Understanding the Variety of Domain Models:
Views, programs, animations, and other models

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Background – About me

Background – Research interests

My general interest:

- Foundations and applications of domain modeling (FADO)
- *Model-driven systems*

Key application fields:

- Modeling in an enterprise context (EM, IM)
- *Enterprise design management* (EA, ISE, EE, BPM, OD, …)

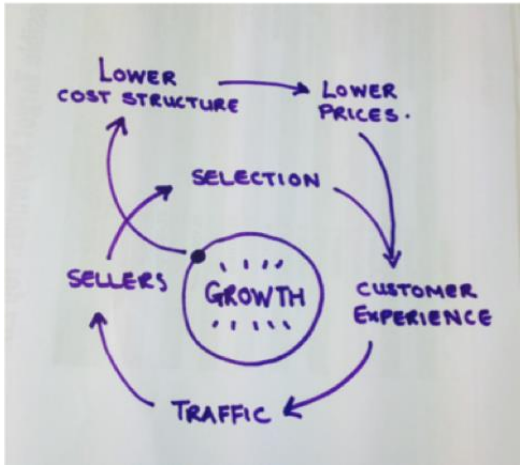
Background – Relevant papers

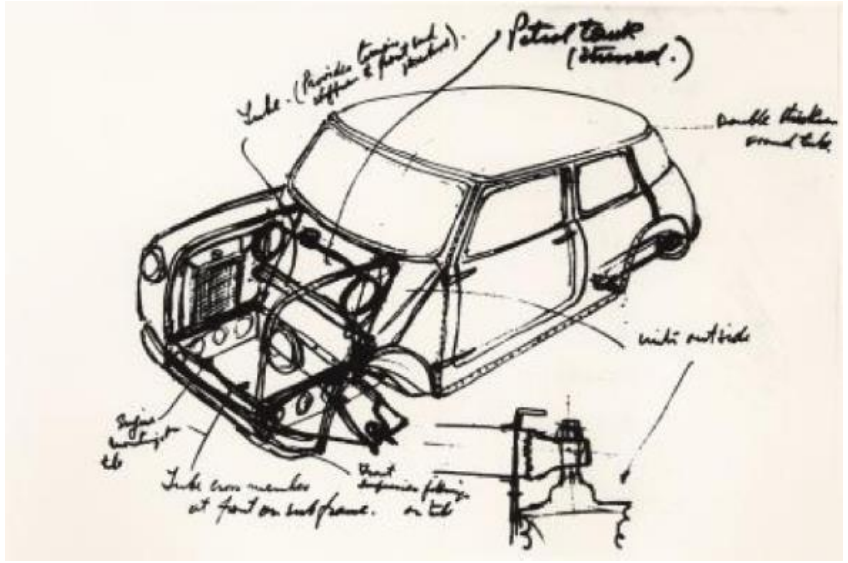
- H. A. Proper and G. Guizzardi. On Domain Conceptualization. In D. Aveiro, G. Guizzardi, R. Pergl, and H. A. Proper, editors, Advances in Enterprise Engineering XIV - 10th Enterprise Engineering Working Conference, EEWC 2020, Bozen-Bolzano, Italy, September 28, October 19, and November 9-10, 2020, Revised Selected Papers, volume 411 of Lecture Notes in Business Information Processing, pages 49-69. Springer, Heidelberg, Germany, 2021. ISBN: 978-3-030-74195-2
- G. Guizzardi and H. A. Proper. On Understanding the Value of Domain Modeling. In G. Guizzardi, T. P. Sales, C. Griffo, and M. Furnagalli, editors, Proceedings of 15th International Workshop on Value modeling and Business Ontologies (VMBO 2021), Bolzano, Italy, 2021, volume 2835 of CEUR Workshop Proceedings. CEUR-WS.org, 2021.
- H. A. Proper and G. Guizzardi. Modeling for Enterprises; Let's go to RoME ViA RiME. In *PoEM 2022 Forum Proceedings*. CEUR-WS.org, 2022
- H. A. Proper and G. Guizzardi. On views, diagrams, programs, animations, and other models. In S. Strecker and J. Jung, editors, Informing Possible Future Worlds - Essays in Honour of Ulrich Frank, chapter 5, pages 123-138. Logos Verlag, Berlin, Germany, 2024. ISBN: 978-3-8325-5768-3 https://doi.org/10.30819/5768

Modeling practices

Modeling is natural

Modeling practices emerge naturally





Modeling practices

Modeling is natural

Modeling practices emerge naturally

When modeling becomes critical, we should start talking about modeling capabilities …

Including modeling related concepts and tooling …

Model-driven systems engineering

How do these relate?

views

diagrams

spreadsheets

domain models

conceptual models

programs

animations

modeling language

specifications

Framework

Domain modeling

Return on Modeling Effort

Conceptual fidelity of models

Managing complexity

Agenda

Domain modeling

Return on Modeling Effort

Conceptual fidelity of models

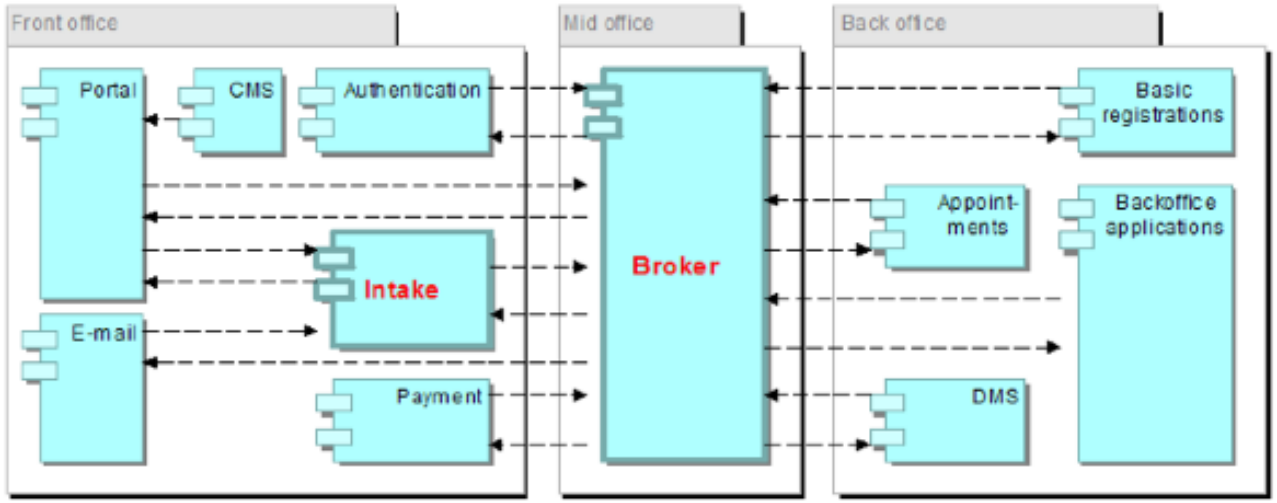
Managing complexity; Views

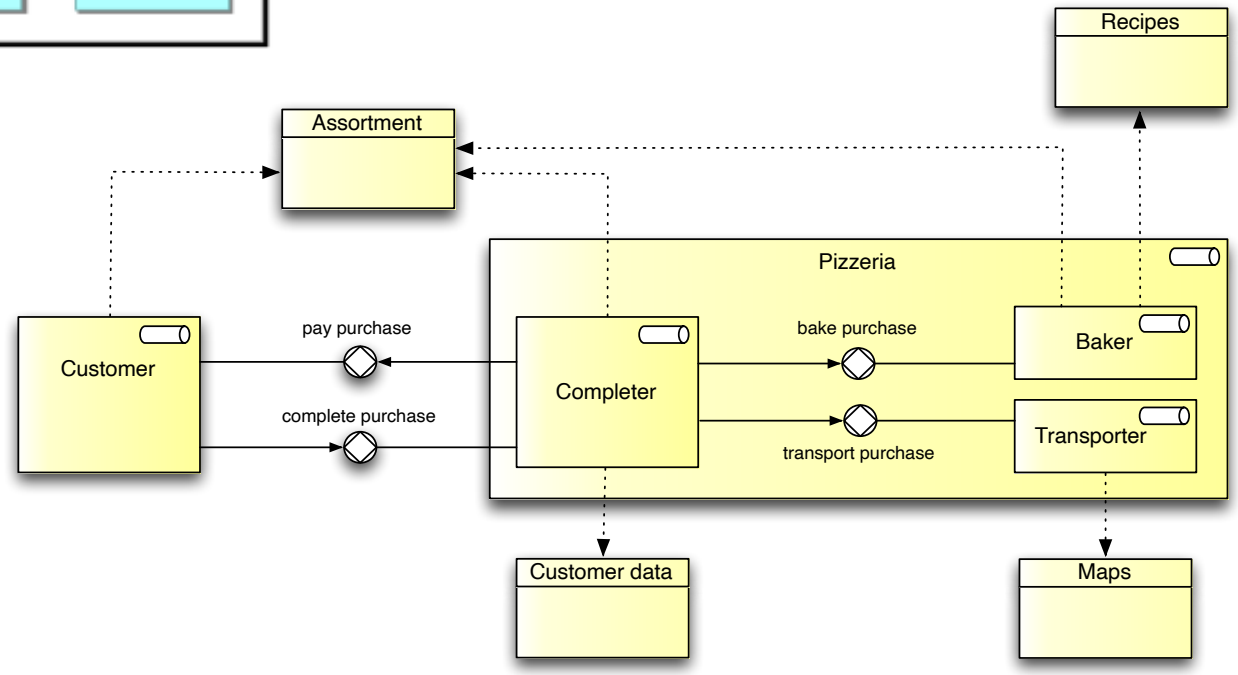
Programs, animations, and other models

Agenda

- Domain modeling
- Return on Modeling Effort
- Conceptual fidelity of models
- Managing complexity; Views
- Programs, animations, and other models

What is a domain model?





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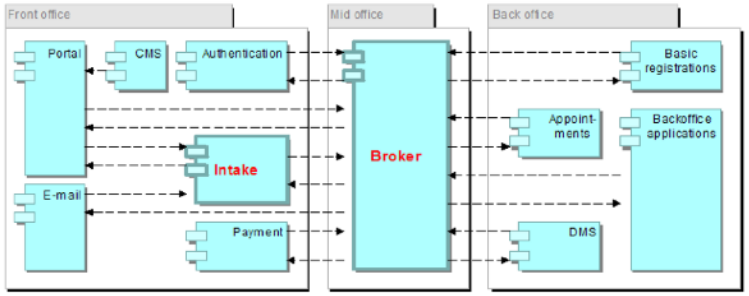

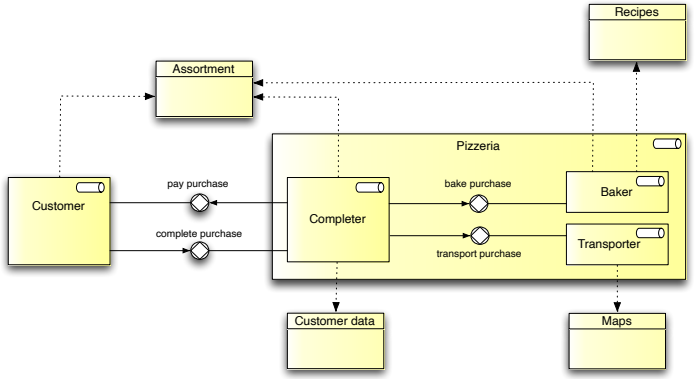

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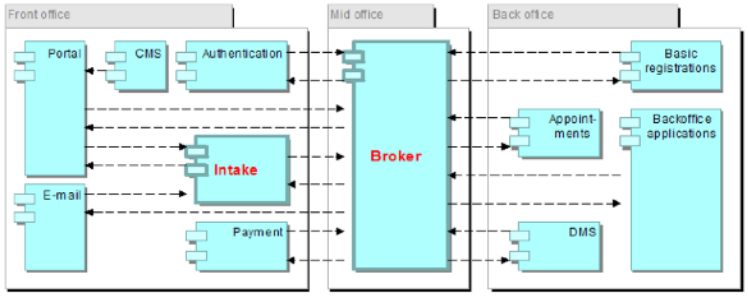

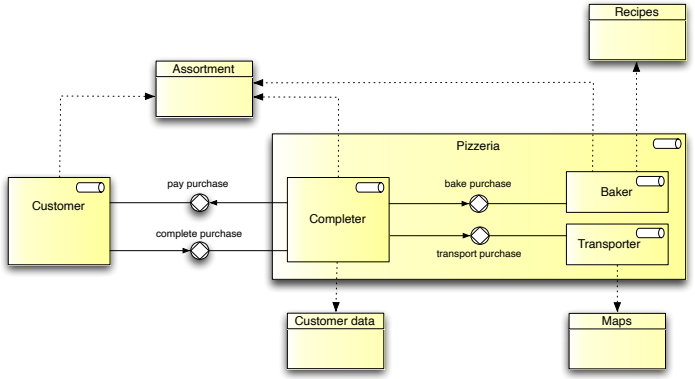

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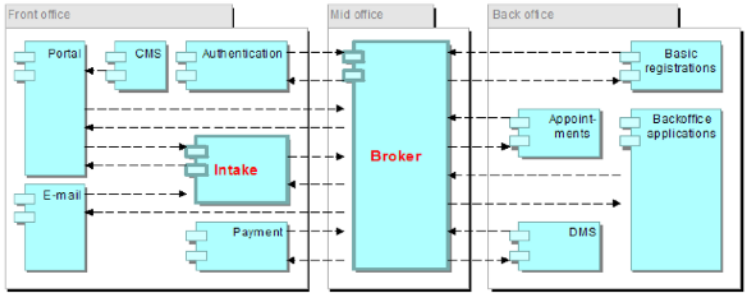

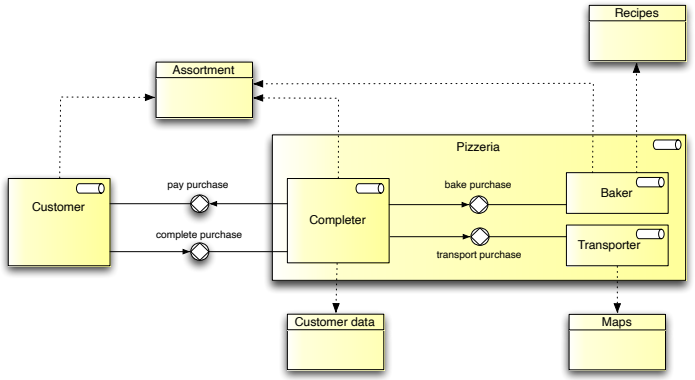

8. Develop Product Concept

Based on the product requirements and specifications, multiple product concepts are developed that can potentially satisfy those requirements. Brainstorming and other creativity techniques are used to generate a range of concept alternatives. These concepts are analyzed with respect to the product requirements as well as the existing technology portfolio, company capabilities, and business strategy in order to select the most promising architecture. The architecture is refined and the best aspects of other concepts are synthesized into the concept.

Tasks

1. Brainstorm and develop top-level product or system concepts to satisfy product requirements.
2. Analyze, evaluate and select a preferred product concept considering product requirements, company technology and capabilities, development risks, and business strategy.
3. Partition the system into subsystems or modules (and derive subsystem requirements
4. Brainstorm and develop subsystem concepts to satisfy lower-level requirements.
5. Analyze, evaluate and select subsystem concepts considering requirements, company technology and capabilities, development risks, and business strategy.
6. Identify need for risk-reduction development or investigation and launch effort.
7. Document the concept.

Inputs

1. Product requirements document

Outputs/Deliverables

1. Product concept block diagram
2. Layout drawing
3. Concept selection matrix

Personnel Involved

Marketing
Project Manager
Design Engineers
Manufacturing Engineer
Test Engineer
Supply Management

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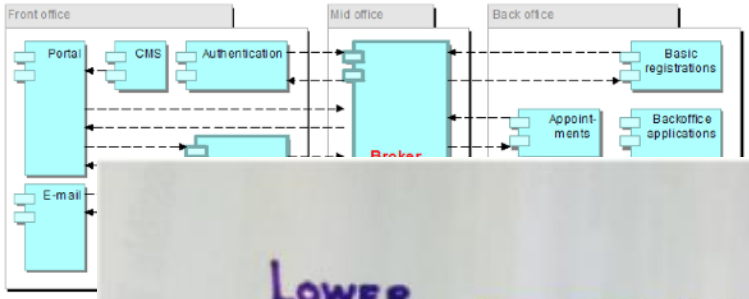

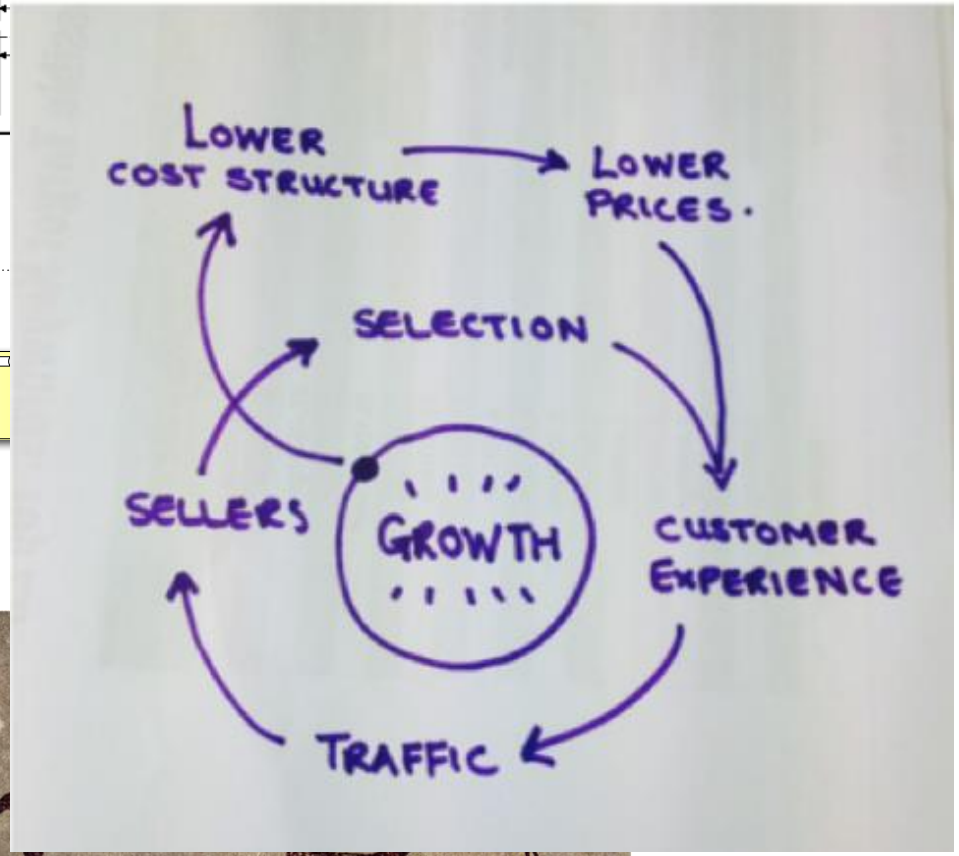

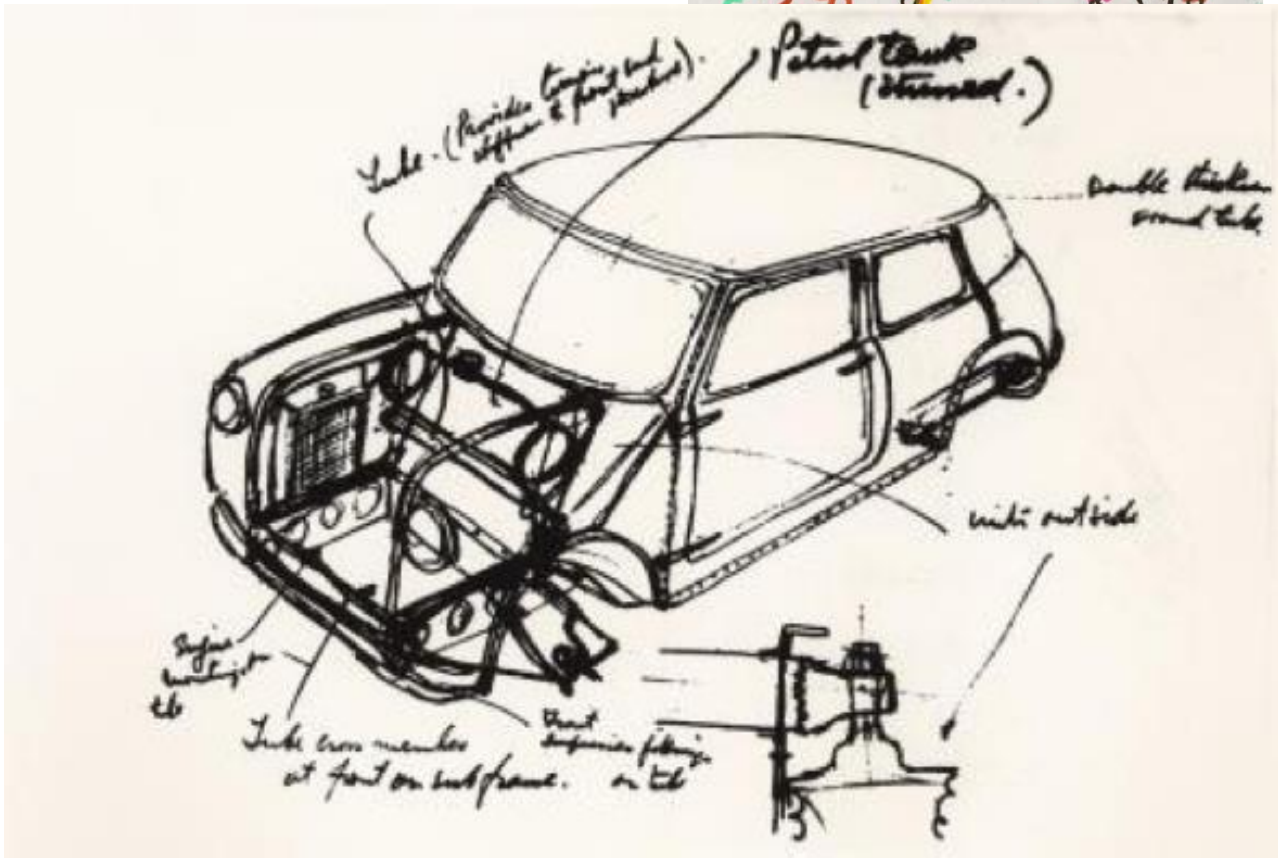

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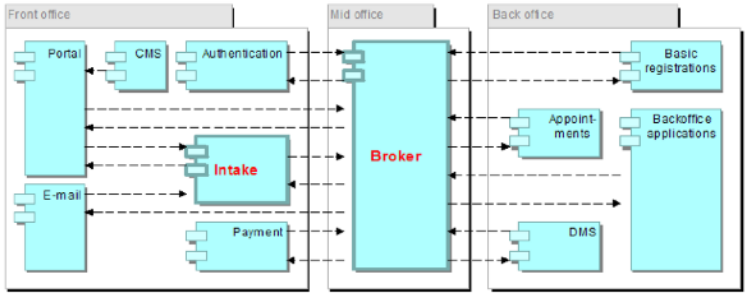

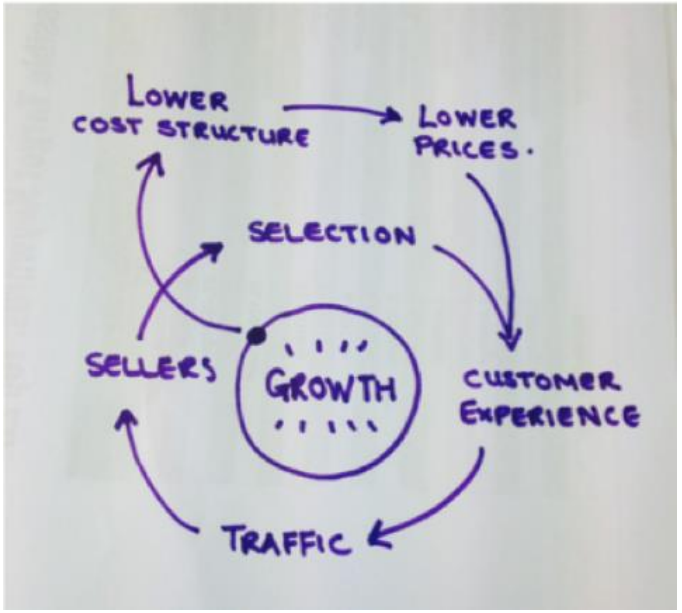

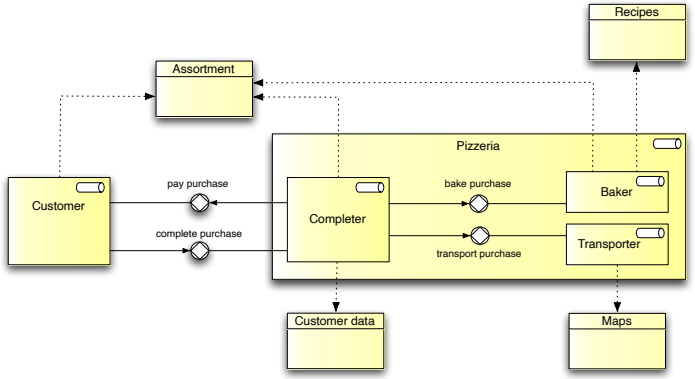

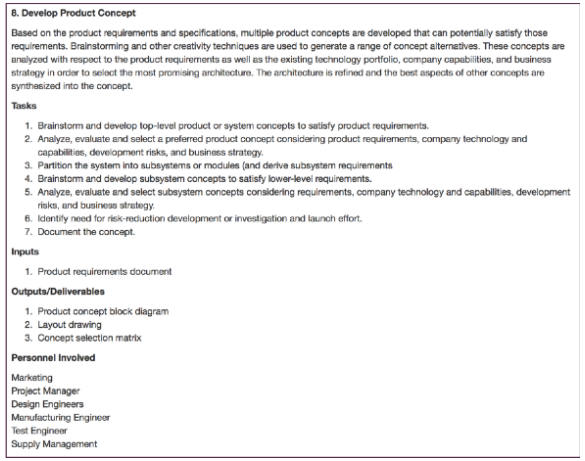

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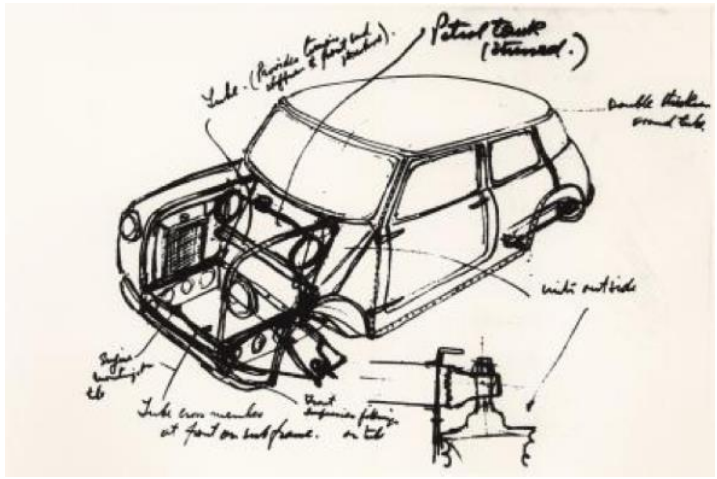

Domain model

A social artefact that is

understood, and acknowledged,

by a (collective) human agent

to represent

an abstraction

of some domain

for a particular cognitive purpose

H. A. Proper and G. Guizzardi. On Domain Conceptualization. In D. Aveiro, G. Guizzardi, R. Pergl, and H. A. Proper, editors, Advances in Enterprise Engineering XIV - 10th Enterprise Engineering Working Conference, EEWC 2020, Bozen-Bolzano, Italy, September 28, October 19, and November 9-10, 2020, Revised Selected Papers, volume 411 of Lecture Notes in Business Information Processing, pages 49-69. Springer, Heidelberg, Germany, 2021.

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Based on Peirce, Ogden & Richards, Apostel, Stachowiak, FRISCO, …

And our own work 😇

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Domain model

A social artefact that is understood, and acknowledged, by a (collective) human agent to represent an abstraction of some domain for a particular cognitive purpose

Examples:

enterprise models, business process models,
ontology models, software models, information models,
value models, … .. .

Domain model

A social artefact that is understood, and acknowledged, by a (collective) human agent to represent an abstraction of some domain for a particular cognitive purpose

Models are represented on some kind of medium

This could be an interactive, or a non-interactive medium

It could also be an “experiential” medium

Domain model

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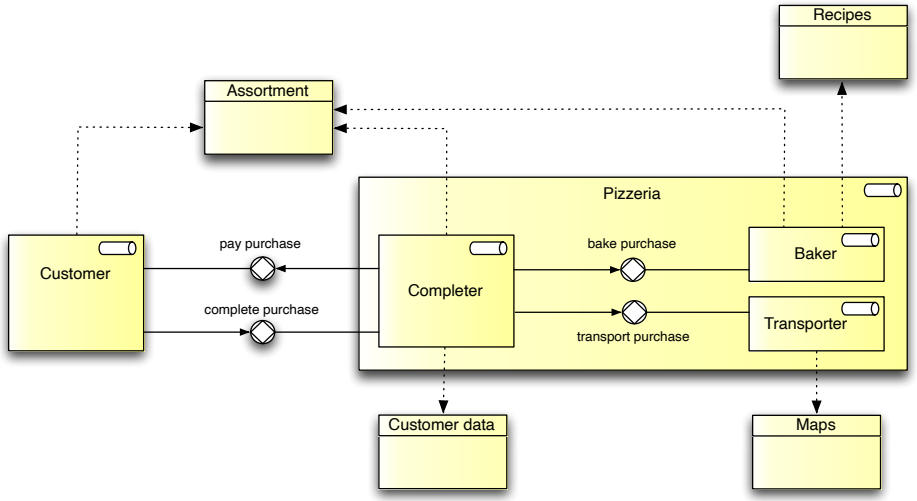


{ **dynamic, static** } x { **models, domains** }

The modeled domain may be static or dynamic

The model (qua artifact) may be static or dynamic

Examples (domain : model)

- Dynamic : dynamic — *An animation of a business process*
- Dynamic : static — *A business process in BPMN*
- Static : dynamic — *A navigable application architecture*
- Static : static — *A diagram with an application architecture*

{ **dynamic, static** } x { **models, domains** }

The modeled domain may be static or dynamic

The model (qua artifact) may be static or dynamic

Dynamic models can be interactive or non-interactive

For instance: a “My Pizzeria” game of a planned pizzeria

Agenda

Domain modeling

Return on Modeling Effort

Conceptual fidelity of models

Managing complexity; Views

Programs, animations, and other models

Return on Modeling Effort (RoME)

Effort in creating, administering, and using, models

- *How to measure?*
- *How to reduce?*

Benefits of creating and using models

- *How to measure?*
- *How to increase?*

How to make trade-offs?

Value bearers for modeling

Value in creation

The process of (co)creating a (conceptual) domain model

Value in use

The operational usage of the model (in line with its purpose)

Value in transaction

The (ownership of the) model itself

ViA: Value in Action

Value in creation

The process of (co)creating a (conceptual) domain model

Value in use

The operational usage of the model (in line with its purpose)

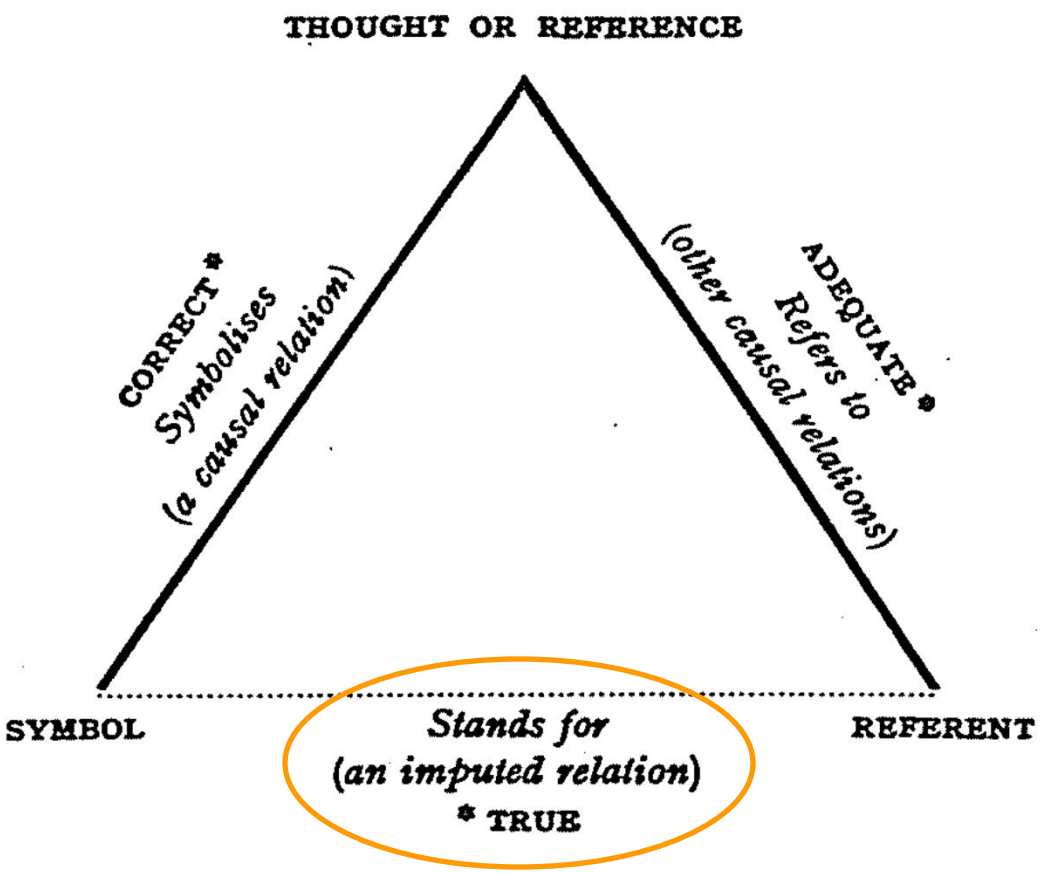
Domain model

A social artefact that is understood, and acknowledged, by a (collective) human agent to represent an abstraction of some domain for a particular cognitive purpose

For what purpose do we create models?

Domain models as complex speech acts

Semiotic triangle



C. K. Ogden and I. A. Richards. The Meaning of Meaning - A Study of the Influence of Language upon Thought and of the Science of Symbolism. Magdalene College, University of Cambridge, Oxford, United Kingdom, 1923.

Foundations: Taxonomy of modeling goals

Philosophy of mind and philosophy of language:

Direction of fit

John R. Searle, S. Willis, et al. Intentionality: An essay in the philosophy of mind, Cambridge university press, 1983.

Direction of fit

X-to-*Y* = Make/does *X* fit to *Y* ?

World-to-Mind (or World-to-Word) "*Make it so!*"

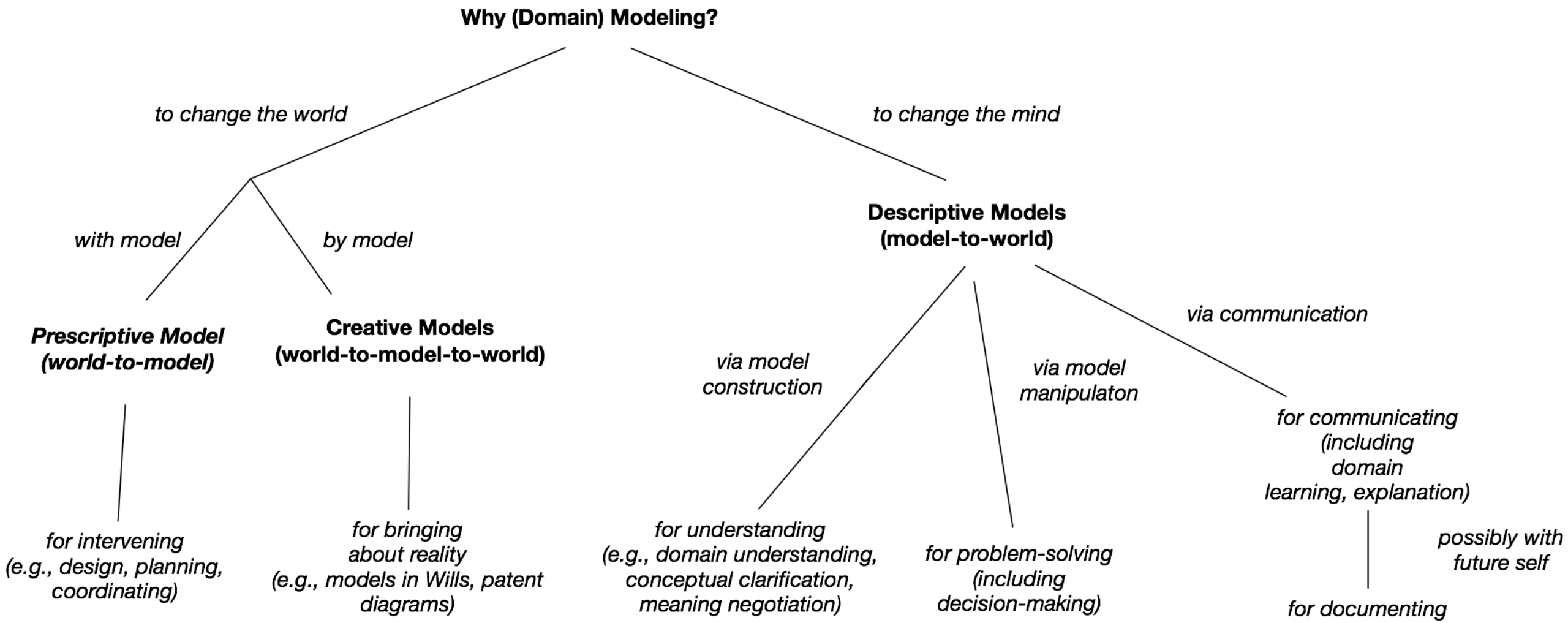
Mind-to-World (or Word-to-World) "*Is it so?*"

World-to-Word-to-World "*By the powers vested in me!*"

Direction of fit

X-to-*Y* = Make/does *X* fit to *Y* ?

World-to-Model	"*Make it so!*"
Model-to-World	"*Is it so?*"
World-to-Model-to-World	"*By the powers vested in me!*"


Why (Domain) Modeling?
to change the world
to change the mind
with model
by model
Prescriptive Model
(world-to-model)
Creative Models
(world-to-model-to-world)
Descriptive Models
(model-to-world)
via model
construction
via model
manipulaton
via communication
for intervening
(e.g., design, planning,
coordinating)
for bringing
about reality
(e.g., models in Wills, patent
diagrams)
for understanding
(e.g., domain understanding,
conceptual clarification,
meaning negotiation)
for problem-solving
(including
decision-making)
for communicating
(including
domain
learning, explanation)
possibly with
future self
for documenting

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Conceptual (domain) model

Traditional view from information systems engineering:

- conceptual models express the concepts, and their (allowed) relations, of the universe of discourse, while avoiding the inclusion of implementation/storage details

> *ISO/IEC JTC 1/SC 32 Technical Committee on Data management and interchange. Information processing systems - Concepts and Terminology for the Conceptual Schema and the Information Base. Technical Report ISO/TR 9007:1987, ISO, 1987.*

The conceptual model of the universe of discourse

Conceptual (domain) model

Older roots:

M. R. Quillian. Semantic memory, Semantic Information Processing. PhD thesis, MIT, Massachusetts, 1968.

as discussed in:

N. Guarino, G. Guizzardi, and J. Mylopoulos.
On the philosophical foundations of conceptual models.
Information Modelling and Knowledge Bases XXXI, 321:1, 2020.

Conceptual (domain) model

A domain model, where

- the purpose of the model is dominated by the ambition for the model to remain as-true-as-possible to the *conceptualization* of the domain by the collective agent, while
- there is an explicit mapping from the elements in the model to the latter *conceptualization*

Conceptual models have a much broader role to play in society than conceptual database design … they allow us to understand the concepts, and their relations, in any domain

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A domain model, where

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Conceptual fidelity

Non/not-so conceptual (domain) models?

Utilization-design (domain) model

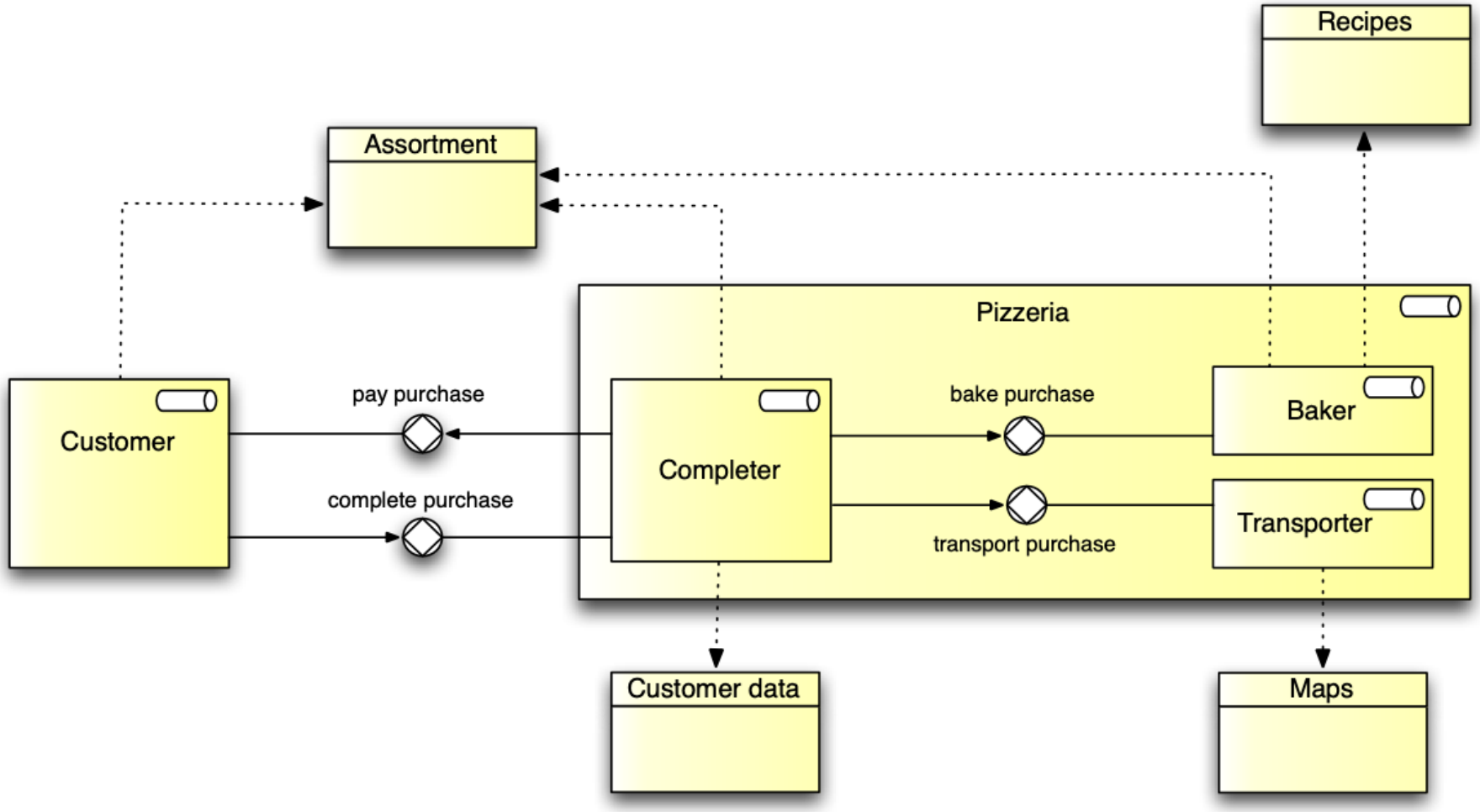
A domain model that has a representation, that is suitable for some computational or experiential purpose, which compromises the conceptual truefulness

It typically involves elements that do not pertain to the domain as such, but rather to its (designed) utilization

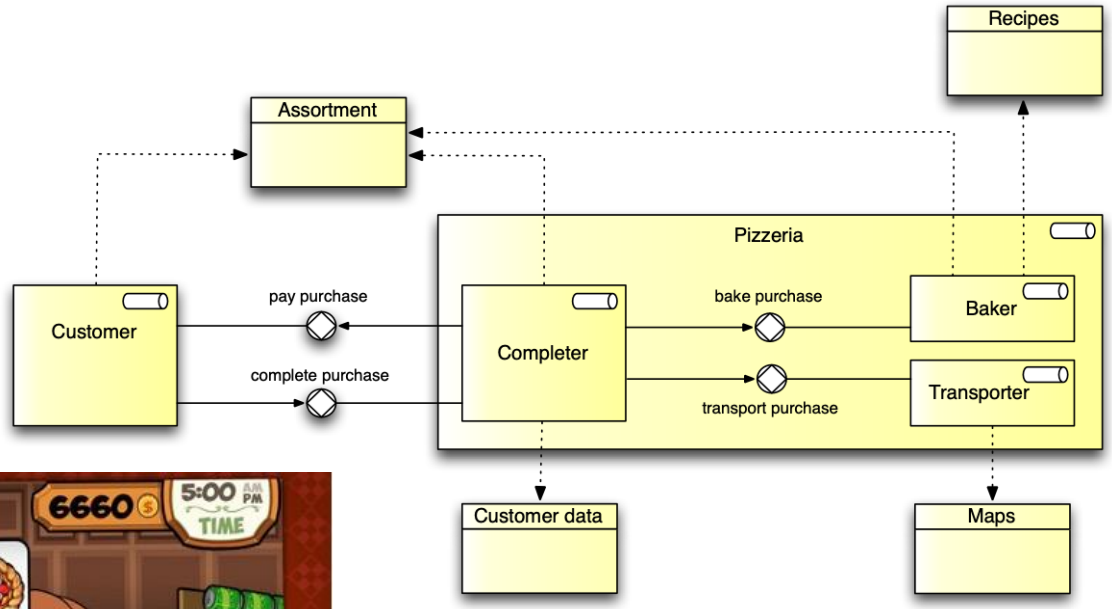
Could e.g. be implementation or experiental related utilization

Conceptual fidelity

Conceptual versus utilization-design

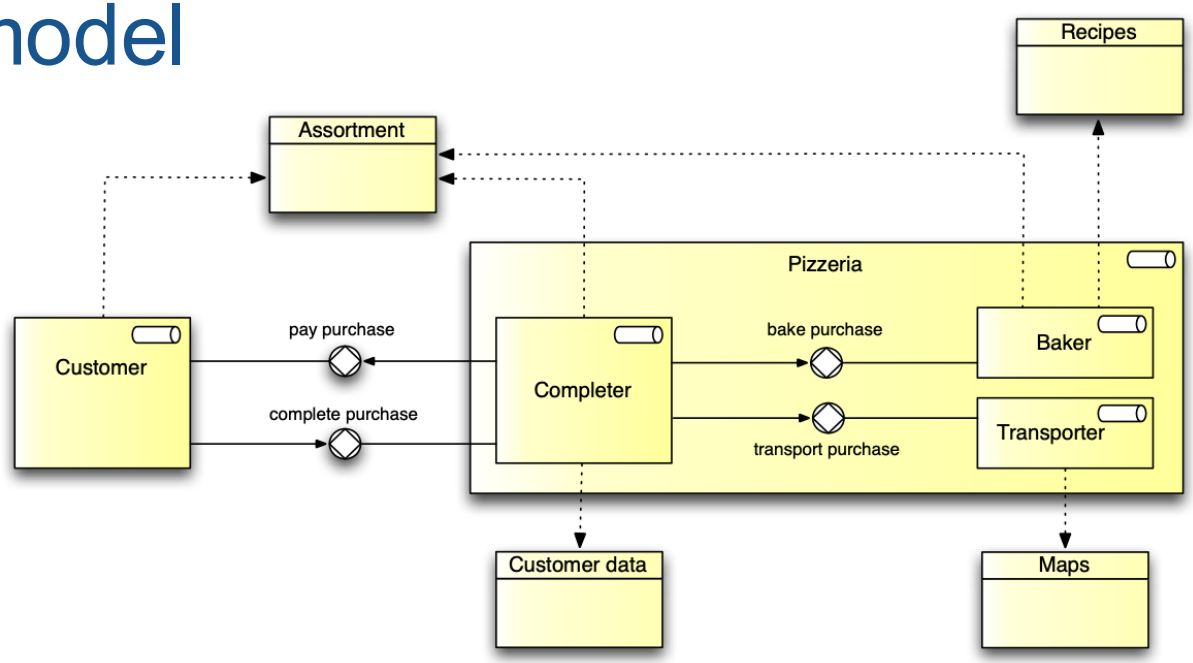


Conceptual versus utilization-design



Conceptual versus utilization-design

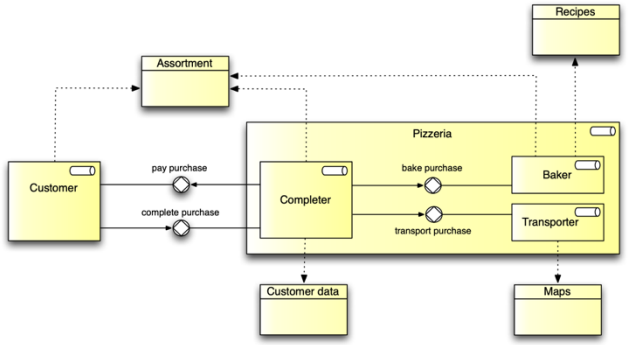
Each utilization-design model should have an underlying conceptual model



Conceptual versus utilization-design

Each utilization-design model should have an underlying conceptual model

Different utilization-design models can have the same underlying conceptual model



Conceptual versus utilization-design

Each utilization-design model should have an underlying conceptual model

Different utilization-design models can have the same underlying conceptual model

Utilization-design is also connected to the medium used to represent the model, and ultimately the purpose of the model

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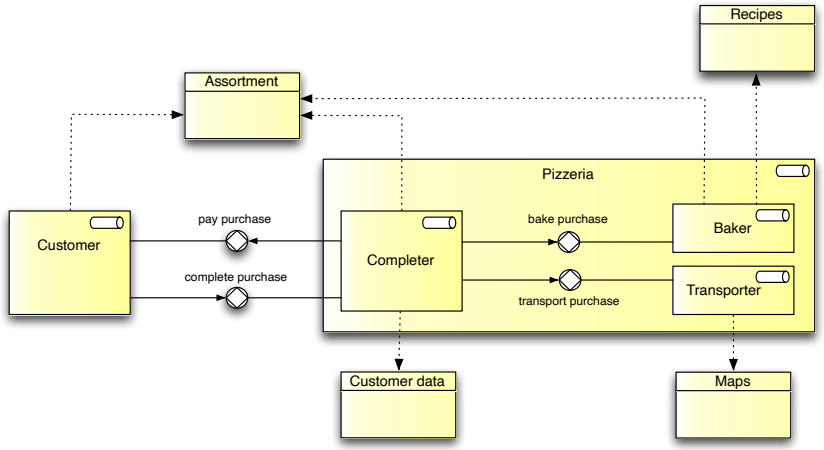
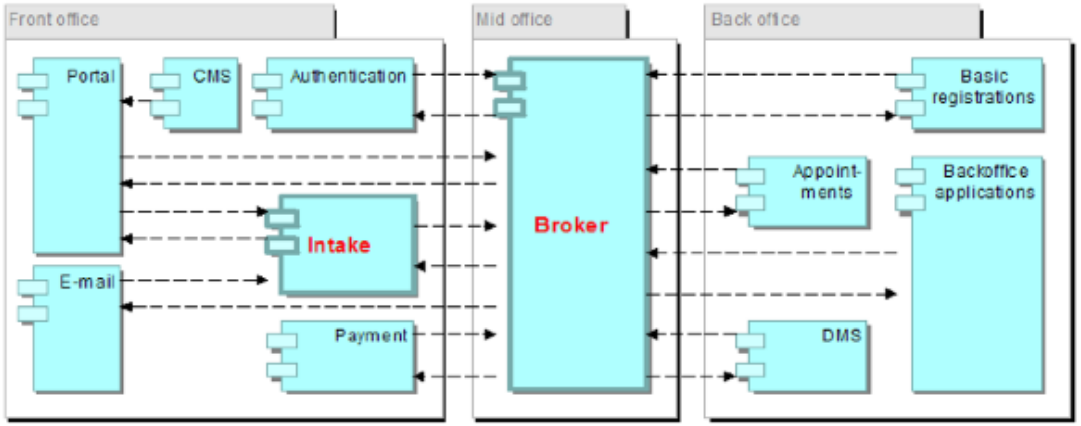
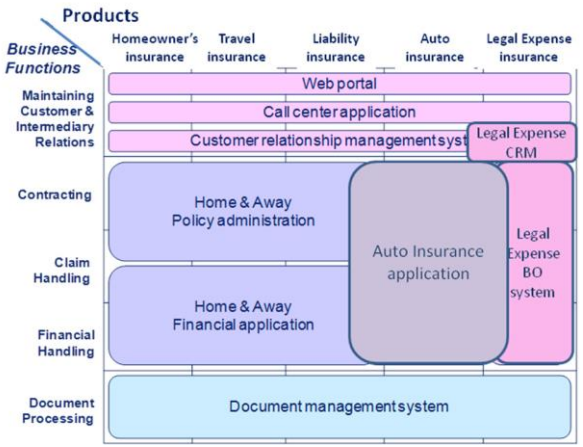
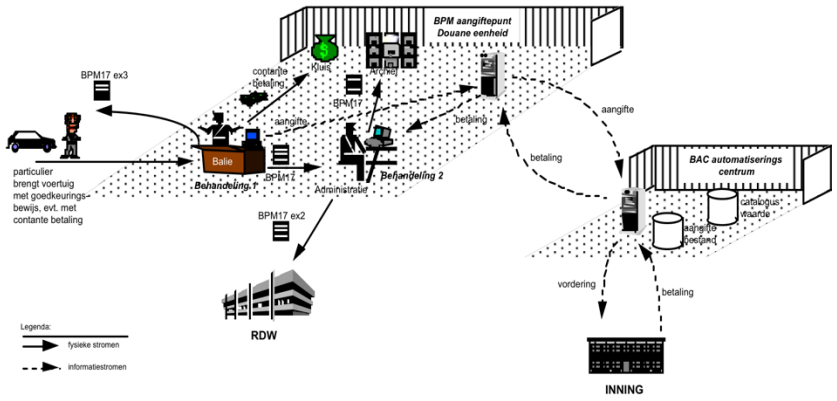
Views


Recipes
Assortment
Pizzeria
Customer
pay purchase
complete purchase
Completer
bake purchase
transport purchase
Baker
Transporter
Customer data
Maps

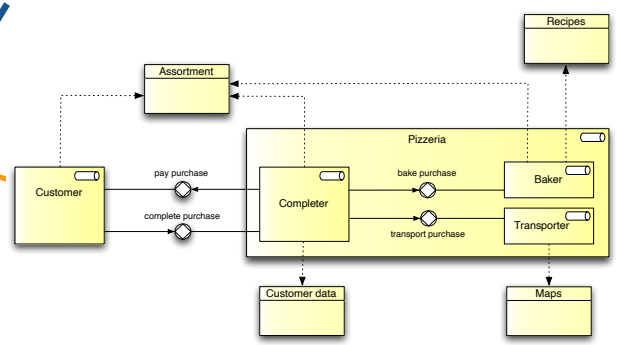

Front office
Mid office
Back office
Portal
CMS
Authentication
Intake
E-mail
Payment
Broker
Basic registrations
Appoint-ments
Backoffice applications
DMS

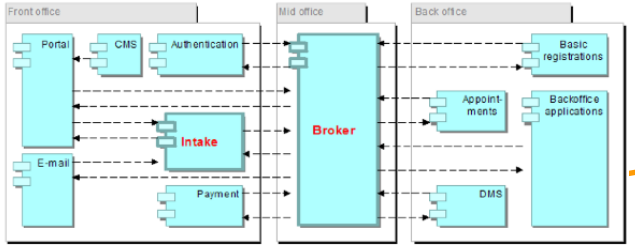

Products
Business Functions
Homeowner's insurance
Travel insurance
Liability insurance
Auto insurance
Legal Expense insurance
Maintaining Customer & Intermediary Relations
Web portal
Call center application
Customer relationship management syst
Legal Expense CRM
Contracting
Home & Away Policy administration
Auto Insurance application
Legal Expense BO system
Claim Handling
Financial Handling
Home & Away Financial application
Document Processing
Document management system

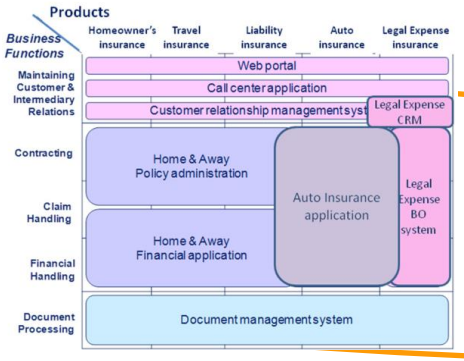

BPM aangiftepunt Douane eenheid
BPM17 ex3
Balie
Behandeling 1
Behandeling 2
BPM17 ex2
RDW
BAC automatiserings centrum
INNING
aangifte
betaling
vordering
particulier brengt voertuig met goedkeurings-bewijs, evt. met contante betaling
Legenda:
fysieke stromen
informatiestromen

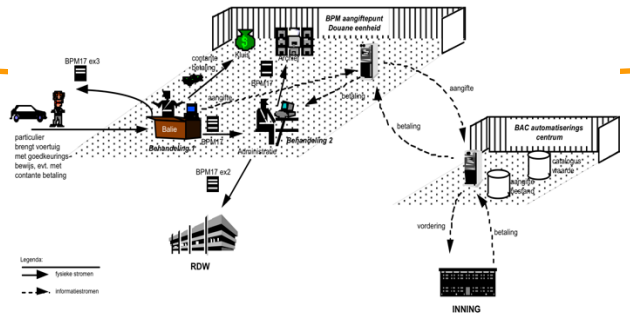
Views

An all encompassing, and too large to show, XXX model with lots of crossing lines …









Views

A view (on another) domain model is:

- *A domain model of the modeled domain, which differs from the original domain model, while:*
  - being at least at the same level of conceptual fidelity,
  - and provide a coherent subset of the information as (potentially) provided by the original domain model

Operations to construct views

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Selection:

- Focusing of the view on a specific part of the original model
- Leading question: *What to focus on?*

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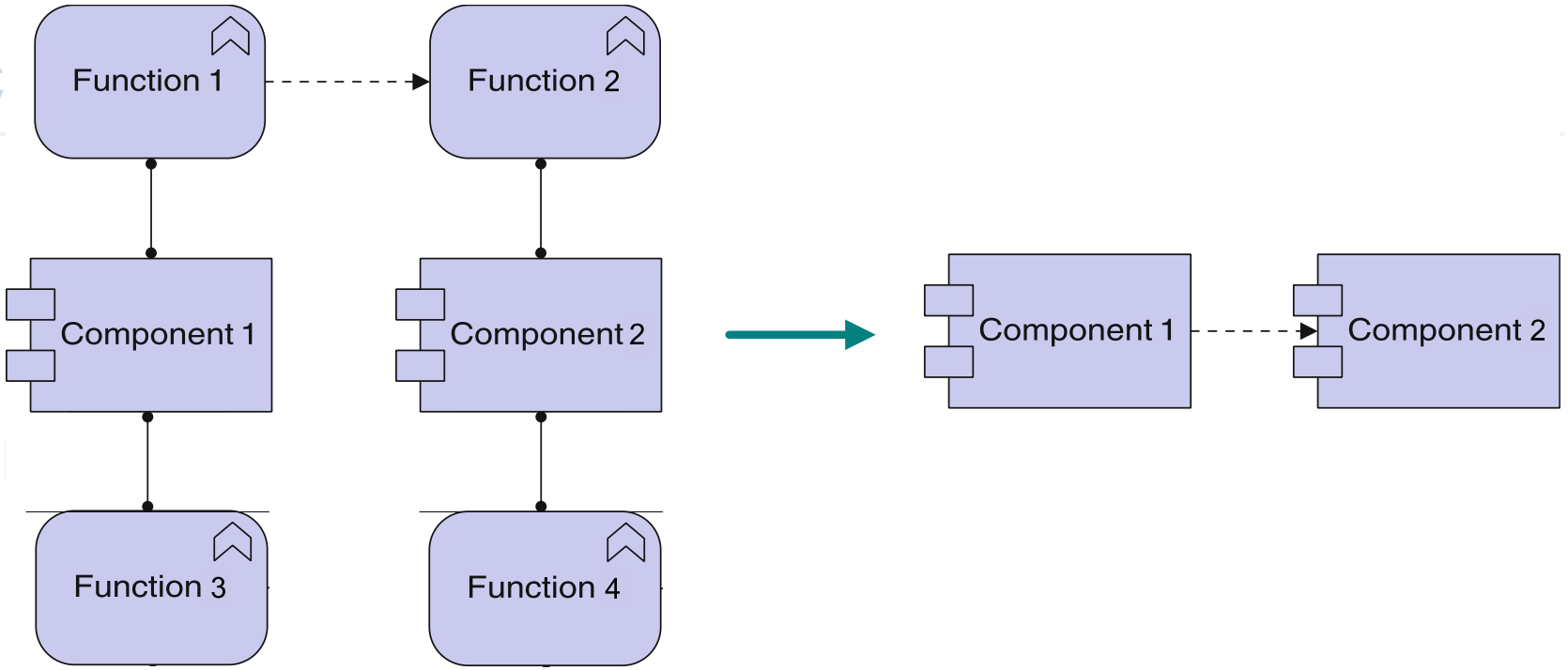

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Aggregation of relations, (un)folding of models, decomposition, schema abstraction, …

Operations to construct views

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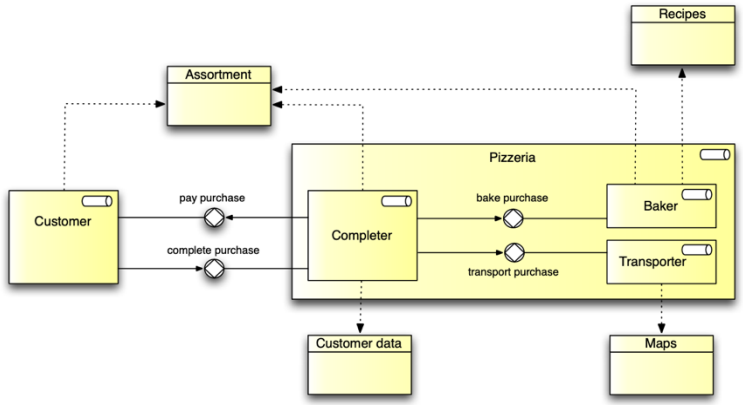
- Further abstracting away from the original domain, by clustering different elements into more coarse grained ones
- Leading question: *What level of detail is needed?*

Translation:

- A translation between one modeling language/medium to another modeling language/medium
- Leading question: *Which language and medium to use?*

Operations to construct views



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View update “problem”

A view is a model that is derived from another model

Generally involves a surjective function …

Views can be edited as well …

Does lead to the traditional “*view update*” problem when the view involves e.g. a further abstraction or a temporal selection

Agenda

Domain modeling

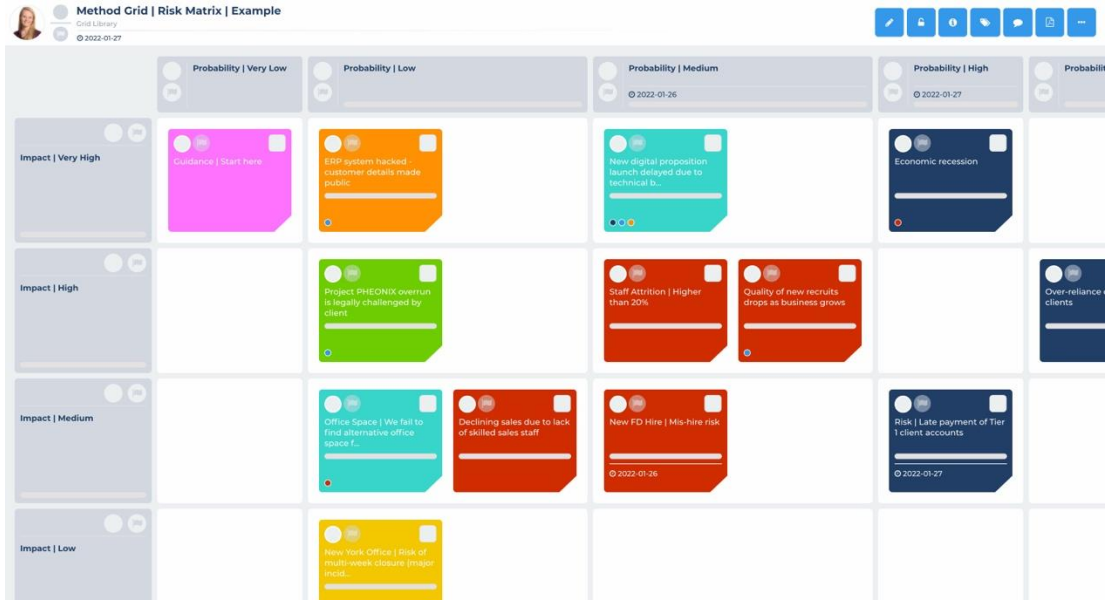
Return on Modeling Effort

Conceptual fidelity of models

Managing complexity; Views

Programs, animations, and other models

Tables



Value Interfac	Value Trans	Occurrence	Valuatio	Value	Total
{MONEY,GOOD}		10		100	
	MONEY	10	10	100	
	(all transfers)	10	0	0	
INVESTMENT				0	
EXPENSES				0	
total for actor					100

Table (qua model)

A model/view with a static (in principle) two-dimensional grid representation of a (possibly derived) ternary relation (type) concerning the modeled domain

Dynamic-ifying a table:

- We could “allow” ourselves to blend in/out specific rows/columns, thus changing the “informational payload” that the model provides to us at that moment

Spreadsheets as models?

A spreadsheet can be used to represent/render a table

A spreadsheet with actual formulas, but no “open” cells would be an example of a table (qua model) with derived parts

A spreadsheet with “intentionally left open” cells to enable “what if analy… …ple of an *interactive model* as it allows one to…

Warning: A lot of spreadsheets contain “hidden” domain models …

Diagram (qua model)

A model that is represented in a two dimensional (static) graphical form

Dynamic-ifying diagrams:

- We could allow ourselves to blend in/out specific (types of) elements [think: layers in Google Maps]
- Or … enable navigation through the model based on (different kinds of) part-whole relations
  [think: zooming in on Google Earth]

Specifications

G10 Design Specification		
Aesthetics	*What shape will it be? What colour(s) will it be? Will it have different textures? Will it have a particular style? Will it have any particular aroma? Will it have any particular flavour or flavours?*	
Target Audience	*Who is it for exactly? What are the customer's requirements/user needs?*	My target audience consists of members of the wider IGBIS school community.
Function	*What must it do? What is its purpose?*	
Manufacture	*How will it be manufactured? How will it be cooked?*	It will manufactured as a one of prototype of the product.
Materials	*What will the key ingredients be?*	
Size	*What size will it be?*	
Quantity	*How many portions will you produce and present?*	We will produce two portions of the product.

Machine	CNC Vertical Machining Centre
Make	Makino Max 65S
Table Travel	650 x 400 x 400mm
Load Capacity	400 Kg
Power Supply	200/220V, 3 Phase, 50/ 60Hz, 20 KVA
Machine Weight	4500 Kg
Rapid Traverse Rate [X,Y axis]	30000 [mm/min]
Rapid Traverse Rate [Z axis]	24000 [mm/min]
Feed rate	1-8000 [mm/min]
Spindle speed	12000 [rpm]
No of tools	20
Maximum tool weight	7 [Kg]
Positioning accuracy	±0.0015[mm]
Repeatability	±0.001 [mm]

Specifications

A model that normatively prescribes the properties of a (to be designed, to be elaborated, to happen, …) phenomenon

Program (qua representation)

A specification which captures the required behaviour of a computer in an actionable way, such that a computer can directly exhibit this required behaviour (via interpretation or compilation)

Simulation (qua model)

A model that provides a simulation of the dynamic behaviour of the modelled domain

If simulation-runs can be generated “on the fly” based on different scenario’s, the simulation (qua model) becomes an interactive model

Animation (qua model)

A model that is represented as a "movie" that illustrates the dynamic behaviour in the modelled domain in terms of the involved agents, subjects, etc

If animation-runs can be generated "on the fly" based on different scenario's, the animation (qua model) becomes an interactive model

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