City Builder

During the semester, you must implement a *tycoon-like* real-time city builder game. Time can be sped up during play. An example game series like this is *Sim City*.

A screenshot of the first Sim City game (1989)

Brief description of the game

The player is given a well-defined area consisting of square fields. They can build their own city in this area and manage it as a mayor with wide powers. Overall, the city consists of different types of zones (on which residents build automatically), service buildings to be built separately by the player, and the roads connecting them. The player's goal is to develop a prosperous city where the citizens are happy and the budget is balanced.

The player receives some starting capital for the initial construction of the city, but they must rely on tax revenues for further developments. The game plays in real time, but time will pass much faster compared to reality. The game should indicate the time (year, month, day), and it should be possible to play the game in 3 different speeds, as well as to pause it.

The game has minimal 2-dimensional graphics viewed from top, where the fields are represented by static images. More advanced graphics can also be created as an additional feature (it's the last feature at the end of the document).

Zones

The player can assign three types of zones to each square field of the game area: residential, industrial and service zones. Assigning zones cost money, but citizens will automatically build

apartments and workplaces on these fields (at no additional cost to the city).

People moving to the city can build houses in **residential zone** fields. Each citizen lives somewhere, and the capacity of individual residential fields is finite. Each citizen works exactly at one place, at a workplace created for them in a field of an **industrial zone** or **service zone**, which is reachable from their place of residence. The maximum worker capacity of these fields is also given in the game.

Zones that have already been designated can be reclassified as general fields (if no construction has taken place on them yet), in which case part of the cost will be refunded.

Citizens should undertake work in the industrial and service zones in equal proportion, if a suitable zone is available with free capacity for them to work.

Selecting the zones gives us information about their capacity and saturation (percent full). In addition to the empty zone field, use at least 2 different images to display a specific type of zone. (For example, in case of a residential zone, there could be 1 or 2 houses on the field, depending on its saturation.)

Service buildings

Certain buildings in the city are not built automatically by the citizens as needed, but must be explicitly built by the player on a general, non-zone field. The construction of these buildings has a significant cost and an annual maintenance fee for the city, that is, the player. More than one building of the same type can be built in the city. The buildings can also be demolished, in which case part of the construction cost will be reimbursed. There are two service buildings in the basic task, these are expanded by the optional features. Note: these buildings have nothing to do with the service zones, they just have similar names.

Police. It guarantees public safety for fields within a given radius, which will be important for the satisfaction of citizens.

Stadium. The building occupies an area of a 2x2 squares, and for any zone square within a given radius, it increases the satisfaction of citizens by a bonus if they live or work there.

Roads

Roads can be built on open fields, and they can be torn down. Citizens will automatically build on a zone field only if it is accessible from a public road (on at least one of 4 sides). Otherwise, the field has been designated in vain, and cannot be used. Furthermore, the citizens of the city can only work at a workplace (be it the industrial or service zone) that is accessible by public road from their place of residence. Similarly, service buildings built by the player can only apply their effect if they are built next to a public road.

Roads have a cost and an annual maintenance fee. When demolishing, care must be taken for any

connections that may be lost: if an already constructed building would not be accessible by public road, the operation should be rejected.

Population

The player’s task is to develop as large a city as possible, which also requires a larger population. To help start the city, a smaller population is guaranteed to arrive In the initial phase of the game if there are free residential zones. Later, the arrival of additional citizens is positively influenced by the following factors:

- the general (average) satisfaction level of the residents in the city
- workplaces with free capacity close to the target residential zone
- no industrial buildings close to the target residential zone

For the sake of simplicity, let's consider the city's internal population change to be zero (the number of births equals the number of deaths.)

Satisfaction

Each citizen of the city has a a satisfaction indicator, which is positively influenced by the following factors:

- low taxes
- workplace close to place of residence
- no industrial building close to place of residence
- public safety of residence and workplace (which becomes more and more significant as the population grows).

Satisfaction is negatively influenced by the following factors:

- opposites of the above positive factors
- if the city has a negative budget (operates on loans), this factor should be proportional to the size of the loan and how many years the budget has been negative
- if the proportion of services and industrial production in the city is unbalanced

The satisfaction index is interpreted per citizen and for the entire city also. By selecting the individual zone fields, the satisfaction of the citizens living or working there can be reviewed. Very dissatisfied citizens may move out of the city after a while. If the satisfaction of the entire city becomes critically low, the mayor is replaced and the player loses.

Income and expenses

One of the most important tasks of the player as mayor is to maintain a stable budget so that the city's expenses (in the long term) do not exceed the income. It is possible to overspend: even if the budget turns negative, it is possible to spend more. Let's consider this as the city running on credit, but this leads to increasingly serious dissatisfaction among the citizens, which may ultimately result in the mayor being replaced and the game being lost.

The player can earn income in the form of taxes, for which an annual fixed tax amount can be levied on each zone space. The amount of tax collected depends on how many people live or work in the

given zone field. (If there is no one, then by definition there is no tax.) Expenses consists of one-time construction costs and regular maintenance fees.

The game has an interface to review the budget (income and expenses).

Features

Specifying and implementing the base game is worth **2 complexity points**. (1.5 points for teams of 4, 3 points for teams of 2). Additional complexity points can be obtained by completing the features below. Each team should have 5 complexity points to possibly obtain a grade of 5 (if all the requirements are satisfied). Other features can also be implemented based on your own idea after consulting with the practice teacher.

Fire department [1 point]

A fire can break out in buildings standing on zone fields. The chance of this should be lower for residential and service zones, and higher for buildings in industrial zones. Fires can also break out in service buildings, with the exception of the fire department.

The construction of a fire station as a service building has a dual role:

- It reduces the probability of fires in a given radius (because smaller fires are estinguished quickly without signalling the player)
- It makes it possible to extinguish actual fires, regardless of whether they are within the radius of the fire department. The player has the opportunity to send firefighters in a fire truck from the nearest fire station to the scene, whose movement can be followed throughout the playing field. A fire station has a single fire truck.

If a fire is not extinguished in time it will spread to neighboring buildings after a while.
If you wait any longer, the building will be destroyed.

Education [1 point]

The citizens can have primary, secondary, or tertiary education. All citizens have a basic (primary) education. Secondary education can be obtained at school, and higher education can be obtained at university. As a new service building, schools can be built (1x2 squares), which provide a secondary education to a given number of citizens every year. The university (2x2 squares) serves a similar purpose: to obtain tertiary education.

Since the population of the city is continually replaced by internal processes (retirement / death and birth), a part of the skilled workforce should lose their qualifications every year, thus representing that a more qualified citizen retired and was replaced by a fresh, but still unskilled worker .

Those with a higher education have a higher income and produce more value, so more taxes can be collected from them for their work at their workplace and as citizens in their place of residence. Not everyone wants a higher education, so there should be an upper limit on how much of the city's population can obtain a secondary or tertiary education. School and University buildings have

construction and operating costs, the latter of which must be paid even if they are not used.

Pension [0.5 points]

Let's develop our city's pension system more thoroughly. All citizens should have an age (min. 18) that increases annually and they retire at 65. After that, the retired citizen no longer works, but still needs a place to live. He does not pay taxes. He receives a pension instead, which should be half of the average annual tax paid in the 20 years before his retirement.

We should also calculate (with necessary modifications) a level of satisfaction for retired citizens. Pensioners do not move out of the city even if they are very dissatisfied.

The age of new citizens coming to the city from outside must be between 18 and 60. The pensioner dies with a probability that’s increasing every year above the retirement age. Then a young, 18-year-old citizen will automatically take his place (representing births within the city), but he will not necessarily live in the same place.

Forests [0.5 points]

Forests can be planted on general fields, preferably near residential areas. Forests improve the satisfaction of nearby residents who have a direct view of them, and also increase the desire to move into such zones. Forests can be seen by citizens living at most 3 squares away from them if there are no buildings between them. Forests should also reduce the negative effect of industrial zones on residential zones if they are located between two such squares.

Forests grow for 10 years, then they reach their mature state. Accordingly, the bonus for forest fields should increase continuously in the first 10 years after their planting. There is a one-time cost of planting forests, and they also have to be looked after for 10 years afterwards (maintenance costs).

When starting a new game, there should already be forested areas on the playing field.

Vehicles [1 point]

Let's show the citizens' movement with vehicles on the roads. Vehicles travel between residential buildings and workplaces in both directions. The citizens to be displayed (who are at the moment travelling between their home and workplace) should be selected randomly. Vehicles are more likely to depart from and arrive at residential buildings where more people live. Make sure that there cannot be multiple cars in the same position and they cannot collide at road intersections.

Persistence [0.5 points]

It should be possible to save and load the game, and to manage multiple saves.

Electricity [1 point]

Every building in the city needs electricity. Make it possible to build a power plant in a 2x2 area. The power plant supplies the adjacent zone fields and service bulidings with electricity. All zone fields and service buildings have a built-in electrical network for the transmission of electricity, so that it

continues to spread through contiguous zones and service buildings. Electricity can be transmitted between non-contiguous areas by building a high-voltage transmission line. In this case no other construction can be done on these fields.

All service buildings and buildings standing on zone fields should have an electricity demand. For zone fields this should scale with the number of people living or working there. The production capacity of the power plant is finite, so in the case of larger cities, the construction of more power plants is definitely necessary.

With insufficient power supply:

- service buildings don't work
- residential zones cannot settle new residents and the satisfaction of existing residents decreases
- taxes paid in industrial and service zones decrease

Demolition without notice [0.5 points]

It should be possible to downgrade zone fields that already have buildings to general fields, as well as to demolish roads that some citizens are currently using to reach their workplace. The game should warn the player and ask for confirmation. After the destruction it becomes necessary for the affected residents to change jobs or even places of residence. This significantly reduces their satisfaction, and requires a one-time monetary compensation from the city budget. If there is no free place of residence for a citizen, they'll leave the city.

Metropolis [0.5 points]

There should be a way to develop the zones further for a fee, which results in an increase of their capacity (number of residences and number of jobs). There should be at least 3 levels for each type of zone. Higher-level buildings should also be visually displayed with different graphics (e.g. family house, apartment building, skyscraper).

Disaster [0.5 points]

Implement some natural or industrial disaster, which can occur rarely and randomly, or at the player's request. Some examples: fire, meteor impact, chemical accident, Godzilla attack. The chosen disaster must also have some visual effect.

More advanced graphics [0.5 - 1 point]

The basic task requires only the implementation of 2-dimensional, top view graphics, where each building is displayed within its own field. Extra points (0.5 points) are awarded for 2.5-dimensional isometric graphics where the buildings visually extend beyond their own cell. Rotatable 3-dimensional graphics is awarded by 1 point.