# Distributed Asymmetric Simulation — Enhancing Participatory Simulation Using the Concept of *Habitus*

Nicolas Becu, Nathalie Frascaria-Lacoste, Julie Latune

**Abstract**
This paper presents a novel way to conceptualize and implement *roles* in computer-assisted participatory simulation. In distributed asymmetric simulation, attention is paid to how tasks, information and perception of the environment are distributed among the different *roles* of the simulation. The innovation lies in the fact that we use the concept of *Habitus* defined by Bourdieu to guide us when distributing features to *roles*. It implies to define for each role a specific simulation environment (visualization, access to information, possible actions) that fits his objective and forces the participant to follow particular action rationales towards the environment. This results in a type of participatory simulation that amplifies the effect of decentering (change of perspective) experienced by participants of a session. It encourages them to deal with plural perspectives and a diversity of representations of the same system. The concept was tested and implemented in an application called NewDistrict. This participatory simulation tool is addressed to an audience concerned by urban development projects and aims to facilitate collective learning on the effects of peri-urbanization on biodiversity. Preliminary results show that it fosters awareness and understanding about differences between the action rationales of *roles* towards the environment. Considering how distant stakeholders' perceptions may be regarding environmental management, we think that distributed asymmetric simulation is especially well suited to applications in the domain of Human-Nature relationship.

**Keywords**
participatory simulation, role-playing game, asymmetric gameplay, biodiversity

## 1 Participatory simulation and asymmetry between participants

In participatory simulation many applications use the concept of asymmetry and *roles* to facilitate the learning by participants (Barreteau, Le Page & Perez, 2007).

The first section is a proposal to differentiate different types of asymmetry between participants that can be found. The aim is to define a use case of asymmetry that allows us to conceptualize the concept of *Habitus* which we present in the second section.

### 1.1 Types of asymmetry

Participatory simulation is a method used to allow a group of participants to a simulation session to immerse themselves in a virtual reality and to test different collective action strategies to solve a problem presented to them (In the remainder of this paper we will use the term *participant* exclusively to refer to person who participate to a participatory simulation session. Participants are located at a same place and can physically interact). In environmental management it is often used to bring together people who are not in the habit of speaking to each‑other and to offer them a framework to better understand how to work together (Becu, Neef, Schreinemachers & Sangkapitux, 2008). During these sessions, tried and tested strategies used for the collective resolution of specific problems are based on a set of capacities and choices that must be combined and sequenced in different ways. Hence, if participants must choose, for example, between a new irrigation canal or dig individual wells, a specific set of skills should be called upon. These skills and means of action can be evenly distributed between the different participants or allocated by role. The former case is well illustrated by the Fishbanks game which simulates the relationship between the renewable stock of sea fish and the overall fishing effort of a sum of boats belonging to several players (Meadows & Meadows, 1993). Each player is the manager of his own fishing company and has the same means of action as the other players (to buy boats, to fish, to sell…). There is thus just one role. In the second case there are several *roles* and each role has certain characteristics and means of action that are theirs and theirs alone. For example, in ReHab (Le Page, Dray, Perez & Garcia, 2014) the players adopting the *roles* of the harvesters can share a harvesting effort over a shared space made up of a set of locations where resource renewal occurs. The player who adopts the role of park manager, can set aside certain production areas and prevent access to the harvesters. Moreover, in ReHab the harvester and the manager do not share the same goals, while in other systems, such as with the cooperative board game « the Forbidden Island », the players do not have the same role but they all share the same goal, which is to escape from the island that is sinking into the sea (Leacock, 2010). In addition, in ReHab, the game space is shared by all the players, i.e., they can all take action in the same places and these places are also represented on a game board which is visible to all players. In other systems, the game zone is different depending on the role played. This is the case with Djolibois, a role‑play game based on the wood‑energy sector in Bamako which has 3 *roles*: producer, wholesaler and manager (Gazull, Gautier & Becu, 2010). The movement of players adopting producer *roles* is limited to a part of the room in which the game is played. This zone represents the timber production basin in the vicinity of Bamako. As for the manager, he/she operates in a zone representing the city of Bamako, while the wholesalers can move between the two zones during one round of the game. Finally, to complement this exploration of what is shared by all participants, and what is not, we must also add the dimension of available sources of information on environmental issues. To effectively resolve the problem in question, the agents will have to gather information on the environmental processes involved. Therefore, in Fishbanks, changes in relative quantities of fish catches in relation to fishing efforts provides information on the status of sea fish stock renewal. All agents can access this information even if the fish catch levels differ depending on the individual choices made by each participant. By contrast, in ReHab only the park manager will know the nesting sites of migratory birds. The harvesters will not have access to this information.

This overview of different participatory simulation tools shows how the elements of a simulation are distributed among the participants. We have categorized them into 4 dimensions and for each of them we distinguished cases in which the type of element considered is identical for all participants (symmetry) and cases for which we find differentiated elements among the participants (asymmetry, see Table 1).

| | Fishbanks | Forbidden island | AtollGame | ReHab | Djolibois |
|---|---|---|---|---|---|
| **Means of action** | S | A | A | A | A |
| **Objective** | S | S | A | A | A |
| **Information source** | S | S | S | A | A |
| **Game space** | S | S | S | S | A |

S = Symmetry between participant ; A = Asymmetry between participant

**Table 1** Symmetry between participants in participatory simulation session (AtollGame is a board game about freshwater lens management; Dray et al., 2007)

The case that associates the asymmetry between participants over the 4 dimensions is especially interesting because it allows to define a framework for conceptualizing the concept of *Habitus* as we will show now.

### 1.2 Extending the role concept to integrate Bourdieu's notion of *Habitus*

Bourdieu defined *Habitus* as a system of aptitudes acquired by implicit and explicit learning that operates like a system organization which generates representations: in other words, as a generator of strategies that can be objectively adapted to their agents' goals without presupposing that they have been deliberately developed to attain them (Bourdieu, 1972). This logic fits in with action rationales related to a specific environment. Bourdieu's approach teaches us that *Habitus* structures the behavior and the actions of the individual while also structuring their position in a position in a multidimensional social space. This last aspect is of particular interest as the implementation of the participative simulation aims to put the spotlight on social relationships (Daré & Barreteau, 2003) and to facilitate dialogue between those in social positions and in positions of power who, ordinarily, do not communicate with each other. One technique used to achieve this is called decentering, which consists in putting oneself in somebody else's shoes and thereby see the system from another's point of view, and thus change the perspective of one's position within the system (Ferber & Guérin, 2003). The innovative approach we put forward in this paper consists in extending the role concept used in participatory simulation to include the notion of *Habitus*.

To reach this objective, we refer once again to Bourdieu who defined *Habitus* as the set of ways of being, feeling, acting and thinking that are proper to an individual (Bourdieu, 1980). In participatory simulation, the role concept already integrates the means of actions (Barreteau et al., 2007). To extend it to include the notion of *Habitus* we propose to complement it with a particular viewpoint on the environment as well as specific access to information sources. In other words we propose a *Habitus* model based on the 4 dimensions of asymmetry between participants that exists in participatory simulation (Table 1). According to this model, a person taking on the role profile of a specific *Habitus* in a participatory simulation will have (1) limited and differentiated access to information on the environment, (2) a limited and differentiated vision of the entities making up the system, (3) specific and ample means of action to establish strategies, and (4) a place in the agents' social space that allows him/her to define their own logical train of thought that can generate their specific objectives.

The implementation of this *Habitus* model was performed on the Cormas platform (Le Page, Becu, Bommel & Bousquet, 2012) and is now a standard model integrated on the platform. This model is essentially based on a configuration of the simulation *space interface* that allows users to visualize, and interact with, entities in the model. Defining a *Habitus* in Cormas, consists in defining: how a user can interact with the interface, what they can see using this interface (what entities are displayed and in which way), the information they can display, the entities they can create, and the types of action they can perform on each of the entities displayed (move them or get them to perform an action).

## 2 NewDistrict: the participatory simulation

NewDistrict is the first participatory simulation tool developed on Cormas platform that take advantage of the integrated *Habitus* module. Each participant interact with the simulation using his own interface and the interfaces are distributed over different computers (This is possible thanks to the *multiple space interfaces* feature and the *distribution module* of Cormas platform). Hence, all participants seat in the same room and can interact physically, but each is immersed in the simulation in his own way, through his interface that provides access to specific information, means of actions and rationales. Because it is distributed and makes an extensive use of asymmetry between participants, we call this tool, a *distributed asymmetric simulation*.

The environmental problem addressed in NewDistrict is that of biodiversity conservation linked to peri-urban development projects. After introducing this issue, we will describe the human-nature interaction model which was developed and its associated scenario. Then in the next section, we will describe the different *Habitus* concept that were developed for this application.

### 2.1 Scripting the biodiversity issues in peri-urbanization development projects

As shown by (Henry & Frascaria-Lacoste, 2012)2012 in development projects deployed in peri-urban zones, biodiversity issues are rarely given sufficient consideration. The authors argue that it is mainly due to a lack of information and means to characterize the current status of biodiversity and the services it provides in a particular area; conflicts of interests between involved stakeholders are also at cause. The stakeholders involved are mainly urban planners, architects, building contractors and politicians. In peri-urbanization, there is another group of stakeholders, i.e., landowners, such as farmers or foresters, who are encouraged to sell their lands to allow the urban projects to be implemented.

NewDistrict, the participatory simulation game, is based on a scenario where environmental problems occur due to peri-urbanization projects. This scenario commences as a mayor takes up office and who now has to make good on his commitment to a local housing development program in his constituency which would mean the building of 9800 extra housing units over the next decade. In this scenario, the densification of existing housing has been ruled out. Peri-urbanization is the only means available to building new housing units. To achieve this goal, the mayor must call in a building contractor. The latter does not initially own the land and to implement the housing projects, he or she must buy land from farmers and foresters whose properties are located in the outskirts of the town. Each role involved in the simulation has their own constraints and objectives. Each role also has an array of means of actions at his disposal linked to practices that are more or less ecological. The mayor and the different actors are not necessarily aware of the different possible environmental impacts their activities may cause; nor of the different ecosystem services they can avail of. Therefore, another role is added to this scenario, which is that of the ecologist, who, on the one hand, has the means to conduct biodiversity monitoring programs, and on the other hand is knowledgeable on the ecological processes and the ecosystem services rendered by the flora and fauna.

**2.2 Model extent and spatial unit**

To model this system we first defined the spatial boundaries surrounding the ecosystem and the extent of the real estate project. We chose to represent a fictive area representing a peripheral area made up of urban and rural zones. It is modeled by a grid map of 15 by 15 hexagons. Each hexagon corresponds to a 5-hectare piece of land and the whole map represents an area of 11.25 km2 (225 land plots). The spatial unit and the parameters of the real estate project were defined so that the building of the 9800 new housing units corresponds to the conversion of 15 land plots of either agricultural or forest use into new housing zones. As each player has his own way to look at the land plots, we present the map interface later in the *Habitus* section (Figure 1).

**2.3 Simulated environmental processes**

Three environmental processes are modeled: bee colonization, bird migration and water quality. They were chosen so that each of them impacts a specific player (positively or negatively). Hence, the presence of a wild bee colony has a positive impact on forest production while Montagu's harrier *(Circus pygargus),* which is a migratory bird of prey, is a predator of crop pests. Lastly, inhabitants are very concerned about water quality and the mayor's popularity depends on the satisfaction of his electors.

The locations where harriers choose to nest or where a colony of bees will settle largely depend on the land use in surrounding areas. The vital living space of a harrier is bounded by 7 pieces of land, while a bee can fly up to 4 pieces of land away from its hive. For each species, a score is associated to each land use type which defines if it is favorable or not for the settlement (Table 2) and specific rules such as land use heterogeneity are also considered. At each simulation turn, calculations are made to determine where harriers have settled at this turn and how healthy they are, and if bee settlements remain or have moved from sites originally colonized.

| | **Favorable** | **Unfavorable** |
|---|---|---|
| Harrier specific | late mowed field | park, new ecological building |
| Applies for both | forest, thinned forest, controlled thinning forest, organic farming field | clear-felled forest, conventional farming field, old building, new conventional building, water-treatment plant |
| Bee colony specific | new ecological building, park | late mowed field |

**Table 2** Relation between land use and species' settlement



The modeling of water quality is very simple and consists in calculating how much the landscape mosaic contributes to water purification or water pollution. To do so, a score is associated to each land use type (a forest scores +5 while a conventional farming field scores -5; a water-treatment plant scores +30). At each turn, the model calculates the sum of all scores and compares it to a water quality scale. When the simulation begins the sum is equal to 0 which corresponds to a sufficient quality (below 0 it is non-drinkable, below -30 swimming is forbidden, for above +60 the EU Water Framework Directive considers good water status has been reached).

**2.4 Human-Nature interactions**

In our simulations human activities consist, on the one hand, in production: forest thinning and clear felling, mowing of fields and harvesting, transition to organic farming. On the other hand, they represent the development of new residential zones (conventional or ecological buildings), building parks or water-treatment plants, etc. When an activity takes place on a piece of land it affects the whole piece of land. Human activities can occur at any time during a simulation turn. These activities have an immediate impact on environmental processes. Hence, if a water-treatment plant is built next to a harrier's nest, the latter turns red, which instantly indicates that it has become nonviable, and that the bird will not settle there at the next turn. Conversely, if a field is converted to organic farming the positive impact on the biodiversity will only become visible at next turn. Finally, the presence of bees and harriers has a positive impact on forests and agricultural production. It increases the gross margin production by up to 30% and this percentage decreases as the distance from the settlement increases.

**3 Implementing *Habitus* for NewDistrict**

The process of building *Habitus* for NewDistrict application, consisted in distributing information and knowledge about environmental processes (harriers, bees and water quality) as well as allocating means of action among the different participant *roles* (mayor, building contractor, farmer, forester and ecologist). Specifying *Habitus* also meant defining how each *Habitus* would perceive his or her environment. In Cormas, this is performed by defining which types of entity are displayed on the *space interface* and which "point of view" is chosen to display the entity. (An entity "point of view" in Cormas, is an algorithm specifying the shape and color to be displayed for an entity depending on its status and its parameter value). Hence the view of the interface of each *Habitus* is different (Figure 1 presents some of the existing views).

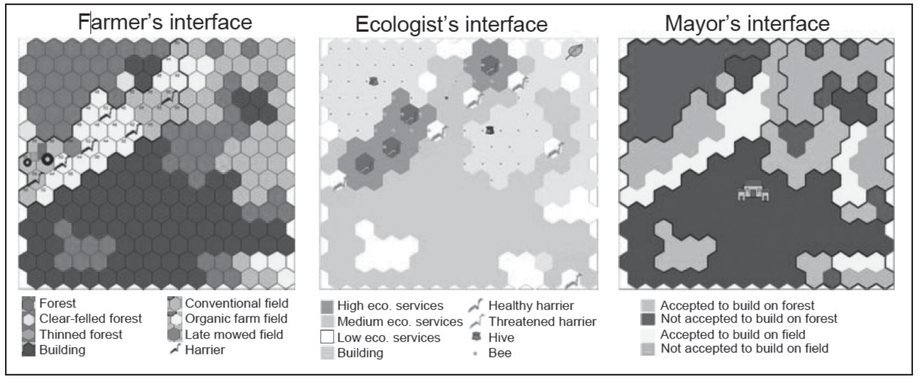


**Figure 1** Main view of the simulated environment for different *Habitus* interface

Finally, as *Habitus* are schemes of thoughts generating strategies, they need to be characterized by a goal. Indeed, a participant playing a *Habitus* needs to know what he or she is there for. Therefore the *Habitus*' pattern also includes a goal which is characterized by a set of objectives that serve as guidance for the participant (Figure 2).

| Habitus' pattern: *Name* (Icon) | Mayor | Building contractor | Ecologist | Forester | Farmer |
| --- | --- | --- | --- | --- | --- |
| -*Objectives* | -Develop15 new building zones<br>-Reach a popularity of 9 points | -Obtain a sufficient return on investment | -Reach the best possible environmental status | -Sustain logging profitability and environmental performance | -Sustain farm profitability and environmental performance |
| -*Perceived environment (which and how entities are shown on the map)* | -Map of local urban development plan, limits of properties | -Real estate value map, limits of properties | -Ecosystem services map, location and healthiness of harriers, location of hives and bees' presence | -Land use map, forest plot profitability, location of hives and bees' presence | -Land use map, farm fields profitability, location of harriers on the farm |
| -*Information at disposal* | -Land use map<br>-Location of harriers and hives<br>-Water quality score | -Map of local urban development plan<br>-Land use map<br>-Location of harriers and hives | -Habitat preferences and tolerances of harriers and bees<br>-Farm fields where bees gather nectar<br>-Water quality score<br>-Maps of land use and of local urban development plan | -Bee population size per hive<br>-Location of harriers | -Location of harriers and hives outside the farm<br>-Healthiness of harriers on the farm<br>-Farm fields where bees gather nectar |
| -*Possible actions* | -Build parks<br>-Build water-treatment plant<br>-Include a land plot in the area accepted (or not accepted) to build on<br>-Exercise pre-emption right and purchase a land plot at its asking price<br>-Grant subsidies<br>-Change profit tax rate | -Propose to buy a forest plot or a field<br>-Build conventional housing<br>-Build ecological housing<br>-Sell new housing<br>-Subscribe a bank loan<br>-Sponsor the ecologist | -Count harriers on the map<br>-Count bees on the map | -Clear-fell a forest plot<br>-Thin a forest plot<br>-Apply controlled thinning practices on a forest plot<br>-Propose a plot for sale<br>-Sponsor the ecologist | -Convert a field to organic farming<br>-Convert a field to conventional farming<br>-Apply late mowing on a field<br>-Put up a field for sale<br>-Sponsor the ecologist |

**Figure 2** *Habitus*' pattern and specifications for the five *Habitus* of NewDistrict



The choices made when designing the five *Habitus* defined in NewDistrict are based on the literature (Henry, 2012) and on our own expertise on how each role behaves and acts in reality. We do not refer to any particular study case but to how development projects related to peri-urbanization are generally conducted in France. Such a generic application gave us enough flexibility to produce a balanced distribution of elements among the *Habitus* but also acted as a constraint because we had a multitude of options to distribute information and the means of action.

We therefore implemented several *Habitus* configurations and conducted 5 successive real–life tests before obtaining the final *Habitus* specifications presented in Figure 2. For each test, we assessed what the testers thought about the ergonomic design of each *Habitus* (accessibility, ease of operation, response time...) (Becu, Bommel, Botta, Le Page & Perez, 2011) as well as what they learned from their simulation experience. We favored active learning processes which are best suited to participatory simulation (Etienne, 2011). Therefore, the *Habitus* were designed so that a person who plays a *Habitus* role does not have all the clues in his perceived environment to fully understand the implications of his relationship to environmental processes. Hence, the farmer has information on field profitability and on harrier location. To fully understand the ecosystem services the harrier provides, the player needs to cross–check these data. Similarly, the farmer's *Habitus* does not give access to harrier health status nor to their habitat preferences. To fully understand their ecology, and thus favor their presence on his farm, the player can either test different farming practices on his farm, and see how these impact harriers, or alternatively request information from the ecologist.

One last feature of *Habitus* implementation in our simulation implies that for it to work, additional processes must be modelled. For example, the *Habitus* of a mayor is strongly correlated with his or her aim to be popular, so this means his actions should have an impact on his popularity. Therefore, we integrated a model of popularity in NewDistrict which depends; in particular, on the distance between urban and green areas (forests and parks) and on how successful the mayor is at balancing the municipal budget. Similarly, we implemented a model for agricultural and forestry yields as well as for bank loans.

## 4 Preliminary results and perspectives

In this paper we introduced a type of participatory simulation, distributed asymmetric simulation, which is distributed and use the concept of *Habitus* to define the asymmetry between *roles*. We presented its first application, i.e., the NewDistrict participatory simulation, which was developed under the Cormas platform. The platform provides generic features to develop such type of simulation tool. It can be used to connect several computers so that a simulation can be performed simultaneously and enables each participant to have their own game interface, means of action and access to information pertaining to their role.

NewDistrict has been tested several times in real-life conditions. However, further sessions are needed to carefully assess the potential and limitations of distributed asymmetric simulations when compared to other types of participatory simulations. Yet, early findings seem to suggest that it facilitates the participant's immersion in the virtual world being played out. The asymmetry forces the participants to overcome the constraints imposed by their *Habitus* role, to seek for new sources of information available and to take into account the other participants' capabilities and constraints. The fact that the simulation is distributed but yet the computers are in the same room, makes that participants interact with their own interface as well as with the other participants (to exchange information on environmental processes for instance). Therefore, the location in the room of the computer-desk belonging to each *Habitus* is crucial. We tested several configurations that involved, for example, positioning the ecologist away from the others or not, or having the mayor and the building contractor next to, or away from, each other. We noted that the degree of proximity to the ecologist influences the economic strategies of the others. But here again additional tests are required to validate our assumptions.

The perspective is now to take the research into a direction in which we explore the different dimensions of asymmetry and their influence on the learning effects in distributed participatory simulations. From our preliminary results we find that the greatest potential for this type of application is in the domain of environmental management. Indeed, environmental management issues often occur between people who ordinarily do not work together; who are more familiar with their retrospective caricatures and clichés, who operate according to different rational approaches, to achieve divergent production goals and who do not share the same notions on the environment. The *Habitus* concept can therefore be used to conceptualize different action rationales. Our assumption is that by getting the different stakeholders to work on their diverging positions, we can help change the relationships between them, and thus to envisage solutions to the different environmental problems.

## References


Barreteau, O., Le Page, C., & Perez, P. (2007). Simulation and gaming in natural resource management. Simulation & Gaming, 38(2).

Becu, N., Bommel, P., Botta, A., Le Page, C., & Perez, P. (2011). How do participants view the technologies used in companion modelling? In M. Etienne (Ed.), Companion modelling. A participatory approach to support sustainable development (pp. 169—186). Versailles: Quae Edition.

Becu, N., Neef, A., Schreinemachers, P., & Sangkapitux, C. (2008). Participatory computer simulation to support collective decision-making: Potential and limits of stakeholder involvement. Land Use Policy, 25(4), 498—509. doi: 10.1016/j.landusepol.2007.11.002





Bourdieu, P. (1972). Esquisse d'une théorie de la pratique - Précédé de trois études d'ethnologie kabyle. Genève: Droz.

Bourdieu, P. (1980). Le sens pratique. Paris: Editions de minuit

Daré, W., & Barreteau, O. (2003). A role-playing game in irrigated system negotiation: between play and reality. Journal of Artificial Societies and Social Simulation, 6(3), <http://jasss.soc.surrey.ac.uk/6/3/6.html>.

Dray, A., Perez, P., Le Page, C., D'Aquino, P., & White, I. (2007). Who wants to terminate the game? The role of vested interests and metaplayers in the ATOLLGAME experience. Simulation & Gaming, 38(4), 494—511.

Etienne, M. (2011, 22/10/2010). Pédagogie active et enseignement de la biodiversité par la modélisation d'accompagnement. Paper presented at the Education au développement durable et à la biodiversité : concepts, questions vives, outils et pratiques, Digne-les-Bains, France.

Ferber, J., & Guérin, V. (2003, 26 janvier au 3 février 2003). Représentations et simulation : de la modélisation à la mise en situation. Paper presented at the Le statut épistémmologique de la simulation: 10ème journées de Rochebrune: rencontres interdisciplinaires sur les systèmes complexes naturels et artificiels, Rochebrune.

Gazull, L., Gautier, D., & Becu, N. (2010). Usage d'un jeu de rôles pour l'analyse préalable d'un SIG: DJOLIBOIS, un jeu spatialisé pour l'approvisionnement en bois-énergie de la ville de Bamako (Mali). Revue internationale de géomatique, 20(1/2010), 7—36.

Henry, A. (2012). Aménagement des Eco-quartiers et de la Biodiversité. (PhD), AgroParisTech.

Henry, A., & Frascaria-Lacoste, N. (2012). Comparing green structures using life cycle assessment: a potential risk for urban biodiversity homogenization? The International Journal of Life Cycle Assessment, 1—2.

Le Page, C., Becu, N., Bommel, P., & Bousquet, F. (2012). Participatory agent-based simulation for renewable resource management: the role of the Cormas simulation platform to nurture a community of practice. Journal of Artificial Societies and Social Simulation, 15(1), <http://jasss.soc.surrey.ac.uk/15/11/10.html>.

Le Page, C., Dray, A., Perez, P., & Garcia, C. (2014). Can Communication Save The Commons ? Lessons From Repeated Role-Playing Game Sessions. Paper presented at the ISAGA conference.

Leacock, M. (2010). Forbidden Island. In Gamewright (Ed.). United states.

Meadows, D., & Meadows, D. (1993). Fish Banks news, Fish Banks limited and Laboratory for Interactive Learning. University of New Hampshire: Durham, NH, USA.



**Acknowledgment**

We gratefully acknowledge financial support from chair ParisTech "Eco-design of buildings and infrastructure" in partnership with VINCI.



**Authors/Contact**

Nicolas Becu
CNRS, UMR LIENSS
La Rochelle, France
nicolas.becu@cnrs.fr

Nathalie Frascaria-Lacoste, Julie Latune
Université Paris-Sud, UMR ESE
ORSAY Cedex, France

Willy C. Kriz, Tanja Eiselen, Werner Manahl

# The Shift from Teaching to Learning: Individual, Collective and Organizational Learning Through Gaming Simulation

Proceedings of the 45th Conference of the International Simulation and Gaming Association

Dornbirn, 2014