Designing Mixed Interactive Systems: model-based approaches

French German Tangible Interaction Studio

August 2013

Emmanuel Dubois (Emmanuel.Dubois@irit.fr)

University of Toulouse

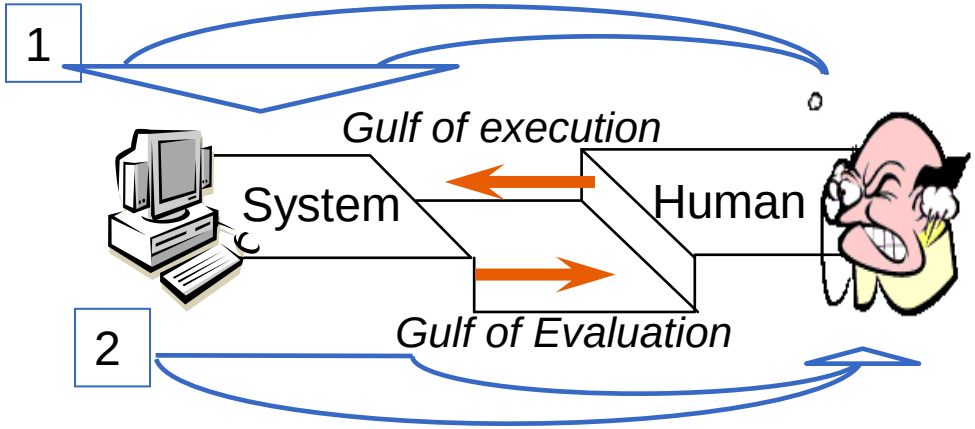
IRIT - Elipse

Goal of the talk

- To discuss where TUI are coming from
- To provide supports to describe, distinguish different forms of TUI
- To show how structured descriptions can contribute to TUI development

Bridging Norman's gaps (1/3)

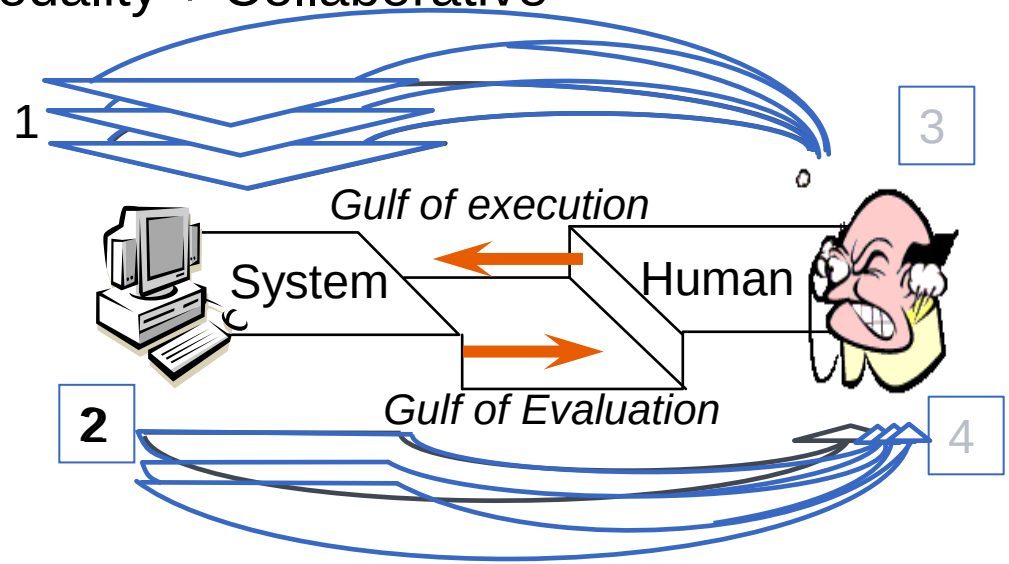
- Use of System capabilities (1, 2)
  - WIMP, Direct manipulation, GUI, Metaphor




```
mag       25123   0.0   0.3   4048 2060 pts/0    S+   07:50   0:00 ssh -X gondor
ray       25804   0.0   0.3   5092 1720 pts/3    Ss+  09:14   0:00 -tcsh
lag       25979   0.0   0.3   5600 1992 pts/4    Ss   09:28   0:00 -tcsh
lag       26001   0.0   0.3   3900 1832 pts/4    S+   09:28   0:00 ssh infere
edu       27651   0.0   0.3   5084 1712 pts/1    Ss   11:37   0:00 -csh
edu       27692   0.0   0.1   2508  880 pts/1    R+   11:38   0:00 ps -au
[edu          ~]$ ln -s ../../audit ./Soutenanceln -s ../../audit ./Soutenance
ln: when making multiple links, last argument must be a directory
[edu          ~]$ pwd
/home/edu
[edu          ~]$ ls
CESAME  CNRS05Save  RJCIHM04  squirrelmail  Templates  WEBMAIL  WWW  WWW_LIIHS
[edu          ~]$ ln -s ../../audit ./Soutenance
[edu          ~]$
```

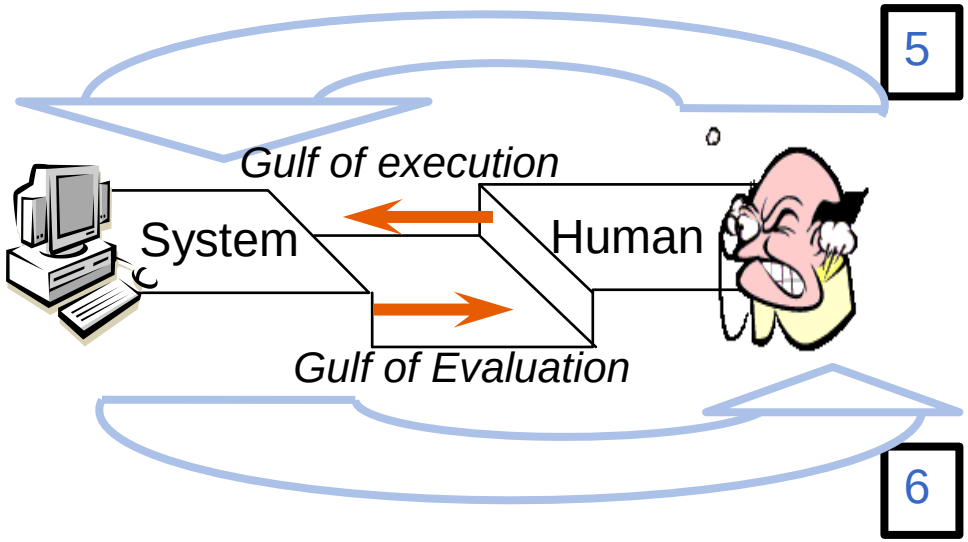
Bridging Norman's gaps (2/3)

- Increase amount and type of possible manipulations (3, 4)
  - ➔ Multimodality + Collaborative



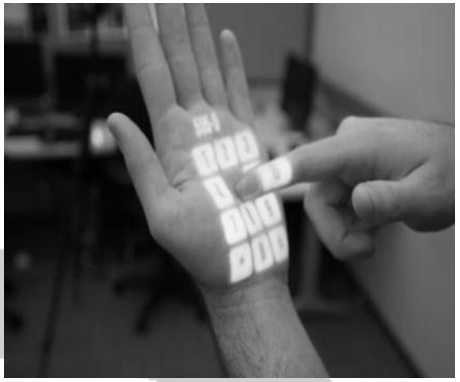
Bridging Norman's gaps (3/3)

- More intensive Use of Human abilities (5,6)
  - Context now integrates physical surroundings and aptitudes



➔ That's the Mixed Interactive Systems (MIS)

From Mouse to ~~mice~~ MIS



ulation

...

Gulf of Execution

Gulf of Evaluation

System

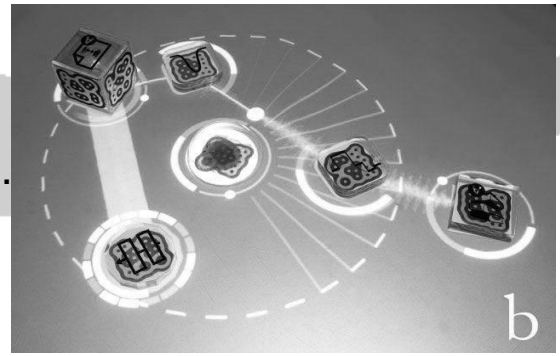
Interaction Space

User

- User
- Physical environment
- User's skills
- Physical artefacts
- Disabilities
- Constraints

Metaphor

Visualization

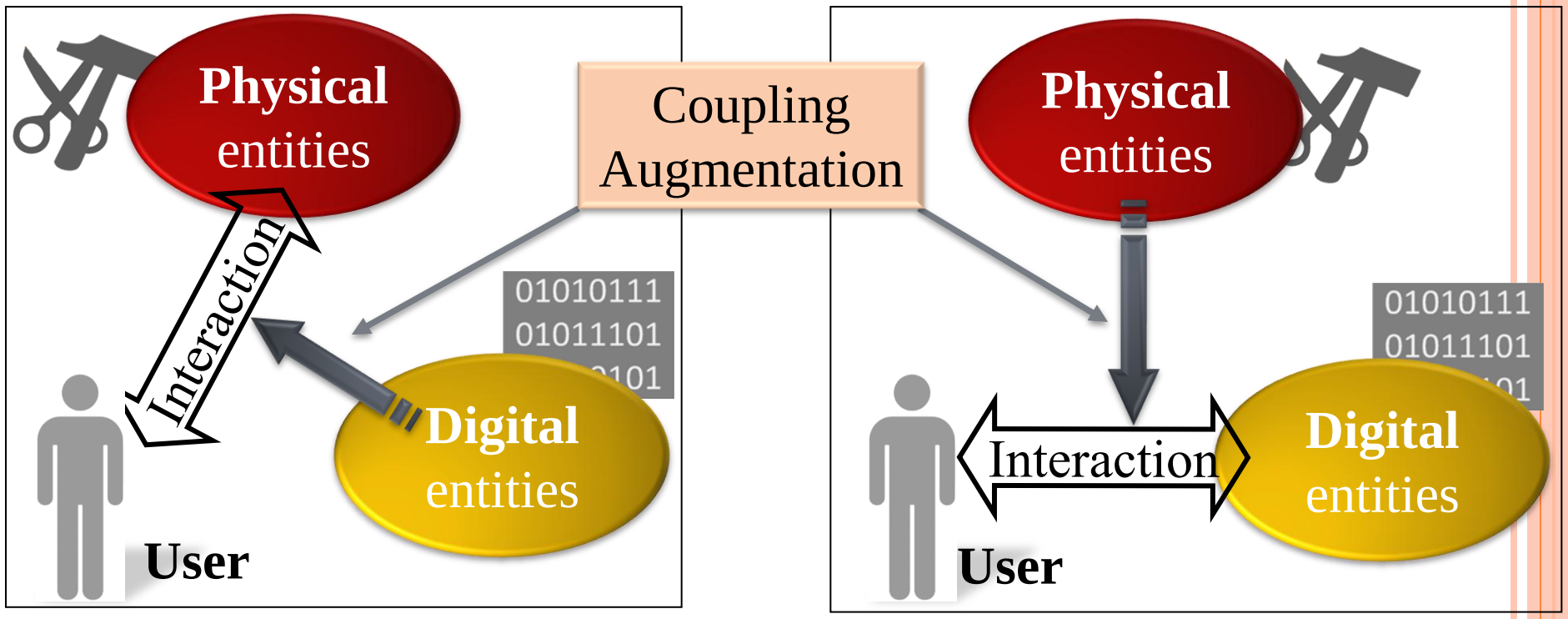


Mixed Interactive System: a definition

- Class of advanced interactive systems
- Merging physical and digital worlds
- In order to take advantage of
  - Computer system capabilities
  - Physical resources and user's abilities, skills,

- Generic terms used to designates
  - Context sensitive / augmented video
    AR, AV, MR, pervasive, …
    and Tangible User Interfaces

Two sub-classes of MIS



Augmented Reality

Augmented Virtuality

Application domains and examples

- Surgery, Maintenance, Architecture
- Education
- Storyboard support
- Games
- Services
  - US-Postal Service
  - Fashionista
- Advertisment
- Public applications
  - (tourist info, museum, shopping center)

Summary and requirements

- MIS advantages
  - Physicality becomes part of the loop
    - Extension of user's body
  - Physical objects are used to communicate
    - No need for a « disturbing » technological artefact for interacting
  - MIS involves everyday life parts of the real world
    - Intrisincally weaved into physical world
- MIS are more and more widely used

➔ Need for assisting the development of MIS to facilitate their design and implementation

Challenges

- At every step of an iterative design process
  - Analysing
    - Multiple stakeholder, unusual interaction techniques
  - Designing
    - Adapting existing HCI design resources
    - Addressing specific considerations
      - Physical environment, not only the user !
  - Prototyping / Implementation
    - Technology: New devices every day, new features
    - Software: Multiple languages, middleware, communication protocol
  - Evaluating
    - Which properties ? Which criteria ? Which measures ?

Existing design support: HCI tools

- Task analysis
  - Very little attention paid to the identification and description of potentially involved physical entities.
- UML and numerous extensions (UMLi, UIML)
  - Not really appropriate for HCI modelling
  - Physical world only depicted through actors
- Prototyping / Participatory Design :
  - No support for reusing the designed solution

➔ Ensure a user oriented approach,
but need adaptation or new resources

Existing design support: practical approaches

- Aims at supporting the implementation of the interaction techniques
- Platforms to handle aspects specific to MIS runtime
  - DART, - McIntyre'04
  - Amire – Grimm'02
  - Studierstube – Schmalstieg'02
- API to easily implement « emerging » devices
  - Phidget - Arduino
  - ArToolkit, Kinnect
  - Leap motion

➔ Proofs of technological feasibility

Existing design support: abstract approaches

- Describing physical properties
  - Knowledge related to real / physical consideration (RBI framework, [Jacob'08])
  - Place and role of human body ([Klemmer'06])
  - Relation among physical objects involved (TAC paradigm, [Shaer'04])
- Describing interaction elements
  - Metaphors ([Fishkin'04])
  - Involved artefacts, relationships and attributes ([Trevisan'08, Chalon'04, Dubois'03])
- Describing mechanisms underlying the mixed interaction
  - Input / Output devices (APRIL, [Ledermann'05])
  - Required interaction modalities (MIM, [Coutix'06])
  - Data flow in haptic interactions (Flow Nets, [Smith'06])
- Describing links among design models
  - Linking human abilities / devices / task models to appropriately combine them ([Klug'07])
  - Linking story-boards with real situations
  - to improve the transfer from design to implementation (DART, [MacIntyre'04])

➔ Provide a structured overview of the domain

ELIPSE SYNTHESIS

- Many design supports exist
  - Different goals: overview, HCI, system
  - Different considerations

    … almost always separately used !

- And yet ...

  ... potential benefits of a modelling approach
  - No longer relying only on the emergence of new technologies
  - Offering a sort of reference language
  - Identifying key criteria for comparing, generating, evaluating MIS
  - Structuring the use of the existing approaches by pinpointing the area of relevance for each of them
  - Providing a development support (design, implement, evaluate)
    - Contribute to the maturity of the domain
    - Better combine complementary design ressources

Facing two questions !

- Which properties are worth considering ?
  - Review of design questions and illustration
  - The ASUR model
- How to integrate a model in a design process ?
  - Illustration of links among models

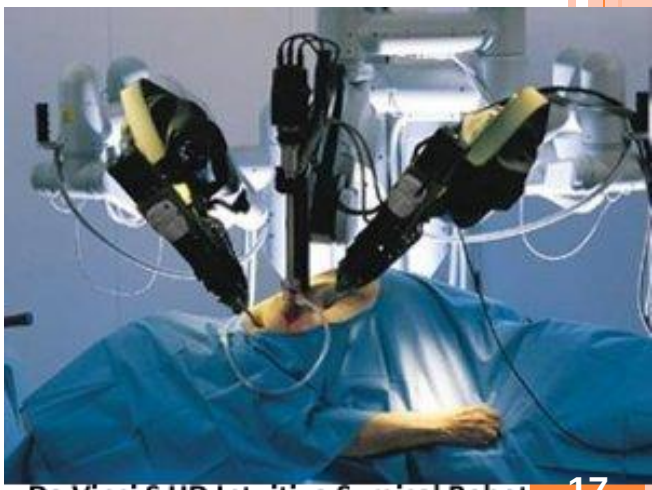
Design Questions in MIS (1)

- Which physical aspects can be integrated / used / impacted
  - In input :
    - get a position / presence, orientation / motion, get an ID / recognise something, detect a sound/a form, etc..
  - In output :
    - add information in a context, move or restrain object, trigger an action

Car navigation system, Extracted from Sawano - SIGGRAPH'05


AudioCube, Extracted from Schiettecatte - TEI'08


Extracted fromHosokawa - TEI'08

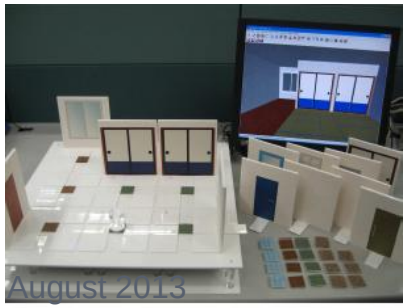

Da Vinci S HD Intuitive Surgical Robot, Surgical Endoscopy, 2009-23(2)

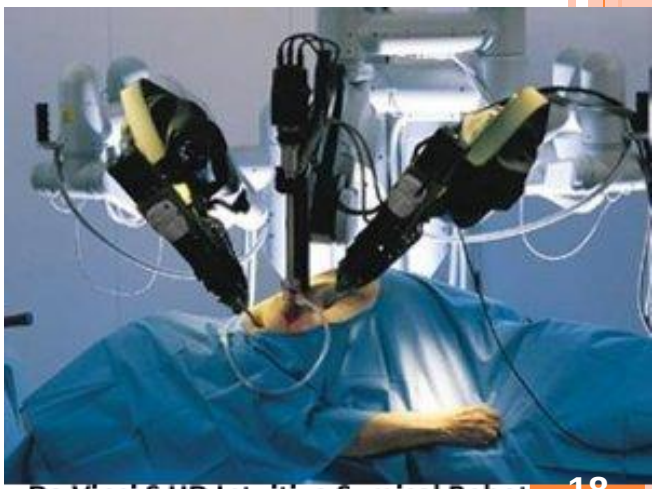
Design Questions in MIS (2)

- How can the physical world be sensed / affected
  - Input:
    - magnetic field (presence, intensity, thresholds), visual fields (images, motions, colours), sound (words, music, noise)
  - Output:
    - visual (text, image, pictures, graphics), sound (speech, sound, noise), gesture

Car navigation system, Extracted from Sawano - SIGGRAPH'05


AudioCube, Extracted from Schiettecatte - TEI'08


Extracted fromHosokawa - TEI'08


Da Vinci S HD Intuitive Surgical Robot, Surgical Endoscopy, 2009-23(2)

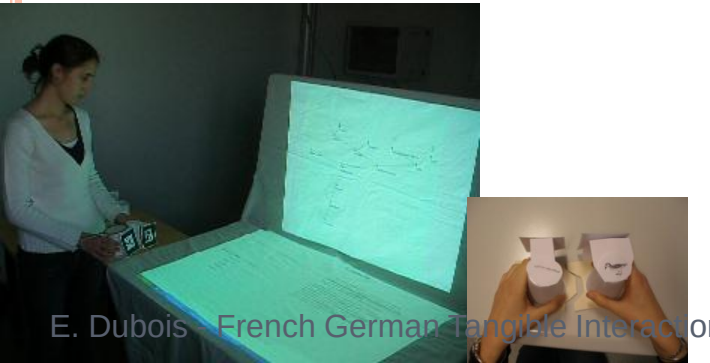
Design Questions in MIS (3)

- Degree of consistency between Input and Output interaction space: interaction space settings
  - Same or different input and output interaction space
  - High / Low focus required to the input space

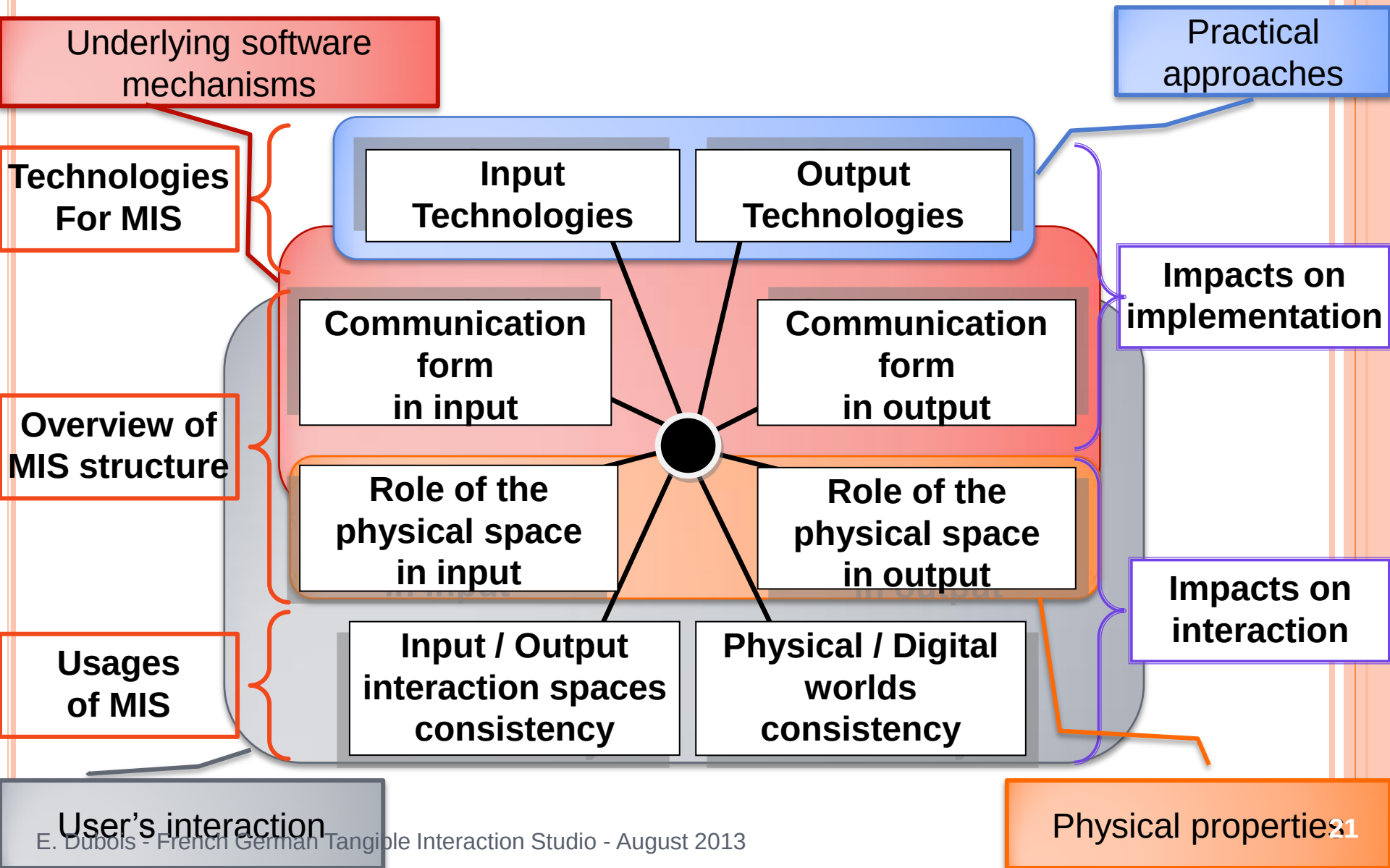
	Input Space = Output Space	**Input Space ≠ Output Space**
Low reference to Input Space		
High Reference to Input Space		

Design Questions in MIS (4)

- Consistency between physical and digital worlds = forms of links
  - Input representation similar/different from output representation
  - Input behaviour similar/different from output behaviour



Design questions vs. Design supports

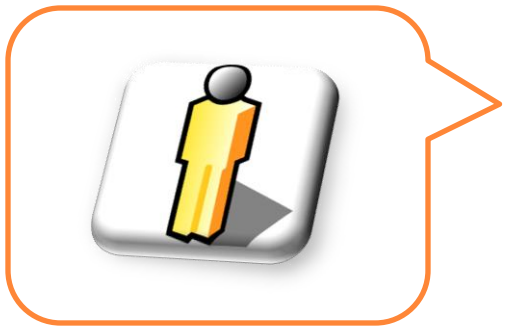


The ASUR Approach

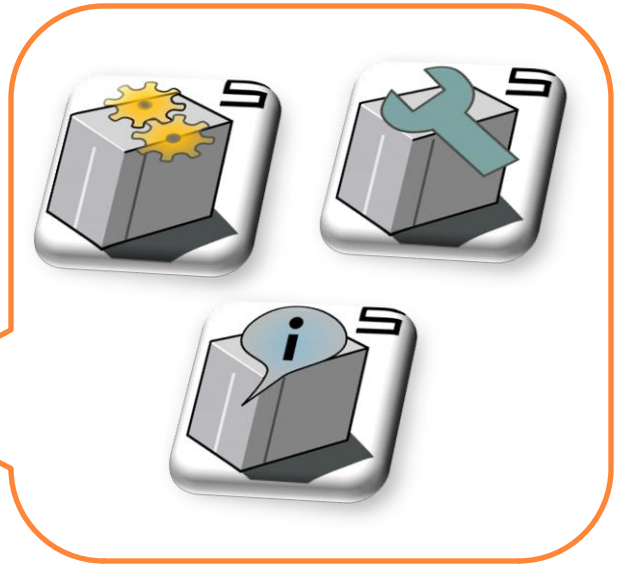
- Describing the user's interaction with a MIS when performing a given task
  - Requirement : identify the object of the task, the real focus
    - Physical or digital
- Characterizing the elements involved
  - Role and nature of physical artifacts
  - Physical – Digital links
  - Technological attributes
- Supporting links with existing design resources
  - Task analysis, implementation, ergonomic criteria

ASUR MODEL: COMPONENTS

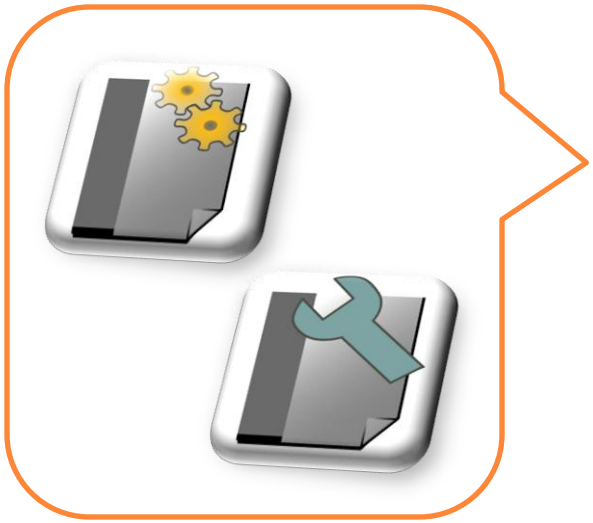
➔ **Role of the physical space**



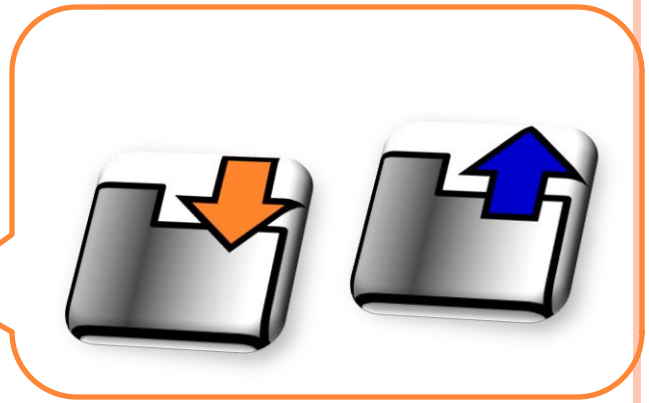
User
(U)



Digital
entities
(S)



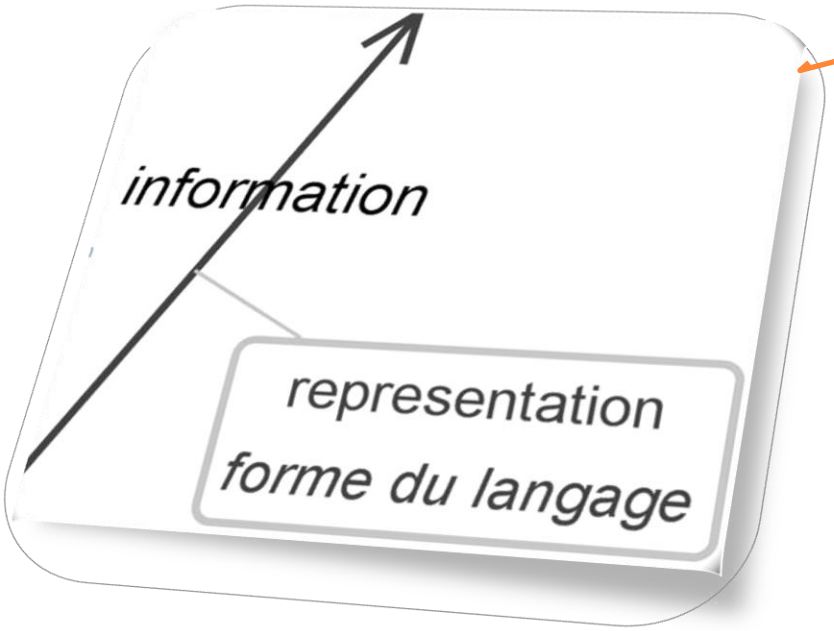
Physical
entities
(R)



Adapters
(*sensors, effectors*)
(A)

ASUR MODEL: INFORMATION FLOWS

➔ **Communication forms**



information : which data is transmitted?

representation : image satellite, coordinates, manipulation, …

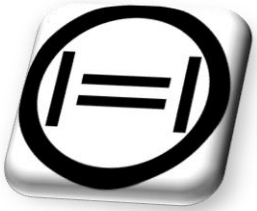
Language form: numerical, position, textual, …

medium : light, force, pressure, digital, …

dimension : 1D, 2D, 3D, …

ASUR MODEL: GROUPING MECHANISMS

➔ **Consistencies**



Physical proximity: 2 physical entities are physically constrained

Example : the camera is fixed on the table

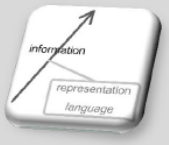
Mixed proximity: a digital entity is the tight representation of a given physical entity

exemple : the physical cube represents the volume of data

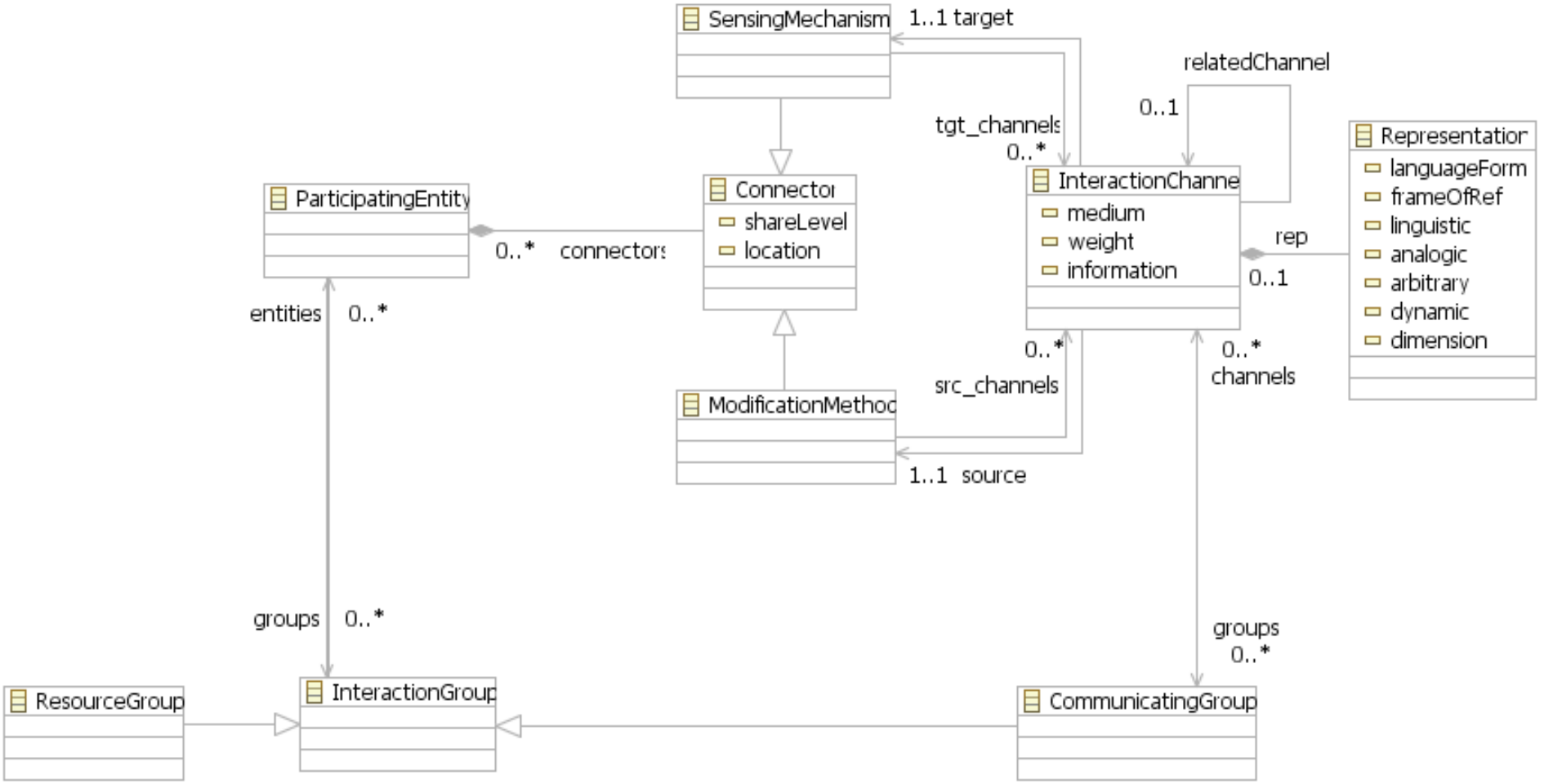
Trigger : under a specific physical condition, a specific information flow is triggered

exemple : narrowing the book from the screen opens the translator

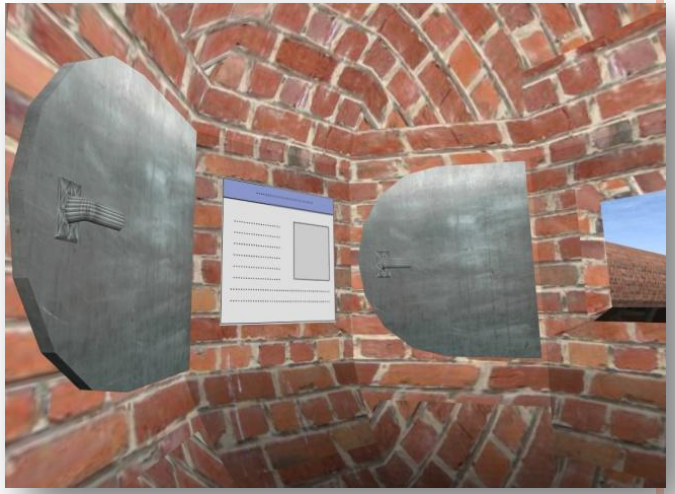
ASUR IN BRIEF…

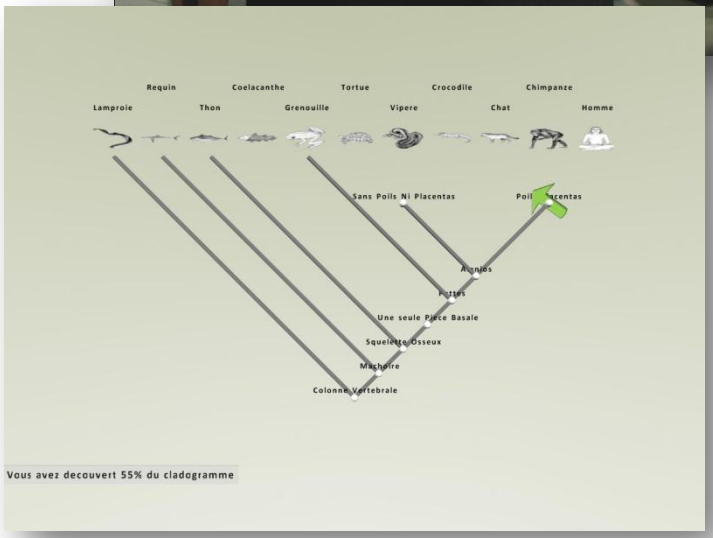
	**Utilisateur** *du système*		**Proximité mixte** *(un élément numérique et un élément physique se comporte de manière identique)* *Exemple : la tasse à café représente le pointeur à l'écran*
	**Objet Physique Central** *(sans lequel la tâche n'a pas de sens)* *Exemple : document papier à compléter, maquette, …*		**Proximité physique** *(2 éléments physiques sont solidaires)* *Exemple : la camera est fixée sur la lampe torche*
	***Outil Physique, instrument*** *Exemple : stylo, aiguille, lampe torche, tasse a café, …*		**Action** *(Si 2 éléments se rapprochent une action est déclenchée)* *Exemple : rapprocher le livre de l'écran exécute le traducteur*
	**Capteur** *(Dispositif d'interaction en entrée du système)* *Exemple : camera, capteurs divers, …*		**Effecteur** *(Dispositif d'interaction en sortie du système)* *Exemple : écran, haut-parleur, bras haptique, …*
	**Objet numérique Central** *(sans lequel la tâche n'a pas de sens)* *Exemple : environnement virtuel, film vidéo, musique…*		**Flux d'information** *(nom d'une tache, d'une information)* *Représentation : Déplacement, graphe, scène 3D, …* *Medium : lumière, force, pression, numérique, …* *Langage : geste, mouvement, entier, texte, …* *Dimension : 1D, 2D, 3D, …*
	**Outil numérique** *(capable de traiter l'information)* *Exemple : calculateur, convertisseur, générateur, …*		***Organe de perception / mécanisme de capture*** *Exemple utilisateur : oreilles, peau, yeux, …* *Exemple : lentille, capteur piézoélectrique, …*
	***Information numérique*** *Exemple : feedback, information numérique diverse, …*		***Organe d'action / mécanisme d'action*** *Exemple utilisateur : bras, jambes, doigts, bouche, …* *Exemple : moteur, ressort, vibreur, …*

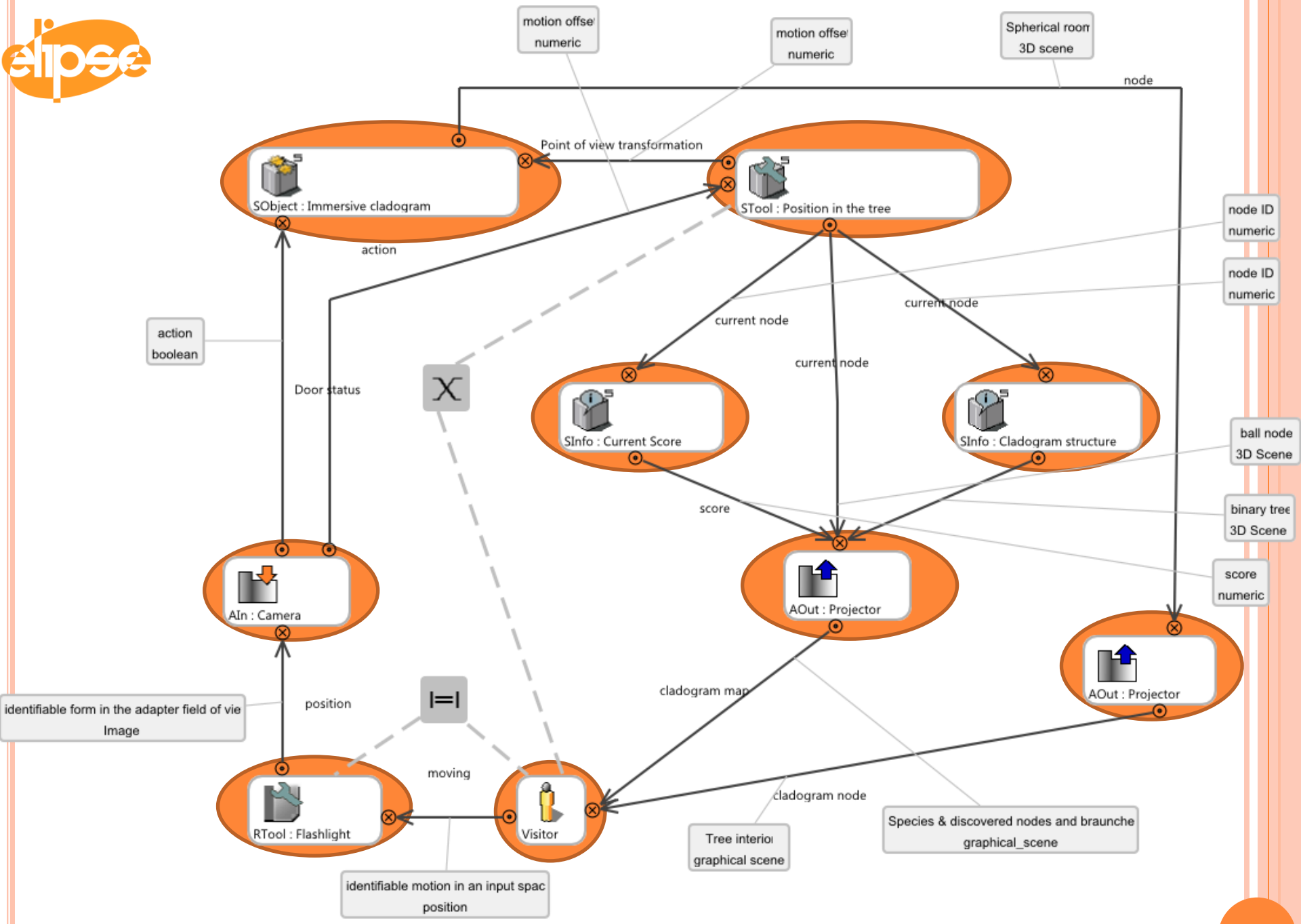
… AND IN DETAIL !



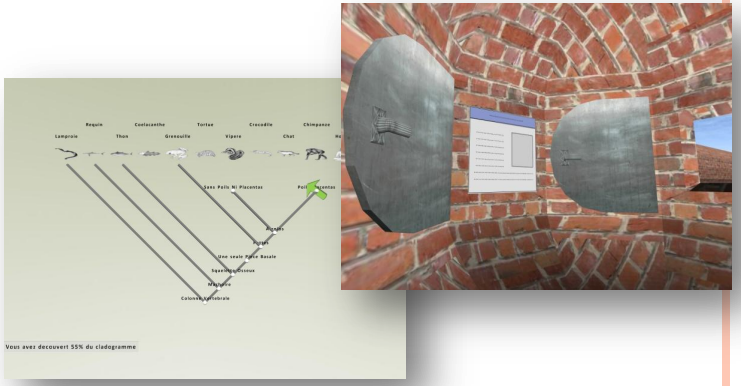
Example : museographic application

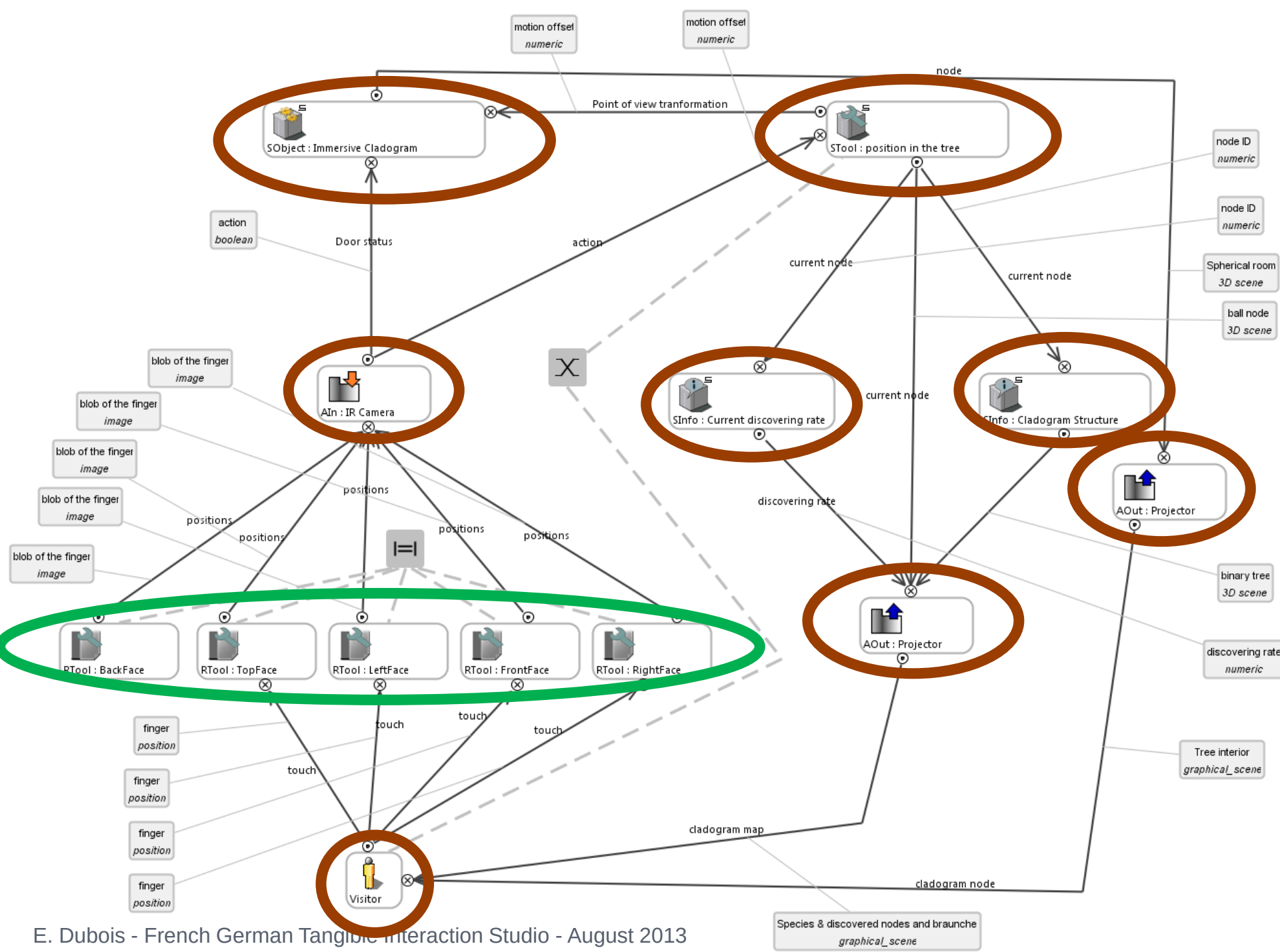





motion offse
numeric
motion offse
numeric
Spherical roon
3D scene
node
Point of view transformation
SObject : Immersive cladogram
STool : Position in the tree
action
node ID
numeric
node ID
numeric
current node
current node
current node
action
boolean
Door status
SInfo : Current Score
SInfo : Cladogram structure
ball node
3D Scene
score
binary tree
3D Scene
score
numeric
AIn : Camera
AOut : Projector
AOut : Projector
cladogram map
position
identifiable form in the adapter field of vie
Image
moving
RTool : Flashlight
Visitor
cladogram node
Tree interio
graphical scene
Species & discovered nodes and braunche
graphical_scene
identifiable motion in an input spac
position

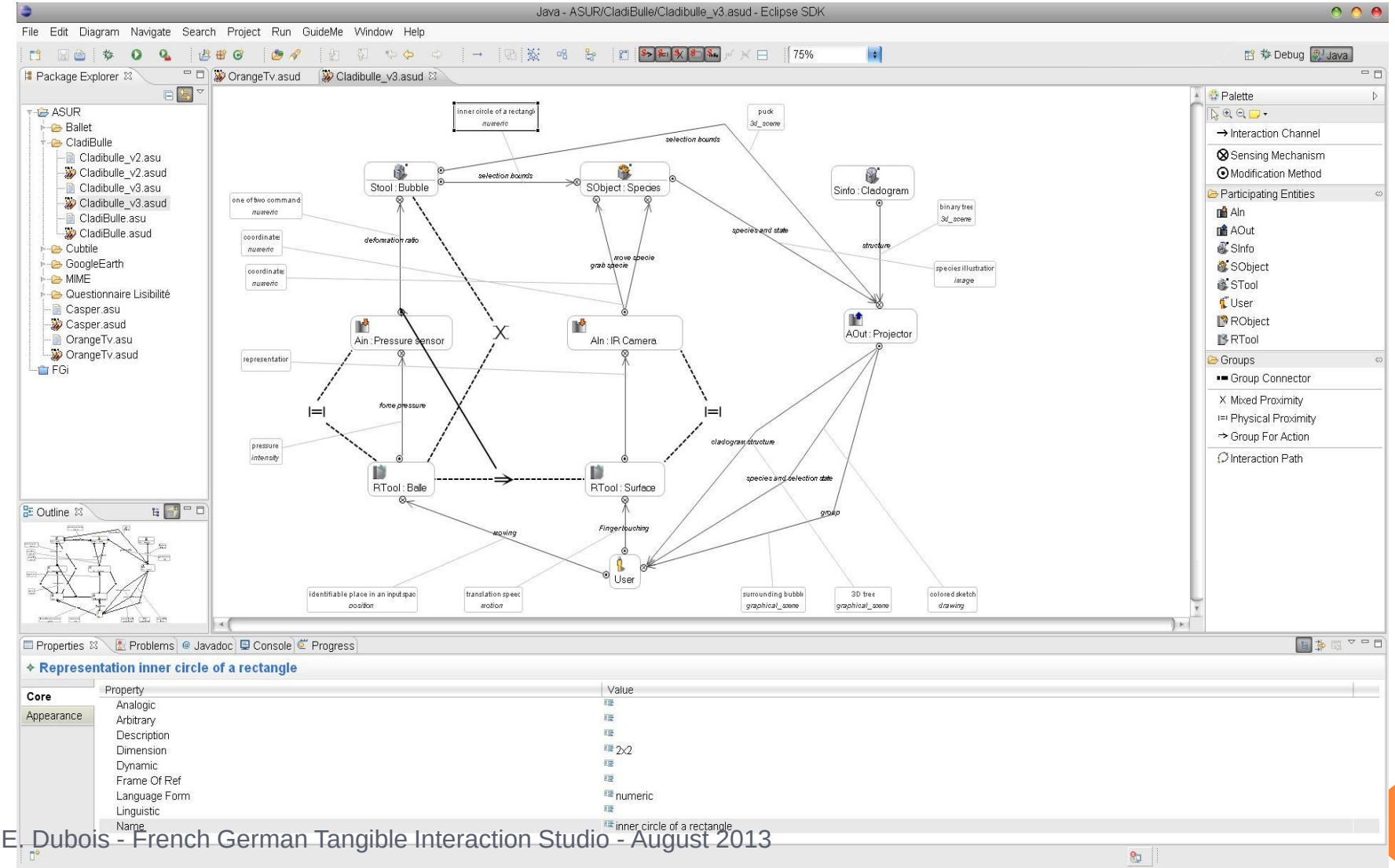
EXAMPLE : MUSEOGRAPHIC APPLICATION




motion offset
numeric
motion offset
numeric
node
Point of view tranformation
SObject : Immersive Cladogram
STool : position in the tree
node ID
numeric
node ID
numeric
action
boolean
Door status
action
current node
current node
Spherical room
3D scene
ball node
3D scene
blob of the finger
image
blob of the finger
image
blob of the finger
image
blob of the finger
image
blob of the finger
image
AIn : IR Camera
SInfo : Current discovering rate
current node
SInfo : Cladogram Structure
AOut : Projector
positions
positions
positions
positions
positions
discovering rate
binary tree
3D scene
RTool : BackFace
RTool : TopFace
RTool : LeftFace
RTool : FrontFace
RTool : RightFace
AOut : Projector
discovering rate
numeric
touch
touch
touch
touch
finger
position
finger
position
finger
position
finger
position
Tree interior
graphical_scene
cladogram map
cladogram node
Visitor
Species & discovered nodes and braunche
graphical_scene

ASUR MODEL: AN INTERACTIVE TOOL

- http://irit.fr/recherches/ELIPSE/guideme/



ASUR MODEL: CONCLUSION

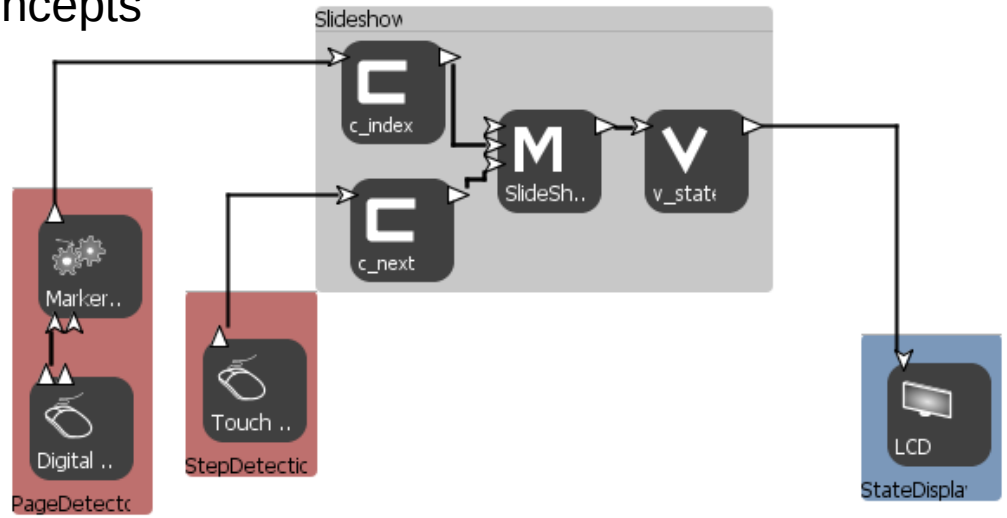
- Benefits
  - Structured view of the entities and their mutual relations
  - Emphasize the different design questions of MIS
  - Flexibility of use: iterative refinment of the model along the design (entities, flow, attributes)

- Limits
  - Not explicitely multi-users
  - Task identification: subject to designer
  - Static view on the entities involved: a snapshot of the MIS
  - Limited to the user's interaction level

What about the software considerations ?

Software design level: an additional model

- The ASUR-IL model [Gauffre 08, Gauffre 10]
  - Design the software architecture of a MIS that conforms to the ASUR model of the user's interaction with the MIS
  - Approach
    - Reuses component-based concepts (component, port, data flow)
      → portability
    - Promotes the distinction between functional core (M) and interaction (C+V)
      → reusability
    - Ensures a clear separation between input / output
      → physical/digital link

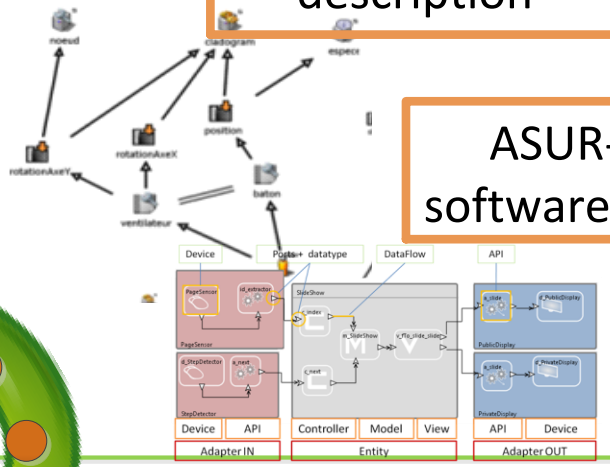


Integrating a modelling approach in an iterative design process

Analysis

Design

ASUR model: user's interaction description



ASUR-IL model: software architecture

Evaluation

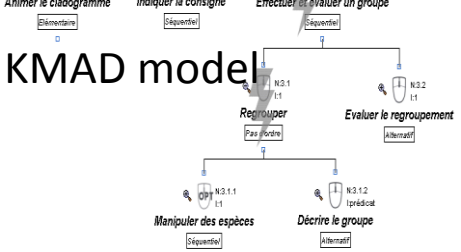
Implementation

Integrating a modelling approach in an iterative design process

Analysis

Museographic application

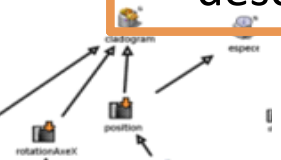
KMAD model



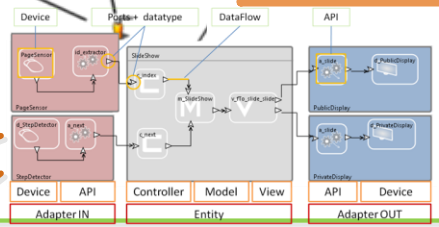
MACS : generating ideas

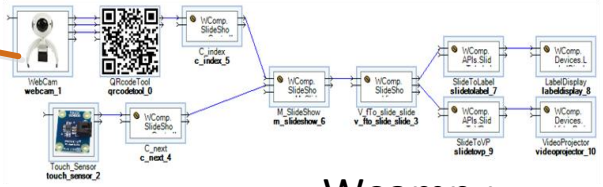
Design

ASUR model: user's interaction description



ASUR-IL model: software architecture





Wcomp : prototyping platform

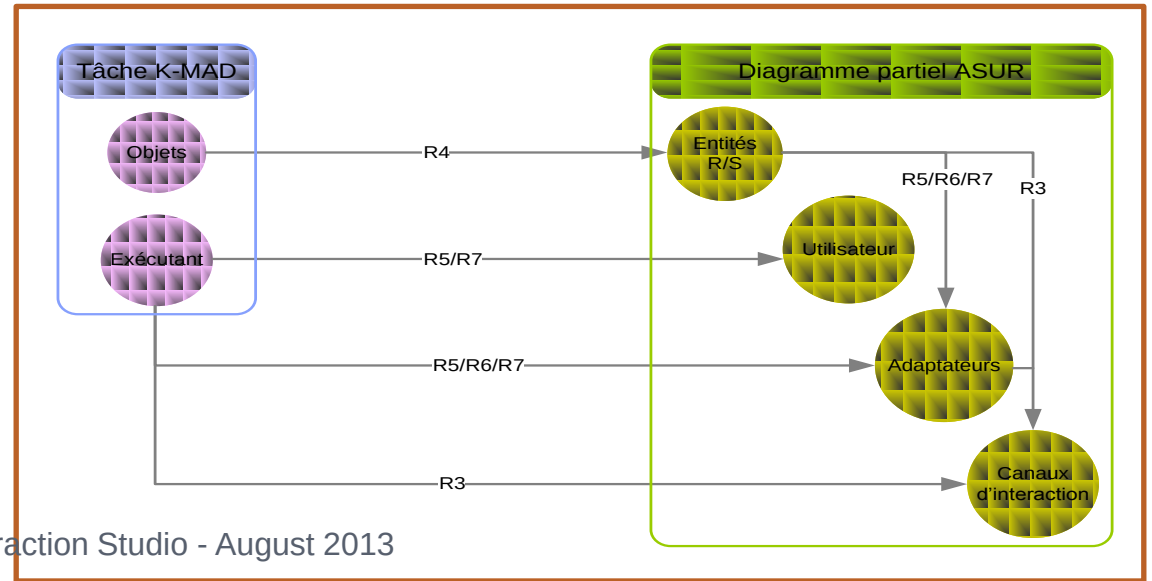
Ergonomic recommendations for MIS

Evaluation

Implementation

Linking Analysis to Interaction design (1/2)

- Goal
  - Mapping identified requirements with interaction design elements
- Mechanism: coupling KMAD – ASUR
  - Translate KMAD elements into ASUR elements
  - Based on rules + algorithm

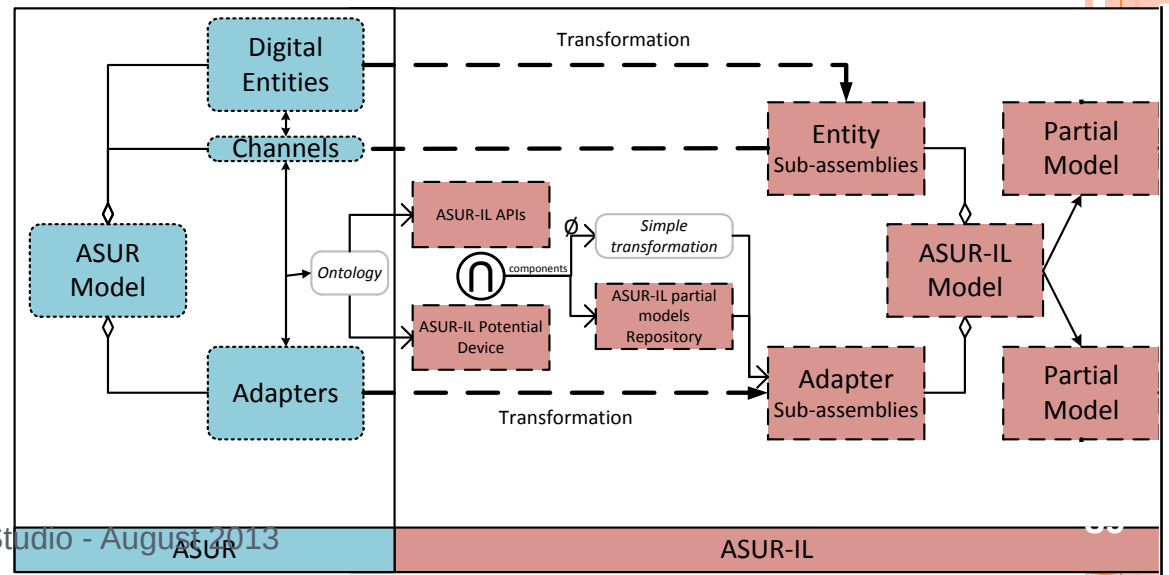


Linking Analysis to Interaction design (2/2)

- Goal
  - Inserting the use of a model in Brainstorming session to stimulate idea generation (ideation)
- Mechanism
  - Coupling a creativity session – ASUR
    - Stimulate the creativity through manipulation of a model
    - Based on steps, guidelines of use
- Interests
  - Suggest dimensions to modify,
  - Provide a reference language and representation
  - Facilitate the use of the generated solutions in the rest of the development process
    - Encoded in a formal language

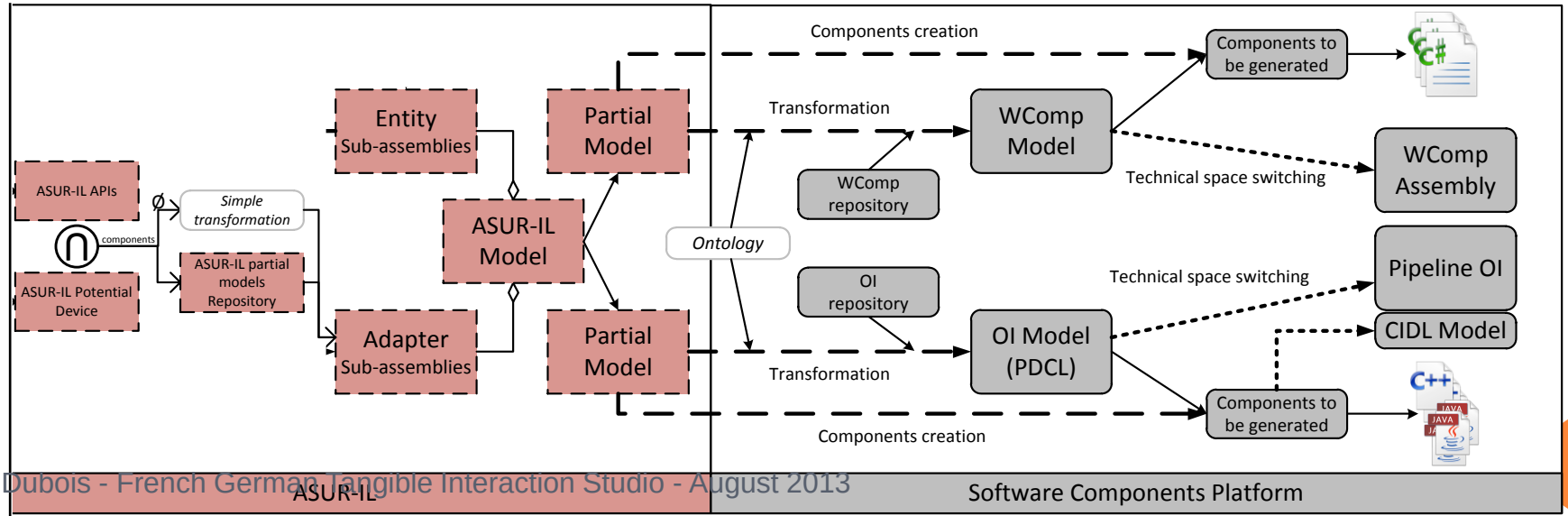
Linking Interaction design to software architecture design

- Goals
  - Generate
    part of a structured set of
    required software elements,
    from
    the abstract specification of
    the user's interaction
  - Tightly coupling
    software design
    decisions
    into interaction
    design results
- Mechanisms
  - Model transformations (ATL)
  - Ontology ASUR / ASUR-IL



Linking Software architecture design to software implementation

- Goals
  - Partial code-generation of a running prototype, based on software architecture description
- Mechanisms
  - Model transformations (ATL)
  - Code generation
    - Software assembly
    - Component interfaces
  - Ontology ASUR-IL / WCOMP or OI



What about evaluation?

- Goal
  - Structuring evaluation results
  - Guiding the design with ergonomic recommendations
  - Linking evaluation results with parts of the modeled design
    - At any appropriate level
- Approaches
  - Formating usability recommendations
    - Context: ex. Domain
    - System characteristics : ex. mobile
    - Situation: ex. Task
    - Interaction mode : ex. Device
    - Data measurement type : ex. Preferences
  - Manual linking with model elements or attributes
    - ➔ Web site : http://www.irit.fr/recherches/ELIPSE/RESIM/)

Conclusion

- MIS = promising form of interaction
  - Public settings
  - Combined with smartphone and its multiple sensors
- Many models useful for their design
  - To describe in a structured way, at different levels
  - To compare proposed solutions
  - To suggest attributes of interest
- Linking mechanisms required
  - To combine and take advantage of the different considerations
  - To create an appropriate chain of models at design time

Opened questions

- Need for MIS models specific to
  - Application domains?
  - Aspects of the mixed interaction ?
    - Software / interaction
    - Physical gestures ?
    - Objects properties?
- Evaluation and validation of model based approach
  - Link with existing design models
  - 3 benefits of a model: describe, compare, generate
  - “Readability” / Understandability of a model
  - Impact on the « quality » of resulting prototypes
    - Quality = usability ? Originality ?

REFERENCES

- Chalon, 2004. Réalité mixte et Travail Collaboratif : IRVO, un modèle de l'interaction Homme-Machine, Thèse de doctorat, décembre 2004
- Coutrix C, Nigay L (2006) Mixed reality: a model of mixed interaction. In Proceedings of the Working Conference on Advanced Visual interfaces (Venezia, Italy, May 23 - 26, 2006). AVI '06. ACM, New York, NY, 43-50.
- Dubois E, Gray P, Nigay L. *ASUR++: Supporting the Design of Mobile Mixed Systems.*Dans : *Interacting With Computers, Special issue on Mobile HCI*, Paterno, F.,, IST - CNR, Pisa - Italy, Vol. 15, p. 497-520, 2003.
- Fishkin K P (2004) A taxonomy for and analysis of tangible interfaces. Personal and Ubiquitous Comput 8(5): Springer Verlag, p. 347-358.
- Grimm, P., Haller, M., Paelke, V., Reinhlod, S., Reimann, C., & Zauner, J. (2002). AMIRE - Authoring Mixed Reality. Dans *First IEEE International Augmented Reality Toolkit Workshop*. Darmstadt, Germny, 2 pages, 2002
- Jacob R J, Girouard A, Hirshfield L M, Horn M S, Shaer O, Solovey E T, Zigelbaum J (2008) Reality-based interaction: a framework for post-WIMP interfaces. In Proc. of the ACM conference on CHI'08, Italy, ACM, New York, pp. 201-210
- Klemmer S R, Hartmann B, Takayama L, How bodies matter: five themes for interaction design. In Proceedings of the 6th Conference on Designing interactive Systems (University Park, PA, June 26 - 28, 2006). DIS '06. ACM, New York, NY, (2006), 140-149.
- Klug T, Mülhauser M (2007) Modeling Human Interaction Ressources to Support the design of Wearable Multimodal Systems, in Proc. of the ACM conf. on ICMI'07, Japan, p 299 – 306.
- Norman, D. A., & Draper, S. W. (1986). User Centered System Design: New Perspectives on Human-computer Interaction (1er éd., p. 526). CRC
- MacIntyre B, Gandy M, Dow S, Bolter J D (2004) DART: a toolkit for rapid design exploration of augmented reality experiences. In Proceedings of the ACM Symposium on UIST'04, USA, ACM, New York, 197-206
- Shaer O, Leland N, Calvillo-Gamez E H, Jacob R J K (2004) The TAC paradigm: specifying tangible user interfaces. Personal and Ubiquitous Computing, 359-369.
- Smith S P (2006) Exploring the Specification of Haptic Interaction, in 13th International Workshop, DSVIS 2006, Ireland, LNCS vol. 4323, Springer Berlin, pp. 171-184.
- Ledermann, F., Schmalstieg, D.. April a high-level framework for creating augmented reality presentations. In VR '05 : Proceedings of the 2005 IEEE Conference 2005 on Virtual Reality, pages 187–194, Washington, DC, USA, 2005. IEEE Computer Society.
- Schmalstieg D, Fuhrmann A, Hesina G, Szalavári Z, Encarnaçäo L M, Gervautz M, Purgathofer W (2002) The studierstube augmented reality project. Presence: Teleoper. Virtual Environ. 11, 1 (Feb. 2002), pp. 33-54
- Trevisan, D.G., Nedel, L. P., Macq, B., Augmented vision for medical applications. In SAC '08: Proceedings of the 2008 ACM symposium on Applied computing, pages 1415–1419, New York, NY, USA, 2008. ACM
- Phidget: http://www.phidgets.com/
- Arduino: http://www.arduino.cc/
- Leap Motion: https://www.leapmotion.com/
- Kmade: http://kmade.sourceforge.net/

REFERENCES

- ASUR modeling approach
  - Metamodel ASUR
    - Guillaume Gauffre, Emmanuel Dubois. Taking Advantage of Model-Driven Engineering Foundations for Mixed Interaction Design. Dans : Model Driven Develoment of Advanced User Interfaces. H Hussmann, G Meixner, D Zuehlke (Eds.), Springer-Verlag, 4.1.3, p. 219-240, Vol. 340, Studies in Computational Intelligence, 1, 2011
  - Creativity and models
    - Christophe Bortolaso, Cédric Bach, Emmanuel Dubois. *MACS: A combination of a Formal Mixed Interaction Model with an Informal Creative Session (regular paper).* Dans : *ACM SIGCHI conference Engineering Interactive Computing Systems (EICS 2011)*, *Pise, Italy*, *13/06/11-16/06/11*, Fabio Paterno, Kris Luyten, Frank Maurer (Eds.), ACM SIGCHI, p. 63-72, juin 2011.
    - Christophe Bortolaso, Emmanuel Dubois. *Model Assisted Creativity Sessions for the Design of Mixed Interactive Systems: a Protocol Analysis (regular paper).* Dans : *IFIP TC 13 International Conference on Human-Computer Interaction*, *Cap Town, South Africa*, *02/09/2013-06/09/2013*, Paul Kotze, Janet Wesson (Eds.), Springer, p. 1-18, 2013
  - Software implementation
    - Emmanuel Dubois, Christophe Bortolaso, Damien Appert, Guillaume Gauffre. An MDE-based framework to support the development of Mixed Interactive Systems. Dans : Science of Computer Programming,Elsevier, Numéro spécial Success Stories in Model Driven Engineering, 2013
    - Guillaume Gauffre, Emmanuel Dubois, Rémi Bastide. Domain-Specific Methods and Tools for the Design of Advanced Interactive Techniques. Dans : Models in Software Engineering. Holger Giese (Eds.), Springer, p. 65-76, Vol. 5002, Lecture Notes in Computer Science, juin 2008.
  - Ergonomic Recommendations
    - Emmanuel Dubois, Dominique L. Scapin, Syrine Charfi, Christophe Bortolaso. Usability Recommendations for Mixed Interactive Systems: extraction and integration in a design process. Dans : Human factors in augmented reality environments. T Huang, L Alem, M Livingston (Eds.), Springer USA, 8, p. 181-199, Vol. X, 1, 2013.
    - Syrine Charfi, Emmanuel Dubois, Dominique L. Scapin. Usability Recommendations in the Design of Mixed Interactive Systems (short paper). Dans : ACM SIGCHI conference Engineering Interactive Computing Systems (EICS 2009), Pittsburgh, PA, USA, 14/07/09-17/07/09, Philip Gray, Gaelle Calvary (Eds.), ACM, p. 231-236, 2009.
  - Link with task model
    - Syrine Charfi, Emmanuel Dubois, Rémi Bastide. Articulating Interaction and Task Models for the Design of Advanced Interactive Systems. Dans : TAsk MOdels DIAgrams for UI design (TAMODIA 2007), Toulouse,07/11/07-09/11/07, Vol. 4849, Springer, LNCS, p. 70-83, novembre 2007.
  - Illustration
    - Christophe Bortolaso, Emmanuel Dubois, Francis Duranthon, Cédric Bach. *Co-Design of Interactive Museographic Exhibits: the MIME case study. (regular paper).* Dans : *Re-Thinking Technology in Museums*, *Limerick, Irland*, *26/05/11-27/05/11*, Luigina Ciolfi, Katherine Scott, Sara Barbieri (Eds.),University of Limerick, p. 37-48, mai 2011
    - Guillaume Gauffre, Syrine Charfi, Christophe Bortolaso, Cédric Bach, Emmanuel Dubois. Developing Mixed Interactive Systems: a Model Based Process for Generating and Managing Design Solutions. Dans : The Engineering of Mixed Reality Systems. Emmanuel Dubois, Philip Gray, Laurence Nigay (Eds.), Springer-Verlag, 10, p. 183-208, Vol. 14, HCI Series, 2010.

Ressources

- MIS repository
  - Models, code, user test results, picture and video of some of our MIS applications
  - http://www.irit.fr/recherches/ELIPSE/guideme/repository/
- GuideMe
  - Tool set for ASUR and ASUR transformations
  - http://irit.fr/recherches/ELIPSE/guideme/
- RESIM
  - Ergonomic Recommendations structured according to ASUR elements
  - http://irit.fr/recherches/ELIPSE/resim/RESIMcible.php

Designing Mixed Interactive Systems: model-based approaches

French German Tangible Interaction Studio

August 2013

Emmanuel Dubois (Emmanuel.Dubois@irit.fr)

University of Toulouse

IRIT - Elipse