User Simulation Model: Overview & Validation

Capturing human behaviour in the built environment using RFID

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Abstract: This paper presents the validation setup for the user simulation model as part of the ongoing research project called “User Simulation of Space Utilisation (USSU)”. The aim of this research project is to develop an overall model for the simulation of human movement and utilization of space capacity in office buildings. In this model, two aspects are essential: the interaction between the building occupants while performing their activities and the way to model these activities in space.

1. INTRODUCTION

Many different building simulation tools have been developed, for example in the field of building energy systems, building physics, building services and air/smoke dispersion. There is an urgent need for these tools due to the growing complexity of buildings and the growing emphasis on performance aspects, for example in the quest for sustainable buildings (Lam, Wong, et al., 2001).

Increasing computer power, refined algorithms and improved calibrated models make it possible to simulate physical processes at more detailed building level in shorter periods of time (Hensen, 2004). As yet, these models rely on assumptions referring to the behaviour of occupants of buildings. In the field of building usage simulation, research is poor on the complexity of human behaviour and the space utilisation in buildings. We think a model for building usage simulation that produces data about
activities of members of an organization can improve the relevance and performance of building simulation tools. This is relevant for engineering domains as well as for architects to evaluate the performance of a building design.

Building usage simulation has common ground to topics in the research area of activity based modelling (Meyer-König, Klüpfel, et al., 2002). Activity based modelling is of interest due to considering travel and activity forecasting processes as a group decision making process introducing interaction between individuals. In our approach we build upon two existing methods for modelling the different kinds of activities found in an organization, namely workflow modelling (resulting in the so-called skeleton activities) and activity based modelling for predicting the individual behaviour (resulting in the so-called intermediate activities) (Tabak, de Vries, et al., 2004). These methods have to be adjusted and extended for applying them into the context of building usage simulation. To our knowledge there are no workflow models which take the location of the former mentioned activities into account.

Although a member of an organization often executes activities alone, without any help (e.g. preparing a presentation), a lot of activities require mutually interaction between people (e.g. giving a presentation). This has major impact on the scheduling process, because the same activity has to be inserted in the schedules of all people involved, and on the location finding process as the activity location should be able to accommodate the size of the group of employees concerned. Determining which activities require interaction is one of the responsibilities of the so-called scheduler. The rule based scheduler tests the current schedule against a set of predefined criteria and if necessary it will adjust the schedule such that it will become a valid schedule. For example:

\[
\text{IF priority of activity } A_{\text{new}} > \text{ priority of activity } A_x \\
\text{THEN } A_{\text{new}} \text{ may interrupt } A_x
\]

The intention is to approximate real world scheduling behaviour of humans.

The paper is organized as follows. First, we point out the current stage in related research areas. Next, we give an overview of the user simulation model for the simulation of human movement and utilisation of space capacity in office buildings. After that, we will describe how to validate our model using RFID (radio frequency identification) technology. We will finish with a brief discussion and future work.
2. RELATED RESEARCH

As indicated in the introduction this research project has common ground to topics in the research area of activity based modelling. Activity based models are used to predict the effect of policy measures on the possibilities of individuals to participate in activities and on the resulting travel demand (Arentze and Timmermans, 2000). Most existing approaches to model activity schedules assume an individual-based decision making process. These models do not take into account the interaction between individuals; at best only implicitly through the inclusion of explanatory variables related to household composition. According to Vovsha, Petersen, et al. (2003) and Scott and Kanaroglou (2002) there is a need for incorporating interaction between household members to develop sound forecasting models. Recently, there is a noticeable growing interest in modelling intra-household interaction in the field of transportation research. According to Vovsha, Petersen, et al. (2004) modelling interaction approaches can be grouped in three categories, namely:

- Structural equation models.
  These models are used to explore the relationships between activities performed by male and female household-heads (Golob and McNally, 1997).

- Models that explicitly consider the intra-household interaction mechanism.
  These models are based on a joint decision making process. The activity schedule of the household is the result of a negotiation process in which the interests of the individuals are weighted against those of the group (Zhang, Timmerman, et al., 2002).

- Models that represent a choice between individual and joint activity/travel.
  These models are based on a discrete number of activities episodes rather than continuous activity durations. Scott and Kanaroglou (2002) have developed such a model in which the daily numbers of non-work, out-of-home activity episodes are modelled for household heads.

In most of recently developed models the group decision-making process is limited to (two) household heads. For our user simulation model we have developed an approach to deal with the interaction between (skeleton) activities of all members of an organization. This approach will be discussed in chapter 3.
3. USER SIMULATION MODEL: AN OVERVIEW

Figure 1 shows the structure of our model for the simulation of human movement and utilisation of space capacity in office buildings. The model consists of a number of sub-models; each of them takes care of one aspect of the office building usage simulation.

![Model structure diagram](image)

Figure 1. Model structure.

The organizational model and the building model depend on user-input. The resource management model integrates these two models. The scheduler takes care of producing the desired output of the system, namely a movement pattern which not only describes which activities are performed and at which location, but also the route that is followed between the locations of these activities. We distinguish two types of activities, i.e. skeleton activities and intermediate activities. Skeleton activities are the main activities in our system and will be discussed in section 3.1.

For modelling real human behaviour and space utilization, workflow depended activities as well as activities that are the result of human nature are crucial to incorporate in our user simulation model. The latter activities are called intermediate activities. Intermediate activities strongly depend on the psychological or social needs and desires of an employee. In our model the intermediate activities are limited to the following:
- Lunch
- Sport (during workday)
- Get a drink
- Smoke (not at workplace)
- Have a short break (e.g. informal meeting with a colleague)
- Go to toilet
- Receive unexpected visitor
- Walk to printer
Walk to mailbox

The intermediate activities are modelled with an activity-based model (Tabak, de Vries, et al., 2006).

In the next sections we will discuss the sub-models in more detail.

3.1 Organizational model

The skeleton activities are the main activities in our system and directly arise from the workflow of the organization. The skeleton activities are highly responsible for structuring the schedules of employees. Examples of these activities are among others: having a meeting, doing research or writing a paper. Because the skeleton activities depend on the workflow of the organization, the user of the system has to specify the structure of the organization in detail as input for the overall model.

An organization consists of a number of roles (e.g. secretary or manager) and a number of organizational-units (e.g. the sales or complaints unit). An organizational-unit usually consists of a number of roles and a role can belong to more than one organizational-unit. The role is linked with the resource person in the resource management model (see section 3.3). A person can fulfill more than one role.

Each organization has its own specific workflow. Not only will the workflow strongly differ between organization-types (e.g. an insurance company has a completely different workflow than a consultancy firm), but also in an organization-type itself the workflow can vary (e.g. not every insurance company has the same workflow).

As mentioned in the introduction our model must provide some means of interaction between individuals. Therefore we introduce the concepts task and task-group in the organizational model (Tabak de Vries et al., 2006). A task is a logical unit of work, which is carried out by one person (Aalst and van Hee, 2002). A task belongs to a certain organizational unit. Each task is considered to be a skeleton activity for which one role is responsible. Some tasks (e.g. having a presentation) require linkages between individuals that belong to the same unit. To determine which tasks are related we apply the concept task-group. A task-group is a collection of tasks which are related to each other in the context of employee-interaction.

For the organizational model the user has to input data related to the organization in question. Among other things, the user has to specify for each role in the organization a set of tasks (see Table 1 for an example). This set of tasks determines which skeleton activities an employee can perform during a workday. Each task has a set of properties, e.g. the time percentage and average duration. Each role has also a task which is marked as the main task; each role spends most of its time on this task. The main task plays a
special role in the scheduling process of activities (see section 3.4.1.4). Input data can be constructed from job descriptions stated by the organization in question. The properties of the tasks can be calculated based on data of the time registration system of the considered organization.

For each employee, the output of the organizational model is a set of skeleton activities for a specific workday. This list of activities is used by the scheduler as starting point for scheduling the activities for the workday in question. These activities are drawn from the total list of tasks of each employee based on the time percentage of each activity; the higher the time percentage, the more time an employee spends on this activity and the higher the probability that this activity will be selected.

<table>
<thead>
<tr>
<th>Task</th>
<th>Time percentage (%)</th>
<th>Priority</th>
<th>Average duration (minutes)</th>
<th>Minimum duration (minutes)</th>
<th>Main task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get PhD coaching</td>
<td>8</td>
<td>9</td>
<td>60</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>50</td>
<td>1</td>
<td>30</td>
<td>15</td>
<td>X</td>
</tr>
<tr>
<td>Give presentation</td>
<td>5</td>
<td>7</td>
<td>60</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Write publication</td>
<td>1</td>
<td>4</td>
<td>60</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Building model

The building model describes how we deal with the spatial conditions in which activities take place. A node object is the central object in our building model. All spatial and physical resources (e.g. workplaces, printers) are located at a node and all nodes are linked with each other by edges.

Each activity occurs at a certain location, called abstract-spaces. An abstract-space has no dimensions. It forms the abstraction of real spaces in buildings and it contains a collection of one or more nodes. The size of this collection specifies the capacity of the abstract-space; for a meeting room, this means the number of available seats.

A building that consists of a number of spaces, like office rooms, meeting rooms or hallways, is represented by abstract-spaces that can contain one or more abstract-spaces. An example of an abstract-space is an office room; this office room, however, can contain a workspace and a meeting space (both are abstract-spaces).

3.3 Resource management model

The resource management model provides the interface for the schedule model with the organizational and building model. It contains and keeps track of all the information related to the recourses available either in the
organization or in the building. We distinguish three different types of recourses:

- **Persons**
  Two sub-types employee and guest are characterized. The most important one, employee, provides the link with the organizational model as well as the link with the scheduler. Each employee has a schedule with activities. The other one, guest, plays a role in the scheduler.

- **Abstract-spaces**
  All activities are performed at an abstract-space. This recourse is linked with the building model.

- **Facilities**
  This type of recourses provides facilities for the organization to perform their activities, e.g. a printer or a pc.

### 3.4 Scheduler

For simulating the usage of office buildings it is essential to know which activities are performed by employees in the organization. Therefore each employee has an activity schedule. This schedule consists of an in time ordered set of activities. Each activity has a location (the abstract-space) and can involve, depending on the type of activity, one or more persons and/or facilities.

For each employee, the schedule describes the order of activities for a certain period, e.g. a workday. It reveals the needed movement demand as derived demand from the activities. With the schedule the system knows the location of each activity for an employee, but not yet which route he or she should follow to get from one activity to another. Therefore, the information about an activity in the schedule is combined with route information to move from the location of an activity to the next activity location. The result is a movement pattern: the activity schedule including the routes (see table 2 for an example of a movement pattern). Routes and movement time are calculated using a shortest path algorithm with the building model as input.

The structure of the scheduler and its Artificial Intelligence (AI)-modules is given in figure 2. In the next sections we will explain what is understood by an AI module. We will also describe the AI modules which currently comprise the scheduler and how these modules are activated.
### Table 2. Example of a movement pattern.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Time</th>
<th>End Time</th>
<th>Location</th>
<th>Priority</th>
<th>Resources</th>
<th>Movement time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>09:29:06</td>
<td>09:35:36</td>
<td>Workplace Joran (9.13: office room)</td>
<td>1</td>
<td></td>
<td>414</td>
</tr>
<tr>
<td>Get a drink</td>
<td>09:35:36</td>
<td>09:38:24</td>
<td>Pantry</td>
<td>5</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Program</td>
<td>09:38:24</td>
<td>09:41:06</td>
<td>Workplace Joran (9.13: office room)</td>
<td>1</td>
<td></td>
<td>414</td>
</tr>
<tr>
<td>Teach</td>
<td>09:41:06</td>
<td>12:18:54</td>
<td>Lecture hall 2 (externalabstractspace)</td>
<td>8</td>
<td></td>
<td>1134</td>
</tr>
<tr>
<td>Program</td>
<td>12:18:54</td>
<td>13:02:31</td>
<td>Workplace Joran (9.13: office room)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend project meeting</td>
<td>13:58:50</td>
<td>17:00:00</td>
<td>Meetings space (9.20: small meeting room)</td>
<td>6</td>
<td>Jos, Bauke</td>
<td>70</td>
</tr>
</tbody>
</table>

Skeleton activity

Intermediate activity

---

**Figure 2.** Structure of the scheduler and its AI modules.
3.4.1 **AI modules**

The scheduler consists of AI modules; there currently are 8 modules. Each AI module is responsible for a separate task in the scheduling process. In the next sections we will give a short description of each module.

3.4.1.1 **Skeleton-scheduler: scheduling the skeleton activities.**

This AI module determines for each skeleton activity in the list of activities generated by the organizational model its start time and end time. When the skeleton-scheduler is activated one skeleton activity at a time is scheduled. The order in which the skeleton activities are scheduled is determined by the priority of the activities; starting with the activity that has the highest priority. When an activity is selected the module looks for timegaps which match with the duration of the activity. From these timegaps the skeleton-scheduler only considers those start times which equal to multiples of a certain period (the so-called timeinterval which is given in the system configuration file and has a default value of 30 minutes) and chooses from all possible start times a start time at random. This means that only start times like 8:30 or 13:00 are considered, when the default value of the time-interval is used.

3.4.1.2 **Interaction-scheduler: determining interaction between activities.**

Based on the concept task-group this module determines for each activity if it requires interaction with other employees (e.g. the activity *give presentation* requires the presences of other individuals). If an activity requires interaction, the module determines which other activities have to be scheduled for which individuals and adds these activities to the appropriate schedules.

3.4.1.3 **Intermediate-scheduler: scheduling intermediate activities.**

The different intermediate activities the simulation model currently takes into account are scheduled by this AI module. Scheduling these activities is done using two different methods, namely the S-curve method and the probabilistic method. Each activity has been assigned to a method based on its characteristics.

3.4.1.4 **Gap-remover: repairing gaps in a schedule.**

The scheduler aims at completely filling a schedule with activities; in other words a schedule usually will not have any spaces which are not occupied by an activity (such spaces are called gaps). The aim of the scheduler is to produce a valid schedule, without any gaps and overlaps (see overlap-
However at certain stages in the scheduling process an activity can be removed and the schedule will exhibit a gap. This AI module finds and repairs any gaps in the schedule by creating a skeleton activity corresponding to the main task of the employee in question with the duration of the gap.

3.4.1.5 **Overlap-remover: repairing overlaps in a schedule.**

As a result of actions taken by some modules, for example the interaction-scheduler or the intermediate-scheduler, overlaps of activities in a schedule can occur. A schedule has an overlap if the start time of one of its activities lies before the end time of the next activity in the schedule. The overlap-remover repairs one overlap in the schedule by rescheduling one of the activities related to this overlap.

3.4.1.6 **Merger: joining several activities into one activity.**

As a result of the way in which the skeleton activities are selected by the organizational model and due to the actions of some AI modules, such as the gap-remover, a schedule can consist of several skeleton activities who belong to the same tasktype and who directly follow each other in time (the end time of an activity corresponds with the start time of the next activity in the schedule). These activities will be joined into one activity by the merger.

3.4.1.7 **Resource-finder: selecting an appropriate location.**

For each activity the module chooses a location which matches with the type of activity and the size of the group of employees concerned.

3.4.1.8 **Movementtime-scheduler: determining the required movement time.**

After the locations of all activities in the schedule are determined, the scheduler can fix the required movement time to walk from an activity to the next activity. Movement time is calculated based on routes between locations of the activities which are determined through a shortest path algorithm. This module is responsible for adding the movement times to the activities in the schedule. This will lead to overlaps in the schedule because there is no time available ‘to squeeze in’ the required movement time; the overlap-remover is responsible for (re)scheduling the activity schedule.

The interaction-scheduler, intermediate-scheduler and overlap-remover are discussed in more detail in Tabak, de Vries, et al. (2006).
3.4.2 The scheduling process

Figure 3 shows an example of the scheduling process for one person; it shows a realistic order of AI modules which are activated when creating a movement pattern for an employee.

When the scheduler is activated and each time when an AI module is finished, all AI modules are asked to determine its importance. Each AI module determines its importance based on the characteristics of the schedule and its activities. In the initial stage of the scheduling process, the importance of skeleton-scheduler is very high, because the schedule contains activities which are not scheduled yet. At the same time the importance of the movementtime-scheduler is low, because the activities do not have a location assigned to it yet. So at a certain stage of the scheduling process a specific AI module can be more important than another AI module, but this can switch around. During the scheduling process the characteristics of the schedule change, as a result the importance of an AI module will change too. In the latest stages of the scheduling process all skeleton activities are scheduled, i.e. the importance of the skeleton-scheduler is low, and for each activity the location is determined, i.e. the importance of the movementtime-scheduler will be high.

![Diagram of scheduling process](image)

*Figure 3. A realistic example of the scheduling process for an employee.*

The scheduler activates the AI module addressed to the highest priority. This results in that the skeleton-scheduler is frequently activated in the first stage of the scheduling process and not anymore in the later stages. The
movement-time-scheduler, however, will only be activated in the later stages of the scheduling process, as you can see in figure 3. When the selected AI module is finished (it has made its modifications to the schedule) again all AI modules are asked to determine its importance and an AI module is selected once again.

The scheduling process of the scheduler is a cyclic procedure, which stops when all criteria are satisfied; the schedule can not be improved anymore within the given constraints, i.e. all AI modules report an importance equal to zero. While during the scheduling process some AI modules will be activated several times, others will only be needed once. Furthermore, the end user of the system does not have any control over the order in which the AI modules are activated; the scheduler selects the AI module with the highest priority as mentioned above. When the scheduling process is stopped, the scheduler has generated movement patterns that describe the space utilisation of the organization for the period in question and where each activity is executed in the building space.

4. VALIDATION

For a thorough evaluation of the system we have performed an experiment for assessing its predictive quality in the context of a real building, organization and actual human behaviour. The experiment results in observed data about the space utilisation of the organization in question. These data will be compared with the space utilisation predicted by our user simulation model to evaluate the simulation model.

4.1 The technology

To capture the real space utilisation we applied RFID (radio frequency identification) technology. This technology is used by some Dutch organizations to regulate their access control and as means of time registration, but up to now never on the detailed scale as we are using it.

An RFID system normally consists of readers and tags. An RFID tag is a device which can be remotely accessed to retrieve data stored in its chip. Each tag is equipped with an antenna to receive and respond to radio-frequency queries from an RFID receiver. There are two types of RFID tags: passive and active tags. Passive tags do not have an internal power supply; the power required to transmit a response is induced through the incoming radio-frequency signal. These tags can only be read out from short distances (up to several meters). The active tags, however, can have a read distance of up to several hundreds of meters. Therefore these tags have been supplied
with an internal power source. An active RFID tag will send out a signal for example every 1.5 seconds. The battery of these tags last up to 5 years. In our experiment we applied the active tags in combination with a number of readers (see figure 4).

### 4.2 The experiment

For this experiment we have utilized one floor of our faculty building and its occupants. For three months we have collected data about the behaviour of all participating employees with carefully placed RFID readers on this floor. Each employee was asked to carry an RFID tag for the duration of the experiment. With the RFID tags we were able to track the movements of the employees across the floor and thereby collecting data about the real space utilization.
4.3 Data processing

When comparing the collected with the predicted space utilisation we have to pay attention to the way in which we collected the activity behaviour. Although the user simulation model predicts space utilisation on the level of (parts of) building spaces, in the experiment we have observed space utilisation on the level of sets of spaces, called zones (see figure 5). The main reason for this was that it proved to be too costly to equip each space with an RFID reader. To be able to compare the observed space utilisation with the predicted space utilization, the predicted data has to be aggregated to allow for comparison and hence model validation.

Furthermore, the recorded data will have to be analysed and adapted to solve problems related to the setup of the experiment in conjunction with the RFID technology. As mentioned above the floor was divided into zones; each zone was equipped with 1 or 2 readers to detect the presence of a tag (and so an employee). A reader uses a spherical radio field to detect tags. When two or more readers are nearby each other, the spherical fields of some readers can overlap; the distance at which this occurs depends on how the reader was set up (e.g. the threshold of the signal strength used by a reader to detect a tag and the type of antenna equipped with the reader). This means that a tag can be in 2 or more zones at the same time. The tracking software selects the reader (and so the zone) addressed to the highest signal strength. However, as the signal strength of a tag recorded by the reader is influenced by all kinds of distortions and reflections, the signal strength is constantly changing. This causes tags (and so people) to jump from one zone to another when they were not moving. These movements have to be filtered out by using smart algorithms.

Table 3. A fragment of the original recorded zone-entries for an employee.

<table>
<thead>
<tr>
<th>Time</th>
<th>Zone entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-3-2006 8:25</td>
<td>Vincent Tabak Entered the Exit elevators OS CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:25</td>
<td>Vincent Tabak Entered the Pantry big meetingroom zone</td>
</tr>
<tr>
<td>13-3-2006 8:25</td>
<td>Vincent Tabak Entered the Open workarea OS CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:36</td>
<td>Vincent Tabak Entered the Offices ATRIUM north CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:36</td>
<td>Vincent Tabak Entered the DS fab zone</td>
</tr>
<tr>
<td>13-3-2006 8:38</td>
<td>Vincent Tabak Entered the Exit stairs zone</td>
</tr>
<tr>
<td>13-3-2006 8:41</td>
<td>Vincent Tabak Entered the DS lab zone</td>
</tr>
<tr>
<td>13-3-2006 8:42</td>
<td>Vincent Tabak Entered the Offices ATRIUM north CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:42</td>
<td>Vincent Tabak Entered the Open workarea OS CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:50</td>
<td>Vincent Tabak Entered the Secretary zone</td>
</tr>
<tr>
<td>13-3-2006 8:50</td>
<td>Vincent Tabak Entered the Pantry big meetingroom zone</td>
</tr>
<tr>
<td>13-3-2006 8:51</td>
<td>Vincent Tabak Entered the Exit elevators OS CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:51</td>
<td>Vincent Tabak Entered the Pantry big meetingroom zone</td>
</tr>
<tr>
<td>13-3-2006 8:52</td>
<td>Vincent Tabak Entered the Open workarea OS CO zone</td>
</tr>
</tbody>
</table>
Table 3 shows the zones an employee has entered in the first half hour of his workday according to the tracking software. Table 4 shows the zone-entries after certain filters have been used, like: discard all *Entered the Exit stairs* zone-entries when the current zone is *DSlab* (people can not directly enter the zone *Exit stairs* zone from the zone *DSlab*).

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</tr>
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<td>Vincent Tabak Entered the Pantry big meetingroom zone</td>
</tr>
<tr>
<td>13-3-2006 8:25</td>
<td>Vincent Tabak Entered the Open workarea OS CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:36</td>
<td>Vincent Tabak Entered the Offices ATRIUM north CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:36</td>
<td>Vincent Tabak Entered the DSlab zone</td>
</tr>
<tr>
<td>13-3-2006 8:42</td>
<td>Vincent Tabak Entered the Offices ATRIUM north CO zone</td>
</tr>
<tr>
<td>13-3-2006 8:42</td>
<td>Vincent Tabak Entered the Open workarea OS CO zone</td>
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</tr>
</tbody>
</table>

5. DISCUSSION AND FUTURE WORK

In this paper, we have set out our user simulation model for interaction in activity location scheduling as part of an overall model for the simulation of human movement and utilisation of space capacity in office buildings. Comparing the predicted space utilisation with the observed human behaviour will be a challenging task. There will be a number of aspects to consider when validating the user simulation model, such as:

− The routes between locations of the activities are generated using a shortest route algorithm; in real life people will not always use the shortest route between two locations. Some people will have a favorite route and others will more or less wander from one location to another.
− Similar considerations count for the selection of a location for an activity. When the system has to choose a location for an activity, it will always select that location which is located at shortest distance from the workplace of the employee in question. In real life people will have a preference for a certain location and are willing to walk longer to reach that location.
− We expect the observed data will show that people make movements that can not be directly explained by normal movement behaviour. Examples of these movements are: an employee turns back to his/her workplace
when he/she forgot something when walking to an activity or wandering behaviour of an employee when having a short break.

In the near future, we hope to present the results of the comparison of the observed data and the predicted data.

6. REFERENCES


