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**Generating job mobility patterns: using simulation techniques
for the explanation of employees' organizational careers.**

K.van Veen, W.S.J.Geerlings, R.Popping

SOM Theme A: Primary processes within firms.

ABSTRACT:

The study of organizational careers of employees developed in the last 20 years into an important branch of social mobility research. However, a major problem in this branch is the presence of many organizational mechanisms, which are theoretical interesting though hard to study simultaneously in the organizational case studies to which the field is restricted. In order to overcome this problem of theoretical complexity and lack of data, a simulation model CLISP is developed that generates career data of employees under controlled conditions. The output of CLISP is a set of data, which is similar to the well-known data sets that are obtained from existing organizations. Some examples are given that reflect the usefulness and possibilities of simulation techniques for the study of organizational careers of employees. For instance, the simulation results can provide us with knowledge about the period in which changes in personnel policies - such as Equal Opportunity measures - will have substantial effects in the measurement techniques, which are often applied.

1. INTRODUCTION¹

In the sixties, social mobility research focussed on the statistical analysis of representative data sets of individuals within society (Blau and Duncan 1967). Since then, the focus shifted slowly from the descriptive analysis of these cross sectional data sets towards the explanatory mechanisms that generate the observed career patterns. One important explanatory mechanism was found in the mobility of employees within organizations. To understand the observed career patterns of employees, the organizational characteristics were seen as crucial and needed further exploration (Baron 1984, Althauser 1989). Slowly a body of empirical research emerged over the years in which the actual careers of employees within organizations was described and explained by using actual career history data of different organizations. In this branch of social mobility studies, individual careers have been reconstructed and explained by using different kind of explanations on an organizational and individual level (Spilerman 1986, Althauser and Kalleberg 1990, Stewman and Konda 1983, Brüderl 1990).

Although the focus on organizational mechanisms leads to an increase in knowledge about relevant career determinants in general, it simultaneously creates a tension between the theoretical claims and the possibilities to test these empirically. First of all, a problem emerges on the theoretical level. Although a number of conditions are specified in the literature which might determine career outcomes of individual employees, the way they simultaneously interact and lead to different distributional outcomes on the organizational level is too complicated to study theoretically. Theories use many *ceteris paribus* assumptions and try to explain parts of observed regularities in career data. How they simultaneously affect the career patterns of employees in each organization is impossible to derive at forehand. Second, studying career patterns implies access to organizations that indeed collected high quality career data over a large number of years. This proves to be a major problem in the field. As a result, most studies in this field focus on one organization with a limited data set and varying qualities of data. This makes the field rather sensitive for criticisms about the ability to generalize results. In addition, the idiosyncratic characteristics of the available data make it often difficult to simultaneously test the relative effects of different theoretical mechanisms. There is simply not enough variation within case studies to distinguish the relative effects of all theoretical mechanisms apart from the specific history of careers in an organization. The need for comparative data is severe in this field.

In order to develop a better understanding of a set of different organizational mechanisms and to study the effects on the final career data, a simulation program has been developed which is capable of generating career data under different conditions. The result is a tool, which can be used in order to understand the different effects of *combinations* of mechanisms within career history data that are usually analyzed within studies of organizational careers. We labeled this tool CLISP: Career Line Simulation Program¹.

¹ The name CLISP is purposefully chosen as a variation on Althauser's Career Line Identification Program,

To show the usefulness and characteristics of CLISP the following steps will be taken. Firstly, a brief theoretical discussion will be given in which a set of well-known organizational mechanisms is introduced briefly. Secondly, the main characteristics of CLISP are discussed and related to the foregoing theoretical discussion. Hence, a number of career data sets will be generated by using CLISP. The careers will be simulated under different conditions and subsequently analyzed. Finally, the results will be discussed and connected to our original purpose: generating more systematic knowledge about the expression of (combinations of) organizational career mechanisms in organizational career data.

2. THEORETICAL OVERVIEW: EXPLAINING INDIVIDUAL CAREERS WITHIN ORGANIZATIONS

In the literature concerning organizational careers, three different sets of factors can be distinguished that are accepted as sets of explanatory mechanisms. These mechanisms are supposed to determine the career trajectories of employees: structural factors, selection policies and differences in individual characteristics between employees (Wielers 1991, Glebbeek 1993).

The structural factors are organizational characteristics, that restrict or open career opportunities for employees. Most important is the sub division of the organization in a set of jobs for individual employees. The numbers and kinds of different jobs, the departments and the hierarchical levels in the organization define together the 'opportunity structure' of the organization. For instance, demographic models show how the relative numbers of jobs on different hierarchical levels of an organization define the objective chances employees have to make career move. Stewman and Konda (1983) showed -among other things- that these chances can differ for each hierarchical level. Hedström (1991) analyzed an exceptional data-set that consisted of a large number of organizations and shows how the shape of the organizations (steep or flat) affects the cross sectional income distribution of the employees and the relative importance of factors such as education and experience on the final positions. From this kind of studies, it can be concluded that the structural aspects of organizations restrict or open career opportunities and affect the career trajectories employees might develop within an organization. A second important structural factor is an extension of the foregoing argument. Not only the stable characteristics, also the dynamic aspects in the organizational structure are relevant and need attention during the explanation. Careers, as sequences of jobs, develop by definition over time so the time-related changes in the organizational structure are important too. Rosenbaum (1984) showed how organizational growth opens career possibilities of employees and how contraction of the organization affects them negatively. Van Veen (1997) analyzed how changes in the formal promotion ladders occurred over time in a large Dutch manufacturing firm and how these changes affect the careers of employees. Therefore, the manipulation of these structural aspects

CLIP (Althausser and Van Veen 1995). The output of CLISP can be used as an input file in CLIP and many other software which is often used to analyze career line data.

in a simulation model is of utmost importance to develop new insights in the determination of career outcomes within organizations.

A second important set of factors, which determines career trajectories, can be classified as the 'selection policies'. The selection policies basically prescribe the entrance criteria that an applicant should meet in order to be selected for specific jobs in the organizational structure. The first important set of criteria concerns the kind of criteria, which applicants should meet in order to enter the organization. Formal education, experience, intelligence, age, race or social skills are often implicitly or explicitly used to select a new employee within an organization. Employers rank the candidates on such individual characteristics into a labor queue from which they select the most suitable applicant according to their own selection policies (or preferences) (compare Thurow 1975). The selection criteria at the so called 'ports-of entry' (Doeringer and Piore 1972) can be extended to the jobs that are shielded from external competition and are only accessible to internal candidates. This shielding of this subset of jobs within an organization is the empirical result of the selection policies the employer applies to this subset. Internal labor market theories suggest for instance that for many jobs within organizations the development of firm specific skills is necessary. This creates the necessity for the employer to select candidates from a subset of internal employees instead of the external labor market¹. Formal job ladders can thus be seen as the materialization of the employers' selection preferences for this subset of jobs². It is clear that the selection policies should be a factor to manipulate in the simulation model. The selection policies are an important factor and needs to be specifiable for (subsets of) the different jobs. Both differences in entrance policies as well as different criteria for different job levels need to be specifiable in detail.

A last group of relevant factors in the explanation of careers are their individual characteristics of employees. Many theories are specified which use these characteristics to explain the trajectories that employees have. Human capital theories (Becker 1964) for instance start with the idea that employees can increase their productivity by investing in their educational levels. Others direct their attention towards characteristics such as race or gender in order to explain discrimination of these subgroups (e.g. Brüderl 1990). Although it seems that employee's characteristics are incorporated in the selection policies of the organization, it is still necessary to distinguish the characteristics separately in the simulation model. In the first place, actual preferences of employers are also dependent on the available supply of candidates. If employers prefer employees with a specific educational background, they need to have this supply at hand in order to realize the preferred outcome. If there is a shortage for this subgroup, the employer has to adapt the selection criteria to the new situation (for instance select people who have a higher/lower education or decide to develop skills within the organization instead of direct selection from the external labor market). The specification of these individual characteristics is necessary in order to handle these supply and demand differences over time. A second reason for the incorporation of individual characteristics is the variability of these attributes, which makes a major source of variations in outcomes. Employees grow older, are trained, learn on the job, become more senior, are more or less socialized, et cetera. The incorporation of these potential changes in individual attributes makes that employees have variable access

to certain jobs. An individual employee can be selected for a certain job in later periods, which was not possible in an earlier period because (s)he did not have the appropriate individual attributes. As a result, the simulation model should contain individual characteristics, which these 'individuals' can offer at the point-of-entry of the organization and subsequently develop during their careers.

A simulation model in which each of the three subsets of factors can be manipulated is useful for the study of employees within organizations. By combining variations in structural factors, selection policies and individual characteristics, a detailed comparison of different kinds of career mechanisms can in essence be obtained. The enormous complexity and dynamic character of the career mobility processes can be studied in a controlled setting and be analyzed with the statistical techniques, which are presently known.

3. EXISTING MATHEMATICAL / SIMULATION MODELS

In the literature, different models can be found which are focussing on related problems. Models that can be used to develop insight in organizational careers can be divided in two different classes that each have their own perspective: the manpower planning perspective and the analytical perspective. The manpower planning perspective originates from the seventies. These models were explicitly developed to create knowledge about the expected labor demand in the future within organizations. Based on information about the labor demand researchers tried to predict the amount of employees needed to staff the organization in the future. The methods and techniques that have been developed from this perspective are well known (Burack 1988, Bechet 1994). Within the manpower perspective three different approaches can be distinguished: in which personnel supply, personnel availability and integration models. Three methods to estimate personnel buildup are used. First, extrapolation, the assumption is that personnel supply can be derived from trends from the past. This concerns the rather simple extrapolation of trends in the past into the future. Second, methods based on correlation are used. These models consist of the specification of relationships between personnel supply and explanatory variables such as turnover, sales volume, or production. For example, if the turnover of an organization changes, the personnel supply will also change by a known factor. The third method consists of personnel availability techniques. In these methods, it is not the past development on an organizational level which is studied, as in the two foregoing methods, but the individual employee within an organization. These dynamic systems models "attempt to predict the life movements of people within a closed system and their interactions with other systems" (Yelsey 1982). Individual employees are followed through a closed system of jobs. Two kinds of dynamics are usually distinguished in this approach: a push-flow and a pull-flow, as is depicted in figure 1.

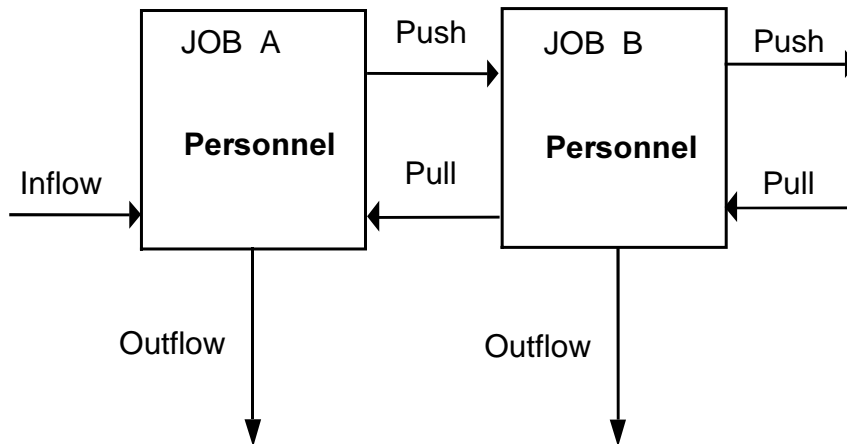


Figure 1: A flow model

In a push-flow model, movements of groups of employees from one job to another occur regardless of a job opening existing on that particular job level. If the transition rate from job A to job B is 4 percent per year and the number of employees in job A is 50, two employees will be promoted to job B each year. Supply of employees is leading to sequences of jobs for employees, based on a so called 'seniority-performance based switching mechanism.' In contrast, the pull-model takes into account the availability of a job opening so applies the 'vacancy-based switching mechanism for individual careers' . (Stewman and Yeh, 1991) If one job is free on job level B then only one employee from job level A will be promoted. In practice, these transition rates are calculated on the basis of historical patterns to forecast the flow of staff between the job levels in the future. There is no matching between individual employees and specific jobs in this model but only a movement of *groups* of employees through predestined job levels. Employee characteristics do not change over time in these dynamic models, except for the sequences of different job titles.

The third group of models consists of the integration models such as goal models. These models are mainly based on linear programming methods. Based on a set of constraints, the model finds the optimal solution in terms of the number of employees in a given job structure based on some ex ante specified criteria (or goal functions). Usually, within the set of criteria, the demand for personnel within an organization is taken into account. The disadvantage of these integration models is that for reaching the optimal solution and the desired occupation of jobs, jobs often have to be understaffed and overstaffed for short time intervals. This is often not applicable within organization. For an in-depth overview of the kind of models that have been developed over the last decades see Niehaus (1985) and Ward et al. (1994). After a first quick development of these forecasting models in the early eighties, the field did not make much progress. The predictions turned out to be rather vulnerable for changing circumstances and made them not very helpful in practical situations.

The analytical perspective is the second perspective in which mathematical models are used as research instrument. In the analytical perspective, models are developed to gain insight in variables, which affect the careers of employees in organizations. For example organizational careers within organizations with an internal labor market (Konda et.al. 1981, Stewman 1986, Rosenbaum 1984) Vacancy and job evaluation models, which can be influenced by managerial policies (for example, hiring people from outside). Here, data sets from personnel information systems with empirical career information are analyzed, ex post, to reveal the structural patterns in the career data.

Quite some progress is made in both manpower planning and the analytical perspective. Given our purposes, however, the two perspectives have two major disadvantages. First, each of them is strongly dependent on historical data regarding the flows of personnel. Second, the models consider employees as entities that are completely void in the models: only their quantity changes not their qualities. Nothing is usually said about the development of individual qualifications of the employees and the consequences of these changing attributes during the rest of their career. An implicit assumption is that when a transition between jobs exists, the selected employees are indeed qualified for their next job. As a result, variations on an individual level are hard to consider. Even worse, if the content of a job changes and requires new qualifications of the employees, there is no possibility to accommodate these changes in the current models. For instance, the introduction of new technology in the production process might lead to the supply of new training programs for old and new employees. The effect of attending these training programs on the future careers of these employees are hard to foresee and also hard to integrate into the models. The conclusion is that additional parameters are needed to match new job requirements and employee qualifications in order to be able to study the distribution of employees over the new job structure. The current models are static in the sense of the development of the qualifications of employees and evolution of entry requirements (or selection criteria) needed to obtain a job. Therefore a new model to study these changing processes has to be developed. To create knowledge about the interactions between changing characteristics of employees, new selection criteria for jobs and the opportunity structure of the organization, a more dynamic model is needed.

The main conclusion is that the current models simulate the organization and employees on a too abstract level through which relevant details of the allocation processes are overlooked (Geerlings et al, 1998). In the next section a new approach will be described which does consider these problems and takes more details into account.

4. MODEL CHOICE AND LAYOUT

To study the described processes in more detail, a simulation approach is chosen. Shannon (1975: p.2) defines simulation as follows, 'Simulation is the process of designing a model of a real system and the conduction of experiments with this model for purpose either of understanding the behavior of the system or of evaluating various strategies'. For our purposes a simulation model gives us the opportunity to take more variables into account both on an individual as well as on a structural level which influence career

paths of employees in an organization. With such a simulation model, different scenarios of career development can be calculated. Three main factors can be discerned which influence the careers of employees. See figure 2.

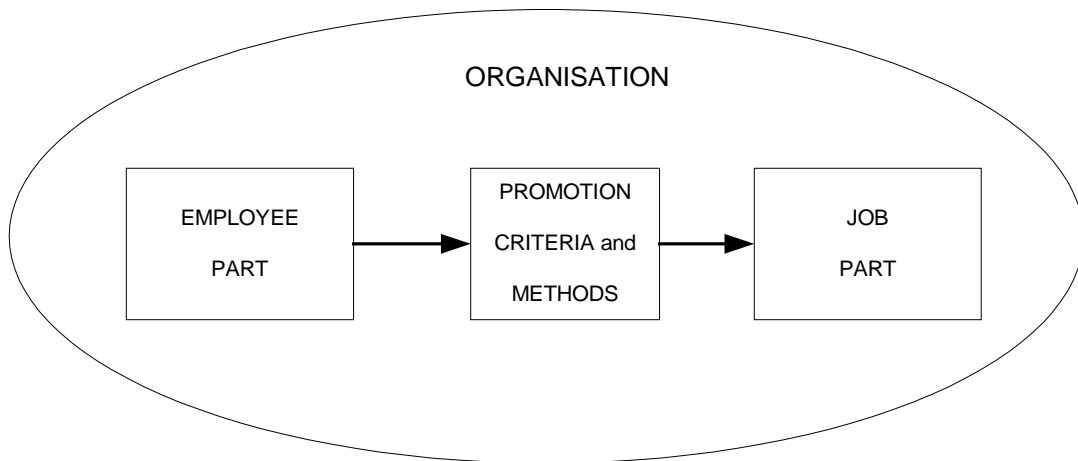


Figure 2. Three parts of career lines

These three parts are (a) characteristics of the employees (b) the criteria and the method of promotion and (c) structure of jobs within the organization. The employee part essentially facilitates human capital theory related hypothesis. Differences on an individual level can be modeled and different investment decisions of individuals can be specified. Both stable (gender, race) and variable attributes (education, tenure, age) can be used. The second part consists of the job structure and opens possibilities to use structural factors that determine careers. Here, hierarchies of jobs can be specified in all kinds of job ladders. The third and last part consists of the promotion criteria. This group of factors specifies the link between the employee and the job structure part. On the one hand, promotion criteria are formulated for each job, which a candidate must meet in order to be selected and allowed to enter the job. Due to the fact that individual characteristics vary over time, candidates can shift in the labor queue that is present for each job. Individual employees can move in this queue into the direction of the exiting selection criteria for a job. This feature opens the possibility to explore processes related to changing selection criteria and the development of the employee's career or the effect of inflow of new employees with other competencies. On the other hand, the promotion criteria are connected to the structural part of the model. This connection consists of two choices. First, a chain of jobs must be defined through the job structure which employees might follow during their career. This is essentially equal to restricting the entry for certain jobs to the occupants of other (lower level) jobs. Second, the different promotion criteria have to be specified in such a way that it becomes possible to actually choose an individual employee that will be promoted from

the subset of candidates. By specifying the factors in these three parts, all common career factors are present and connected in a theoretically sound way.

The goal of this article is, on the one hand, to demonstrate the potential of simulations when studying the effects of different theoretical career mechanisms. On the other hand, it gives the possibility to analyze the effects of changing conditions within organizations and their effects on the career outcomes. In order to do so, the model should meet two requirements. First of all, the relevant theoretical parameters must be adaptable in the simulation model in order to study the effects of different specifications. Secondly, it must generate data that reflect the career information of individual employees over time in different conditions. If the program meets both requirements, the career patterns can be connected to the organizational conditions and thus makes it possible to analyze their effects by using standard techniques such as Regression Analysis, Event History Analysis or Career Line Analysis. In the next section, the specification of the simulation model is described in detail.

5. The design of the Career Line Simulation Program

Using simulation as a methodology opens the possibility to implement a wide range of variables that have an effect on a career path. The choice which variables should be included in the simulation model depends largely on phenomena a researcher wants to study. We have made the choice to incorporate the most common aspects of employee and an organization. Once again the goal of this article is to highlight the power of simulation models to give insight in how careers of employees within organizations develop. By offering a setting that gives the ability to generate data under controlled conditions, it is possible to show the added value as a research tool in the field of organizational careers.

In this section, we will describe the way the three parts are specified in CLISP. We start with the characteristics of the employees. Next, the criteria for promotion are presented. Finally, the specification of the job structure is discussed. For each variable, a description of the initial value is given or, if necessary, the used stochastic process with its parameters.

5.1 Characteristics of the employees

To generate the desired output, employees should be defined which have individual and varying characteristics. The model should solve two problems in this respect. First, a start file has to be created which contains all employees that are present on $t=0$ (can be any arbitrary point in time) in the organization. Second, new employees have to be created to enter the organization when vacancies are not filled with an employee who already had a job in the organization. In the database, all individual employees are defined by assigning them with a unique identification code. In addition, each employee who enters the simulation has the following attributes:

- **Employee id:** Unique number to identify each employee.
- **Gender:** is assigned randomly.
- **Year of birth:** year of birth is assigned to each employee through a uniform probability

distribution. The range of possible values is defined before starting the simulations. For example, the minimal age for employees to start working is 20 years and (s)he retires at the age of 65. Date of employment is 2000. The range of the year of birth is 1935 to 1980.

- **Year of entry in the organization:** is generated randomly according to a uniform probability distribution for the start file. For example, the first year of the simulations is 2000. The date of birth of the employee is 1965. Minimal entry age for a job is 25. The first possible year for appointment is 1980. Subsequently, a specific date of employment is chosen within the range of 1980 to 2000. The employees who are created during the simulation receive the year of entry in the organization.
- **Hierarchical level (or job title):** this is equal to the job an employee occupies for the start file. The jobs are randomly assigned with the construction of the start file. As soon as an employee is assigned to a new job, job title changes too. This also counts for new employees.
- **Educational level:** for each hierarchical level, a range of possible educational levels can be assigned. Through a normal probability distribution, each employee receives its educational level. The assigned education level is fixed in time by default.
- **Level of job specific experience:** This variable represents the experience of an employee in a job. This variable has a range from 1 –3. Through a normal probability distribution, the value will be assigned to each employee within the start file.
- **Growth of job specific experience:** Once in a job, an employee trains him/herself by developing work experience. As a result, this variable will be raised with one point for every year the employee stays in a job. Once, the employee reaches the maximum level of job experience (for example 3) the level of job specific experience is stopped. If an employee is selected for a new job, the development of experience will set back to zero and starts over again.
- **Seniority:** the number of years an employee works for the company.

Some of the scores on these attributes are adapted after each simulation round. For instance, level of seniority is raised with one for all employees within the organization adapted after each of the simulation rounds. After each round of the simulation, for each of the employees in the organization, the scores on each of these attributes are registered in the output database. As a result, all relevant career information of the employees is available for each employee for each simulation round. Employees can be followed during their careers. All relevant information is stored in different databases.

When the simulations start, a set of employees is generated based on the selection criteria that have been specified for each function in the structure of the organization see next section. When an employee is created, the first job will be registered to make it possible to reconstruct his career. In addition, it is possible to enter a set of employees in the structure for which the individual attributes differ from these structural aspects or to use a data set from an existing organization.

5.2 Structure of the organization

The structure of an organization to be simulated has to be defined by the user of CLISP. The number of different hierarchical levels, the number of jobs on these levels and the connections between the jobs must be specified in order to define the key structural features of an organization. What results is an organization with different kinds of career ladders. Two possible career paths through an organization are shown in figure three.

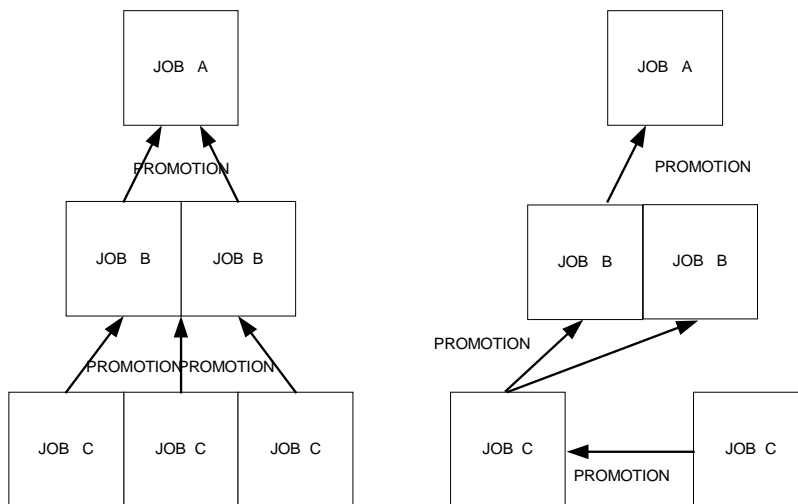


Figure 3 horizontal and vertical promotions

Here we see an organization that is defined by a number of jobs. Each job shift can subsequently be seen as a 'promotion', horizontally or vertical. As the job structure is specified the job ladders are formed by the way jobs are linked to each other. By connecting jobs, a queue of jobs is constructed. For example, the job structure on the left side in figure two can be represented as follows:

| | | | | | | |
|----------|---|---|---|---|---|---|
| Job | A | B | B | C | C | C |
| Occupied | n | y | y | y | y | y |

If job A is not occupied then the program looks at the next function to the right, B in this case for an employee to promote to job A. The job structure on the right side of figure 2 can be specified with the following queue:

| | | | | | |
|----------|---|---|---|---|---|
| Job | A | B | B | C | D |
| Occupied | y | y | y | n | y |

If job C is vacant and needs a new employee, the program automatically starts a search at D. By using this procedure, vertical and horizontal function moves can easily be incorporated. So the candidates for job A are always searched at B, B by C and so on. As a result, all jobs are linked and can be seen as a hierarchy of job and is similar to organizational structures which can be observed in every organization.

Three connections are specified regarding the jobs in the organization structure. The first and second are education and age of an employee. These can be specified for each job. Every employee that is created for the start file or during a simulation round will have an age or education within the specified range. Through this cross-link it is impossible to create a financial director with an age of 17 and only primary school. The third is minimal time in function; the amount of time, which an employee has to spend in a function before it, will be admissible for promotion to a next function. This mechanism makes sure that employees develop a minimal amount of experience in their present job before they become a potential candidate for the next higher job on the job ladder.

5.3 The search method and the promotion criteria

After specifying the employees and the organizational structure, the final decisions have to be made on the search method and the promotion criteria. The search method is rather straightforward. As soon as a vacancy emerges in the organizational structure, the program will start searching for a suitable employee in the total pool. By default, the program restricts the search to employees on the next lower job. Subsequently, the program has to make a decision about the employee within this subgroup that should be promoted. To make this choice, different selection criteria can be specified for the different jobs. The users of the program can choose from 5 different selection criteria:

1. age
2. level of training
3. seniority
4. gender
5. experience in the job that is performed.

For every selection criterion, minimum and maximum values can be specified. As a result, the user has a choice for each different job level which selection criteria or combinations of selection criteria will be used. For example, the user can specify for a certain job that only employees with an age between forty and forty-five years old, seniority of minimal 10 years and at least a college degree will be seen as candidates for the job.

Once the relevant criteria are defined, the method of using these criteria can be chosen. The method of using the criteria stands for the order and/or weight given to the chosen criteria. By default, three different methods are available in the program.

1. An inexorable criterion.

This is a criterion that an employee must meet in order to become a candidate. Employees, who meet

an inexorable criterion are selected, other employees are by definition excluded. The subset of employees that remains will be ranked on the other selected criteria.

2. Summation of the weighted selection criteria.

For each criterion an employee meets, a value between 0 and 1 can be assigned. The total score must accumulated to one if an employee will be considered as a perfect candidate for a job. For example, age counts for 0.3, seniority 0.2 and education for .5. If an employee matches the first and second criteria (s)he has a score of 0.5. After calculating all the scores, the employee with the highest score is promoted. If more than one employee has the highest score, one of them is selected randomly;

3. No specification.

Each of the employees who fulfills the criteria can potentially be selected. No ranking within the pool of suitable employees can be made. For example the chosen selection criteria are: age between 25 – 29 years and seniority between 5 – 10 years. All employees that meet these criteria are qualified for the vacant function. One of them is selected randomly.

The selection of the new employees is a comparison between the promotion criteria and the method of the vacant position on the one hand and the available employees with their varying characteristics on the other hand

5.4 Outflow of employees

After the characteristics of employees and, the structure of the organization are defined and the selection procedure is specified, the simulations can start. However, the only thing missing is the dynamic element in the simulations. By defining an exit rate for all the employees, vacancies can emerge which subsequently have to be filled again. The organizational exit of employees can be caused by two reasons. First, employees grow old and create outflow due to the fact that they reach their retirement age. All employees who reach the age of 65 are removed by definition from the population. Their chance of exit is equal to one. Second, people leave the organization because they find other jobs or see other opportunities outside the organization. The possible outflow chances can be specified for different age cohorts due to the fact that they change during the occupational careers of individuals (Spilerman 1986). The program accommodates the possibility to specify the age cohorts and the chance to leave the organization. For our example and rather arbitrary, the outflow proportions Spilerman (1986) found in his research in are used in CLISP:

1. age cohort 20-29
the outflow chance is 25 percent.
2. age cohort 30-39
the outflow chance is 40 percent
3. age cohort 40-49

the outflow chance is 15 percent

4. age cohort 50 – retirement age,
the outflow chance is 20 percent

In the specification of the outflow proportions for different age cohorts, the total chance must accumulated to one. The employees leaving the company are selected randomly from these categories.

5.5 Creation of a manned organization

The total set of parameters in CLISP is discussed in the preceding section. In this paragraph we will pay attention to the way in which the organization as defined will be staffed before the first simulation rounds. The user of CLISP starts with defining for each job level which characteristics an employee must possess to occupy the job. After this, the user specifies the amount of employees that works in the job (for example 10 employees). Subsequently, the program creates 10 employees with characteristics as discussed in section 5.1. Using the job parameters as input. An array having length 10 is created. In each field of the array has a double index (i,j) where i denotes the job level. J denotes the employee, which is a pointer to an employee in the system with the attributes mentioned. The fields of the employee records consist of the individual characteristics of section 5.1. The employee record will be stored in an output file after a “year” of simulation, which equals one full simulation round. For the rules of promotion, promotion criteria and the other parameters are defined which are related to the different job level. For each criterion, an array with two indexes is created (i,j). I denote the job level and j the concerned parameter. All kind of search operations can be executed using these arrays. As every job is occupied at the end simulation “year”. The last output file of employees’ data consists of the job structure of the simulated organization. In this file, each employee is assigned to his latest occupation. .

A user of CLISP can also use existing, 'real' data as input for the simulations. CLISP can use the original data file that contains the individual characteristics of employees in an organization at a certain point in time. The program can 'read' the job structure of this organization from the file with individual data. A second file is needed which holds the job level related parameters. Another possibility is after restoring the employee records to specified the job level related parameters in interaction with simulation program. Now the organization is manned. The next step is that employees leave the organization. The unoccupied job must be filled with correctly qualified employee from within the organization. To find the right employee a Search engine used which will be discussed in the next section.

5.6 Employee mover engine

To create career lines of employees, employees should move through the defined organizational structure. The trigger in CLISP as mentioned before, is a job that becomes unoccupied: a vacancy. Once a vacancy emerges, an employee will be sought through the search engine based on the specified selection criteria. In this section, the operations of the search engine (employee mover) will be discussed.

Before the employee mover engine starts, the user of CLISP must specify the length of the simulation in number of “years”. A simulation round or a “year” encompasses:

- Step 1: Selecting employees who have reached the retirement age,
- Step 2: Selecting employees who leave the organization on the basis of predefined chance distribution which varies per age-cohort,
- Step 3: Writing the actual data of the employees who left the organizations to a file,
- Step 4: Marking the vacancies in the employee array.
- Step 5: Starting the search engine to re-occupy the marked jobs,
- Step 6: Updating the time dependent characteristics of all employees. For example age, time spent in job or seniority.

The last action in a simulation round or “year” is to write the attributes of the employees to a file.

Before the simulation starts, the ‘empty’ organizational structure is filled with employees according to the specification of CLISP user. The first year can begin. First, it is determined which employees left the organization. The subsequent search cycle will be executed;

Phase 1: The employee mover engine identifies the highest unoccupied job in the organization structure;

Phase 2: The employee mover engine applies the selection criteria of this vacant job;

Phase 3: A search takes place for the employees which meet the criteria for the vacancy. The search takes place one job level lower;

Phase 4: An employee is selected, which is subsequently promoted to the vacancy;

Phase 5: The employee record is updated;

Phase 6: The job that is left unoccupied by the promoted employee will be the starting point of a new search cycle and the program shifts back to Phase 2;

Phase 7: This sub cycle will stop when a vacancy is created on the lowest job level. Then, a new candidate from the external labor market is ‘generated’ who has attributes that match the selection criteria for the lowest job. It is assumed by CLISP that it is always possible to find an outside candidate who fulfils all criteria for selection. The search cycle start again by Phase 1;

Phase 8: As all unoccupied jobs are filled, the search cycle ended.

After the last phase, the time dependent characteristics of the employees are updated. The last action in a ‘year’ is that all the attributes of all employees are copied to a career database file. Subsequently, the next ‘year’ of the simulation starts with selections regarding the outflow rules the employees. The research cycle will start from the beginning.

This procedure in CLISP will end once all ‘years’ have passed. The researcher is left with a large longitudinal database, which contains all relevant career information of the employees who moved through in the simulated organization for a longer or shorter time span. All career-related events in the whole life span of the employee can easily be reconstructed from these files. The program delivers a similar database as is necessary to for tools such as CLIP, the Career Line Identification Program (Althausen 1989, Althausen and Van Veen 1995).

6. ANALYSING DIFFERENT SCENARIOS WITH CLISP.

The goal of the following examples is to highlight the added value of CLISP simulation in developing more detailed insight in processes concerning careers of employees within organizations which are based on the many possible scenarios and can be carried out by manipulating the three factors (employee part, promotion criteria and methods and job part). Before showing the examples we draw short the attention to some of the experiments we perform to test the stability of the results of the simulation. There are several distribution of probability are used in CLISP. The question is if the outcomes of every single round differ much from another. In order to test the stability of the outcomes, twenty different simulations were carried out, each of a length of 100 'years' using the same parameters. The amount of twenty simulations was considered to be high enough to cover all possible outcome variations. The analysis of the development of the regression weight over time is done with a MANOVA. This test calculates for each simulated year the mean of the regression weights and compares this with the other 19 simulations. The nil hypothesis is that the 20 simulations do not differ. MANOVA uses the F-test to calculate if differences exist. The F-value is 0.93 with $df(20,1)$ the p-value is 0.688. The outcome is clearly not significant. Of course, the outcomes of the single simulations differ from each other. Our conclusion was that the mean of 5 simulations is sufficient to minimize the risk of reporting observations that are exceptional. In the next paragraph we describe the chosen parameters and their values.

6.1 Starting values and theoretical conditions for our examples

For reasons of clarity, the following assumptions has been made; the studied organization consist of an internal labor market, promotions consist of only vertical moves in the organization hierarchy. A vacancy model is chosen, which implies that only promotions occur if a higher function is vacant (White 1970). Of course, other users can manipulate these restrictive assumptions by changing the parameters of CLISP.

6.2 Assumptions

Following our earlier discussions is necessary to discuss the structure of the organization first. In each of the examples, a company of 700 jobs is defined with each a total of 700 employees. Subsequently, three different conditions are distinguished in which the jobs are distributed differently over the hierarchical levels. As a result, the shape of the organization is varying. The three shapes are:

- 'square', on each of the seven hierarchical levels, the same number of employees is found;
- 'pyramid', the distribution over the hierarchical levels from low to high has the shape of a pyramid;
- 'circle', the distribution over the hierarchical levels has the shape of a circle.

Compared to existing organizations, these three shapes are rather extreme. However, the extreme versions serve the purposes of this article better. Besides any kind of organization shape can be simulated within CLISP.

The second condition refers to the strength of the selection method. Two conditions are specified.

In a condition with weak criteria, the selection criteria for vacancies are decisive. This means that if none of the potential candidates on the lower hierarchical level meets the selection criteria, a new employee is generated. This implies that the internal labor market is not totally closed for outside competition and is rather 'weak' in restricting entrance to the bottom of the organization. So under extreme conditions, external entry is possible besides via the regular ports of entry at the bottom of the company. The second condition contains strong selection criteria. This implies that even if none of the employees on a lower level meets the criteria, the relatively best -but not perfect- candidate is chosen and promoted to the vacancy. In this condition, the internal labor market is totally closed for external competition.

Given the specification of three shapes of the company and two kinds of selection criteria, six different situations can be compared. In each of these situations the selection criteria for promotion follow two steps.

For each of the seven levels, it is demanded that the employee fall into a certain age category. There is overlap in the categories between the different hierarchical levels. As a result, job shifts of more than one hierarchical level are not excluded. This might be seen as a simulated expression of the so-called fast movers (Stewman and Konda, 1983). The second selection criterion that is used within each age category is the highest level of educational training. If two or more candidates meet both criteria, one of them is selected randomly for promotion. See appendix 1, table 1, for an overview of the chosen values.

6.3 The first descriptive results of CLISP.

For each of the six conditions, the simulations have been performed for fifty rounds or 'years'. After each five-year period, the career data of the employees was copied into a database. For the analyses, the set of employees the simulation that were present at $t=0$ are removed, because the career history before $t=0$ is by definition unclear. Only the career data of employees who enter the organization during the simulation are analyzed.

In order to compare the differences between the six conditions, a large number of different analyses can be chosen. For illustrative purposes, we just chose an interesting one. In figure 4, the proportion of promoted employees is related to the number of years in the company. This is repeated for each of the six conditions. There are a few striking results. First of all, it turns out that for each of the six conditions the proportion promoted employees starts high, decreases quickly afterwards and then stabilizes around the fifteenth year of service. The reason for this general trend can be found in the ongoing selection over time. As time progresses, more and more people bounce against selection criteria, which are too high for them. They are stuck at their last job and reduce the proportion of promotions for the whole group. A comparison between the strong criteria condition and the weak criteria condition shows an even more interesting result. When the weak selection criterion is applied, the proportion of promotions becomes zero after 20 years of service. This indicates that all employees have in fact reached their highest hierarchical level after twenty years of service, considering their attributes and the selection criteria for the hierarchical levels. When the strong criterion is applied, however, there is still a proportion of promotions, even after

40 years of service. The reason for this difference is that the strong-criterion condition selects *always* within the organization, even if there are no perfect candidates. This creates a situation in which employees can grow above their best ‘fitting’ level due to internal shortages of perfect candidates . In the weak-criterion condition, this is not possible because a lack of perfect internal candidates is compensated with an external search and selection. Finally, if the different organizational structures are compared, it turns out that different career patterns emerge. The square organization starts high and remains rather high. A circle-shaped organization starts as the highest but then reduces to the middle level. And finally, a pyramid-shape starts lowest and remains lowest in terms of proportions of promotions. The exit of an employee generates fewer promotions within this organizational structure.

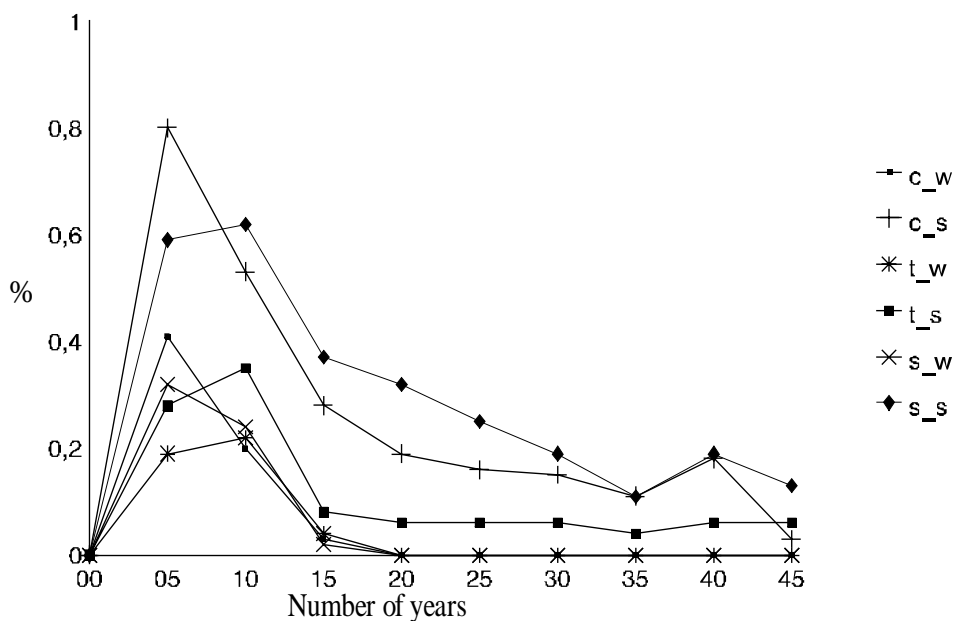


Figure 4: Proportion of promoted employees related to the number of years in the company.

This simple descriptive analysis shows how the simulation program can easily assist theoretical reasoning in the field of organizational careers. By systematically manipulating different career related aspects, it is easy to gain simple insights in a very complicated situation. The different theoretical conditions can be manipulated at beforehand and some rather simple plotting techniques lead already to interesting results. However, the databases which are generated can also be used for more advanced statistical techniques. Due to the fact that the databases have an identical structure as the ones, which are usually used in the case studies, all of the available techniques can essentially be applied. This can range from Regression analyses, Career Line Analyses, Event History Analyses to Multiple Grade Ratios. In

order to illustrate this point, a more substantial problem will be analyzed in the next session.

6.4 A second example: the effect of changing selection policies on career patterns

A fundamental problem in the explanation of employee's careers consists of the relation between the historical events that lead to a certain employee distribution in an organization and the possibilities these employees have in the future. The distribution of employees over jobs at a certain point in time (say $t=10$) is the result of past selection policies and as such a clear historical artifact. However, to understand the total career of an individual, the future career possibilities (incorporated in the organizational structure and selection criteria) are of utmost importance too. This observation leads to the conclusion that both the past and future conditions in which careers develop are interesting for the explanation of the career trajectories employees follow over time. The historical changes are important to incorporate. For instance, the slow replacement of selection criteria such as tenure and internal experience by formal education within internal labor markets needs attention in studies of organizational careers (Van Veen 1997). Another example is found in the changing ideas and selection policies about gender differences within organizations. The increasing emphasis on equal opportunities in the organizational selection policies should have some effect on the male/female distribution over the hierarchical levels. The question which remains is how this change in selection policy affects the determinants of the careers of employees and how this change appears in the analysis of the career data. Because of the complexity of the career processes in organizations, such a problem is hard to analyze up-front, especially if we are also interested in differences in these processes between organizations with different shapes. In order to overcome such difficulties, some simulations are run which give insights in these career developments which are otherwise hard to get. We will focus our analysis on the abolishment of discriminatory selection policies towards women.

To study the relative effects of different selection criteria over time on the career outcomes, the following procedure is used. First of all, an organization is simulated in which gender is the main selection criterion and in which men is preferred over women. After a number of simulation rounds, the selection criterion is changed into a selection criterion in which both men and women have equal chances. In fact, the new selection criterion is education. After this change in selection criterion, the simulations are continued for the same organization with which we started. During the simulation rounds, career data are copied after specified intervals such that a database remains in which the effects of the changing selection criterion can be observed over time. Subsequently, cross sectional analysis should be made to determine the relative value of the criteria in the explanation of the variance in the attained hierarchical level of the employees. For the purpose of this example, we chose to analyze a large number of time points and to plot the regression weights in a diagram. The effect of the changes in selection criterion on the distribution of employees over hierarchical levels is determined. These analyses will be performed for the three different organizational shapes, which have been described earlier. See appendix 1, table 2, for an overview of the chosen values.

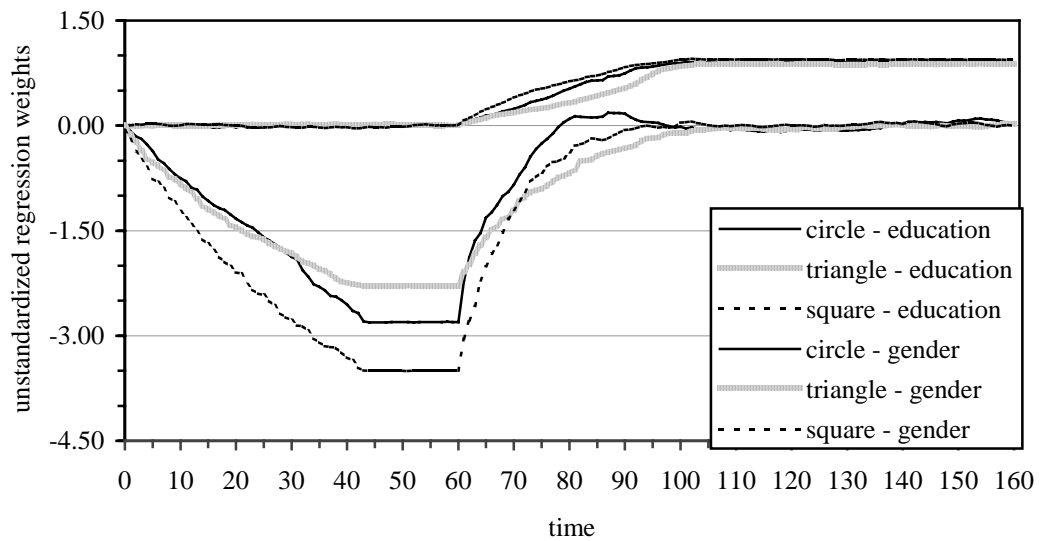


Figure 5: Changing regression weights due to changes in selection policies.

In figure 5, the results of these analyses are plotted. Horizontally, time progresses in which each 'year' equals one simulation round. Vertically, the unstandardized regression weights are expressed which result when the effect of gender on attained hierarchical level is calculated cross sectional. For the first ten years, the organization uses a discriminatory policy towards women. Women are never selected for jobs above the second hierarchical level. As can be seen in the figure, this policy results in a sharp decrease in the regression weights until the forty-fifth year for each of the three organizational shapes. In this year, the regression weights stabilize. The decrease develops much quicker in the square-shaped organization than in the triangle and the circle. The circle shaped organization, however, makes a sudden drop at the end of the period and stabilizes in between the triangle and square shaped organization.

In the sixty-fifth year in the simulations, the selection policy is adapted. The original discriminatory policy is abandoned and replaced by selection based on educational levels of the candidates (which has no relation with the gender of the employees). However, this policy is introduced in the original organization and is applied in a situation, which still reflects the distributional results of the old policy. As can be seen in the value of the regression weights in the subsequent years, a slow adaptation takes place. The new selection criterion leads to a new distribution of male and female employees over the hierarchical levels. The surprising aspect is, however, not the distributional adaptation itself, but the period which it takes to reestablish the situation of $t=0$. The discriminatory policies might decrease the regression weights rather quickly in the first ten years, the policy change takes over 40 years to establish a situation, which is

actually more preferred and appears only after the hundredth year. Based on this observation, it can be concluded that policy adaptation might lead to new selection strategies on an individual level. But even with a very strict application of this new selection policy, it takes -*ceteris paribus*- almost a whole working life of 40 years to get rid of the influence of the old policy. A second interesting result is the speed with which the regression weights adapt to the original situation. The circle shaped organization adapts most quickly and passes the zero line already after 20 years, which is in the eightieth year. The square shaped organization shows a similar speed, but this levels off in the end. The triangle shaped organization, however, is most interesting. The effect of the discriminatory selection policies had the least effect on the gender distribution in terms of the regression weights. However, it turns out to be most conservative when an attempt is made to restore the original situation.

Once educational level is introduced as the selection criterion, the regression weights of this variable start to rise slowly. They stabilize at the same point in time as when the effect of gender totally disappears. At that point in time, all the employees who entered the organization under the old selection policy have disappeared and are replaced with a totally new set of employees. The unstandardized regression weight stabilizes at a 1.00 exactly, which could be expected due to the fact that 7 educational levels are distinguished in the simulations. Each of the hierarchical levels had its own educational criterion, which makes that there are no exceptions left at this point in time.

What can we learn from this particular example of the use of a simulation model? First of all, changes in selection policies are, *ceteris paribus*, only visible after a rather long period. Policy evaluations on a short notice should therefore not be focussed - for instance- on the distribution of men and women over hierarchical levels. Only the application of the new policy rules in particular vacancy filling procedures can give some insight in the effects of the new policies over a long term. In addition, if the gender distribution is studied anyway, the shape of the organization seems to matter too. If only a quick cross-sectional comparisons of such organization is made, it could be easy to conclude that one organization changed its policies and showed significant improvements while the another one doesn't. However, as has been shown, pyramid-shaped organizations take more time to show a significant difference in distribution than circle- or square-shaped organizations. Even if the policies and the timing of the policy changes are exactly identical in the two organizations, the emergence of the observable results has a different timing.

7. CONCLUSIONS

Considering the foregoing results, a number of conclusions can be drawn about the usefulness of the application of CLISP in the field of organizational careers. First of all, CLISP seems to have a clear value in this field due to the fact that it can cover the area between complex combinations of theoretical arguments and the usual restriction to case studies. Simulation models, in which structural aspects, selection criteria and individual characteristics can be manipulated, offer possibilities to analyze complex interdependencies between these factors, which are hard to make without this tool. The combined

manipulation of, for instance, different selection policies and organizational shape can be analyzed rather easily. Secondly, CLISP can be used to develop knowledge about long term consequences of certain theoretical arguments or actual policy changes within organizations. Consequences of different arguments can be calculated and compared over longer periods. Thirdly, CLISP can easily be used to overcome restrictions career data of case studies have. The results of simulation studies can show whether certain career patterns are indeed the result of the mechanisms suggested by the researcher or whether other or additional factors are also present.

It can be concluded from this study that CLISP is an important tool to assist researchers in the field of organizational careers. On the one hand, it can be used when theoretical complexity becomes too huge. At the other side, when actual career data are not discriminatory for certain arguments, CLISP can be used to find a solution after all. For instance, are the observed patterns the result of the organizational shape, new selection policies or a combination of both? But besides these advantages, this additional method has some (temporary) difficulties too. These are related to the program itself. The simulation results as presented here are partly easy to implement but are partly the result of ad hoc adaptations of the program. Further work is necessary in order to change the program such that each of the structural, selection and individual characteristics can be manipulated in a less time consuming way. However, these technical extensions are presently developed (including another version of the model, which is object-oriented). Once this is done, generating career data by using a simulation program can be a simple but important tool in the social mobility research field in general and the field of organizational careers in particular.

Appendix 1.

| Organizational Level | Number employees | | | Minimal Age | Education Level |
|----------------------|------------------|---------|--------|-------------|-----------------|
| | Square | Pyramid | circle | | |
| 7 | 100 | 1 | 40 | 50 | 7 – 8 |
| 6 | 100 | 4 | 70 | 45 | 5 – 7 |
| 5 | 100 | 50 | 140 | 40 | 5 – 6 |
| 4 | 100 | 75 | 200 | 35 | 4 – 5 |
| 3 | 100 | 140 | 140 | 30 | 3 – 4 |
| 2 | 100 | 180 | 70 | 25 | 2 – 3 |
| 1 | 100 | 250 | 40 | 20 | 1 – 2 |

| | |
|-----------------------------------|-----------------------------------|
| Retirement age | 65 years |
| Level of job specific experience | 1 – 3 |
| Growth of job specific experience | 5 |
| Minimal time in function | 2 years |
| Selection criteria | first age, second education level |
| Selection method | No specification |

Table 1. Values of CLISP first example.

| Organizational | Number employees | | | Gender * | Education | |
|----------------|------------------|--------|---------|-------------|-----------|--------|
| | Level | Square | Pyramid | | | Circle |
| | 7 | 100 | 1 | 40 | 1- 2 | 7 – 8 |
| | 6 | 100 | 4 | 70 | 1- 2 | 5 – 7 |
| | 5 | 100 | 50 | 140 | 1- 2 | 5 – 6 |
| | 4 | 100 | 75 | 200 | 1- 2 | 4 – 5 |
| | 3 | 100 | 140 | 140 | 1- 2 | 3 – 4 |
| | 2 | 100 | 180 | 70 | 1- 2 | 2 – 3 |
| | 1 | 100 | 250 | 40 | 1- 2 | 1 – 2 |

*1 = male

*2 = female

| | |
|-------------------------------------|--|
| Retirement age | 65 years |
| Level of job specific experience | 1 – 3 |
| Growth of job specific experience | 5 |
| Minimal time in function | 2 years |
| Selection criteria 'year' 1 to 65 | Level 1-2 gender = 1-2, Level 3-7 gender = 1 |
| Selection criteria 'year' 65 to 100 | Education level |

Table 2. Values of CLISP second example.

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Endnotes:

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2. The firm specific skills are only an example. For instance, screening and socialization theories lead to similar selection policies.
3. If the employer really has a possibility of choice or the fact that he is forced by the circumstances will be left outside this discussion are not relevant for the purposes of this article. Formal job ladders do exist, are often followed in detail (Van Veen 1997) so are relevant for the understanding of career trajectories.
4. A copy of the program CLISP is available in Dutch.