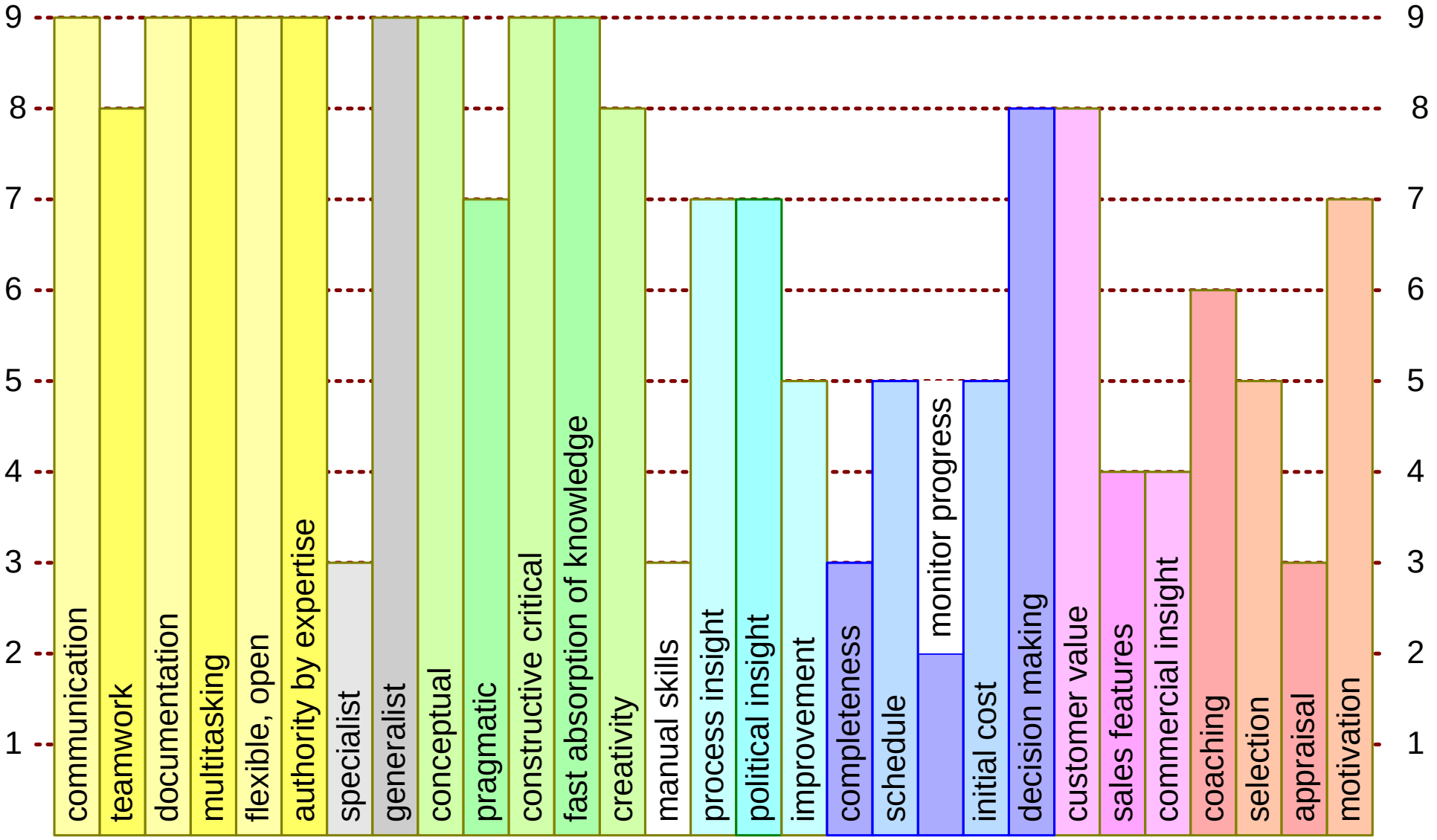
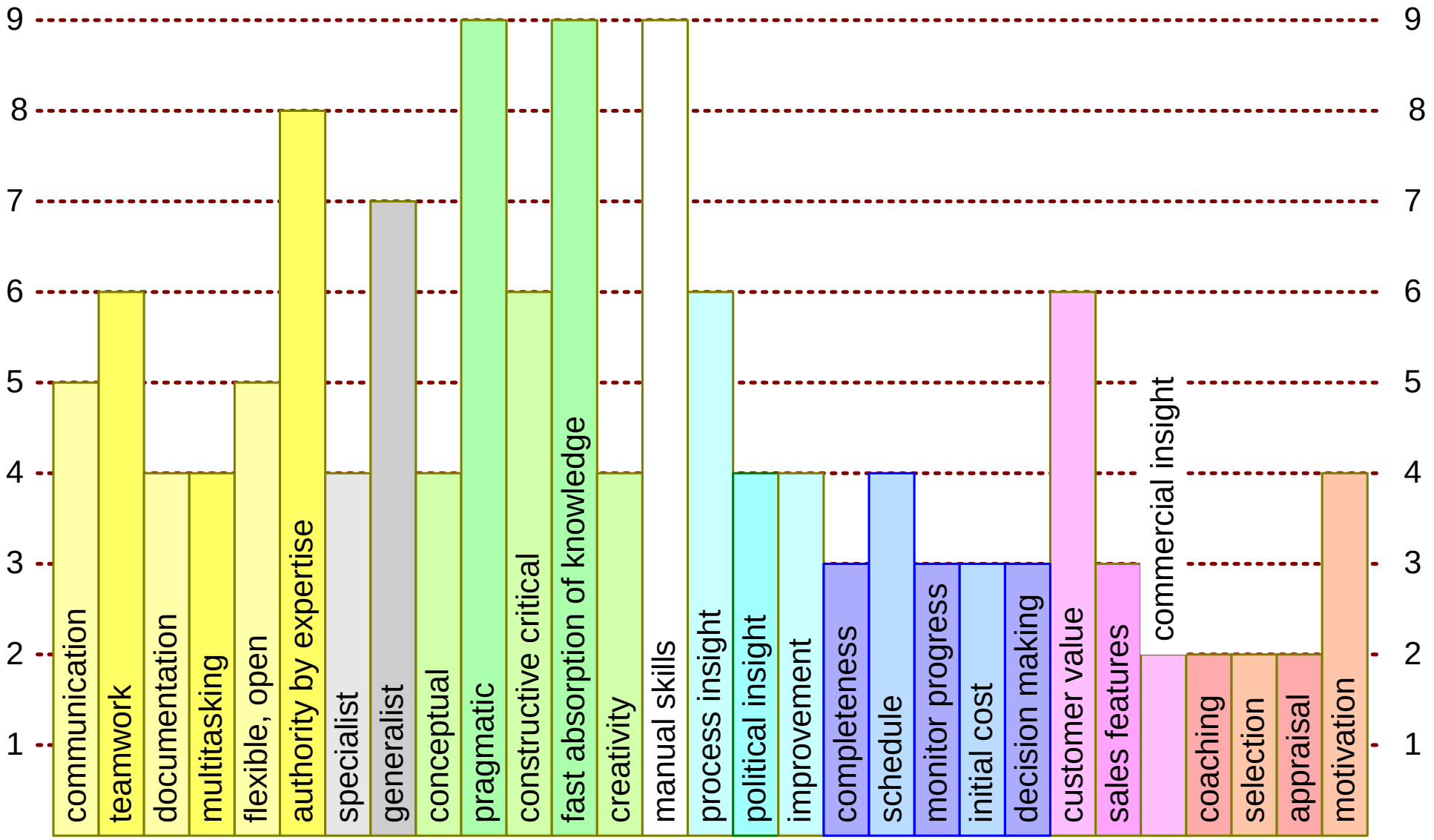
version: 1.0



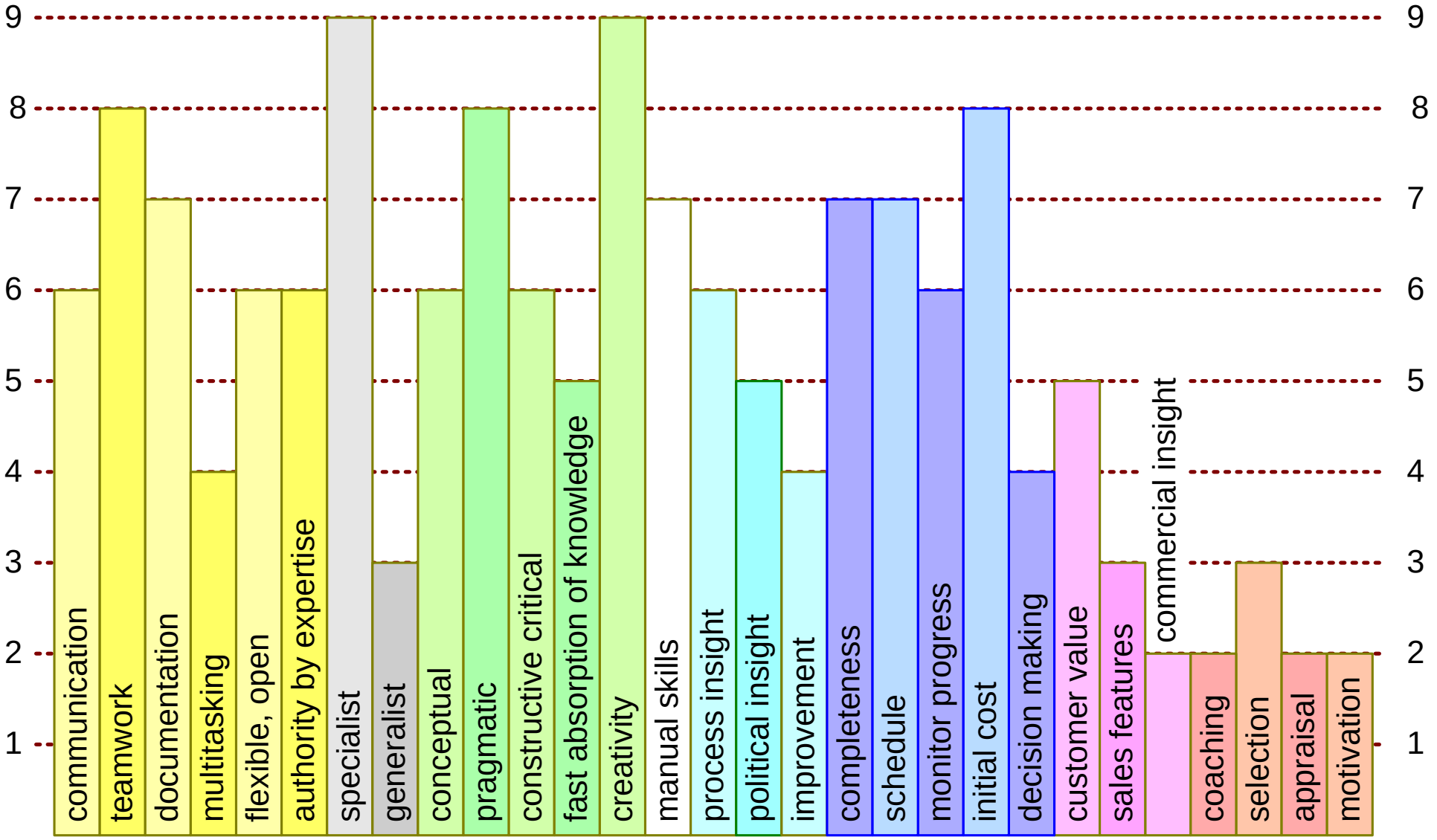
System Architect



Test Engineer



Developer


9
8
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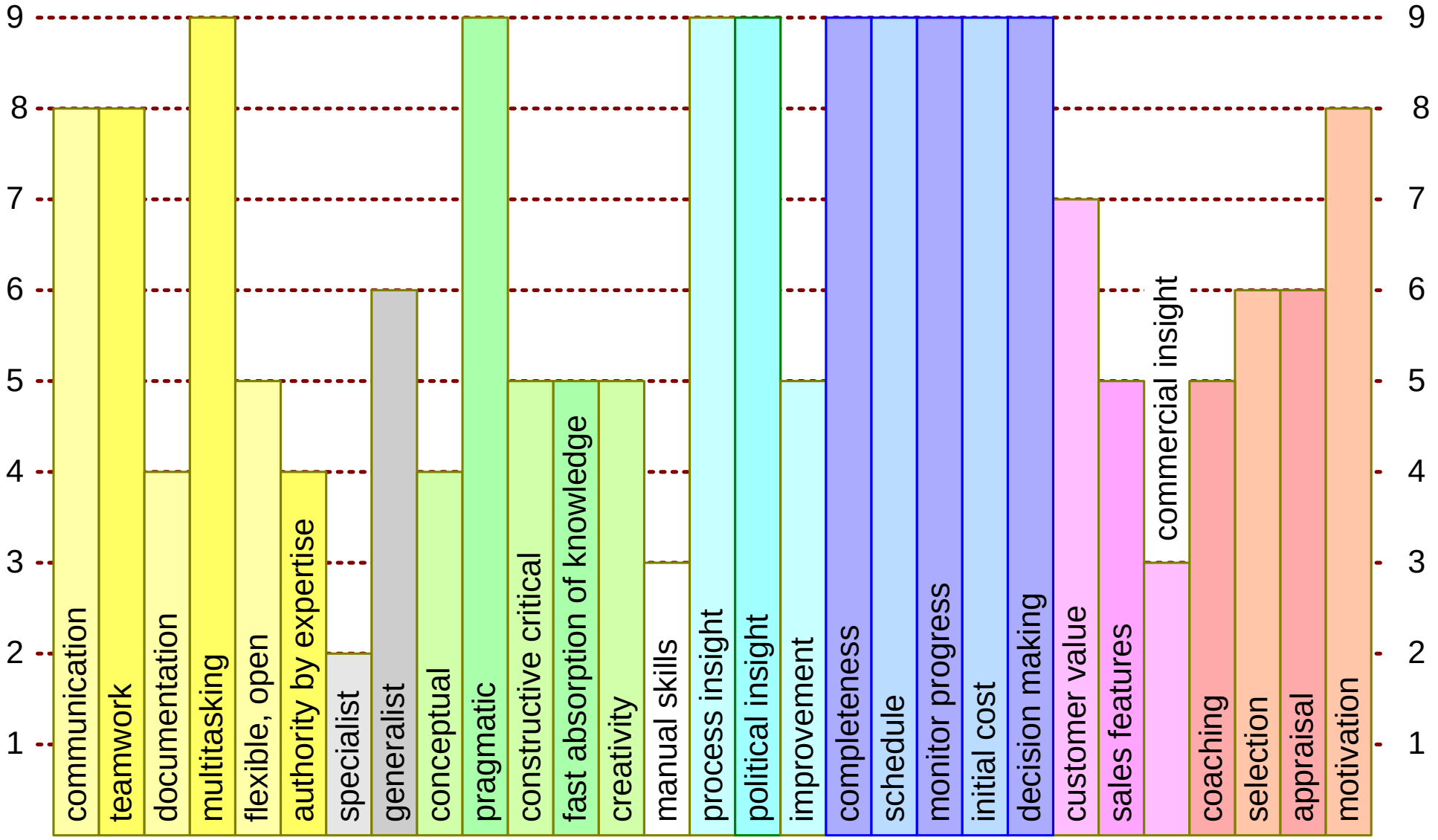
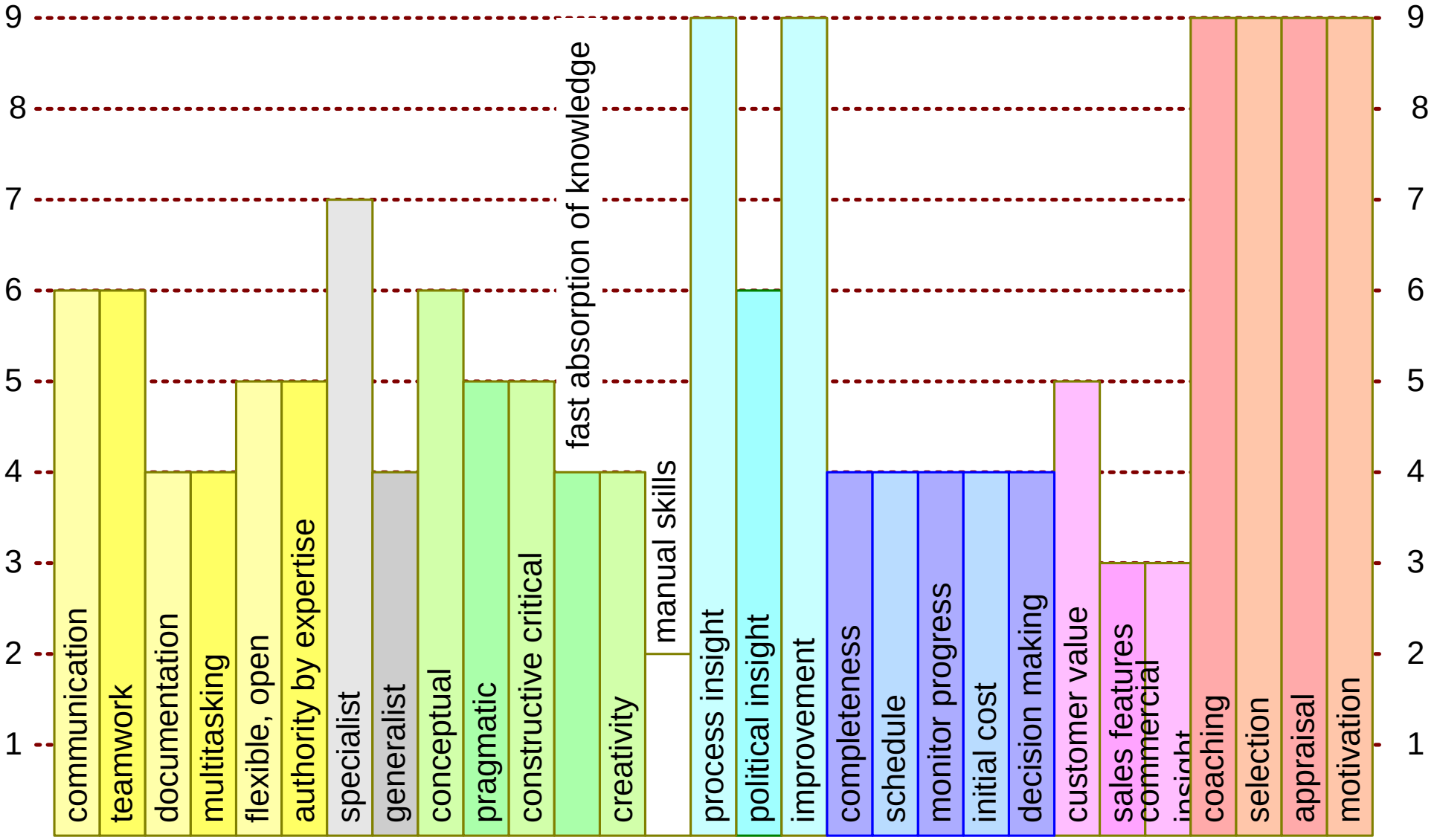
2
1
communication
teamwork
documentation
multitasking
flexible, open
authority by expertise
specialist
generalist
conceptual
pragmatic
constructive critical
fast absorption of knowledge
creativity
manual skills
process insight
political insight
improvement
completeness
schedule
monitor progress
initial cost
decision making
customer value
sales features
commercial insight
coaching
selection
appraisal
motivation

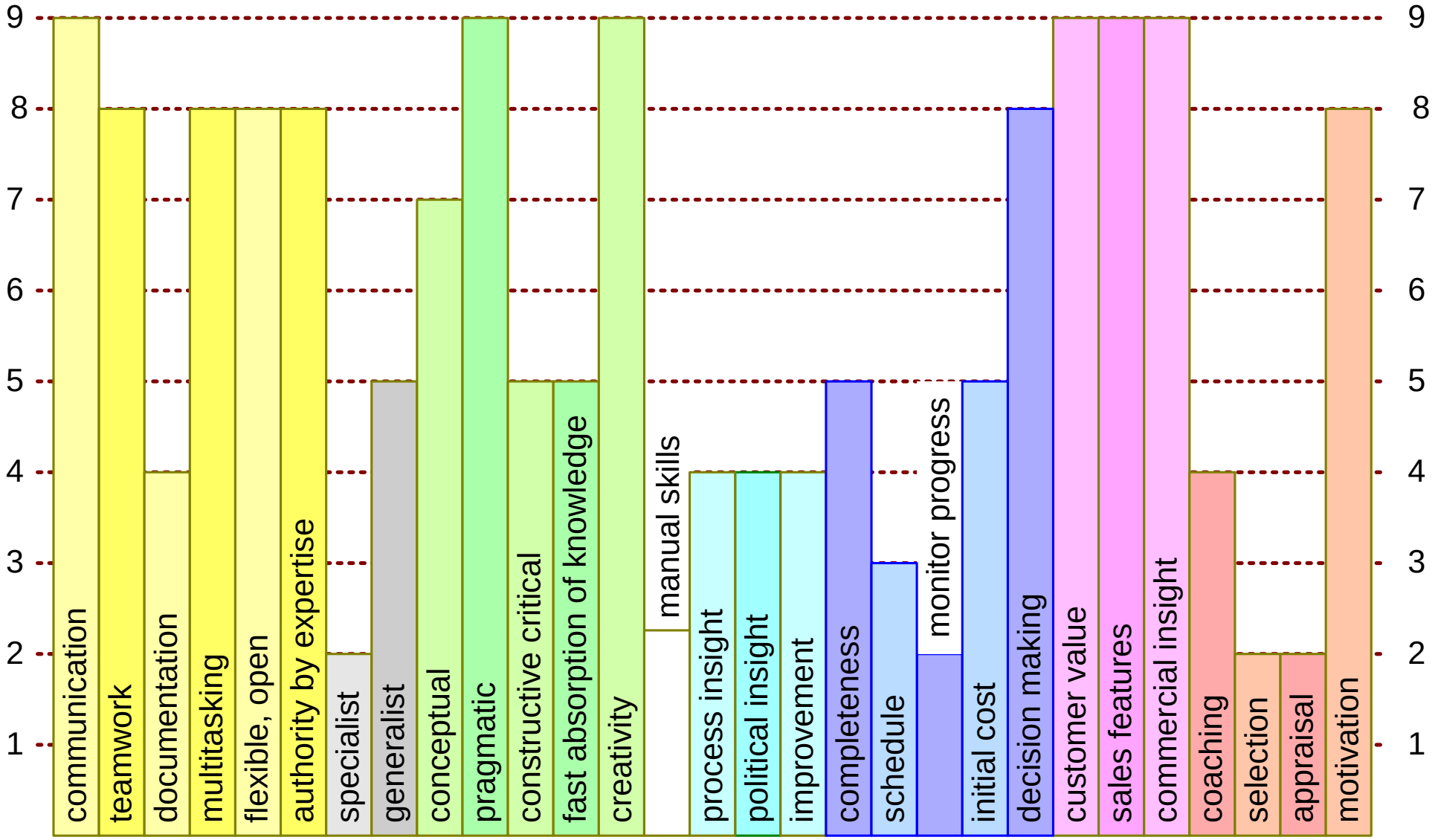
Operational Leader



Line Manager



Commercial Manager



The numbers behind the bars

	communication	teamwork	documentation	multitasking	flexible, open	authority by expertise	specialist	generalist	conceptual	pragmatic	constructive critical	fast absorption of knowledge	creativity	manual skills	process insight	politicsal insight	improvement	completeness	schedule	monitor progress	initial cost	decision making	customer value	sales features	commercial insight	coaching	selection	appraisal	motivation
systems architect	9	8	9	9	9	9	3	9	9	7	9	9	8	3	7	7	5	3	5	2	5	8	8	4	4	6	5	3	7
test engineer	5	6	4	4	5	8	4	7	4	9	6	9	4	9	6	4	4	3	4	3	3	3	6	3	2	2	2	2	4
developer	6	8	7	4	6	6	9	3	6	8	6	5	9	7	6	5	4	7	7	6	8	4	5	3	2	2	3	2	2
operational leader	8	8	4	9	5	4	2	6	4	9	5	5	5	3	9	9	5	9	9	9	9	9	7	5	3	5	6	6	8
line manager	6	6	4	4	5	5	7	4	6	5	5	4	4	2	9	6	9	4	4	4	4	4	5	3	3	9	9	9	9
commercial manager	9	8	4	8	8	8	2	5	7	9	5	5	9	2	4	4	4	5	5	2	5	8	9	9	9	4	2	2	8

Short introduction to basic “CAFCR” model

by *Gerrit Muller* University of South-Eastern Norway-NISE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

The basic “CAFCR” reference model is described, which is used to describe a system in relation to its context. The main stakeholder in the context is the customer. The question “Who is the customer?” is addressed.

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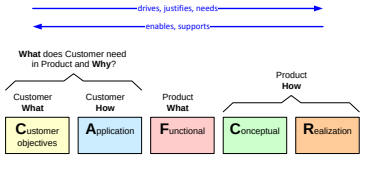
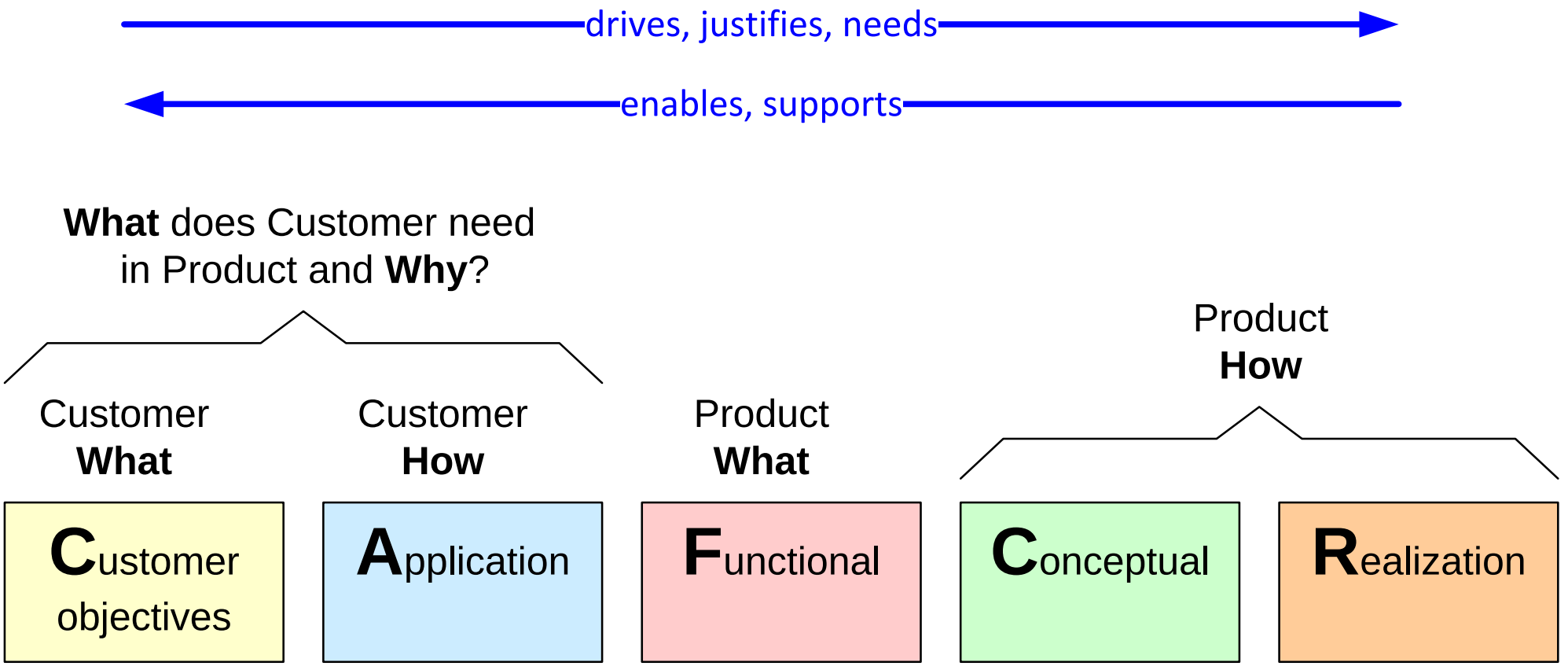
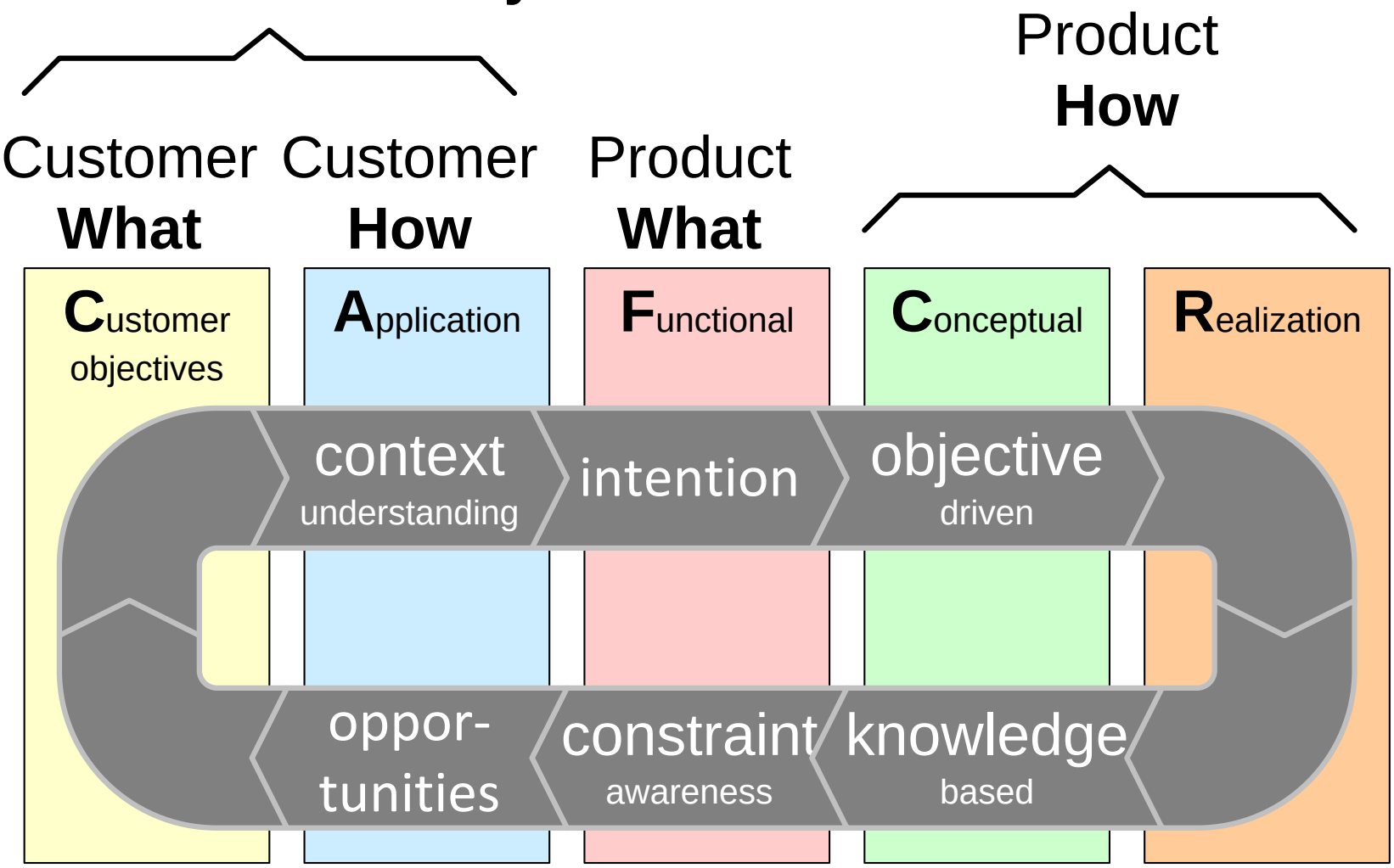


The “CAFCR” model

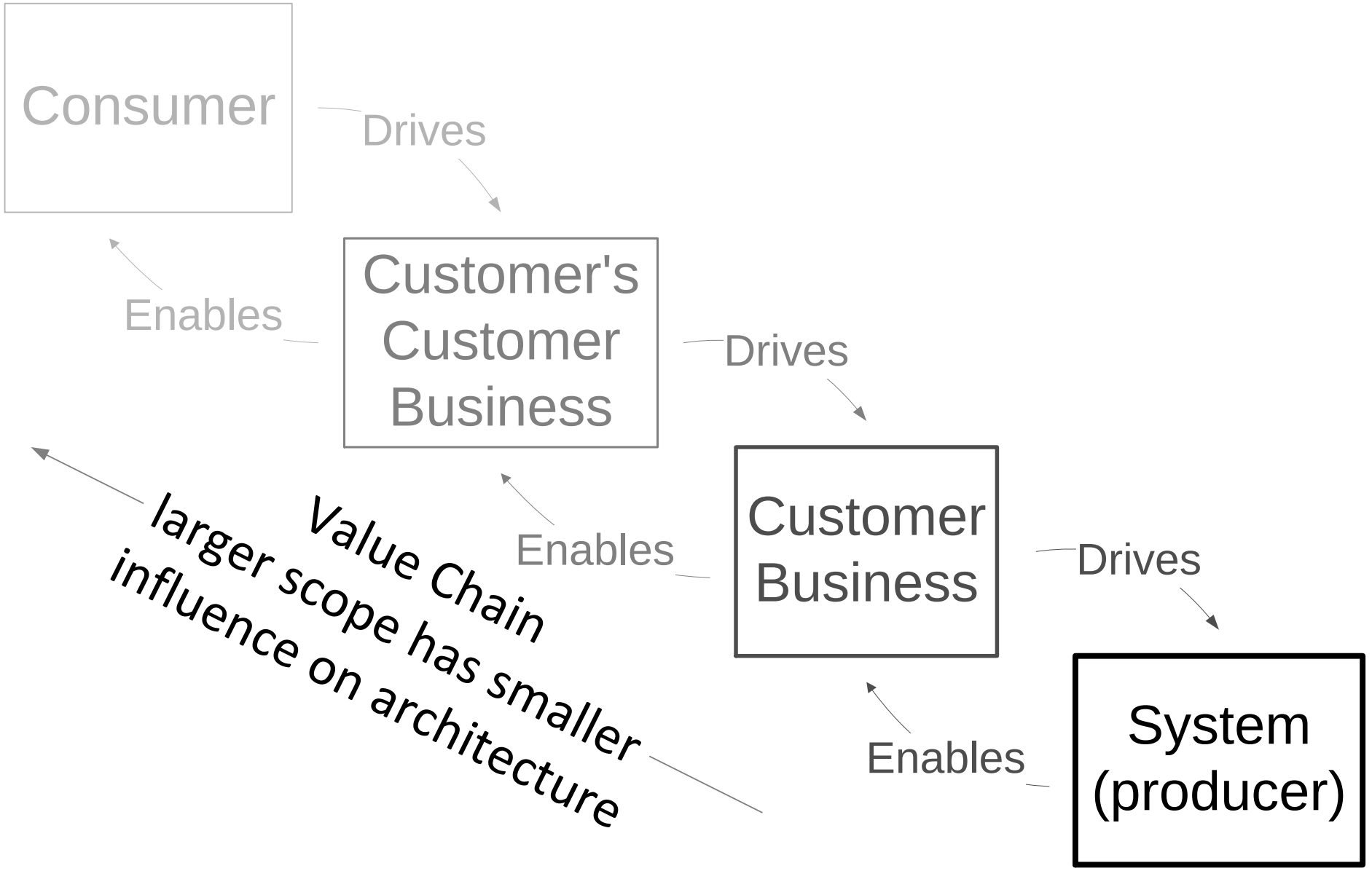


Integrating CAFCR

What does Customer need in Product and **Why**?



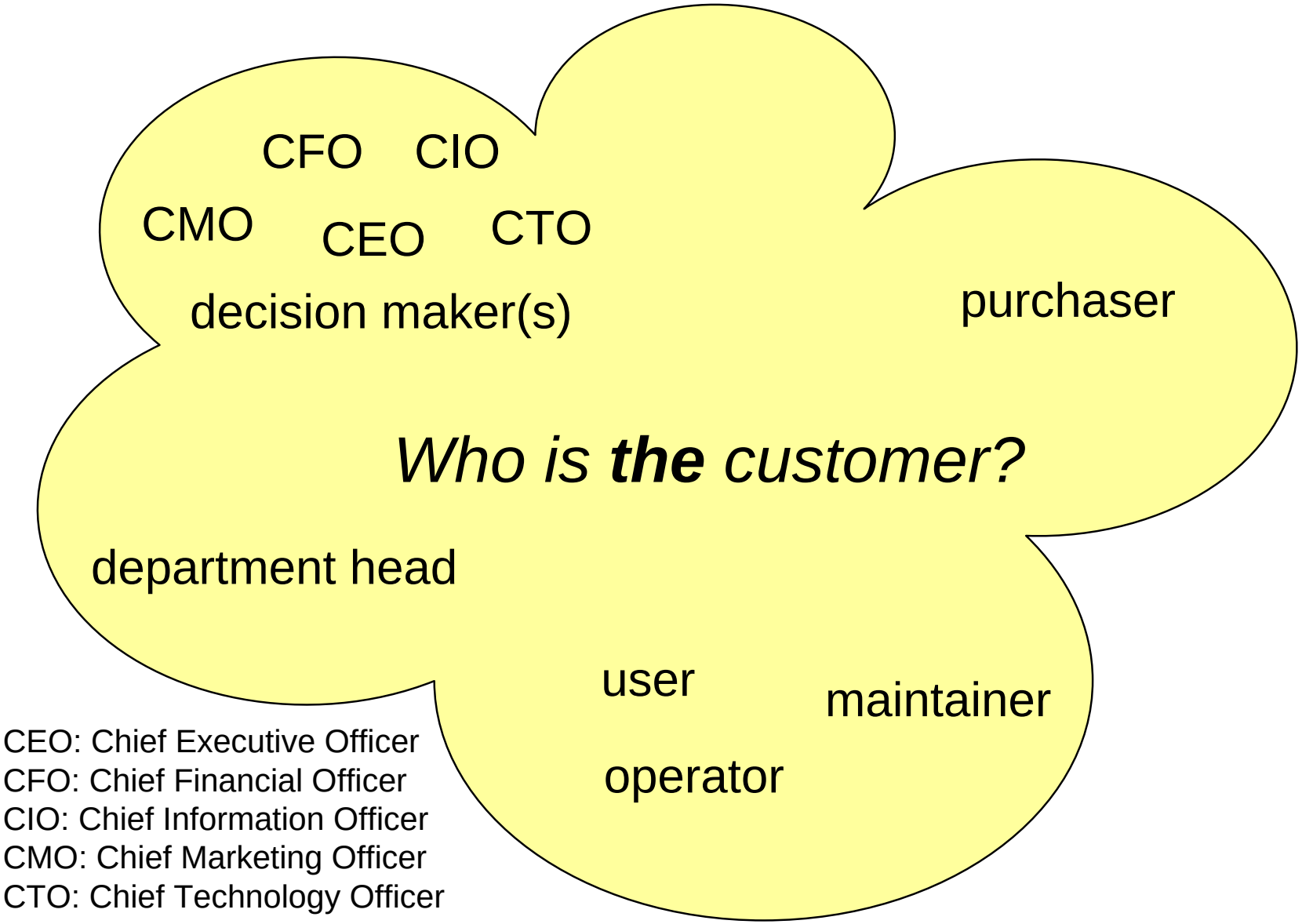
CAFCR can be applied recursively



Market segmentation

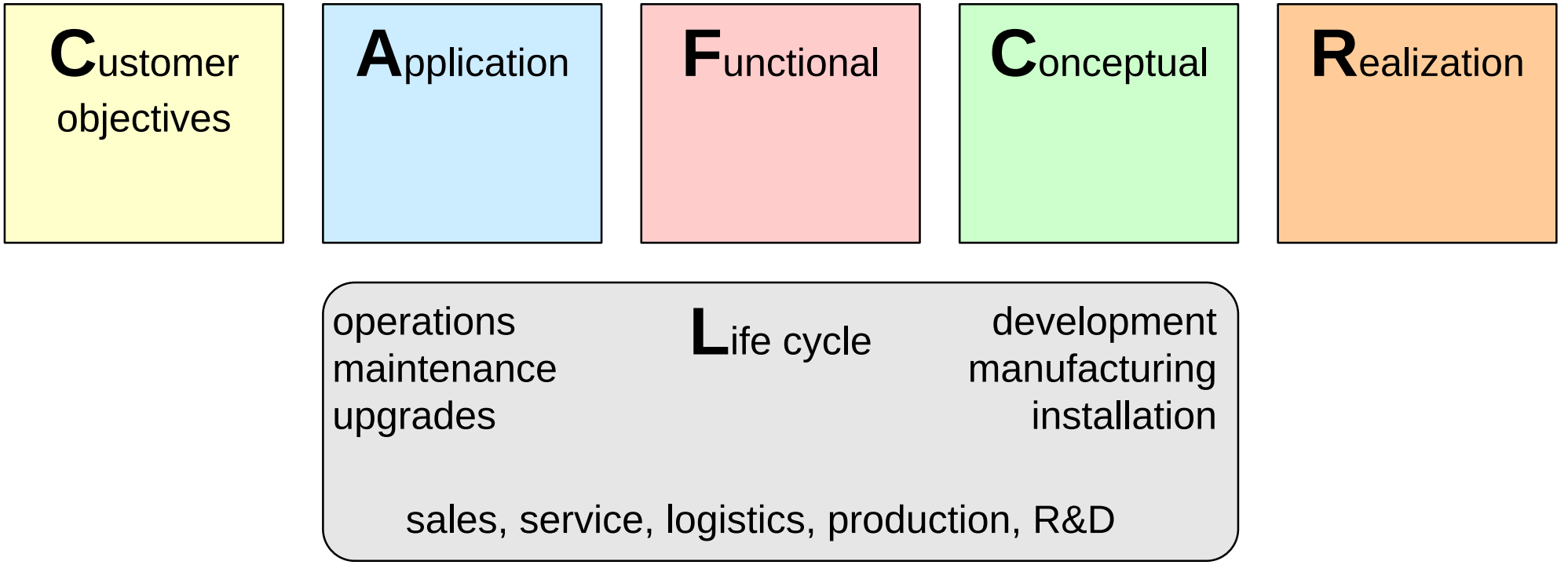
segmentation axis	examples
geographical	USA, UK, Germany, Japan, China
business model	profit, non profit
economics	high end versus cost constrained
consumers	youth, elderly
outlet	retailer, provider, OEM, consumer direct

Example of a small buying organization



CEO: Chief Executive Officer
CFO: Chief Financial Officer
CIO: Chief Information Officer
CMO: Chief Marketing Officer
CTO: Chief Technology Officer

CAFCR+ model; Life Cycle View



Security as example through all views

Customer objectives	**A**pplication	**F**unctional	**C**onceptual	**R**ealization
sensitive information  trusted	selection classification people information authentication badges passwords locks / walls guards administrators	functions for administration authentication intrusion detection logging quantification	cryptography firewall security zones authentication registry logging	*specific* algorithms interfaces libraries servers storage protocols
	desired characteristics, specifications & mechanisms			
 not trusted	social contacts open passwords blackmail burglary fraud unworkable procedures	missing functionality wrong quantification	holes between concepts	bugs buffer overflow non encrypted storage poor exception handling
			threats	

Story How To

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Abstract

A story is an easily accessible story or narrative to make an application live. A good story is highly specific and articulated entirely in the problem domain: the native world of the users. An important function of a story is to enable specific (*quantified, relevant, explicit*) discussions.

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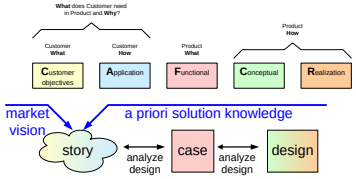
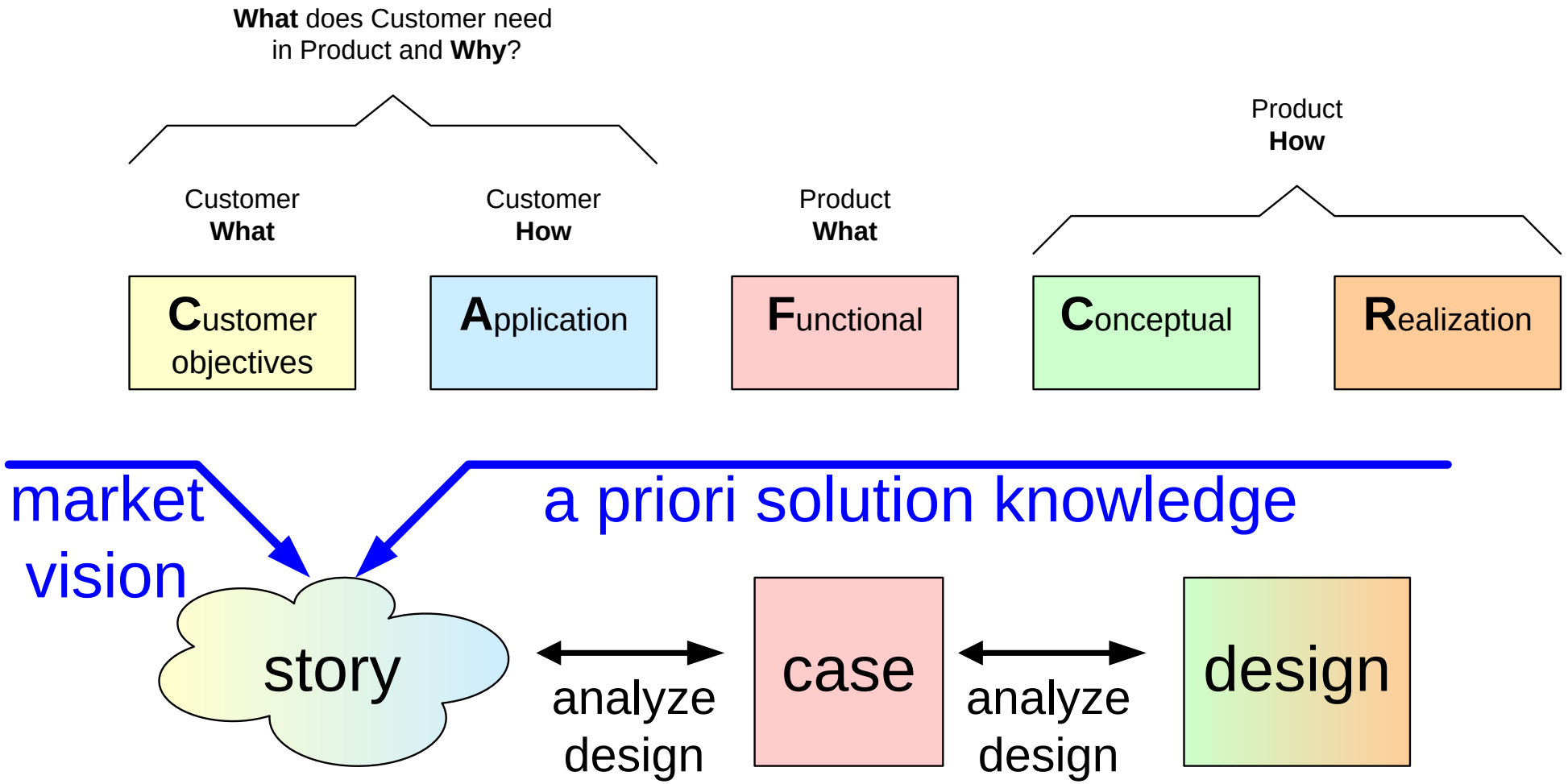
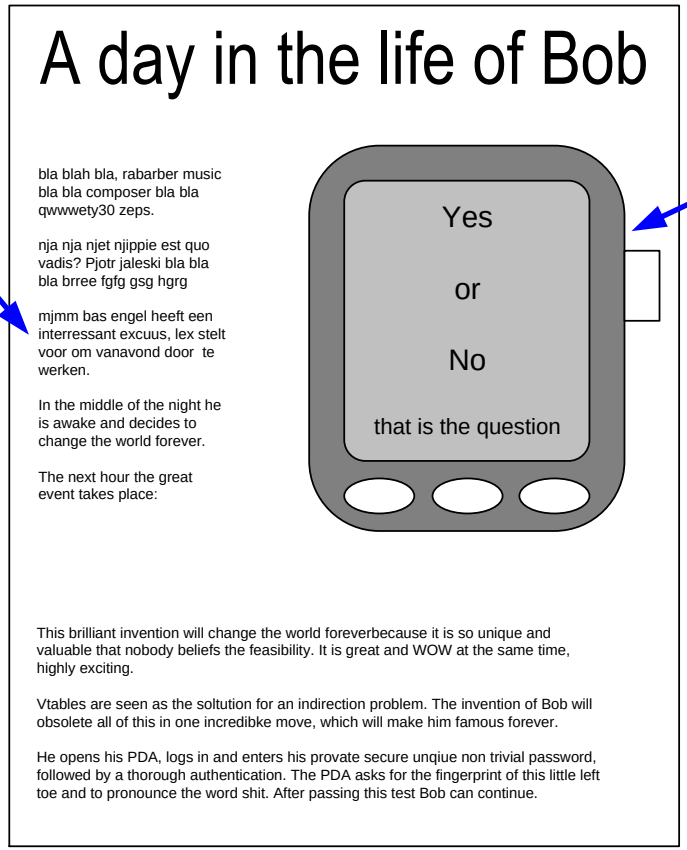


From story to design



Example story layout

ca. half a page of plain English text



draft or sketch of some essential appliance

Points of attention

- purpose — What do you need to know for specification and design?
- scope — “umbrella” or specific event?
- viewpoint, stakeholders — Define your stakeholder and viewpoint f.i. user, maintainer, installer
- visualization — Sketches or cartoon Helps to share and communicate ideas
- size (max 1 A4) — Can be read or told in few minutes
- recursive decomposition, refinement

Criteria for a good story

- Customer objectives / Application
  - accessible, understandable

    "Do you see it in front of you?"
- Customer objectives / Application
  - valuable, appealing

    attractive, important

    "Are customers queuing up for this?"
- Conceptual / Realization
  - critical, challenging

    "What is difficult in the realization?"

    "What do you learn w.r.t. the design?"
- Application
  - frequent, no exceptional niche

    "Does it add significantly to the bottom line?"
- Application / Functional
  - specific

    names, ages, amounts, durations, titles, ...

Example of a story

Betty is a 70-year-old woman who lives in Eindhoven. Three years ago her husband passed away and since then she lives in a home for the elderly. Her 2 children, Angela and Robert, come and visit her every weekend, often with Betty's grandchildren Ashley and Christopher. As so many women of her age, Betty is reluctant to touch anything that has a technical appearance. She knows how to operate her television, but a VCR or even a DVD player is way to complex.

When Betty turned 60, she stopped working in a sewing studio. Her work in this noisy environment made her hard-of-hearing with a hearing-loss of 70dB around 2kHz. The rest of the frequency spectrum shows a loss of about 45dB. This is why she had problems understanding her grandchildren and why her children urged her to apply for hearing aids two years ago. Her technophobia (and her first hints or arthritis) inhibit her to change her hearing aids' batteries. Fortunately her children can do this every weekend.

This Wednesday Betty visits the weekly Bingo afternoon in the meetingplace of the old-folk's home. It's summer now and the tables are outside. With all those people there it's a lot of chatter and babble. Two years ago Betty would never go to the bingo: "I cannot hear a thing when everyone babbles and clatters with the coffee cups. How can I hear the winning numbers?!". Now that she has her new digital hearing instruments, even in the bingo cacophony, she can understand everyone she looks at. Her social life has improved a lot and she even won the bingo a few times.

That same night, together with her friend Janet, she attends Mozart's opera The Magic Flute. Two years earlier this would have been one big low rumbly mess, but now she even hears the sparkling high piccolos. Her other friend Carol never joins their visits to the theaters. Carol also has hearing aids, however hers only "work well" in normal conversations. "When I hear music it's as if a butcher's knife cuts through my head. It's way too sharp!". So Carol prefers to take her hearing aids out, missing most of the fun. Betty is so happy that her hearing instruments simply know where they are and adapt to their environment.

source: Roland Mathijssen
Embedded Systems Institute
Eindhoven

Value and Challenges in this story

Customer objectives

Application

Value proposition in this story:

quality of life:

active participation in different social settings

usability for nontechnical elderly people:

"intelligent" system is simple to use

loading of batteries

Conceptual

Realization

Challenges in this story:

Intelligent hearing instrument

Battery life — at least 1 week

No buttons or other fancy user interface on the hearing instrument, other than a robust On/Off method

The user does not want a technical device but a solution for a problem

Instrument can be adapted to the hearing loss of the user

Directional sensitivity (to prevent the so-called cocktail party effect)

Recognition of sound environments and automatic adaptation (adaptive filtering)

source: Roland Mathijssen, Embedded Systems Institute, Eindhoven