# Simulation model of communication

This is a simulation model of communication between two groups of managers in the course of project implementation. The “world” of the model is a space of interaction between project participants, each of which belongs either to a group of work performers or to a group of customers. Information about the progress of the project is publicly available and represents the deviation Earned value (EV) from the planned project value (cost baseline).

The key elements of the model are 1) persons belonging to a group of customers or performers, 2) agents that are communication acts. The life cycle of persons is equal to the time of the simulation experiment, the life cycle of the communication act is 3 periods of model time (for the convenience of visualizing behavior during the experiment). The communication act occurs at a specific point in the model space, the coordinates of which are realized as random variables. During the experiment, persons randomly move in the model space. The communication act involves persons belonging to a group of customers and a group of performers, remote from the place of the communication act at a distance not exceeding the value of the communication radius (MaxCommRadius), while at least one representative from each of the groups must participate in the communication act. If none are found, the communication act is not carried out. The number of potential communication acts per unit of model time is a parameter of the model (CommPerTick).

Persons have a communication skill, the value of which is a normally distributed random variable with a given mean value (in the model, the skill values are adjusted so that the agent skill values are always at least zero). The average values of skills are model parameters, the values of which are set separately for groups of customers and performers (XSkillsMean, YSkillsMean). The outcome of the communication act is a numerical value, the positive value of which corresponds to the positive result of communication (from the point of view of the group of performers), negative - to the negative. This simulates the instantaneous value of the communication complexity (CommMomentalValue) during the project. Based on the sequence of values of instant

communication complexity, the value of the accumulated communication complexity of the project is formed. The model implements two variants of the accumulated communication complexity: the total sum of the values for the entire time of the simulation experiment (cumulative) and the moving average (CommHistory). The latter corresponds to the (more realistic) case of the final memory of the project participants, in which the results of past outcomes of communication acts are forgotten and the characteristic of communication with the counterparty becomes the "general communication background" - the value of communication complexity accumulated over a certain period of time.

The outcome of a communication act is determined by a number of factors. The first is the ratio of the total values of communication skills (skill) of the participants in the communication act on the part of the customer (variable u) and on the part of the performer (variable v). The value of the expression v / (v + u) specifies the probability of a normally distributed random variable N (EV, σ), the quantile of the level p (p = v / (v + u)) of which is the value of the result of this communication act. The second factor is the EV value of the normal distribution N (EV, σ). The EV is the deviation from the cost baseline of the earned value. The quantity is implemented in the model as a random variable with a normal distribution N (0 + FB, a), where a is a positive constant, FB (FeedBack) is a parameter that sets the amount of feedback between the accumulated communication complexity and the productivity of performers. A positive value of the accumulated communication complexity (the model implements the dependence on the history indicator) leads to a shift in the average value of EV by FB.

The managerial sense of the feedback is the stimulating effect of the positive value of the accumulated communication complexity (positive background of the project implementation) on the productivity of the performers. Provided there is favorable communication ("trust", "mutual understanding") between the customer and the contractor, it is more likely that project operations will be performed with less lag behind the plan or ahead of it.

The model is implemented by means of NetLogo 6.0.4. The behavior of agents in the world of the model (change of coordinates, visualization of agents' belonging to a

specific communicative act at a given time, etc.) is not informative. Content data are obtained in the form of time series of accumulated communicative complexity, the deviation of the earned value from the planned value, average indicators characterizing communication - the total number of communicative acts and the average number of their participants, etc. These data are displayed on graphs during the simulation experiment.

The numerical values of the communicative complexity of the project (which are the output of the modeling process) represent the assessment of the communicative complexity by a group of performers. The assessment of the communicative complexity of the project by the customer's group may, in general, differ from the assessment of the performers, but in the considered version of the model, communication is considered from the point of view of the performer. The value of the total communicative skill of a group of performers determines their ability, for any (including negative) deviation of the EV of the value of the earned value from the planned value, to obtain the most favorable (numerically greater) result of a separate communicative act. In turn, the skill of a group of customers increases the likelihood of the outcome of an individual communicative act in the form of a negative (numerically smaller, including negative) value. Thus, the communicative skill of customers means the degree of aggressiveness of the customer, the tendency to put pressure on the group of performers, the indicator of the desire to dominate - in any course of work, incl. with positive values of the deviation EV (ahead of the work plan).

The control elements of the model allow seven independent values to be varied, which, even with a minimum number of varied values (three: minimum, maximum, optimum), gives 3^7 = 2187 different variants of initial conditions. In this case, the statistical processing of the results requires repeated calculation of the model indicators for each grid node. Thus, the set of varied parameters and the range of their variation is determined by the logic of a particular study and represents a significant narrowing of the full set of initial conditions for which the model allows simulation experiments.

In particular, the developed model makes it possible to conduct a simulation experiment to determine the quantitative measure of the relationship between the value

of FB (feedback) and the ratio of the general average values of the communication skills of the customer's and the executor's groups.

This is a very simple (less than 100 lines of code) model, which is educational in nature and is designed for various simulation experiments. Experiment patterns are stored in the behavior space of the model.

For convenience, a parser .XLS-file is included in the model documentation. By copying the data from the output file generated by NetLogo to the sheet of this file, you can get the results of the experiment in the cells of the worksheet in the form of numbers.