POLITECHNIKA GDAŃSKA

INTELLIGENT LOGISTICS SYSTEMS

ACTIVITY #7

Healthcare module - patient care simulation

dr hab. Daniel Kaszubowski, prof. PG

Department of Transport Engineering

ADTRANS
ADVANCED DATA ANALYSIS FOR TRANSPORTATION AND MOBILITY ACADEMIC TEACHERS

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1. Objective and new skills

The aim of the task is to present the capabilities of the *FlexSim Healthcare (HC)* environment , which is an extension of the basic program. It allows for comprehensive modeling of processes in healthcare facilities, such as hospitals or clinics. HC uses an integrated approach based on 3D objects and *ProcesFlow*, adapted to simulated tasks. It also takes into account the logic of controlling the movement of people (patients and staff) in a 3D environment (module A*).

New skills
Using backgrounds with facility plans
Using new 3D objects from the HC library
Building *Process Flow* using Activity *Templates*
Tracking simulation parameters using a *milestone block*
Building a people movement environment using module A*
Use of preferred travel routes for staff

2. Model assumptions

The model will simulate a basic patient care procedure, including the following sequence of activities: Entry → Registration → Waiting in the waiting room → Preparation for examination → Examination by a doctor → Exit.

The target layout of the 3D model is shown in Fig. 1, while the *Process Flow* divided into two blocks is shown in Fig. 2.

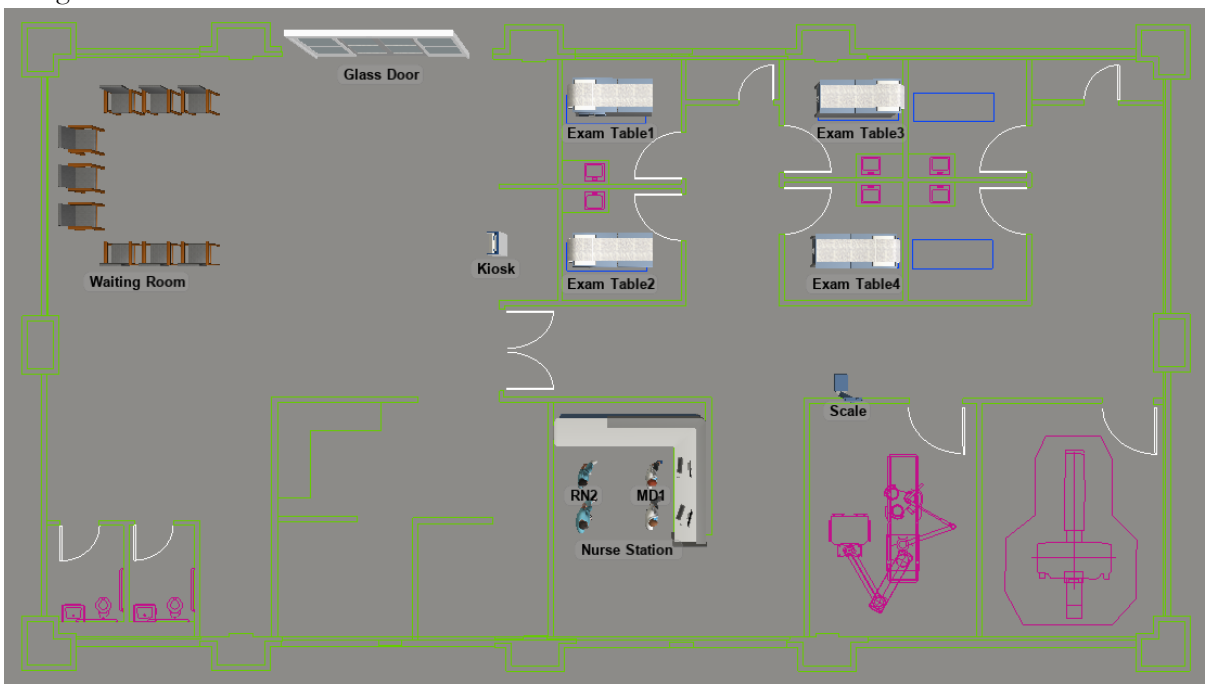


Fig. 1. 3D model layout

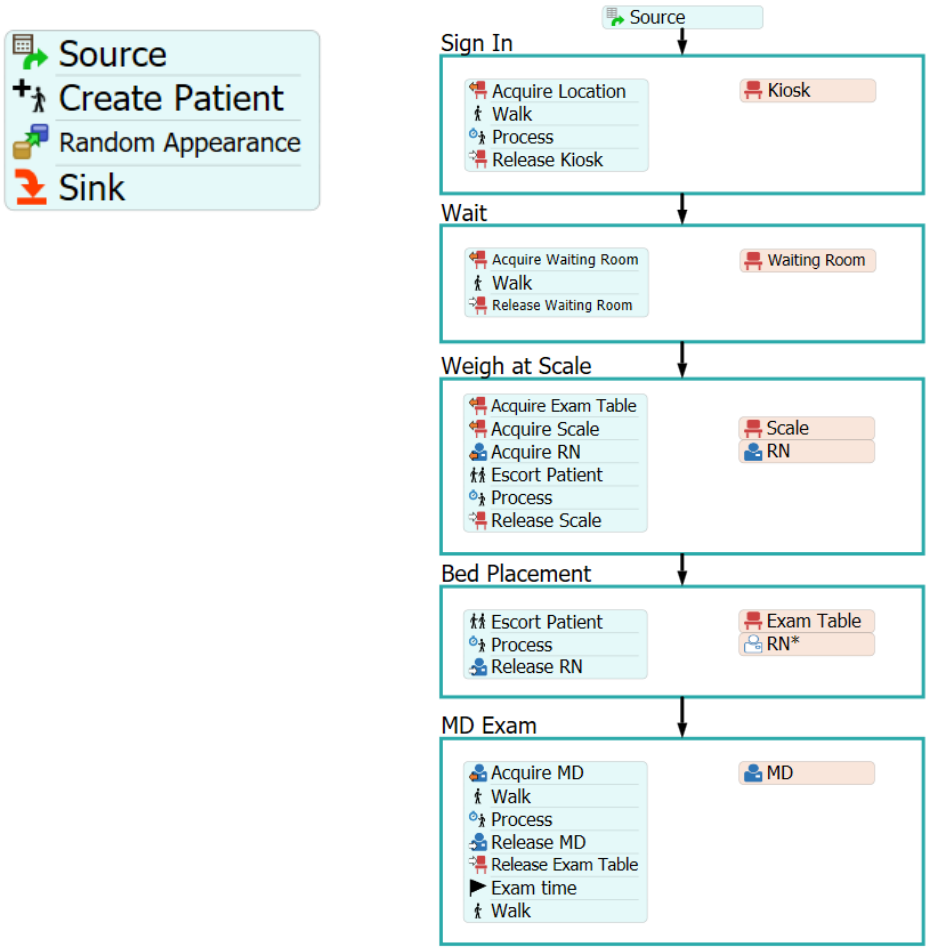
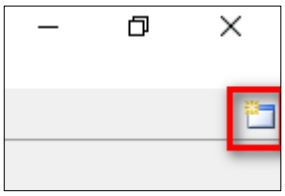


Fig. 1 *Process Flow* diagrams – *Arrivals* and *Patient Flow*

3. Building a 3D model



To activate the *Healthcare environment,* you must run *Flexsim* and create a new model in the standard way. After running it, in the upper right corner of the program window of the main program level, select the *Change Environemnt* icon shown in the figure beside and select *Healthcare*.

The model will use a dwg format background. This will make it easier to arrange 3D objects later. After changing the environment, on the main bar select *Floor Plans* → *Add a Floor Plan* → *Background* → *File (browse)* → *Documents* → *FlexSim2025 projects* → *ER_small.dwg*.

After setting the base, place the following objects in the places shown in Fig. 1 (the English language has been preserved throughout the model):

1. *Kiosk* – *Healthcare* → *Location* library. It should be flipped accordingly.
2. *GlassDoor* – *Healthcare* Library → *Prop*.
3. *Chairs* – *Healthcare* → *Multilocation* library. The object should be flipped appropriately.
4. *Scale* – *Healthcare* library → *Location*.
5. 4 *Exam Tables* – *Healthcare* → Location library.
6. *Nurse Station B* – *Healthcare* → *Prop* → *Rooms* library . The object must be flipped appropriately.

The model will also include hospital staff. Please add:

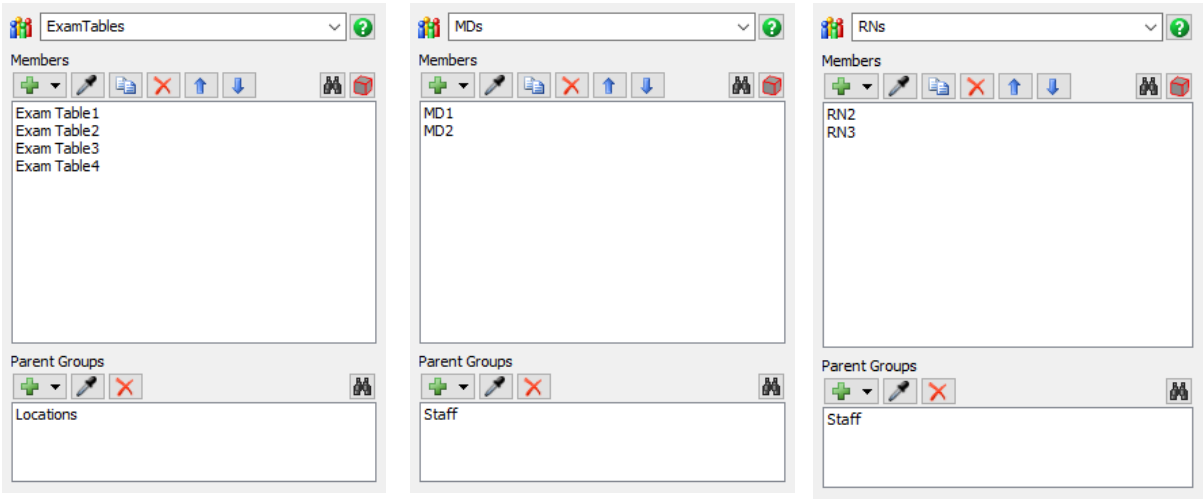
1. 2 MD (doctors) objects – *Healthcare* → *Staff* library.
2. 2 RN (nurses) objects – *Healthcare* → *Staff* library.

All objects should be added to the appropriate groups. Creating groups makes it easier to modify the model and, for example, track changes in parameters when additional staff are added. By default, all objects from the *Locations* library are added to the main *Locations* object group . The same happens with staff, added to the *Staff* group.

Object groups can also be created independently, which will be used in the model. *ExamTables* and *MDs* and *RNs* groups will be created . A group can be created by selecting selected objects LMB+Shift or

adding more objects LMB+Ctrl, and then RMB on any selected element → *Object Groups* → *Add to New Group*. For each of the created groups, remember to correctly provide the *Parent Group* (Fig. 3).

Fig. 3. New object group settings



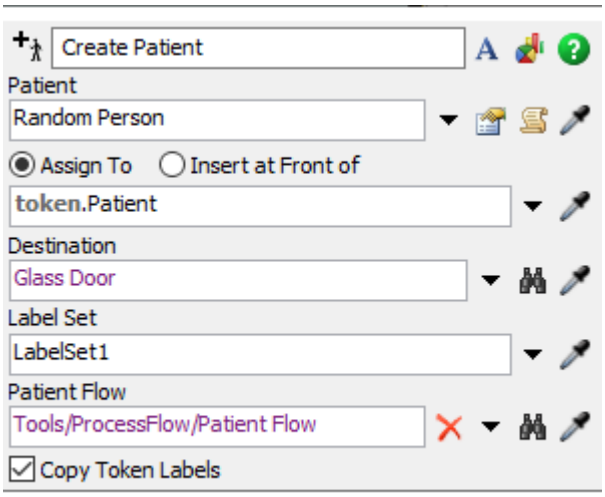
4. *Process Flow* diagrams

4.1. *Arrivals*

The model will be controlled using *Process Flow*. Additionally, built-in Activity templates will be used, the purpose of which is to simplify the use of typical, repeatable sequences of activities. The model control logic is based on two interconnected schemes:

1. *Arrivals* – is responsible for the frequency of generating patients in a specified location in the 3D model.
2. *Patient Flows* – takes over control of patient flow in the model.

Adding both schemes involves selecting *Patient Flows* → *Add a Patient Process Flow* from the main bar. Two separate tabs will be created with the names given above. After entering ***Arrivals*** a simple scheme appears that generates patients via *Date Time Source*, allowing the number of patients to be specified in time intervals. At this stage, it will be one person, which will be changed later to better reflect the model's operation. The settings for the *Create Patient* block are shown in Fig. 4. The entry in the *Patient Flow* field indicates what scheme this block is associated with - here *Patient Flow*, i.e. the second of the created schemes. The *Destination* field indicates the patient's place of appearance - *Glass Door*, which can be selected with the picker.



Rys. 4 Ustawienia Create Patient

4.2. *Patient Flow*

4.2.1. *Sign In, Wait*

The second scheme, ***Patient Flow,*** starts with a *Scheduled Source*. In this case, it means that when a patient is created in *Arrivals,* a single token will be generated that will trigger a sequence of further actions.

The first two tasks in patient service are registration *(Sign In)* and waiting in the waiting room *(Wait)*. *Arrivals* is responsible for the entrance. The activities within these two tasks are shown in Fig. 5 .

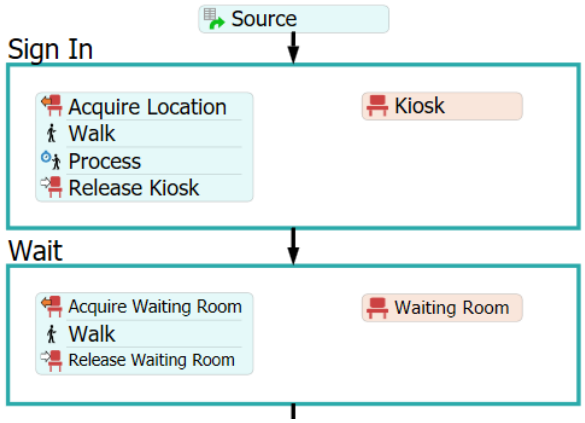


Fig. 5 *Sign In* and *Wait* groups

Adding tasks will involve using the built-in activity templates *(People Activity):*

1. In the library, select *HC Activity Sets* → *Walk then Process* and drag it to *Process Flow*, then rename it to ***Sign In*** .
2. The resource block name should be changed to *Kiosk* and the picker should point to the appropriate 3D object.
3. In the *Process* → *Process Time* block the time should be changed from minutes(10) to minutes(3).
4. The source should be connected to the frame surrounding the added template, which means that the tokens will enter the individual blocks within it sequentially.
5. You should add another template *Walk then Process* and rename it to ***Wait*** , while connecting it to *Sign In.*
6. The resource name should be changed to *Waiting Room* and the sampler should indicate the previously inserted benches in the waiting room.
7. The *Process* block should be removed from the inserted template – select this block with Ctrl+LMB, move it outside the group and delete it.

4.2.2. *Weight at Scale, Bed Placement, MD Exam*

The next three groups of activities are shown in Fig. 6. The patient is taken by the *RN* to the *Scale*, then the *RN* leads him to the *Exam Table,* where the patient is visited by the *MD* . After the examination is completed, the patient returns to the waiting room.

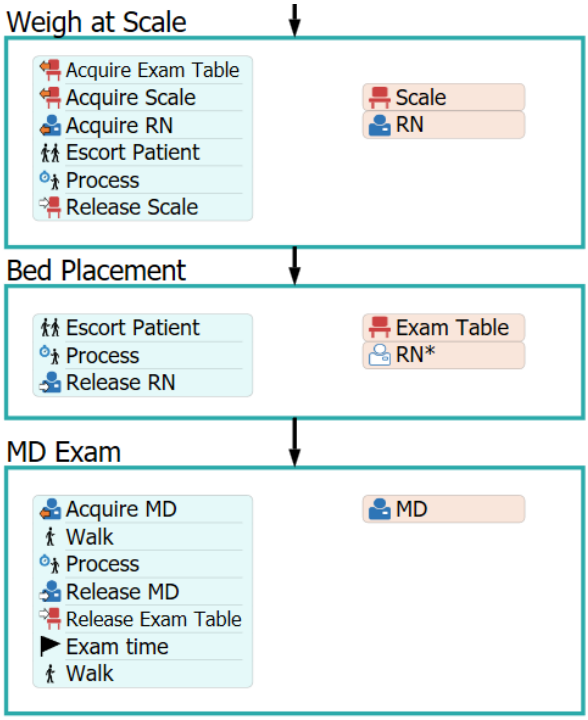


Fig. 6 *Weight at Scale, Bed Placement, MD Exam*

Weigh at Scale Groups and ***Bed Placement*** include the following activities:

1. From the library, select *People Activity Sets* → *Escort then Process* and drag it to *Process Flow*, then rename it to ***Weigh at Scale,*** linking it to the preceding Wait group.
2. *Location* resource name needs to be changed to *Scale,* the *Staff* resource to *RN.*
3. In the *Scale* resource block, point to the picker or select the *Scale* from the list.
4. In the *RN* resource block, you should point to any element of the *RN* group with the picker or select from *the Staff Group* → *RNs* list. As a result, the entry *Any member of RNs* should appear in the *Staff* field, i.e. any element of this group.
5. In the *Process* → *Process Time* block the time should be changed from minutes(10) to minutes(1).
6. *Release RN* block should be removed from the inserted template – this block should be selected with Ctrl+LMB, moved outside the group and deleted. The resource will be further used in the next activity template.
7. From the library, select *People Activity Sets* → *Escort then Process* again and drag it to *Process Flow*, then rename it to ***Bed Placement***, linking it to the preceding *Weigh at Scale* group.
8. *Location* resource name needs to be changed to *Exam Table* and point to any element of the *ExamTables* group with the picker or select *Location Group* → *ExamTables* from the list. The result should be the record *Any member of ExamTables* .

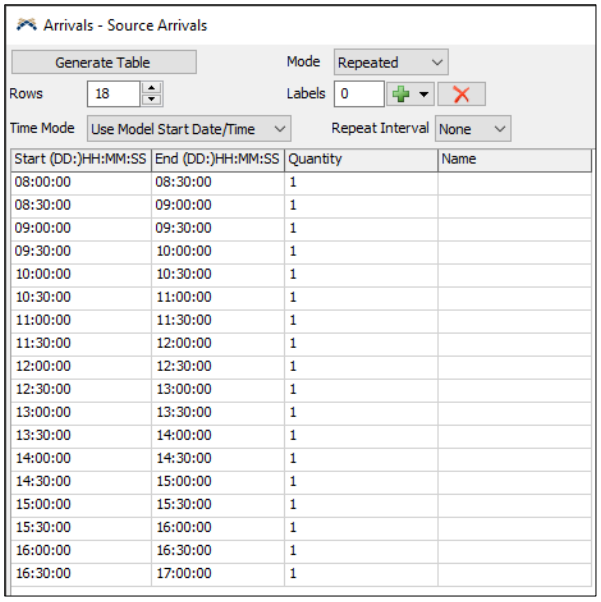
9. In the *Staff* resource block, the *RN* resource in the *Weigh at Scale* group should be selected with the picker. This means that both activities use resources from the same group. The result is the entry *Reference to RN* and changing the icon in the resource block.
10. *AcquireRN* block should be removed from the template. This resource has already been claimed.
11. From the current template, the *Acquire Exam Table* activity should be moved and moved to the beginning of the activity group in *Weigh at Scale*. This change ensures that the patient will not be taken to the scale if there is no available bed in the exam room.

The last group of tasks is ***MD Exam***:

1. From the library, select *People Activity* sets → *Process with Staff* again and drag it to *Process Flow*, then rename it to ***MD Exam***, linking it to the preceding Bed Placement group.
2. The resource block name should be changed to *MD* by pointing or selecting the appropriate resource group *(→ Any member of MDs)*.
3. The patient.Locations[1] record in *the Destination* field of the *Process* block indicates the last location the patient occupied, in this case a specific bed in the examination room. This indicates the place where *MD* will go .
4. In *the Process* → *Process Time* block the time should be changed from minutes(10) to minutes(30).
5. From the *Basic* library , select *the Milestone* block and name it *Exam Time*. In the *Milestone Collector* field, select *PersonMilestones*, and in *Milestone Name,* enter *Milestone1*. This block will be used to generate statistics for the model, in this case the examination time for each patient.
6. After *the Milestone*, you need to add a Walk block to the group, selecting Waiting Room in the *Destination field* . The block is responsible for returning the patient to the waiting room.

4.2.3. Change in frequency of visits

Checking the model in practice requires increasing the frequency of patient visits. *Date Time Source* in the *Arrivals* tab allows you to define the number of patients at specific times of the day (Fig. 7). In the properties of this block, in *Edit Arrivals* → *Rows,* increase the number of rows to 18, without changing the number of patients *(Quantity = 1* .



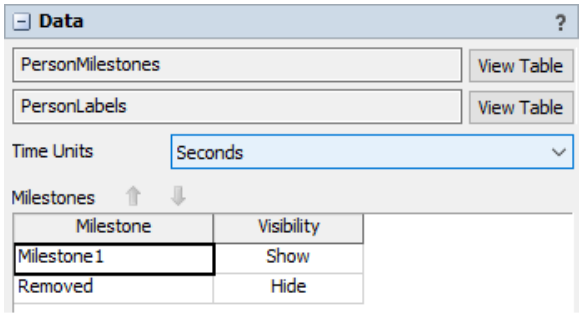
Start (DD:)HH:MM:SS	End (DD:)HH:MM:SS	Quantity	Name
08:00:00	08:30:00	1	
08:30:00	09:00:00	1	
09:00:00	09:30:00	1	
09:30:00	10:00:00	1	
10:00:00	10:30:00	1	
10:30:00	11:00:00	1	
11:00:00	11:30:00	1	
11:30:00	12:00:00	1	
12:00:00	12:30:00	1	
12:30:00	13:00:00	1	
13:00:00	13:30:00	1	
13:30:00	14:00:00	1	
14:00:00	14:30:00	1	
14:30:00	15:00:00	1	
15:00:00	15:30:00	1	
15:30:00	16:00:00	1	
16:00:00	16:30:00	1	
16:30:00	17:00:00	1	

Fig. 7. Change in patient generation frequency

4.3. Simulation analysis

Healthcare environment allows for the collection and analysis of detailed data on processes and their participants. The *Dashboard* option is used for this purpose, but it is adapted to the specifics of the simulated activities. Among others, there are charts that provide a detailed analysis of patient activity, the structure of staff work time, or the use of equipment.

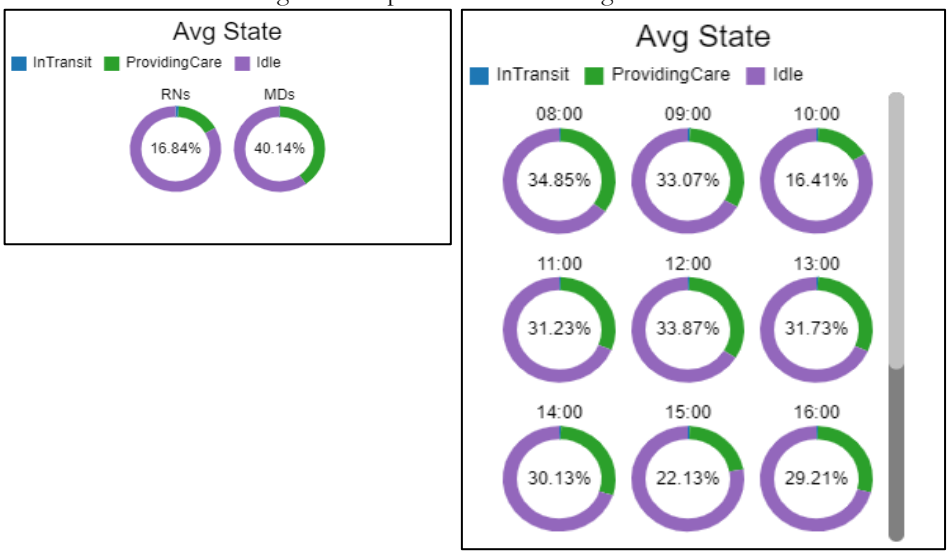
One way to analyze patient activity is to use *Milestones*, which are used to determine key stages of their service. After adding a new *Dashboard* to the model, in the *People* chart group, you should select the *Avg Milestone Times* chart. In the *Data* section, verify the correctness of the settings according to Fig. 8. The resulting chart will show the average patient service time.



Rys. 8 Ustawienia Avg Mielstone Times

Another useful type of chart is *Avg State* from *the Staff State* group. It shows the structure of work time utilization of selected staff groups. In the *Options* section, you can select the groups that will be displayed and the method of what will be the subject of comparison. This can be a comparison between the use of work time between *RN* and *MD* or a comparison of work time utilization in individual hourly intervals (Fig. 9).

Fig. 9. Examples of staff time usage charts



5. *A* Navigation* Module

5.1. Adding a *Grid*

The module allows for determining the shortest route between designated locations, taking into account user-defined barriers. This is to prevent passing through objects in the 3D model. In the case of the current

model, this will mean moving staff and patients along corridors and offices marked on the downloaded base.

The model with added *A* Navigation elements* is shown in Fig. 10. Adding barriers consists of performing the following steps:

1. Placing an A* *Grid* object from the *A* Navigation* library in the 3D model. After dragging it onto the model plane, it will take the form of a square with a blue border. It marks the area in which the movement of patients and staff will be limited by the *Divider* barriers added later.
2. The frame dimensions should be changed so that they include all model elements and the outline of the walls marked on the base.
3. After selecting *A* Grid* , set the grid density *(Node Spacing X/Y)* to 0.5m.
4. *Divider* elements should be added to the model , which will be an impassable barrier for moving people - they will be treated as physical walls. In Fig. 10 they are marked as darker lines that coincide with some of the wall contours on the base. Since each *Divider* element is treated as a separate element of the 3D model, due to the limitations of the version of the program used, only the barriers necessary within the movement routes resulting from the activities specified in *Process Flow* were added.

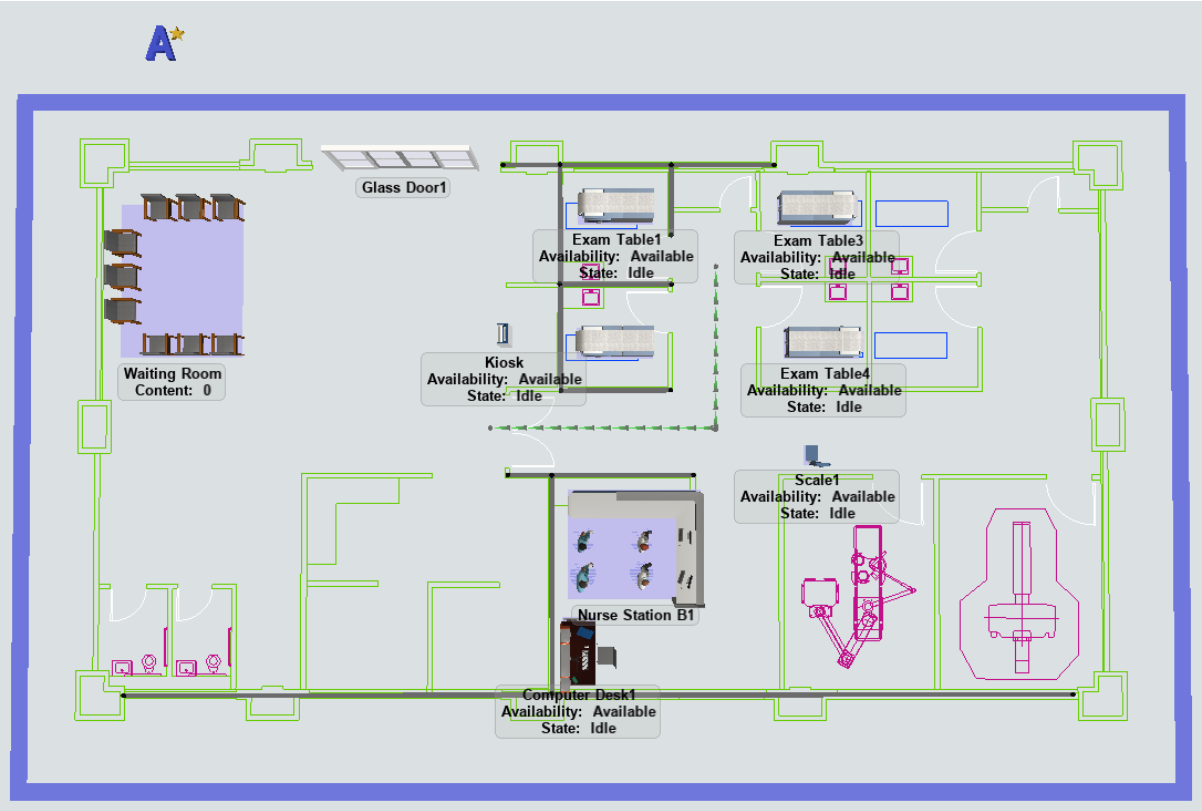
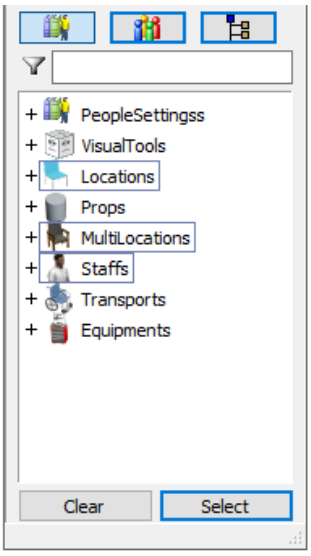


Fig. 10 *A* Navigation* elements

5.2. Adding 3D Objects to *A* Navigation*

Adding physical *Location* or *Prop* objects to *A* Navigation* adds a narrow area around them that is inaccessible to mobile *Staff* objects. However, mobile objects requires that the introduced barriers be taken into account when designating routes. Elements can be added to *A** In *Setup* → *Members* , select *All Members* and then use  to add elements as shown in Fig. 11.



Rys. 11 Dodawanie obiketów do A*

5.3. *Travel Threshold* and *Preferred Routes*

In the model, you can refine the details of determining the routes for mobile objects using the *Travel Threshold* option *(A* Navigation* properties → *Visual* → *Show Travel Threshold).* It displays potential points by which a moving person can reach a stationary object. *A* navigation* will determine the shortest route between the mobile object and any red point of the target object (example in Fig. 12). When the mobile object reaches any blue point, the task is considered completed (Fig. 13).

In practice, this means that if the selected red points of an object are on the wrong side of the barrier due to its imprecise arrangement, people may try to approach the object from the wrong side ("through the wall"). When arranging objects, the location of the red access points should be taken into account to eliminate conflict situations.

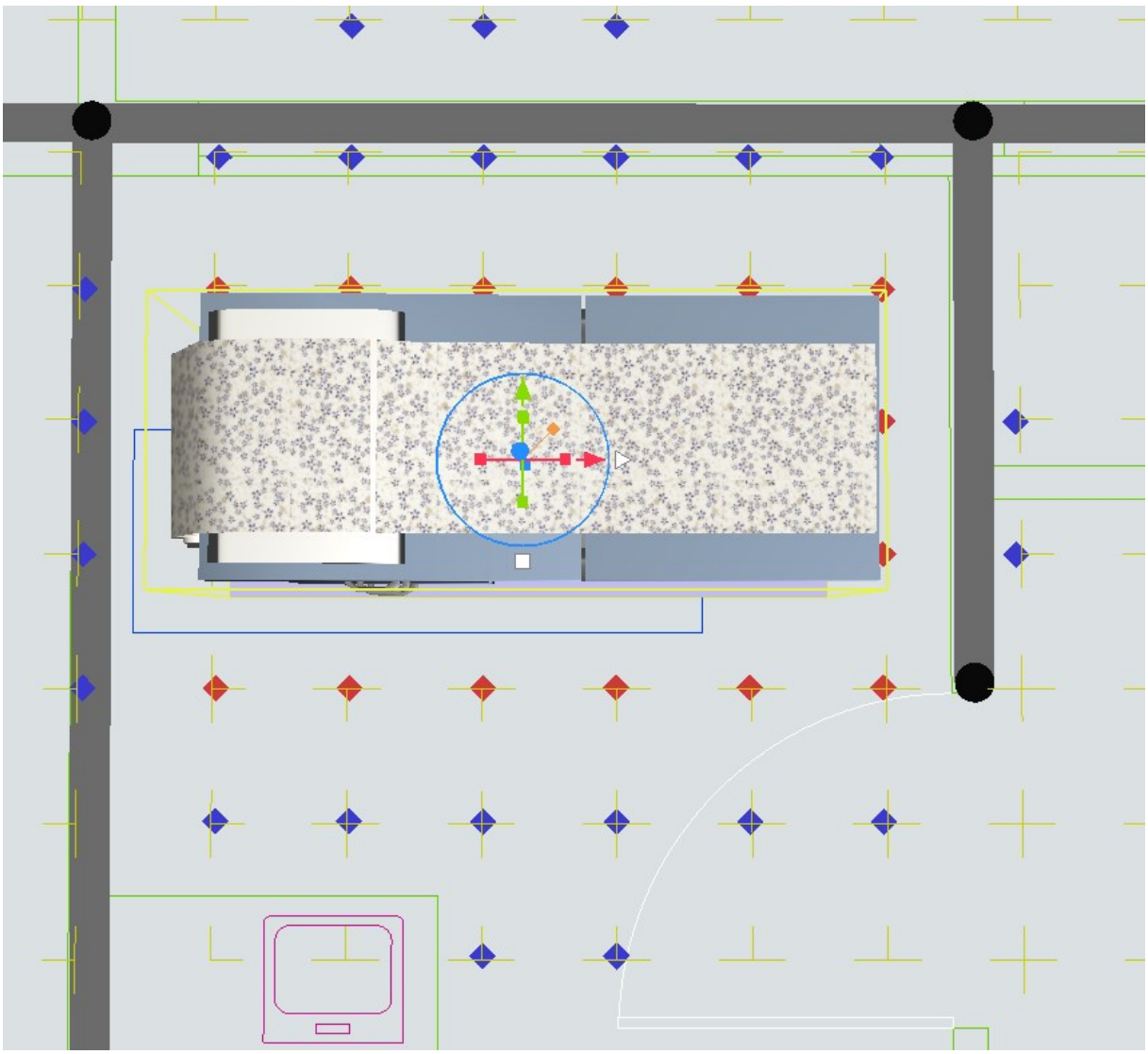


Fig. 12. *Travel Threshold Example*

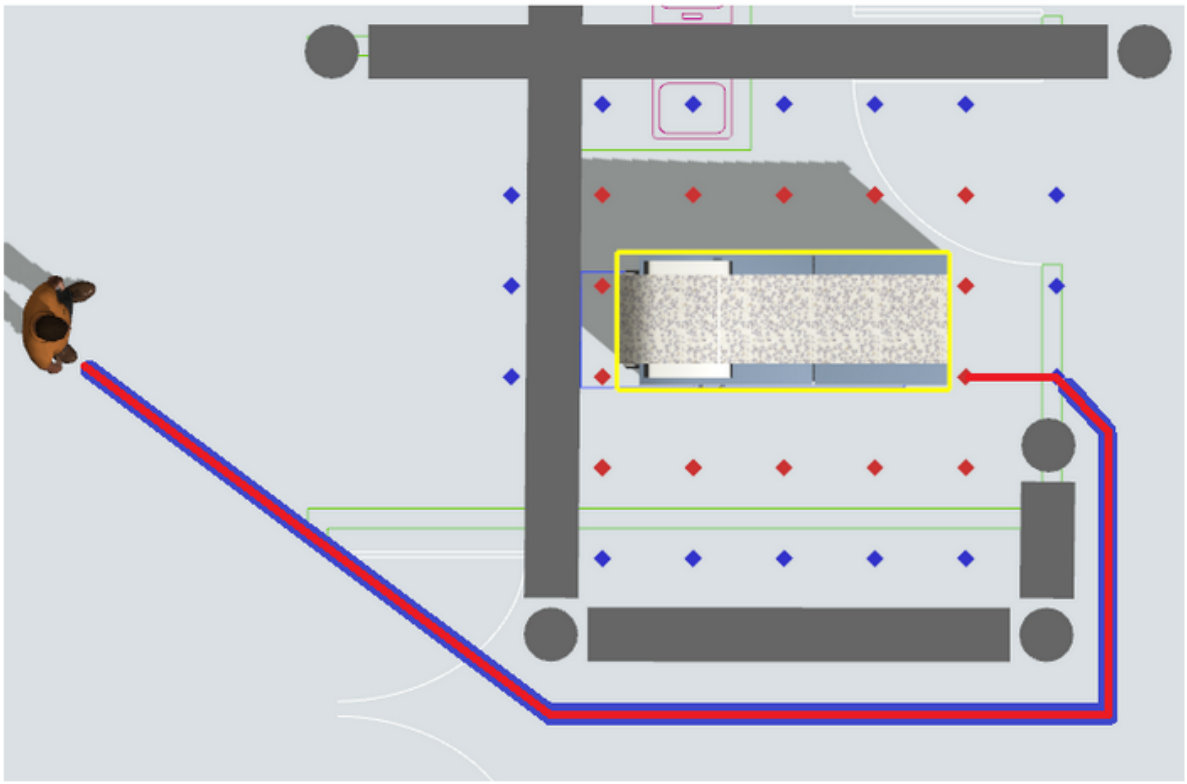


Fig. 13. How the route in Travel Threshold is calculated

Another way to improve the model is to add *Preferred routes* (green arrows in Fig. 14). They indicate the preferred path only when the object is near it. Additionally, they are directional, i.e. for movement in both directions, two appropriately directed paths should be added.

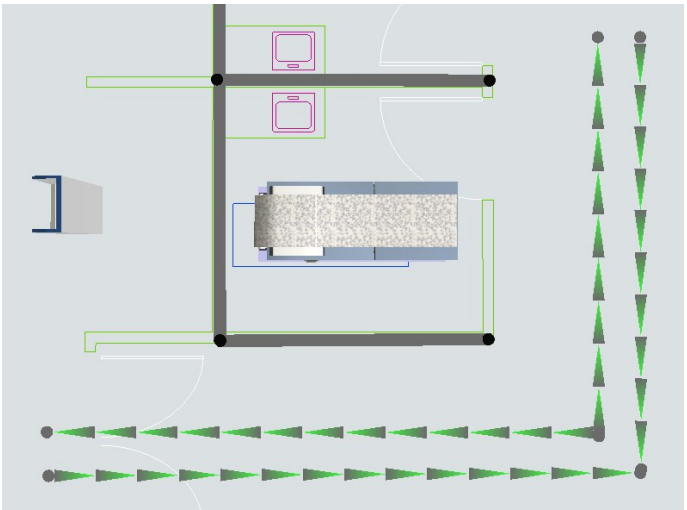


Fig. 14. *Preferred paths*