Modeling and Execution of Software User Interfaces
The context
The need
The missing part
The UI Modeling Problem
User interface and interaction development is a painful phase of software process… for everybody!… not only for the Web!
The UI Design Problem

- Costly and Inefficient process
- Complexity of user interfaces (UIs)
- Ineffective tools
- Manual development
- No MDE technology
The UI Design solution: IFML

- Platform independent description of UIs
- Focused on user interactions
- No definition of graphics and styles
- Reference external models
User interaction has been overlooked in software engineering standards

Hence the Interaction Flow Modeling Language (IFML)

In less than 2 years (a record in OMG!), we obtained approval of the beta IFML standard

Version 1.0 due to come out in these weeks
The Interaction Flow Modeling Language
IFML Objectives

- Binding to Persistence Layer
- Navigation Path
- Content
- Event
- Binding to Business Logic
- Binding to Persistence Layer
IFML Objectives: Content
IFML Objectives: Navigation Path
IFML Objectives: Events
IFML Objectives: Binding to business logic
IFML Objectives: Binding to business logic
IFML Objectives: Binding to persistence

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Covered aspects

- **Multiple views** for the same application
- **Mobile and multi-device** applications
- Visualization and input of data, and production of **events**
- **Components** independent of concrete widgets and presentation
- **Interaction flow**, initiated by the user or by external events
- **User context**: the user status in the current instant of the interaction (position, history, machine, platform,...)
- **Modularization** of the model (design-time containers for reuse purpose)
- User input **validation and constraints**, according to OCL or other existing constraint languages
Basic navigation flow between ViewComponents
IFML by example

Basic navigation flow between ViewComponents

View Container → ParameterBinding → View Component → Event

«ParameterBindingGroup»
SelectedArtist → AnArtist
IFML by example

Album Search

Title: [input]
Year: [input]

Albums

2 Albums Found
- All the Way
  Let's talk ...
- [view]

Album

Title: All the Way
Year: 1999
Cover: [image]

ParameterBindingGroup
- Title -> AlbumTitle
- Year -> AlbumYear

ParameterBindingGroup
- SelectedAlbum -> AnAlbum

Window AlbumSearch
  Form
    Album Search

Window Albums
  List
    Album List

Window Album
  Details
    Album Details
IFML by example

Nesting of ViewContainers Tagged ViewContainers (XOR)
IFML – adding details to ViewComponents

ViewComponentParts:
• Data binding
• Parameters

Types of ViewComponents (<<List>>)
Joint use of IFML and other modeling languages:

- DataBinding to classes and attributes of UML Class Diagrams
- Also with other content models, such as: Entity-Relationship, Ontologies, ...
IFML by example

Actions
Joint use of IFML and other modeling languages

Connection of Actions to back-end business logic as

- UML methods of classes
- whole UML dynamic diagrams
  - activity diagram, sequence diagram, state chart diagram, ...
IFML by example

Albums

Album List

Album Deletion

«ParameterBindingGroup»
SelectedAlbum → AnAlbum

«Behaviour»
Album.Delete

Actions
IFML – subtyping events

- OnSelect event
- OnSubmit event

Catching events

Throwing events
IFML – subtyping components

.. And as many others as you want!
ActivationExpression, SubmitEvent, Event generation
IFML concrete syntax by example

[L] Message Writer

Action Confirmed

Action Confirmed

Send

Save

«ActivationExpression»
State <> “Reply All”

«ActivationExpression»
State = “Reply” or State = “Reply All”

«ActivationExpression»
State <> “Reply

«ActivationExpression»
State <> “Reply All”

intra-component events and flows
Capturing of custom events

Note: typical problem of event-based systems (termination, ...)
IFML example – online payment

Shopping Cart

Customer Information

Payment Information

Confirmation

«List»
  Product List

Checkout

«Form»
  Customer Information

«ParameterBindingGroup»
  Name ➔ Name

«ParameterBindingGroup»
  Name ➔ Name
  CreditCard ➔ CC

«ParameterBindingGroup»
  Total ➔ Amount

«Details»
  Confirmation Message

Execute the payment
IFML concrete syntax – modules

IFML Modules - definition
IFML concrete syntax – modules

IFML Modules - usage
Multiple aspects modeling – 1
(business and requirements)

UML Use Case

UML Sequence

UML Statechart

BPMN process

IFML
Integration with UML Use Cases

Each use case can be described by

- A business process
- A plain UI description in IFML
- Some UML dynamic diagrams (e.g., activity, sequence, ...)
Integration with BPMN

The UI of each activity can be described by an IFML module. Some UML dynamic diagrams (e.g., activity, sequence, ...)
Example of UML - IFML mapping

IFML models can be reworked or refined after being generated.

IFML Model

xUML Use Case Diagram

xUML Sequence Diagram
Multiple aspects modeling – 2
(implementation and architecture)
Description of deployment architecture

- UI is just one facet of system design
- Often need to position it in a broader architectural vision

UML deployment diagram
UML Sequence Diagrams

Tiers and calls
Explicit description of interactions between tiers

1: Update
2: updateQuantity(product, qty)
3: updateShoppingCart
4:
5: Empty
6: emptyCart
7: emptyShoppingCart
8:
9: Checkout
10: checkOut
11: CustomerInformationForm
12: SubmitForm
13: formData
14: getCustomerinfo
15:
16: verifyUserInfo
17: authorizePayment
18:
19:
Model-driven Development Process

- Manual specification of BPMN process model
- Automatic transformation of BPMN to WebML
- Possible manual refinement of WebML models
- Automatic running code generation on J2EE platform
- Virtuous development cycle

![Diagram of the Model-driven Development Process]

1. Business process specifications (BPMN)
2. Choreography model (extended BPMN)
3. Application executable model (IFML)
4. Running application (J2EE)
The generated model artifacts
IFML is defined through a metamodel

How does it work? IFML metamodel (1)
IFML metamodel (2): Content Binding

- Data binding to Classes and Attributes
- Dynamic Behavior to Methods and Diagrams
Practical results of having a standard

- An official **metamodel of the language** which describes the semantics of and relations between the modeling constructs

- A **graphical concrete syntax for the interaction flow notation** which provides an intuitive representation of the user interface composition, interaction and control logic for the front-end designer

- A **UML Profile** consistent to the metamodel

- An **interchange format** between tools using XMI

- All this, specified through standard notations themselves
Also: interchange with profile-based diagrams. The UML Profile for IFML

Static aspects

Dynamic aspects

SelectMailMessages(mBox)
Model integration and interchange

- Tight and seamless integration between different modeling tools
  - Thanks to XMI interchange format, UML profiles, vendor-specific notation implementations
  - Thanks to model to model transformations

- IFML modeling and industrial-strength UI generation
- UML tool implementing IFML profile
- BPMN and/or UML editor
- Other Domain-specific modeling tool
Executability experiment within OMG

IFML editor → IFML model → IFML code generator produces Platform specific UI code → UI execution

UML editor

Alf editor + parser calls Alf compiler produces fUML model

fUML model

input fUML Interpreter

backend business logic execution
Joint usage of IFML with other MDA languages can be devised:

- SysML
- SoaML
- ...

... and also with other frameworks (e.g., Model Driven Enterprise Engineering)
The Metamodel
-- excerpts --
Example 1: online mailer (e.g., Gmail)

Typical email interface

Usability

Friendliness

Complex interaction flows
Top down design from containers

[XOR] MAIL Top

[D] [L] MailMessages | [L] Contacts
«Window» [XOR] MAIL Top

[D] [L] Messages

[XOR] MessageSearch

[XOR] MessageManagement

MailBox

Message List

[L] Settings

[L] MessageWriter
Parameters and Conditions

MessageList

- «List» MBoxList
  - «DataBinding» MailMessageGroup

- «ParameterBindingGroup»
  - SelectedMailBox → MailBox

- «List» MessageList
  - «DataBinding» MailMessage
    - «ConditionalExpression»
      - self.mm2MailMessageGroup = MailBox
    - «Parameter» MailBox
Activation expressions

MailBox

- MessageList
- MessageSelectionMode
- Parameter Binding Group
  - SelectedMessages → MessageSet
  - ActivationExpression
    - not MessageSet.isEmpty()
Search forms

[XOR] MessageSearch

[D] Search

«Form»
Message keyword search

Show search options

«Modeless» FullSearch

«Form»
Message Full Search

MailBox

«List»
Message List

«ParameterBindingGroup»
Keyword \(\rightarrow\) Key

«ParameterBindingGroup»
Keyword \(\rightarrow\) Keyword

«ParameterBindingGroup»
Keyword \(\rightarrow\) Key
From \(\rightarrow\) FromKey
To \(\rightarrow\) ToKey
[XOR] MessageSearch

[D] Search

«Form» Message Keyword Search

«SimpleField» Keyword: String

Search mail

Show search options

«Modeless» FullSearch

«Form» Message Full Search

«SimpleField» Keyword: String

«SimpleField» From: String

Search mail

MailBox

«List» Message List

«DataBinding» MailMessage

«ConditionalExpression» MailMessage IN
self.mm2MailMessageGroup = Mailbox

«ConditionalExpression»( if (Key.size() <= title.size()) then
Sequence(1..title.size() - Key.size()) -> exists(i |
    title.substring(i,i+ Key.size()) = Key )
else
    false) OR
(if (from.size() <= self.from.size()) then
Sequence(1..self.from.size() - from.size()) -> exists(i |
    self.from.substring(i,i+ from.size()) = from )
else
    false
)
Example 2: Instagram

- Typical mobile UI
- Simple app
- Complex interaction
Fig 9.3

[H] Start Page

Register -> Sign In

Register

Sign In
Figure 9.9

<<Module>> MediaViewer

«NestedList» MediaViewer

«DataBinding» Media

«ConditionalExpression»
MediaOIDs->includes (oid) order by postTime DESC

«VisualizationAttributes» postTime, location, file

«VisualizationAttributes» numLikes

«NestedDataBinding»

«NestedDataBinding» likedBy

«VisualizationAttributes» userName

«NestedDataBinding» contains

«VisualizationAttributes» postTime, location, file

«VisualizationAttributes» numLikes

«ConditionalExpression»
MediaOIDs->includes (oid) order by postTime DESC

«VisualizationAttributes» userName, photo

«NestedDataBinding» postedBy

«ActivationExpression»
likedBy->size() <= 10

«NestedDataBinding»

«NestedDataBinding» likedBy

«VisualizationAttributes» userName

«NestedDataBinding» contains

«VisualizationAttributes» userName, text

«NestedDataBinding» comprises

«VisualizationAttributes» tagName

«NestedDataBinding» mentions

«VisualizationAttributes» userName

«ActivationExpression»
likedBy->size() > 10

«ActivationExpression»
numLikes > 10

«ActivationExpression»
size() > 6

«ActivationExpression»
seeLikers

«ActivationExpression»
seeAllComments

«ParameterBindingGroup»
OIDs → MediaOIDs
Figure 9.11

Contains (Comment)
QualifiedBy (Tag)

SeeSameTag event

anmarce427 Como Lake

marcobrambi Great to do #research and #teaching in a place like this. Looking forward to an #office with #lake view
Fig 9.13

"Like" event

2066 likes

anmarce427 Como Lake
view all 269 comments
marcobrambi Great to do #research and #teaching in a place like this. Looking forward to an #office with #lake view
anmarce427 #IFML @marcobrambi

"Comment" event
Fig 9.16
Fig 9.17

COMMENTS

anmarce427 Como Lake
3 days ago

marcobrambi Great to do #research and #teaching in a place like this. Looking forward to an #office with #lake view
3 days ago

anmarce427 @marcobrambi
41 seconds ago

Add a comment
Fig 9.19

MediaMap

PhotosOfUser
Fig 9.21

<<Module>> MediaTiled

<<ViewContainer>> MediaAsTiles

<<List>> MediaTiles

«DataBinding» Media
«ConditionalExpression» MediaOIDs->includes (oid) order by postTime DESC
«VisualizationAttributes» file

Select

«ParameterBindingGroup»
OIDs → MediaOIDs

«ParamBindingGroup»
Selected → MediaOIDs

<<ModuleReference>>
MediaViewer
Fig 9.22

Logged-in user

Generic user

"Edit Photo" event (touch)

"Options" event

"Edit Your Profile" event

"Toggle" event
Fig 9.25

<<Module>> Tag

<<ViewContainer>> TagInfoAndMedia

«Details» TagInfo

- «DataBinding» Tag
- «ConditionalExpression» tagName == tag
- «VisualizationAttributes» tagName, numPosts

[XOR] <<ViewContainer>> TaggedMedia

«List» MediaOids

- «DataBinding» Media
- «ConditionalExpression» qualifiedBy == tag

[D][L] <<ModuleReference>>
MediaTiled

[L] <<ModuleReference>>
MediaViewer
Example 3: eBay
Fig 9.29

<<siteview>> eBay Web Interface

[H][L] <<page>> Home
[L] <<page>> DailyDeals
[L] <<area>> CustomerSupport
[L] <<area>> Sell
[D] <<page>> Tell us
[L] <<modeless>> Notifications
[L] <<area>> MyeBay
[L] <<page>> Create
[L] <<area>> Listings Categories & Collections
[L] <<page>> Review
[L] <<page>> NewFeatures
[L] <<area>> Community
[L] <<area>> Announcements
[L] <<area>> MoneyBack
[L] <<area>> SecurityCenter
[L] <<area>> ResolutionCenter
[L] <<area>> SellerCenter
[L] <<area>> Policies
[L] <<page>> SiteMap
[L] <<page>> OfficialTime
[L] <<page>> Survey
Fig 9.32
Fig 9.33

EBAY GARAGE GIVEAWAY
With Dale Earnhardt Jr.
Enter for a chance to win a 2014 Camaro and meet Dale Jr. at his dealership
Ends June 30

Ends now
Fig 9.33/b
Select Purchase Format

Select Condition

Select Location

Select Search Alternatives

Deselect

See All

Search Results

Products

Listing Summary

See Listing Summary

Recently viewed

Listing Details

See All

Search options

Remove

Cancel All

Cancel

See All

Multiple Options

SelectedSearchKey → SearchKey

SelectedCategories → Cartegories

SelectedSearchAlternatives → Alternatives

SelectedOption → AvailableOption

SelectedItemCond → ItemCond

SelectedLocation → Location

SelectedSearchKey → SearchKey

SelectedFormat → format

ListBox → blockVariable

Matrix View

List View

onMouseOver

Alternate

SortOption

Sort

SortBlockSize=

SELECT Purchase Format

«ConditionalExpression»

self.listing->forAll(L | L.PurchaseFormat.oclIsKindOf(format))

OR (self.listing->forAll(L | L.ItemCondition=ItemCond) OR
(self.listing->forAll(L | L.Location==Location))

AND if (keyword.size() <= name.size())

then Sequence(1.. name.size() –Keyword.size())

-> exists(i | name.substring(i, i + Keyword.size()) = Keyword)

else false

AND category = CategoryOIDOrderBy SortOption Desc

See Listing Summary

«Tree» CategoryFacet

CategoryFacet

RelatedTo

«VisualizationAttributes» title

«NestedDataBinding» contains

«VisualizationAttributes» Blob

«NestedDataBinding» RelatedTo

«VisualizationAttributes» title

«DataBinding» Listing

Recently viewed

AvailableOptions

AvailableAlternatives

SelectedOption → AvailableOption

SelectedSearchAlternatives → Alternatives

SelectedSearchKey → SearchKey

SelectedCategories → Cartegories

SelectedSearchKey → SearchKey

SelectedFormat → format

pluck $List$:

£$List$.contains($List$) OR
$List$.substrings(1..$List$.size() –Keyword.size()) -> exists($Char$ | $List$.substring($Char$, $Char$ + Keyword.size()) = Keyword)

else false

AND category = CategoryOIDOrderBy SortOption Desc

«DataBinding» Listing

AvailableAlternatives

AvailableOptions

Alternatives

Options

DataBinding

DataBinding

DataBinding

ParamBindingGroup

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The WebRatio tool
Drawing vs. modeling
An Eclipse-based development environment allowing:

- **Modeling:** ER + IFML + BPMN
- **100% code generation** of standard JEE applications
  - Clear separation between design time and run time
  - No proprietary runtime
- Quick and agile development cycles
- Extending the generation rules
  - Defining new presentation styles
  - Defining new components
- Versioning, teamwork, full lifecycle mgt
- Truly multi-role model-driven development
Some numbers

**WebRatio is**
- now at 7\(^{th}\) release
- on the market since 2001

**WebRatio customers**
- 130+ companies and 500+ commercial users
- mainly Italy, USA, Europe and Latin America

**WebRatio adoption**
- 15,000+ users of the free edition
- Used in hundreds of universities all over the world

**WebRatio partners**
- 40+ software houses and system integrators
- 300+ universities worldwide, 13,000+ students
You capture business requirements in abstract, technology independent models

BPMN + IFML

WebRatio – Step 1
You customize the environment by defining your own generation rules.
You get a tailored, yet standard, Java Web application with no proprietary runtime.
Get the application
Involve business users in the development process and converge quickly to the target
Our innovation environment

Research
(Research group at Polimi)

Spin-off
(WebRatio)
& other SME Partners

Teaching
(Polimi and int.l courses)

Method, Language and Platform

Customers
(including EU projects)

innovation

Toolsuite, industrial requirements

Standard

requirements

use cases

innovation
Do not change the generated application code

Touch the generation rules instead
Kinds of application

Corporate Operations
- Human Capital Management
- Product Lifecycle Management

Customer Management
- Customer Relationship Management
- Marketing Resources Management
- Web Customer Services
- B2C/B2B E-Commerce

Supply Chain Management
- Supplier Relationship Management

Knowledge Management
- Knowledge Management
- Learning Management
- Project Management
- Web Front-End of accounting sys.
- Payment Services Orchestration
- Front-Office Process Mgmt

Business Intelligence
- Business Intelligence

Financial Services
- Financial Services

Enterprise Resource Planning
- Human Capital Management
- Corporate Operations
- Recruitment
- Training
- Workforce Management
- Enterprise Governance
- Risk and Compliance
- Order Mgt
Acer

B2C + CMS Web applications initially for 14 EU countries

Corporate news, Product technical & commercial data, Service & Partner area, Where to Buy...

Multilingual, multi-actor, distributed workflows for local and central PMs, local and central MarCom managers

... and a: very limited Time to Market (7 weeks!!)
<table>
<thead>
<tr>
<th>Class</th>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Number of localized B2C web sites</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Number of main CMS applications</td>
<td>4 (Admin, News, Product, Other content)</td>
</tr>
<tr>
<td></td>
<td>Number of supported languages</td>
<td>12 for B2C Web sites, 1 for CMS</td>
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<tr>
<td></td>
<td>Number of data entry masks</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated database tables</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated database views</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated database queries</td>
<td>279 for data extraction, 89 for data update</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated JSP page templates</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated or reused Java classes</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Number of automatically generated Java lines of code</td>
<td>12 500 Non commented Lines of code</td>
</tr>
<tr>
<td>Time &amp; effort</td>
<td>Number of elapsed workdays</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Number of development staff-months (analysts and developers)</td>
<td>6 staff-months (6 weeks x 4 persons)</td>
</tr>
<tr>
<td></td>
<td>Total number of prototypes</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Average elapsed man days between consecutive prototypes</td>
<td>5,4</td>
</tr>
<tr>
<td></td>
<td>Average number of development man days per prototype</td>
<td>15,5</td>
</tr>
</tbody>
</table>
## Size & effort

<table>
<thead>
<tr>
<th>DEGREE OF AUTOMATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of manually written SQL statements</td>
<td>17 (SQL constraints)</td>
</tr>
<tr>
<td><strong>Percentage of automatically generated SQL code</strong></td>
<td>96%</td>
</tr>
<tr>
<td>Number of manually written/adapted Java classes /JSP templates</td>
<td>10% JSP templates manually adapted</td>
</tr>
<tr>
<td><strong>Percentage of automatically generated Java and JSP code</strong></td>
<td>90% JSP templates, 100% Java classes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COST AND ROI</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost of software development of first version</td>
<td>75.000 €</td>
</tr>
<tr>
<td>HW, SW licenses, and connectivity cost of first version</td>
<td>70.000 € (db server license)</td>
</tr>
<tr>
<td>Return on investment of first version</td>
<td>12-15 months</td>
</tr>
<tr>
<td>Average effort of extension to one additional country</td>
<td>0.5 staff-months</td>
</tr>
<tr>
<td>Average cost of extension to one additional country</td>
<td>7.500 €</td>
</tr>
<tr>
<td>Average ROI of extension to one additional country</td>
<td>2 months</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRODUCTIVITY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of function points</td>
<td>177 (B2C web site) + 612 (CMS) = 789</td>
</tr>
<tr>
<td>Average number of function points delivered per staff-month</td>
<td>131.5</td>
</tr>
</tbody>
</table>
On the positive side:

- Almost 80% of the delivery effort concentrates in the phases of data design, hypertext design and prototyping:
  - more development time is spent with the application stakeholders

MDD allows a more flexible distribution of responsibilities between the IT department and the business units

The peak productivity rates has reached five times the number of delivered function points per staff-month of a traditional programming language like Java
On the negative side..

- Acer estimates that it took from 4 to 6 months to have fully productive developers with MDD, IFML, and WebRatio
- Difficult to find skilled people

..but..

- The initial investment in human capital required by MDD pays off in the mid term
  - MDD benefits testing, maintenance, and evolution (which account for over 60% of the total lifecycle cost)
  - reasoning on the system is far more effective at the conceptual level
Maintenance effort

Served Countries and Applications

- Number of developers
- Number of maintained applications
- Number of served countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
<th>Number of developers</th>
<th>Number of maintained applications</th>
<th>Number of served countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>4</td>
<td>4</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>2002</td>
<td>4</td>
<td>4</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>2003</td>
<td>4</td>
<td>4</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>2004</td>
<td>5</td>
<td>4</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>2005</td>
<td>5</td>
<td>4</td>
<td>31</td>
<td>5</td>
</tr>
</tbody>
</table>
• Public company owned by the City of Turin in Italy
• Local public transport serving 190 million passengers every year.
• A new e-ticketing system (available at http://ecommerce.gtt.to.it and serving 64,000 daily passengers)
• published on-line in only 2 months.
• The application comprises 100 page templates (IFML pages) and 1215 IFML units.
• KEY: iterative and quick prototyping approach supported by WebRatio
• Multi-utility company buying and selling wholesale electric power.

• Integrated Energy Management System that replaced individual productivity tools used by traders for the management of electric power.

• KEY: quick prototyping approach and involvement of actual users in the development process.

• Deployment of final app in 6 months after the initial meeting with WebRatio (time to market that took one-third of the time estimated in case of adoption of a traditional development)
Other experiences

- Banking (UniCredit)
  - BPM + SOA + Web interfaces
  - Crucial points: modularization, multiple models integration, multiple tools integration, strict runtime platform requirements

- Banking (ABI)
  - System integration (Pure backend!)
  - Why IFML?

- Latin America
  - Cooperatives, banks, public bodies, central government

- Wholesale (IKEA)

- Financial / leasing (GE Capital)
Where IFML works

- Models integration
- Large applications with strong need for coherence and standardized paradigms
  - Cooperatives, banks, public bodies, central government
- Service orientation
- No pure modeling exists
- Code generation still win-win
Components and pages per project
Components per page (avg)
Man/days per component
Man/days per page

![Graph showing man/days per page]

- Effort per project (man/days) vs. man/days per page
- Axis labels: 0", 0.2", 0.4", 0.6", 0.8", 1", 1.2"
## Tool usage stats

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td># of times the tool has been opened daily</td>
<td>1.79</td>
</tr>
<tr>
<td># of daily code generations</td>
<td>11.76</td>
</tr>
<tr>
<td># of 1-click generation and publishing of the application</td>
<td>0.26</td>
</tr>
<tr>
<td># of checks of the modelling warnings</td>
<td>2.09</td>
</tr>
<tr>
<td># of checks of graphical layout warning</td>
<td>0.11</td>
</tr>
<tr>
<td># of automatic generations of the documentation</td>
<td>0.02</td>
</tr>
</tbody>
</table>

http://www.modeldrivenstar.org

The brand new IFML book!
Morgan Kauffmann, OMG Press, USA
(some) references


Thanks!

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