From Requirements to Code: A Full Model-Driven Development Perspective

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SYSTEMATIC APPROACH
METHODOLOGICAL GUIDANCE
MODELLING TECHNIQUES OFFER!!!
TAKE 3, PAY 2

NOTATION

YET ANOTHER METHOD
NICE & CHEAP
- **Business process modelling (BPM)**
  - Specification of the (current and/or proposed) enterprise processes.
  - Important practice in Requirements Engineering and Software Engineering
  - Multiple BPM techniques

**Techniques**
- BPMN
- Merode
- Petri Nets
- IDEF0
- Use Cases
- DFD
- Taxis
- REVS
- NIAM
- ISACS
- Merise
- PSL/PSA
- Workflow
- UML Activity Diagrams
- **Business process modelling (BPM)**
  - Specification of the (current and/or proposed) enterprise processes.
  - Important practice in Requirements Engineering and Software Engineering
  - Multiple BPM techniques
The OLIVANOVA approach:
- Conceptual modelling
  - Object Model
  - Dynamic Model
  - Functional Model
  - Presentation Model
- Model compilation
Communication Analysis:
- Requirements engineering approach for information systems
- Provides a requirements structure
- Provides a flow of activities

The OLIVANOVA approach:
- Conceptual modelling
  - Object Model
  - Dynamic Model
  - Functional Model
  - Presentation Model
- Model compilation
Good practices in IS requirements Engineering:

- Offer external view of the IS.
- A communicational approach to IS analysis.

![Diagram showing interactions between subject system, organisational system, and information system with communicative interactions between actors.]
Good practices in IS requirements Engineering:

- Offer external view of the IS.
- A communicational approach to IS analysis.
- **Differentiate problem space vs. solution space.**
Good practices in IS requirements Engineering:

- Offer external view of the IS.
- A communicational approach to IS analysis.
- Differentiate problem space vs. solution space.
- *(Stepwise) refinement of complex systems.*
**Motivation**

- **Wise** (stepwise) refinement of complex systems

---

**Problem space**

- L1. System / subsystems
- L2. Process
- L3. Communicative interaction

**Solution space**

- L4. Usage environment
- L5. Operational environment

**Diagram**

- **Subsystems**
  - L1. System / subsystems
  - L2. Process (Logical events)
  - L3. Communicative interaction
  - L4. Usage environment
  - L5. Operational environment

- **Communicative events**
  - L2. Process (Logical events)
  - L3. Communicative interaction

- **Physical events**
  - L4. Usage environment
  - L5. Operational environment
An **observer** wants to interpret a **domain**.
(e.g. an **analyst** wants to understand and model **organisational processes**)

- A set of **concepts** is the result of the interpreting action.
- Concepts are structured by **composition** relations (part-of).

**NOT A TRIVIAL PROBLEM!**
Which concepts are primary?
Which ones are subordinate?
Conception of Communication Analysis

- Stems from research on IS fundamental concepts
  - Extension of the FRISCO report.

- Evolves in collaboration with industry
  - Valencia Port Authority
  - Infrastructure and Transport Ministry of the Valencian Regional Government
  - Anecoop S. Coop. (2nd grade cooperative that aggregates +100 agricultural cooperatives)


- Requirements structure and method activities

### Requirements levels

- **L1.** System/subsystems
  - Static perception
  - Dynamic perception

- **L2.** Process
  - Business problem decomposition
  - Communicative event diagramation

- **L3.** Communicative interaction
  - Communication objects identification
  - Communicative event specification

- **L4.** Usage environment
  - Communication objects specification
  - Usage req. capture and interface design

- **L5.** Operational environment
  - Business object classes modelling
  - Usage req. capture and interface design

### Communication Analysis activities

- **(1)** Strategic description of organisation
  - Problem decomposition

- **(2)** Communicative event diagramation
  - Communicative event diagrams

- **(3)** Business objects identification
  - Communicative event specification

- **(4)** Communicative event specification
  - Business object classes specification

- **(5)** Business objects specification
  - Usage req. capture and interface design

- **(6)** Usage req. capture and interface design
  - Component design

- **(7)** Object classes modelling
  - Logical design

### Solution space

- **L5.** Operational environment
  - Implementation

**LEGEND**

- **Activity**
- **Influence**
- **Outcome**
- **Production**
- Activity 1. Strategic description of organisation.

- Describe the Organisational System from a strategic p.o.v.

- Decompose the problem
  - Customer Service Departments (salesmen)
  - Production Department (clerks)
  - Accounting Department (accountant)
  - Management Board

- Strategic business indicators
  - Increase in the number of photographers
  - Increase in the number of exclusives
  - Cash flow
  - etc.
Proposal

- Requirements structure and method activities

### Requirements levels

#### Problem space
- L1. System/subsystems
- L2. Process
- L3. Communicative interaction

#### Solution space
- L4. Usage environment
- L5. Operational environment

### Communication Analysis activities

- Dynamic perception
- Static perception

#### Activity Legend
- Activity
- Influence
- Outcome
- Production

#### Diagram Description

1. **STRATEGIC DESCRIPTION OF ORGANISATION**

2. **COMMUNICATIVE EVENT DIAGRAMATION**

3. **BUSINESS OBJECTS IDENTIFICATION**

4. **COMMUNICATIVE EVENT SPECIFICATION**

5. **BUSINESS OBJECTS SPECIFICATION**

6. **USAGE REQ. CAPTURE AND INTERFACE DESIGN**

7. **OBJECT CLASSES MODELLING**

- COMPONENT DESIGN
- LOGICAL DESIGN
- IMPLEMENTATION

#### Solution Space Diagram

- BUSINESS OBJECT GLOSSARY
- DETAILED B.O.G.
- I.S. MEMORY MODEL
Activity 2. Communicative event diagramation

- **Communicative interaction.** Interaction between actors in order to exchange information.
  - **Ingoing communicative interaction** primarily feed the IS memory with new meaningful information.
  - **Outgoing communicative interaction** primarily consult IS memory.
- **Communicative event.** An ingoing communicative interaction that fulfils the following unity criteria.

![Diagram](image-url)
## Activity 2. Communicative event diagramation

- **Communicative event.** An incoming communicative interaction that fulfils the following unity criteria.

<table>
<thead>
<tr>
<th>UNITY CRITERIA FOR BUSINESS PROCESS MODELLING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRIGGER UNITY</strong></td>
</tr>
<tr>
<td>Trigger responsibility is external.</td>
</tr>
<tr>
<td>The event occurs as a response to an <strong>external</strong> interaction.</td>
</tr>
<tr>
<td>Some actor establishes contact with the IS and triggers organisational reaction.</td>
</tr>
<tr>
<td><strong>COMMUNICATION UNITY</strong></td>
</tr>
<tr>
<td>Each and every event involves providing <strong>new meaningful information.</strong></td>
</tr>
<tr>
<td>Input messages are representations of something that happens in the IS environment.</td>
</tr>
<tr>
<td><strong>REACTION UNITY</strong></td>
</tr>
<tr>
<td>The event triggers IS reaction, which is a <strong>composition of synchronous activities.</strong></td>
</tr>
<tr>
<td>Events are asynchronous among each other.</td>
</tr>
</tbody>
</table>
Illustrative example

Photographer

Photography Agency, Inc

PHOTOGRAPHER
APPLICATION

PHOTOGRAPHER SUBMITS AN APPLICATION
TECH. DEP. CLERK

PHO 1

RESOLUTIONS

PHO 3 MANAGEMENT BOARD RESOLVES APPLICATIONS

PHO 3.1 BOARD REJECTS

PHO 3.2 BOARD ACCEPTS

TECH. DEP. CLERK

PHO 2
Communicative event diagram of Photography Agency, Inc.

L1. System/subsystems

L2. Process

L3. Communicative interaction

L4. Usage environment

L5. Operational environment

Legend:
- Actor
- Communicative event
- Ingoing communicative interaction
- Outgoing communicative interaction
- Precedence relation
- Specialised communicative event

- **Business Object Glossary.** Structure that specifies business objects.
  - Business objects are conceptions of entities of the Subject System in which the Organisational System is interested.
  - Complex aggregates of properties (not o-o fragmentation)
    - Report record
    - Photographer record
    - Report delivery note
  - Business forms are catalogued.

- **Business indicators at the process level.**
  - Production department: productivity and profitability indicators
    - Delivery performance to customer
    - Photographer productivity
Requirements structure and method activities

**Requirements levels**

- **L1. System/subsystems**
  - Problem space
  - Dynamic perception
  - Strategic description of organisation
- **L2. Process**
  - Dynamic perception
  - Communicative event diagramation
- **L3. Communicative interaction**
  - Dynamic perception
  - Communicative event specification
- **L4. Usage environment**
  - Dynamic perception
  - Usage req. capture and interface design
- **L5. Operational environment**
  - Dynamic perception
  - Component design

**Communication Analysis activities**

- **Dynamic perception**
- **Static perception**

**Diagram legend**

- Activity
- Influence
- Outcome
- Production

**Diagram symbols**

- PROBLEM DECOMPOSITION
- BUSINESS OBJECT GLOSSARY
- DETAILED B.O.G.
- I.S. MEMORY MODEL

**Diagram symbols**

- COMMUNICATIVE EVENT DIAGRAM
- COMMUNICATIVE EVENT SPECIFICATION
- COMMUNICATIVE EVENT TEMPLATES
- INTERFACE DESIGN MODEL
- INTERFACE DESIGN MODEL

**Diagram symbols**

- COMPONENT DESIGN
- LOGICAL DESIGN
- IMPLEMENTATION
- **Activity 4. Communicative event specification.**
  - Template structure

<table>
<thead>
<tr>
<th>Level</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1.</td>
<td>System/subsystems</td>
</tr>
<tr>
<td>L2.</td>
<td>Process</td>
</tr>
<tr>
<td>L3.</td>
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<td>L5.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirement Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
</tr>
<tr>
<td>Contact requirements</td>
</tr>
<tr>
<td>Communicational content requirements</td>
</tr>
<tr>
<td>Reaction requirements</td>
</tr>
</tbody>
</table>

PHO 3. Management board resolves applications

**Goals:** The IS aims to obtain a response to outstanding photographer applications.

**Description:** Monday mornings, the management board holds a meeting. A member of each department is present. A Production Department clerk has prepared a list of outstanding (pending) photographer applications and a résumé of each applicant. Management board proceeds to evaluate and resolve each application. Depending on the documentation, a photographer is either accepted or rejected. Accepted photographers are classified into a quality level (this level will determine their rates). After the meeting, the list of resolved applications is returned to Production Department.
Goals:
The IS aims to obtain a response to outstanding photographer applications.

Description:
Monday mornings, the management board holds a meeting. A member of each department is present. A Production Department clerk has prepared a list of outstanding (pending) photographer applications and a résumé of each applicant. Management board proceeds to evaluate and resolve each application. Depending on the documentation, a photographer is either accepted or rejected. Accepted photographers are classified into a quality level (this level will determine their rates).

After the meeting, the list of resolved applications is returned to Product Department.
Activity 4

**Contact requirements**

**Primary actor:** Management board.  
**Communication channel:** In person.  
**Temporal restrictions:** This communicative event occurs Monday mornings.  
**Frequency:** Of the 10-20 monthly applications, around 5 are accepted.

**Communicational content requirements**

**Support actor:** Production Department clerk  
**Communication Structure:**

<table>
<thead>
<tr>
<th>FIELD</th>
<th>OP</th>
<th>DOMAIN</th>
<th>BUSINESS OBJ.</th>
<th>EXAMPLE VALUE</th>
</tr>
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</table>

**Legend**

- Physical Event
- Information Flow
- Actor Pool
- Information Objects
**Activity 4. Communicative event specification.**

- **Communication Structure of event PHO 3**

<table>
<thead>
<tr>
<th>FIELD</th>
<th>OP</th>
<th>DOMAIN</th>
<th>BUSINESS OBJ.</th>
<th>EXAMPLE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESOLUTIONS = Application() = &lt; ID card # + Name + Address + Postcode + City + Phone # + Equipment + Experience + Portfolio + Resol. date + Decision + [ Accepted = &lt; Level &gt; ] &gt;</td>
<td>i</td>
<td>text</td>
<td>PHOTOGRAPHER (ID card #)= &lt;</td>
<td>19.345.631-Q Sergio Pastor González Camino de Vera s/n 46022 Valencia</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>text</td>
<td>Decision=acc decision + resol date + level</td>
<td>9638700000 ext 83534 Canon A1 w. telemacro Worked for Mangum Ph N/A (sample of work)</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>date</td>
<td></td>
<td>November 21, 2008 acc</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>document</td>
<td></td>
<td>1 (highest quality level)</td>
</tr>
</tbody>
</table>

**LEGEND**

- **CSs Primitives**
  - `<+>` aggregation
  - `{ }` iteration
  - `[ ]` alternative
  - `( )` selection

- **Information acquisition operations**
  - `d` derivation
  - `i` input
Contact requirements


Primary actor: Management board.

Communication channel: In person.

Temporal restrictions: This communicative event occurs Monday mornings.

Frequency: Of the 10–20 monthly applications, around 5 are accepted.

Communicational content requirements

Support actor: Production Department clerk.

Reaction requirements

Business object: If the application is accepted, the photographer becomes part of the agency.

Communication Structure:

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<td>46022</td>
<td></td>
</tr>
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<td>d</td>
<td>text</td>
<td>Valencia</td>
<td></td>
</tr>
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<td>Phone # +</td>
<td>d</td>
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<td>&lt; Level &gt; ]</td>
<td>i</td>
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Requirements structure and method activities

- **Requirements levels**
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- **Communication Analysis activities**
  - Dynamic perception
  - Static perception

- **LEGEND**
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- **Problem space**
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Communication Analysis offers a systemic way to structure requirements

Specific techniques for IS analysis
- Communicative Event Diagram.
  - Communicational perspective on business process modelling
  - Unity criteria to deal with encapsulation (granularity of processes)
- Communication Structures
  - Specifies messages related to communicative events
  - Derivation of IS memory from communication structures

Future work
- Propose precise guidelines to derive IS memory
- Design user interface from communication structures
- Report industrial case studies in the use of Communication Analysis
- Take advantage of MDD and code generation frameworks
- Extremely long etcetera under the proposed “full MDD” perspective...
Model Driven Development permits

- **Reason** about the system prior to its construction
  - You can simulate the behavior to foresee the consequences of a system
- Derivate the final system in an **automatic** way
  - Obtaining a consistent result
We have been building

- Traditional Information Systems
- Web-based Information Systems
- SOA-based systems
- Pervasive Systems

... but, what is next?
Conceptual models are needed for a systematic development of biological systems

Software

Conceptual Models

Programming Languages

Binary Code

Abstract Elements

Reusable Blocks

Code

Life

Conceptual Models

Standard Biological Parts

ADN
Physical Level

Instruction Level

Representation Level

Semantics: Add the values from the processor registers ‘3’ and store the result in the register ‘8’
### Physical Level

<table>
<thead>
<tr>
<th>AUG</th>
<th>GAA</th>
<th>CAC</th>
<th>GAC</th>
<th>GAG</th>
<th>UAA</th>
</tr>
</thead>
</table>

**Semantics:** Process a protein with the four selected amino acids

### Instruction Level

START  Glu  His  Asp  Glu  STOP

### Representation Level

However, ¿Why?
Thanks for your attention!