The Design of Selection Systems: Context, Principles, Issues

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This chapter addresses the design of systems for personnel selection which enable organizations to build up and maintain a competent and well-motivated workforce. While the use of selection systems is seen as a task for HRM specialists and managers, their design is typically depicted as a task for psychologists. They are expected to develop selection systems in such a way that valid predictions of performance and effective employee decisions are attained. There is an extensive psychological literature on selection, most of which describes systems design as a linear sequence of steps that include job analysis, choosing tests, administering tests, conducting a validation study, and composing a test battery (e.g., Guion, 1998; Schmitt & Chan, 1998; Smith & Robertson, 1989; Thorndike, 1949). Owing to its strong focus on predictive tools and statistical prediction techniques the perspective of these publications has been labeled as a "psychometric paradigm" (McCourt, 1999). Although this perspective has much to offer, it also has some limitations. First, it ignores much of the context of selection, in particular the fact that there are different stakeholders in organizations with diverging interests in selection. Secondly, it overlooks the fact that a variety of demands have to be met in designing selection systems, and that the search for a solution requires an iterative rather than a linear series of steps. Third, it disregards design facets other than prediction that may nonetheless have a strong impact on the effectiveness of the system. This chapter presents a view of selection systems design that aims at overcoming these limitations. It describes the context of the design process, including the roles of stakeholders, presents a methodology that tackles multiple demands in an iterative process, and demonstrates the importance of facets other than prediction.

THE CONTEXT OF SELECTION

For people in organizations selection usually matters. That is, they find it important who is selected for a particular job, who is involved in decision making, on what grounds candidates are accepted or rejected, etc. This is especially true for positions that are highly visible, in which great power is vested, or on which many others or the organization as a
whole depends. Selection for such key positions is far from neutral. On the contrary, various parties struggle to influence job descriptions, requirements, procedures, and actual decisions. Psychologists charged with the design of selection systems for situations like this find themselves in a political arena in which "rationality" is readily perceived as the pursuit of specific interests and therefore difficult to achieve.

While power and politics do not fit well in the "psychometric paradigm," they are an obvious part of organizational life. Organizations are sites of power games between various types of stakeholders striving for dominance (Clegg, 1975; Mintzberg, 1983). Clearly, the area of selection is not exempted from such power games, nor does the design of selection systems take place in a political vacuum. Thus, when a manager proposes to design a new selection system (which usually means the redesign of an existing system), this is likely to be seen as a political move which can mobilize various actors in favor or against. Likewise, the decision to involve an expert (the psychologist) and to allocate resources to the project will be understood in political terms and be responded to accordingly. Such political responses may exert strong influences on the design and use of selection systems. All this suggests that the role of stakeholders has to be acknowledged and that their views have to be taken into account when designing selection systems.

In addition, selection systems must be designed in a manner compatible with the organization's structure and modus operandi. Thus, in a hierarchical and mechanical organization the design process will be rolled out top-down and be highly proceduralized, whereas in a flat and organic organization the design process may proceed more informally. Moreover, the system itself will have to fit within the organization's culture, be compatible with other HRM systems, be acceptable to line, staff, employees, customers, etc. A fit to available resources is also important; that is, the size and scope of the system will have to match available resources, in terms of staff, time and budgets. We will show that most of these issues can be addressed by involving stakeholders in the design process.

**Selection Systems and Their Development**

In the context of personnel selection we prefer to define a selection system as a configuration of instruments, procedures, and people created with the purpose of selecting candidates for certain positions, in such a way that they can be expected to optimally fulfill pre-defined expectations. Thus, the selection system enables the organization to interact with a pool of candidates and to identify those who most likely match standards of future performance. There are three essential components of the selection system, representing its hardware, software, and human resources, namely 1) instruments, such as tests and job samples, 2) procedures for administering these instruments and handling information, and 3) people using the instruments and applying procedures.

Although selection instruments receive much attention in the literature, and choosing reliable and valid tests is often described as the designer's key task, this is not the most critical factor for a successful design in our view. Strictly speaking, the instruments themselves do not predict. Prediction is achieved by processing information from the instruments according to a certain procedure. When used appropriately and combined well, good instruments will lead to high overall effectiveness, but when used or combined improperly effectiveness will be low. There are several more reasons why good predictors may not
produce good results. For example, there may be too much redundancy in the test battery, weights may be chosen inadequately, cutoffs may be set too high or vary over time, the prediction may target the wrong type of criteria, the composition of the battery or the manner of administration may be at odds with candidates' expectations and lead to unwanted withdrawals, users may be doubtful about the adequacy of the selection procedure and therefore disregard its outcomes, and so on. One might say that a well-chosen procedure adds value to the instruments and that the art of design is to maximize this added value. The human component of the selection system should not be overlooked either. Good selection tools in the hands of people without proper qualifications or attitudes cannot be expected to produce good results. The presence of knowledgeable and competent staff certainly adds to the effectiveness of selection. Table 4.1 describes the three components of the selection system and lists a number of typical elements to be considered in the design process.

Developing a selection system is a process encompassing various stages and requiring considerable time and resources. We focus on the design of the system as the most critical part of this process, and will not dwell upon its actual construction and implementation.

**Design Methodology**

Descriptions of a methodology for the design of personnel selection systems have been given elsewhere (Roc, 1989, 1998). Here, we limit ourselves to a brief description of the design process and a discussion of design tools.
FIGURE 4.1  Basic design model (after Roozenburg & Eekels, 1991; Roe, 1998)

The design cycle

A useful notion originating from design methodology in the technical sciences (Eekels, 1983; Roozenburg & Eekels, 1991) is the "design cycle." The basic version of the design cycle model, depicted in Figure 4.1, comprises the following six steps.

1. Definition. The first step is defining the goals and functions of the selection system. Goals refer to the effects to be attained by using the system, while functions refer to the way in which these effects are brought about. Identifying goals and functions
requires a study of stakeholder views. A certain level of performance among selected candidates, a sufficient supply of candidates to fill vacancies, and a limited degree of attrition are examples of goals that stakeholders typically want to see fulfilled. Making valid predictions of performance and providing information that is useful for decisions about an individual's career are examples of functions.

2. **Analysis.** In the next step goals and functions are analyzed and spelled out in terms of requirements the system should meet and constraints it should observe. Requirements pertain to the system's functionality (what it is used for; e.g., predictive validity), constraints refer to limitations that should be taken into account (e.g., time or costs). Knowing requirements and constraints is important, as they guide the next step of the design process and provide criteria for later evaluation. Both notions will be clarified when we discuss the "Program of Requirements."

3. **Synthesis.** The third step represents the creative core of the design process. It consists of inductively generating possible solutions for the design problem as embodied in the requirement and constraints. Although the designer may be familiar with existing solutions and tools, there is usually a need to "invent" new solutions that optimally match the unique conditions of every case (applicant population, training and job content, organizational setting, etc.). The term "synthesis" is used to indicate that separate or known parts are combined to make a new whole. The result of this step is a provisional design of the selection system (or a part of it).

4. **Simulation.** The fourth step is of a deductive nature and consists of establishing the expected operational, predictive, and economic properties of the provisional design. Examples of such properties are duration, capacity, validity, levels of performance, decision errors, utility etc. Simulation can be done by means of reasoning, running experimental try-outs, performing validation studies, or using models.

5. **Evaluation.** After the expected properties of the selection system have been established, they are evaluated, using the criteria in the "Program of Requirements." The result of this step is a judgment about the value of the proposed system for the stakeholders. This step should answer the question whether the system is or is not satisfactory.

6. **Decision making.** The final step is taking a decision about accepting the selection system for operational use or rejecting it. In case of rejection the process may continue with step 3, and make an effort to modify and improve the previous solution. When shortcomings in the "Program of Requirements" appear, one may return to step 2 and reformulate requirements and constraints first. The design cycle comes to an end when the proposed design has finally been accepted.

The model described here shows only the general logic of the design process. In practice, several parts of the system may be designed in parallel or sequentially, and the cycle may be run through several times. Also, the actual course of affairs may deviate in the sense that synthesis and simulation become closely intertwined or that other shortcuts are applied. The main advantage of the design cycle model is that it helps to understand that design has inductive and deductive moments and that a larger or smaller number of iterations are necessary to find an adequate solution. The model is also helpful in clarifying the importance of establishing design criteria beforehand and using them for evaluation afterwards.
### Design tools and inventories

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### Design tools

Like in other areas in which design is used, such as architecture and product development, there are several tools that designers of personnel selection systems can rely on. In Table 4.2 we have listed a number of these tools. Here we will briefly clarify each of the table's entries. Some tools will be discussed in subsequent sections, when we address a number of specific issues related to analysis and synthesis. For information on predictors, criteria, and predictor–criterion relationships we refer to other chapters of this book.

1. **Design process tools.** Apart from common project management tools, such as the project plan and the project structure, there is one tool that is particularly useful in structuring and controlling the design process, namely the “Program of Requirements” (or PoR). The PoR is basically a list of demands which the to-be-designed artifact – here the selection system – should meet. These demands derive from the goals and functions identified in a dialogue with stakeholders. It would be wrong to assume that the main goal for a selection system is to fill a limited number of positions with well-performing candidates and that the main function is making valid predictions, an assumption often made in the selection literature. Discussions with stakeholders may reveal many diverging goals and functions. For example, Wise (1994), in a chapter on military selection and classification, mentions: seat fill, training success, reduced attrition, job proficiency, job performance, qualified months of service, total career performance, performance utility, total MOS (military occupational specialty), unit performance/readiness, social benefit/problem avoidance, and accommodating recruit preferences (pp. 354–356). In design projects that we have conducted such aspects were normally part of the PoR. Some other aspects were: the fit of the system into employers’ overall HRM policy, its integration with the training system, the avoidance of discrimination, the fair treatment of candidates, the handling of
TABLE 4.3 Example of items from a “Program of Requirements”

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<td><strong>R1. Fulfillment of quota</strong></td>
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<td>The selection system must yield a sufficient number of qualified candidates to fill the annual number of vacancies.</td>
</tr>
<tr>
<td><strong>R5. Success in training</strong></td>
</tr>
<tr>
<td>The system must maximize the success rate in initial training; the success rate should not be lower than 80%.</td>
</tr>
<tr>
<td><strong>R12. Multilingual examination</strong></td>
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<tr>
<td>The system must allow the examination of candidates in English as well as French.</td>
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<th>Constraints</th>
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<tr>
<td><strong>C2. Treatment of candidates</strong></td>
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<tr>
<td>Candidates must be treated correctly and with due personal attention.</td>
</tr>
<tr>
<td><strong>C7. Operational reliability</strong></td>
</tr>
<tr>
<td>The system and its hardware must be minimally vulnerable to malfunction. It must be possible to restore the system within 24 hours in case of breakdown.</td>
</tr>
<tr>
<td><strong>C13. Cost-effectiveness</strong></td>
</tr>
<tr>
<td>The system must be cost-effective, taking account of direct costs, depreciation of equipment, overhead and personnel.</td>
</tr>
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candidates’ complaints, the supply of information to commissioners and candidates, legal aspects, flexibility of use, time demands, costs, etc. PoRs, as we have used them, typically contain several dozen items, classified into requirements and constraints, depending on whether they refer to goals and functions or to conditions to be taken into account. Each item is given a code and a label for easy identification and its content is described in a short statement. Some examples are given in Table 4.3.

It is helpful to assign weights to these items based on stakeholders’ ratings. We have used the following three-point scale – “absolutely essential” (3), “desirable” (2) and “not really needed” (1) – and based weights on average ratings and degree of consensus. This helps to differentiate between more and less important aspects, and offers a possibility to identify and manage diversity of opinions among stakeholders.

PoRs sometimes contain a few items that are “specifications” rather than requirements or constraints. Specifications are in fact partial solutions to the design problem, as they designate particular properties the system must have. Examples of specifications are particular tests (e.g., NEO-PR), rating scales (e.g., C-scale), cutoff scores (e.g., 6 points), etc. The number of specifications in a PoR should be kept low, so as not to restrict the designer’s degrees of freedom unnecessarily.
The PoR has a dual function. As is shown in Figure 4.1, it helps to give direction to the design process from the start onward (feedforward), and it serves to evaluate and modify results obtained during the design process (feedback).

2. Tools for analysis. After the PoR has been set the designer will do some analyses in order to identify the desired properties of the selection system. Three types of analytical tools are useful at this stage: trajectory analysis, job and task analysis, and competence analysis. We use the term trajectory analysis to refer to the activity of identifying the positions candidates can occupy between the moment of application and some “final” point in their career, the transitions between these positions, the duration of these transitions, and the numbers involved. We recommend making a trajectory analysis for the current system of recruiting, selecting, training, allocating, and promoting personnel, as well as for the new system of which the selection system will be part. The analysis provides the designer with useful information regarding 1) quota and selection ratios and 2) the positions which are pivotal for the selection system. Many texts on personnel selection assume that there is only one pivotal position (or job) to be filled and that there is only one criterion or set of criteria to be predicted. Although this may sometimes be true, it is much more common that candidates are subsequently treated as entrants, trainees, occupants of position A (junior), job B (senior), and the like. An exemplary description of a trajectory is given below (see Figure 4.4). In such a case the selection system is not only expected to improve job performance but also to enhance successful transitions and reduce dropout.

Identifying positions is a crucial step that must precede job analysis and setting criteria. It is particularly important to identify diverging requirements and possible conflicts stemming from different positions. Quite often there is a discrepancy between the requirements for training and job success. For a student or trainee, characteristics such as verbal and numerical ability, achievement motivation, and submissiveness may be important, while for the fulfillment of the position entered after completing the training, communicative skills, technical competence, and independence are more important.

Methods for job and task analysis serve as tools for identifying training and job criteria to be predicted as well as candidate attributes that can play a role as predictors. Competence analysis can be seen as an extension to job and task analysis. It concentrates on candidate attributes that are to be considered when deciding on the composition of the selection battery. For methods for job and task analysis we refer to Fine and Cronshaw (1999), Landau and Rohlert (1989), as well as to Voskuil (Chapter 2, this volume). Competence analysis, which we think is needed (Roe, 2002), is less extensively treated in the literature. We will give a brief coverage of this topic below.

3. Tools for synthesis. A key issue in the design of a selection system is which predictors to use for predicting the appropriate criteria, and how to make decisions that produce the desired numbers of suitable candidates. The designer's task is to explore and compare alternative ways of composing selection batteries and establishing decision rules, taking account of the outcomes of analyses and available techniques.

Two types of tools are especially useful here. First, prediction modeling tools help to create “prediction models” (Roe, 1983) by means of which candidates' predictor scores can be transformed into estimates of future criterion scores. Some authors speak of performance modeling and performance models (Campbell, 1990, 1994; Greuter, 1988). Prediction
modeling tools are in fact generic versions of prediction models in algebraic, graphic, or tabular (spreadsheet) form. As the prevailing format of the prediction model is algebraic, the main modeling tool is a multiple linear regression function (or density function). The actual prediction model is constructed by identifying the number of criteria and predictors, the type of measurement scale, compensatory or non-compensatory combination of predictors, the type of weights, etc. We refer to selection handbooks (e.g., Guion, 1998; Schmitt & Chan, 1998; Roe, 1983), which also provide examples of graphical tools, such as bivariate scatter plots, and tabular tools, such as expectancy charts.

Secondly, decision modeling tools help to create “decision models” that spell out how predicted values of criterion variables link to choice options. A good example is the generic multi-attribute-utility model, which can be turned into a model specifically geared to the selection problem at hand by specifying choice options, utility functions, etc. (Cabrera & Raju, 2001). In building explicit decision models the designer can also use tabulation tools to specify decisions for various (combinations of) predicted criterion scores or predictor scores. When it comes to determining cutoff scores, an important part of decision models, several methods can be used (see Roe, 1983).

Prediction and decision models can, but need not be, fully specified. Parts of the prediction process and/or parts of the decision making can be left to the judgment of people fulfilling the role of “selector.” In other words, the selection system can be based on a combination of statistical and clinical selection methods. See, for example, the semi-clinical selection method by Roe (1998).

An important issue for designers is the linkage between prediction model and decision models. Older publications in selection have routinely opted for simple solutions based on the assumption that utility is a linear function of the predictor variable (Cronbach & Gleser, 1965). Thus, there are standard recipes for setting a cutoff score on a predictor composite or a cutoff profile when using multiple tests in parallel. With more complex selection systems comprising several sequential modules there are more options to consider, and the designer will need a compound modeling tool to build a combined prediction–decision model that produces valid predictions and adequately tailors the applicant stream simultaneously. We will give an example later in this chapter.

4. Simulation tools. Every time the designer considers a particular set of predictors and a particular manner of predicting and decision making, he or she will have to establish the properties of the resulting selection system. We differentiate between three types of tools for simulating the systems’ properties: flow models, selection effect models, and validity simulation models. A flow model is a spreadsheet tool that shows the effects of selection on the applicant stream. This is most useful when there are several stages of selection. Given an estimate of the number of candidates entering the system and selection ratio for each stage, the model shows the numbers of candidates surviving each stage. This information can subsequently be used for evaluating costs and capacity requirements. Of course, the tool can also serve to compare various selection scenarios involving different combinations of cutoffs, or variable numbers of applicants entering the system or withdrawing from the system voluntarily.

We use the term selection effect model to refer to a tabular or graphical tool for establishing the effect of selection on predictor and/or criterion variables. An example of a simple graphical format is given in Figure 4.2. Graphs like this have been used to illustrate the
phenomenon of "restriction of range" (Roe, 1983; Rydberg, 1962), but they are also helpful in visualizing the performance increments, that is, upward shifts in the (expected) criterion score distribution. Tabular effect models, also known as "expectancy tables," are more informative and make it easy to compare effects. Obviously, selection effect models rest on certain assumptions regarding the bivariate (or multivariate) distribution of predictor and criterion scores. Probably the best-known expectancy tables are those by Curtis and Alf (1969) and Taylor and Russell (1939), which show selection effects on the criterion variable for varying cutoffs/selection ratios and predictive validities.

All simulations involving expected levels of criterion scores require knowledge of predictive validity. Since empirical validation is only possible after completing the design and implementing a system, the designer will have to rely on estimates of predictive validity. Apart from simply assuming a certain level of validity for a particular composite or battery, he or she can derive estimates from published correlation data, for example by meta-analysis or validity generalization. However, the use of these methods is usually not sufficient since intercorrelations must also be known. Unless data on intercorrelations can be obtained from an applicant sample, one has to work on the basis of assumptions. Because of the assumptions involved we refer to methods producing validity estimates as "validity simulation." They include multiple regression analysis based on hypothetical correlation matrices and synthetic validation.

It should be noted that methods for simulating validities and selection effects are not only useful for evaluating a particular variant of the selection system under consideration by the designer; but may also be used for a comparison of variants. As part of this, the
designer may engage in sensitivity analysis to find out whether modifications of a design will make a difference in selection outcomes.

5. Prototyping tools. While much of the design is oriented to the conceptual framework and content of the selection system, the appearance and "feel" of the systems in the hands of candidates and users should be given due attention as well. Now that much of selection testing takes place by means of computers, it is feasible to use computer technology to develop an early prototype. Prototyping can help to visualize test formats, report formats, the administrator's console, etc., and in this way support the design of the system's interfaces.

Competence Analysis

An important issue facing every designer of a selection system is how to make the inferential leap from job content to performance criteria and candidate attributes. The suggestion offered in selection textbooks (e.g., Guion, 1998) is to use a job analysis method that provides attribute ratings, to rely on sources that have made such ratings in the past (line O*Net), or to make direct ratings. None of these approaches is wholly satisfactory since they do not answer the question of which aspects of performance differentiate between successful and non-successful workers, and fail to give a clear rationale for the choice of candidate attributes. Although job analysis remains a necessary first step at the analytical stage of the design process, competence analysis may complement it and help to identify criteria and predictors. In this context competence is defined as "an acquired ability to adequately perform a task, role or mission" (Roe, 2002). The notion of competence is closely linked to the activities that individuals, groups, or larger entities in organizations are expected to undertake in order to fulfill the organizations' missions. Competences are formulated in the "technical" language of the organization (grinding, selling, leading, etc.), not in the vocabulary of the behavioral scientist (perceiving, interpreting, manipulating, etc.). They relate to the molar level of paid-for actions, not to psychological abstractions that cut through these actions. Competences are acquired in a process of learning-by-doing, either on the job or in a simulated environment, in interaction with the real work environment, including equipment, clients, colleagues, etc.

A distinctive feature of this learning process is its integrative character. That is, relevant knowledge, skills, and attitudes which were acquired earlier become integrated while building a behavior pattern optimally suited to perform the task at hand. For example, knowledge of medical terms, writing skills, and a prudent attitude become integral parts of a doctor's competence of writing prescriptions, along with other bits of knowledge, skill, and attitude. Our conception is markedly different from that Boyatzis (1982) or Spencer and Spencer (1993), who define competence as "an underlying characteristic of an individual that is causally related with criterion-referenced effective and/or superior performance in a job or situation" and thus use it as a container notion embracing all kinds of human attributes. We not only differentiate competence from knowledge, skills, and attitudes, but also from abilities, personality traits, and other characteristics (including values, interests, and biographical characteristics). With reference to theories from educational and
work psychology, we consider these latter characteristics, which are largely dispositions, as factors facilitating or constraining the learning processes by which knowledge, skills, and attitudes, as well as competences, are built (Roe, 2002). While acknowledging that dispositions influence everyday work performance directly, we assume that their influence is at least partly indirect, that is, through the attained mastery of competences (also knowledge, skills, and attitudes).

In this view competences are conceptually close to performance. They can be seen as immediate antecedents of performance that will express themselves in the way the person fulfills his or her duties, given a sufficient level of motivation and situational resources. Figure 4.3 illustrates our view on the architecture of competences, showing the seven types of concepts we have mentioned.

Competence analysis based on this view follows a different route in the search for relevant attributes than traditional methods. It poses a series of questions, first about on-the-job learning experiences necessary for mastering critical duties (competences), next about knowledge, skills, and attitudes that are essential in this learning process, and finally about the abilities and personality dispositions that are likely to influence learning processes and/or to affect performance once the critical competences have been attained. The search for dispositional attributes thus focuses on aptitude–treatment interactions (Snow, 1989) in work-relevant learning, rather than on direct contributions to performance itself. The analysis gives a conceptual underpinning to the identification of KSAOs as recommended by other authors (e.g., Guion, 1998; Schmitt & Chan, 1998). In addition, it emphasizes the
role that learned attributes – knowledge and skills, but also attitudes and (basic) competences – can play as predictors, as far as candidates have had relevant learning and work experiences.

Competence analysis may also be used to identify criteria for selection, since competences are useful proxies for performance. In the next section we will discuss the use of competences as criteria for selection. There we will focus on competences which have not yet been attained by all candidates but will have to be learned after selection and admission to on-the-job training.2

Of course, the logic of competence analysis as proposed here can only demonstrate its value when there is evidence on requisite knowledge, skills, and attitudes, and on aptitude-treatment interactions in work-related learning. To date this evidence is scarce and dispersed, and sometimes little else avails but reports from subject-matter experts involved in work-related education. But to the extent that such information is available, it can supplement or support inferences about candidate attributes derived by traditional methods.

ARCHITECTURAL DESIGN

The description of design in terms of job analysis, choosing tests, administering tests, conducting a validation study, etc., offers a fairly good description when creating simple selection systems. However, it does not do so when large numbers of applicants are involved and stakes in terms of scarce competence, attrition, turnover, malfunction, or safety are very high. In such situations, which exist in many large corporations, the government, the military, aviation, and other special sectors, the designer’s task is much more complex. Here, an approach is needed that is both flexible and systematic, and that helps to establish an architecture that matches major requirements without going into detail. In this section we will list a number of steps that may help to arrive at a suitable architecture. Although these steps are described serially, it is important to stress their interdependence. The essence of architectural design is to consider the relationships between design options and to arrive at an optimal set of choices for the system as a whole. Steps 1 through 4 will address structural facets of the selection system (how will the system be composed?), whereas steps 5 through 7 deal with operational facets (how will the system work?). Step 8 addresses the integration of structural and operational facets in a global overall design (what will the system look like?). In our discussion we will refer to tools discussed above.

Step 1. Trajectories and positions

The first step is to decide whether selection will aim at one or more trajectories, and whether there are one or more pivotal positions to consider. A single position should not be taken as the default. First, for any significant position there is usually a preceding position that has to be successfully fulfilled (e.g., as trainee) and/or a subsequent position to which successful candidates are expected to move. Taking such positions into account as well may increase overall effectiveness. Second, it is worth while to see whether there is a secondary track that can absorb candidates who are not suitable to occupy a pivotal
position in the primary trajectory but who are sufficiently qualified to fulfill other needs. This is especially useful for jobs that pose very high demands on candidates, such as fighter jet pilot or air traffic controller. The very low selection ratios at later selection stages imply high sunk costs spent on rejected but highly qualified candidates. Opening a second trajectory, containing related jobs, may therefore add considerably to the overall utility of selection within the HRM system as a whole. A scheme illustrating a career trajectory within a fictive company is given in Figure 4.4.

**Step 2. Criteria**

The second step is deciding on the number of criteria. Rather than making an a priori choice for single or multiple criteria we suggest looking at competences, and asking ourselves two questions. First, which competences are critical in the sense that insufficient mastery leads to unacceptable cost, damage, or risk? Second, which competences will be sufficiently mastered if no selection is applied? Obviously, competences that are not critical, and competences that are either present or can be learned by all candidates within a reasonable amount of time, should not be included in a selection system. The system should focus exclusively on critical competences that are unattainable without special pre-
cautions. The number of such competences should define the number of criteria for selection. Normally, there will be more than one criterion.\(^3\)

Of course, the designer should at this stage keep an eye on the nature of the criteria, especially whether they are meant to be dynamic or not. Dynamic criteria gauge learning performance (acquisition of competence), static criteria performance at the end of learning (attained competence).\(^4\) Other aspects of criteria and the means of measuring them can be addressed later in the design process.

**Step 3. Predictors**

In the third step the designer will look for potential predictors and decide on the types of predictors to be used, in terms of the underlying prediction principle (Wernimont & Campbell, 1968) and content. Relevant questions are: 1) Will the criteria require the use of sign instruments, sample instruments or both? 2) Which types of attributes are likely to contribute most to the prediction of the criteria? Competence analysis may help in answering these questions, giving suggestions about the contribution that abilities and personality traits (and other stable characteristics) can make, and about the degree to which success depends on acquiring competences on the job. The first points at sign prediction, the latter at sample prediction (cf., assessment exercises, job samples, or simulators). It is sufficient for the designer to know the types of predictive information the system will have to gather; a specification in terms of variables and instruments can follow at a later stage.

**Step 4. Selection stages and batches**

In the fourth step the designer will have to decide about segmenting the selection system in stages and batches. Stages refer to system parts that correspond to phases in the selection process, batches to groups of candidates being processed. As for stages, the most important questions to answer are: 1) Can all information on candidates be gathered “at once,” for example within the time-span of one or two days? 2) Will it be cost-effective to examine all candidates with the total system, or will substantive savings be obtained by reducing the number of candidates flowing through parts of the system? Regardless of the precise content the selection procedure may get later on, it is important to think about the system's scope and to determine whether it is practically and economically feasible to conduct a full examination of all candidates. If the answer is yes, a relatively simple architecture with a single test battery may suffice. But if the answer is no, the designer will have to look into options for segmenting the system, that is, splitting it up into modules, and designing the corresponding parts of the overall prediction and decision model.

With regard to batches the following questions are relevant: 3) Will all candidates be available within one period of time, for example a month of the year? 4) Can the examination of candidates take place in one location (testing site, Internet)? Although the focus of these questions seems purely on logistics, they imply design choices that can have marked effects on the system's effectiveness. For instance, if the number of candidates is large and all of them apply within a short time period (e.g., the end of a school year), the designer might opt for a system that quickly reduces numbers to manageable size. A steady flow of candidates during the year, on the other hand, enables one to process them with a uniform
procedure. The first may reduce effectiveness by high numbers of false negatives, the second may raise costs by not optimally using system resources (e.g., personnel, test equipment). In the second case it might be preferable to accumulate candidates and examine them in larger batches.

**Step 5. Compensation**

Apart from the structural features of the selection system, the designer should also look at operational aspects. The fifth step, then, is taking a decision about how to deal with compensation. Compensation can be looked at from two angles: prediction and decision making. In the context of prediction compensation is customary. Thus, a compensatory prediction model is adopted in which the same (predicted) criterion performance can result from different combinations of predictor scores. However, in exceptional cases, the designer can also opt for conjunctive or disjunctive prediction models in which the (predicted) level of the criterion is determined by the lowest or highest predictor score (see Guion, 1998, p. 53). As a rule, decisions follow predictions; thus, in the first case decisions are based on a single cutoff score for the weighted predictor sum, in the second case on multiple cutoffs.

Compensation in the case of multiple criteria is another issue. Here, the focus is typically on decisions, not on prediction (as the very use of multiple criteria points at the absence of a single overarching criterion). Often, compensation in decisions is not considered appropriate and separate cutoffs are preferred. For example, air traffic controllers are not supposed to perform with greater efficiency at the expense of lower safety. They must satisfy separate standards for these criteria.

Although practitioners are sometimes skeptical about compensation and favor multiple cutoffs, designers should be prudent and avoid using multiple cutoffs without justification. The reason is that multiple cutoffs can easily lead to high numbers of false negatives, that is, candidates who are unduly rejected, and thereby to a waste of human resources.

**Step 6. Weights**

The sixth step involves choosing the parameters for prediction. Although designers may sometimes opt for non-linear prediction models (e.g., Roe, 1983), a system with a linear prediction model will do well in most cases. Regarding the parameters, two questions are to be answered: 1) Are there reasons to prefer unequal weighting over equal weighting? 2) If so, are empirical weights to be preferred over rational weights? Given the properties of the linear model and the statistical limitations of small and medium-sized samples, equal weights may be considered as the default. For a practical reason, namely the comparability of scores from different instruments, this rule is applied to standardized rather than raw scores. Designers do well to opt for unequal weights when validities of predictors are likely to show substantial differences (e.g., .10 or more). A rule of thumb is that weights that are roughly proportional to the expected validity give good results. Weights may, however, be rounded off to integers without much loss of overall predictive validity (Wherry, 1975). These wisdoms run counter to the recommendation in much of the older literature that
weights be determined empirically by means of multiple regression analysis. Since there are usually no empirical data at the design stage — apart from estimated or simulated validities — the designer has little choice but to begin with rational (i.e., self-set) weights, and can decide to introduce empirical weights at a later stage after the appropriate empirical information has been collected. This is normally after the selection system has been put to use.

**Step 7. Cutoffs**

The seventh step is about decision parameters, that is, cutoffs. Here the question for the designer is whether the selection should be based on absolute (fixed) cutoff scores, relative (variable) cutoff scores, or semi-absolute cutoff scores, which can be seen as a compromise between the two. Absolute cutoffs give stable results and are seemingly “fair” to candidates, but the number of selected candidates may be too high or too low. In the absence of criterion evidence they may be set too high or too low. Relative cutoffs (based on selection ratios) give the right numbers of selected candidates, but may also be set too high or too low. When applied to separate batches, relative cutoffs may vary and be seen as unfair by candidates. In such cases one can “freeze” cutoffs as established in one batch and apply them to other batches. These semi-absolute cutoffs resemble the method of “predicted yield” (Guion, 1998). From a practical perspective the best approach is to set relative cutoffs for a limited period of time, and to replace them by semi-absolute or absolute cutoffs when possible.

**Step 8. Integration**

The preceding steps guide the designer through a number of interdependent choices and provide some support in taking decisions on structural and operational features of the selection system. The list does not spell out all issues to be considered. For instance, the predictors to be included, the precise structure of the prediction and the decision model, etc., are still to be decided upon. Yet, the designer will be able to develop an overall view of the system and make a composite description that integrates all aspects mentioned. Thus a design document can be made that describes positions, criteria, predictors, stages, as well as choices regarding quota, selection ratios, cutoffs, etc. The format for the description can be textual but also abstract or symbolic. For instance, components can be referred to as criteria A, B, C, . . . ; stages I, II, III . . . ; predictors 1, 2, 3, . . . , etc., without further specification. The document may also contain tables or flow charts that highlight particular parts of the design. A document outlining the system’s architecture should stimulate critical discussions in the design team and promote sound decision making, before engaging in further design.

**Exemplary Design Issues**

In this section we discuss three issues which illustrate the kind of problems designers may encounter when designing a selection system in practice. They relate to sequential
selection, batch-wise selection, and compensation. We will draw attention to some non-trivial implications that certain design options may have and the reasoning the designer may apply in searching a solution.

**Sequential selection**

Many advanced selection systems comprise a series of modules that offer successive hurdles to the candidates. After each module a number of candidates are rejected while the remaining candidates move on to the next module. Thus the group of candidates gradually shrinks until the final hurdle has been taken. Modules can be composed of different types of tests, an assessment center, a job simulation, but also a training course. For instance, the selection of future military pilots includes several tests modules, a set of assessment exercises, flying a basic simulator (grading), and even flying a real airplane. All these modules precede entry into the ground school, which is the first phase of a training trajectory leading to a pilot career.

Segmenting a selection process like this has a number of implications which the designer should consider carefully. A first issue is the nature of the prediction model. Will the test module have to predict success in the basic simulator and success in the first real flight? Figure 4.5 illustrates some options in choosing a prediction model for sequential selection. Theoretically there are several ways to build a prediction model. On the one hand (panel a), one can use predictive information from module I to predict performance in module II, and use performance in module II to predict performance in module III, etc. On the other hand (panel b), one can use information from every module to build a growing composite that predicts the performance in the pivotal position entered after passing the last module. Combinations of these two principles are also conceivable.

It is important to note that the second model is potentially more effective than the first because every new step brings a further increase in predictive validity. Predictive validity of the first model will be equal to the predictive validity of its last module. Although some-
times favored by practitioners who expect colleagues earlier in the chain to "stop sending us the wrong people," this model leads to a waste of predictive power that limits overall selection effectiveness.

A second issue in sequential selection relates to cutoff scores. Practitioners often expect best results from high cutoffs, both in terms of the performance of those ultimately selected and lower capacity demands and costs in subsequent modules. When these expectations are not met the usual response is to raise cutoffs and to select more strictly. Theoretically this way of thinking is flawed, since it ignores the fact that later selection steps can only operate on candidates who have passed earlier steps, and that errors made in earlier steps — especially false negatives — cannot be corrected for. In fact there is a "selection paradox" in the sense that lower initial cutoffs give more room for selecting candidates with high criterion scores than higher initial cutoffs. This paradox manifests itself in two ways: 1) The criterion scores of the strictly selected candidates become even lower, and 2) the number of acceptable candidates declines. The latter can pose a pernicious problem for organizations that go to great lengths to recruit and select highly qualified personnel and continue to suffer from scarcity. When responding by raising selection standards further, especially in early stages, the result will be opposite to what they aim for and scarcity will only increase.

What can designers do about this problem? First, they can look into the sequence of predictive modules and try to optimize it. Second, they can devise a series of cutoffs tailored to the expected increase in predictive validity. Cutoffs for early modules will be low to moderate; only cutoffs for later modules will be high.

The third issue concerns the sequence of modules. Although this may not be perceived as important by practitioners, designers do well to take a close look at it, since it may have a great impact on the system's effectiveness. Several aspects have to be considered simultaneously. First, the flow of candidates through the modules, which can be modeled by multiplying the selection ratios. At each stage, the cumulative selection ratio is the product of the selection ratios of the preceding stages. The second aspect is the cost associated with administering each module. Fixed and variable costs should be included in a cost accounting calculation, on the basis of the expected flow of candidates as shown by a flow model. Cheap modules should be put at the beginning, when the number of candidates is still large, and expensive modules at the end. The third aspect is the logistic one. Modules with a large capacity (e.g., Internet testing) that can be operated at any moment in time will precede modules that assume group-wise testing. Modules requiring administration in small groups or individually will usually be put at the very end. The fourth aspect is predictive validity. Other things being equal, one would place modules with high validity early in the system. But given the payoff relationships between these four aspects, designers will have to play around with various options and look for an acceptable solution. There are some other aspects, such as the intrusion of privacy (see Roe, 1989), which should also be considered.

**Batch-wise selection**

Selection usually occurs in batches. That is, applicants for a given type of job present themselves at moments spaced in time, rather than at once. Therefore, the selection process has
TABLE 4.4  Simulated selection effects for batch-wise selection. Means and standard deviations for selected applicants on predictor (X) and criterion (Y) variables for different numbers of batches and two levels of validity; selection ratio = .50 (after Roe, 1983, p. 474)

<table>
<thead>
<tr>
<th>Selection method</th>
<th>r_Y = .30</th>
<th>r_Y = .60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M_x</td>
<td>sd_x</td>
</tr>
<tr>
<td>Fixed cutoff population</td>
<td>.7978</td>
<td>.6029</td>
</tr>
<tr>
<td>Relative cutoffs</td>
<td># of Batched</td>
<td></td>
</tr>
<tr>
<td>1000/2000</td>
<td>1</td>
<td>.7899</td>
</tr>
<tr>
<td>5/10</td>
<td>200</td>
<td>.7309</td>
</tr>
<tr>
<td>4/8</td>
<td>250</td>
<td>.7162</td>
</tr>
<tr>
<td>3/6</td>
<td>333</td>
<td>.6948</td>
</tr>
<tr>
<td>2/4</td>
<td>500</td>
<td>.6601</td>
</tr>
<tr>
<td>1/2</td>
<td>1000</td>
<td>.5636</td>
</tr>
</tbody>
</table>

to be repeated, each time producing a number of selected candidates. Although batch-wise segmentation of selection is hard to avoid, because it reflects the inherent dynamics of the labor market, it represents an issue that designers should consider. The reason is that there are different ways to organize batches which affect the system's effectiveness differently.

The potential impact of batch-wise selection can be illustrated by considering a situation in which selection is based on a relative cutoff, that is, the best p% of the candidates is selected. How does this compare to a situation where all candidates apply at once and the same proportion of candidates would be selected? A simulation study by Roe (see Roe, 1983) provides the answer to this question. In this study random scores based on a bivariate normal distribution were generated. Selection was based on the total sample of 2,000 candidates and on sub-samples varying in size from 2 to 10.

Table 4.4 shows the results of the selection in terms of the means and standard deviations of the selected candidates for both X (predictor) and Y (criterion). As the results for Y depend on the validity a comparison is made between r = .30 and r = .60. The table shows that selecting from batches is less effective than selecting at once. If all selected candidates are taken together their mean score on the criterion is lower while the standard deviation is higher. For the predictor the effect is more dramatic, of course. The size of the batch also matters. In this study the focus was on very small batches, but larger batches generally give better results than smaller batches.

Designers can exercise some control over batch sizes. This requires an analysis of vacancies and the yield of recruitment over time, the costs and logistic aspects of testing candidates in smaller and larger batches, and the selection effects of smaller and larger batches. One way to increase the batch size is by accumulating candidates, that is, to ask them to stay available until a certain moment in time at which the pool will be large enough for efficient examination. Alternatively, one may conduct examinations immediately but keep
the scores in reserve until a sufficient number of candidates have been processed to make a solid decision.

It might seem that relative cutoffs make batch-wise selection cumbersome. This is only partially true. Of course, selection effects would be stable if fixed cutoffs were used. But fixed cutoffs combined with smaller batch sizes may lead to situations in which no suitable candidates are selected while vacancies have still to be filled. This issue has been discussed earlier, but it appears more difficult to resolve in the case of batch-wise selection.

Compensation

Many people involved in the practice of selection appear to favor the use of multiple cutoffs. Thus, candidates for pilot training may first be selected on the basis of test scores, next on the basis of assessment center scores, then on the basis of simulator scores, and so on, without considering the relationships between the scores from the successive stages, and without applying compensatory rules. Whether it is useful to compensate for scores from earlier selection stages depends on the underlying prediction model. When the prediction model is of the type depicted in Figure 4.5a, that is, when every module is used to predict performance at the next stage, compensation is obviously not needed and separate successive cutoffs can be applied. However, when modules are incorporated in a single cumulative prediction model of the type shown in Figure 4.5b, compensation is preferable. We have already noted that the second model is preferable to the first since it can achieve higher predictive validity. When it comes to decision making, we can add that it is also preferable because it leads to fewer false negatives.

But how does compensation work with the second kind of prediction model? Let us take the example of three modules each producing a composite score $X_i$, thus: $X_i$, $X_{II}$, and $X_{III}$. At stage I one would use the prediction model $Y' = W_{i}X_{i} + W_{II}X_{II}$ and set a cutoff score for selecting the $q_1\%$ best candidates. At stage II one would use the prediction model $Y' = W_{II}X_{II} + W_{III}X_{III}$ and set a cutoff score in a similar way. At stage III the prediction model would expand into $Y' = W_{II}X_{II} + W_{III}X_{III}$ and a cutoff would have to be set. And so on.

This approach to compensation implies that a weak score in $X_i$ can always be compensated, provided that the scores $X_{II}$ and $X_{III}$ are high enough. Such “full” compensation may not always be desirable, though. Candidates with too low scores on the tests may not be qualified enough ever to be considered successful in subsequent stages. Therefore, designers may want to set a minimum score for each module’s composite, acting as a threshold. Such a (semi-)absolute cutoff can be used in conjunction with the compensatory cutoffs just discussed. This combined approach to sequential selection can be quite effective in maximizing the contributions of each module, while reducing false negatives.

We give an example in Table 4.5. Here selection is based on relative cutoffs or selection ratios. In each phase one first selects the $p_1\%$ candidates with the highest scores on the score for the specific module, and next the $q_1\%$ candidates with the highest scores on the accumulated composite. For example, in the third phase one will select 75% on the basis of $X_{III}$ and 80% on the basis of $Y' = W_{III}X_{III} + W_{II}X_{II} + W_{I}X_{I}$. The total selection ratio of the third phase is $.75 \times .80 = .60$. The last three columns of the table illustrate
TABLE 4.5 Example of dual cutoff scores in sequential selection, using selection ratio $p$ for each module and selection ratio $q$ for the composite derived from the accumulating prediction model. Selection flow in terms of cumulative selection ratio and numbers of in-flowing and out-flowing candidates at each phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Module score</th>
<th>Prediction model</th>
<th>$p$</th>
<th>$q$</th>
<th>$p \times q$</th>
<th>Cumulative selection ratio</th>
<th># of Candidates in</th>
<th># of Candidates out</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>$X_I$</td>
<td>$W_I \cdot X_I$</td>
<td>.90</td>
<td>.90</td>
<td></td>
<td>.900</td>
<td>1,000</td>
<td>900</td>
</tr>
<tr>
<td>II</td>
<td>$X_{II}$</td>
<td>$W_I \cdot X_I + W_{II} \cdot X_{II}$</td>
<td>.85</td>
<td>.85</td>
<td>.68</td>
<td>.612</td>
<td>900</td>
<td>612</td>
</tr>
<tr>
<td>III</td>
<td>$X_{III}$</td>
<td>$W_I \cdot X_I + W_{II} \cdot X_{II} + W_{III} \cdot X_{III}$</td>
<td>.75</td>
<td>.75</td>
<td>.60</td>
<td>.567</td>
<td>612</td>
<td>367</td>
</tr>
<tr>
<td>IV</td>
<td>$X_{IV}$</td>
<td>$W_I \cdot X_I + W_{II} \cdot X_{II} + W_{III} \cdot X_{III} + W_{IV} \cdot X_{IV}$</td>
<td>.70</td>
<td>.70</td>
<td>.42</td>
<td>.454</td>
<td>367</td>
<td>154</td>
</tr>
<tr>
<td>V</td>
<td>$X_V$</td>
<td>$W_I \cdot X_I + W_{II} \cdot X_{II} + W_{III} \cdot X_{III} + W_{IV} \cdot X_{IV} + W_V \cdot X_V$</td>
<td>.60</td>
<td>.60</td>
<td>.42</td>
<td>.365</td>
<td>154</td>
<td>65</td>
</tr>
<tr>
<td>VI</td>
<td>$X_{VI}$</td>
<td>$W_I \cdot X_I + W_{II} \cdot X_{II} + W_{III} \cdot X_{III} + W_{IV} \cdot X_{IV} + W_V \cdot X_V + W_{VI} \cdot X_{VI}$</td>
<td>.50</td>
<td>.50</td>
<td>.25</td>
<td>.16</td>
<td>65</td>
<td>16</td>
</tr>
</tbody>
</table>

The drastic selective effect of sequential selection, even when seemingly mild cutoffs are used.

**Conclusion**

It is almost universally agreed that positions in organizations should be offered to people on the basis of demonstrated competence or expected performance. The larger the responsibilities vested in positions and the greater the risks of damage to people and their possessions, the more it is demanded that candidates are carefully selected. The message of this chapter is that effective selection requires serious preparation. Decades of research and development have resulted in a large body of knowledge and tools that can be applied for selecting personnel. But all this is little more than a stock of ingredients from which a proper choice has to be made and a system has to be created that can adequately separate candidates into those who will and will not perform well. The focus of this chapter has been on the process by which effective selection systems can be built. We have discussed the context of selection and the role of stakeholders, the nature and process of design, some design tools, and some typical design issues. Although this is very limited and does not give the reader a comprehensive picture of the development of selection systems, we hope that we have pointed out a way forward in an area that is sparsely covered in the selection literature.

In our view, the time and resources spent on design can be seen as an investment in effective selection. This is especially true when design is understood as anticipating the future in an open-minded and experimental way. We cannot put enough emphasis on the
necessity of a thorough analysis to clarify the aim and context of selection. Such analysis, based on a dialogue with stakeholders, is a step toward a good result. But exploring options, subjecting them to desk-based simulations and making comparisons, is another essential part of the design process. This activity certainly involves the use of tools and data from the literature, but it also calls for inventiveness in finding solutions that uniquely match the technical requirements and practical conditions that the system has to meet.

What will normally not be included in the design process, or only at a very late stage, is a validation study. Here, our description of the design process deviates from what is commonly recommended in the selection literature. Although we assign great importance to a well-conducted validation study as a means to verify the predictive value of a selection system, we think that effective selection systems can be designed without doing a validation study and that the conditions under which systems have to be designed normally do not allow for a preceding validation study. In our view there is sufficient research evidence and a good-enough set of design tools to postpone validation research until after the implementation of the system. We dare to make a comparison with building a bridge or aircraft. Like these artifacts, selection systems can be built on the basis of existing knowledge and simulations during the development process. We would like to add that more effort should be spent on developing test-benches, in the sense of both statistical models and simulation tools, which would facilitate the designers' work and enhance the quality of its outcomes.

Notes

1. In Roe (2002) we also distinguish basic (or partial) competences which are of a lower degree of complexity. Basic competences can be seen as building blocks for several higher-order competences.

2. The notion of competence sheds another light on so-called "dynamic criteria" (Steele, Johnson, Osburn, & Peper, 2000). Since it takes some time to fully master competences, the repeated measurement of competences (i.e., at the start, during, and at the end of on-the-job learning) will reveal candidates' differential progress. The competence framework can help to understand diverging requirements posed by different positions in a career trajectory, especially those between the position of student or trainee and those of employee. At an initial stage the emphasis is on acquiring knowledge and skills, and a greater role will be played by dispositions required for scholastic learning and fulfillment of the student role. At a later stage differences in knowledge and skills turn into predictors, along with dispositions needed for learning at the workplace and fulfilling the specific work role.

3. For practical reasons the designer may want to limit the number of criteria to four or five. A larger number of criteria will add disproportionately to the complexity of the system and reduce its overall transparency and effectiveness.

4. The notion of "dynamic criteria" as used here designates criterion constructs that relate to a desired change of performance over time, especially learning. It should be distinguished from changes in predictor–criterion relationships over time, which have also been referred to as "dynamic criteria" (Steele, Johnson et al., 2000).

5. For some personality variables the scale may be transformed in such a way that the resulting score can be used as a linear predictor. For instance, when both high and low extroversion is undesirable a new variable may be created by taking the deviation from the scale midpoint.
References


