# HOW DECISIONS CAN BE ORGANIZED – AND WHY IT MATTERS

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**Abstract:** Recent theoretical advances allow organizational designers and managers to better understand how decision processes can be improved. These advances allow managers to address a number of critical questions about the structure and process of decision making, issues that are relevant for any kind of organization be it social, political, or economic. Can we add another employee somewhere in the decision process to increase economic performance? Can we add or eliminate a channel of communication to raise the quality of decisions? What level of skill is worth paying for when we hire a decision maker? Is it a good idea to push decision makers beyond their current capacity if doing so increases their error rate by five percent? Where does the injection of inexperienced decision makers hurt the least? We describe an organizational design approach that provides answers to such questions, and we offer specific guidelines that managers can use to improve decision making in their organizations.

**Keywords:** Organization design, decision making, organizational performance, decision aggregation, decision delegation, decision rights, decision evaluation

Members of organizations must repeatedly make strategic and tactical decisions, and occasionally mistakes happen. The processes by which decisions are made and implemented are clear and well-documented in some environments, but in other environments decision processes are less obvious. Regardless of whether the process is deliberately structured or has a more emergent character, the mechanics of organizational decision processes have a significant effect on the overall quality of the decisions that managers make. This observation naturally raises interest in how organizational decisions may be improved.

The purpose of this article is to present recent advances (Christensen & Knudsen, 2010) that allow organizational designers to better understand how decision processes can be improved. Our approach builds on the information processing perspective in economics (Marschak & Radner, 1972) and engineering (Moore & Shannon, 1956a; 1956b). We directly extend prior work by Sah and Stiglitz (1985, 1986) to show how the organization of decision making matters for the overall performance of the organization. Analysis of decision flows – their properties and possible weaknesses – is the core of our approach. We analyze the sequential flows of decisions through the organization as it evaluates the quality of investing in alternative projects and eventually decides to accept or reject them. The decisions are made by delegating decision rights to agents whose abilities are incorporated in a screening function that maps the project information (indicators of project quality) onto a distribution of outcomes.

In the following sections, we first describe, and illustrate with examples, how organizational decisions can be visually represented. Second, we characterize the abilities of individual human actors, as we explain how sources of error may compromise performance even if actions are well intended. We draw on experiments with real human subjects to situate our framework in a realistic context. Third, we show how fundamental properties of organizational decisions can be derived from visual representations. This provides a method



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for extracting performance measures that can be used as a basis for addressing important questions regarding organizational design. In conclusion, we offer advice for practitioners based on our approach. The predictions derived from our theoretical framework, combined with empirics relating to the nature of screening abilities, offer a set of guidelines for the organizational designer. Those guidelines include a new method to analyze organizational performance comprised of four steps: visualize, enumerate, aggregate, and compare.

## VISUALIZATION OF ORGANIZATIONAL DECISIONS

To grasp the basic elements of our approach, it is helpful to consider the stylized approach of Sah and Stiglitz (1986). In their approach, a decision-making organization is referred to as an e*valuation structure*, and the task of such an organization is to accept or reject a set of proposed projects according to a given criterion. In evaluation structures, *individual agents* screen each project and the organization then aggregates their opinions to form a final decision (verdict) whether to accept or reject the proposed project. The concept of a *project* is very broad. It can include investing in a joint venture, the development of a new product, hiring new employees, or choosing a particular medical treatment for an ailing patient.

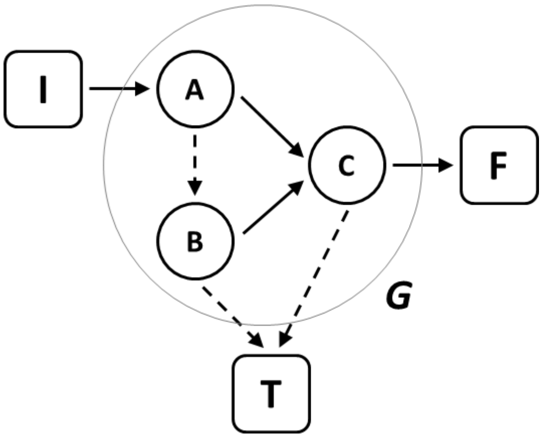



**Fig. 1.** Example of an evaluation structure with three agents

The flow of decisions in an organization can be visually represented as a graph of nodes and edges. For example, consider the decision-making organization shown as the circle G in Figure 1. The organization has three agents, denoted A, B, and C. Projects arrive at the organization from an input source (I), and they flow through the organization until they are either terminated (T) or followed through (F). Termination is the act of forgoing the project while following through is the act of investing resources in the project. The solid lines in Figure 1 symbolize acceptance of a project; the dashed lines symbolize rejection. The example shown could be a business unit prospecting for the acquisition of patents, a credit evaluation team in a bank, or an academic journal's board of editors and reviewers who consider accepting or rejecting a submitted paper. Agent A represents the initial reviewer or dispatcher; B the specialist or second opinion; and C the verifier or controller. Consider the case of deciding whether to acquire a patent or provide a bank loan. The first decision maker is Allen (A), who is only given the right to accept certain types of easily identifiable proposals aligned with the core business. If the project falls outside the domain in which he has decision rights, or if he is in doubt, then he must pass the project to Bill (B), who is a specialist in assessing unusual or problematic cases. No matter whether it is Allen or Bill who accepts the project, it must still move on to Carol (C), who checks that procedures have been properly followed, checks for project consistency with the core business, runs a background check, and finally approves (or rejects) the project for implementation. Note how Allen and Carol help to balance the workload as they aid the specialist Bill in focusing on time-consuming analyses on a smaller and more difficult set of projects. Note also the delegation of decision rights in this organization. No agent can singlehandedly accept a project. Either A and C or B and C must agree to implement the project. Both B and C have the power to reject a project on behalf of the organization, although in B's case only if asked by A. In contrast, A does not have rejection powers.

The outcome of this exercise (Figure 1) is a visual representation of the roles, project flows, and decision modes in this organization (evaluation structure). Once such a representation has been made, the abilities of the individual human actors must be considered.

## AGENTS AND THEIR ABILITIES

Human agents sometimes fail at making good decisions. We use the term agent to characterize individual human actors as well as groups or entire departments embedded in the organization. Such agents may fail because:

1. The task environment is noisy – that is, the outcome of the project is uncertain.
2. The agent is noisy – that is, his or her behavior is not consistent.
3. The agent is biased – that is, particular alternatives are favored by the agent over equally valid alternatives.

In noisy task environments, a common approach is to simplify the decision process by selecting projects that are perceived to clearly produce positive earnings in terms of expected net economic value. If the underlying project distribution contains a long tail of projects with rare but unbearable consequences, then a safety margin must be included. This would be the case for critical decisions in nuclear power plants and other high-reliability organizations.

Agents may be noisy and exhibit inconsistent behavior for several reasons. A composite agent consisting of a specialized team of individual actors – each having different preferences, motives, or abilities – may dispatch incoming projects to its members on an availability basis. The outcome of the decision will then depend on the random appointment of actors engaged in the assessment. Random behavior can also be an inherent property of individual human actors. In the weak form, the individual may fail to discriminate between proposals of minor quality differences with consequences to bear for the marginally beneficial projects. In the strong form, the individual may fail to make consistent decisions regardless of the quality of the proposals.

In addition to noise in evaluation processes, cognitive biases are potential sources of error in decision processes. A biased agent will tend to prefer particular alternatives over equally valid alternatives. Biases commonly occur because of motivational problems associated with poorly aligned incentives. Examples include favoritism towards some types of projects, personal prestige, and obsession. Other biases appear when human agents are challenged with creating mental representations from complex data and/or abstracting from irrelevant information. In contrast to the noise of the environment, it is important to note that biases are internal to the organization. They are not random, but rather they systematically affect the extent to which the agent satisfies the organization's objectives.

## SCREENING FUNCTIONS

The abilities of individual agents are captured by an agent *screening function*. A screening function describes the relation between the observable properties of a project, $x$, and the probability that the agent will accept such a project, $f(x)$. The concept of an agent screening function and the mathematical mapping it represents is grounded in empirical evidence. The agent screening function can be measured by submitting agents to laboratory tests or by recording, observing, and analyzing their daily work. The agent's task is to accept (reject) projects with a quality above (below) a given reservation level (which can be set to zero). The perfect evaluator never fails to meet the reservation level, resulting in a screening function that is a step function: the probability of accepting "bad" projects is zero, and "good" projects are accepted with a probability of one. The level of imperfection in agents can therefore be measured as the degree of deviation from this desired behavior. With perfect agents, the organization is, of course, superfluous. Yet, drawing on case studies and laboratory experiments, agent perfection is not the usual case.

In a case study (Christensen & Knudsen, 2009) of credit evaluation in a bank, 209 "fake" credit applications (each with a face value of approximately $1 million) were constructed from the bank's recent history and fed through the bank's credit evaluation process. The objective of the bank was to accept as many applications as possible while keeping the default rate below a certain threshold (0.5 percent). The fake applications had a mixture of 12 commonly used indicators of quality and (historically) well-known quality distributions. This setup was designed so that the screening functions from 40 randomly chosen employees could be extracted. These screening functions had a sigmoid shape and deviated notably from the perfect screening function that defined the ideal of perfect credit assessment. The shape of these empirical screening functions demonstrated that credit evaluation is a very challenging task associated with a strong form of bounded rationality. No matter how attractive the proposed project (i.e., probability of default lower than 0.5 percent), the project could still be rejected (and vice versa at the other end of the spectrum). As a consequence, these agents were positioned in a conservative evaluation structure (roughly a four-level hierarchy) favoring rejection for all but a small portion of the "best-looking" applications. While this approach eliminates a lot of Type II errors (acceptance of a bad project), it does so at the expense of increasing the frequency of Type I errors (rejection of a good project), thereby robbing the bank of business opportunities.

A laboratory experiment, performed at Lab@SDU on students from the University of Southern Denmark, extracted screening functions from 36 persons of mixed gender, nationality, and line of academic study.[1] The task was to categorize visual displays of simple geometric figures characterized by two independent parameters (position and size). The figures were randomly generated and defined as good or bad according to a simple geometric rule. The screening functions that were extracted from the subjects had a sigmoid shape. The shape of these empirical screening functions demonstrated that categorization of the chosen geometric figures is a moderately difficult task associated with a weak form of bounded rationality. Only projects of marginal value were subject to very noisy decisions, while projects with marked positive (negative) value were accepted (rejected) with a probability close to one.

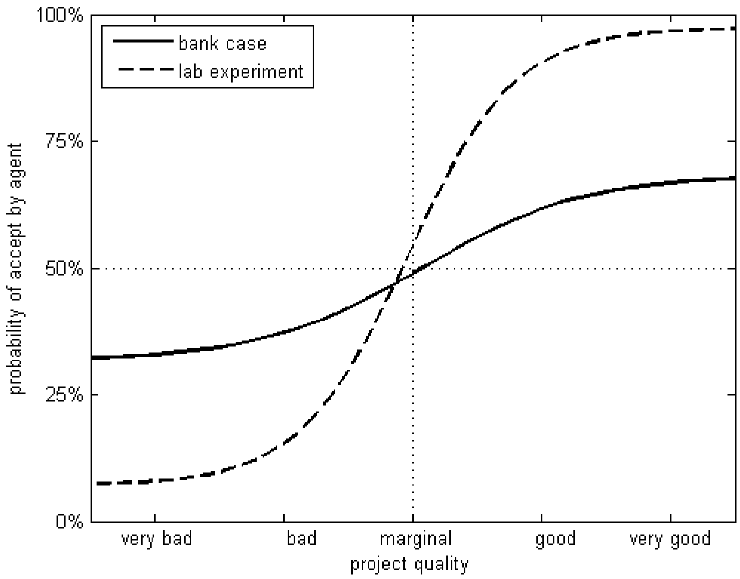



**Fig. 2.** Average agent screening functions

Figure 2 illustrates the average agent screening functions in the above two cases. They both fit a generic sigmoid curve (known as the hyperbolic tangent) with very little unexplained variance (< 0.5 percent). While neither function displays any significant bias, both exhibit the notable difficulty with which human agents assess quality in the "gray" area where project quality is marginally positive or negative.

1 The experiments, conducted in collaboration with Massimo Warglien of the University of Venice, are part of a larger research project "COPE – Change, Organizational Plasticity, and Evolution" under the Sapere Aude program of the Danish Council for Independent Research.

## FROM AGENTS TO ORGANIZATION

The properties of the organization are not just the sum of the properties of its members. The emergence of properties at the macro level of organized departments, business units, and enterprises is determined not only by the micro level properties of the individual agents. The exact network that connects organizational units, especially the delegation of decision rights on behalf of the organization, plays a crucial role in determining the overall screening function of the organization, the time required to make a decision, the costs of remunerating employees for making decisions, and more. Considering all the factors that influence the organizational decision process, it appears that organization design is perhaps even more important than the abilities of the employees as a determinant of the overall success or failure of the enterprise. Indeed, the work of Christensen and Knudsen (2010) shows that under certain sets of conditions (e.g., that agents are not entirely incapable), arbitrarily accurate decisions may be obtained by fine-tuning the organization. This result leaves only three excuses for making poor decisions in an organization: (1) complete lack of knowledge in the problem domain, (2) the cost of the decision process, and (3) poor organizational design. The critical issue is how different organizational forms aggregate micro-level properties, such as individual abilities, into macro-level properties, such as error rates, risk, and profitability. The generic method for extracting the macro properties starts with the previously created visualization of the evaluation structure (Figure 1) and proceeds to an *enumeration* and *aggregation* scheme.

First, enumerate all possible paths through the network. Each path must represent who is involved along the path, the exact sequence of accepts/rejects, and the ultimate decision regarding the project. This procedure creates a valid representation of the decision structure (or network) and the flows of projects through this structure. Second, develop a representation of the aggregate screening function of the entire decision structure. This is done in the following way. Under the assumption that the agents are (conditionally) independent, produce a symbolic representation of the probability that each path will realize (i.e., a project will flow to the end of the path). For every agent Z that accepts the project along the path, inject the agent screening as a factor, fZ, in the probability of the path, and for every agent Z that rejects the project along the path, inject a factor, 1-fZ, in the probability of the path. Carrying out the above procedure for the example in Figure 1 gives the results shown in Table 1. The enumeration of decision paths through the organization reveals five possible ways in which a project can be realized. Each path is listed in Table 1 along with the probability that a project will be realized through it. The plus/minus superscripts on the agent labels indicate accept and reject, respectively. The aggregate organizational properties regarding the screening process can be calculated from the expressions in Table 1.

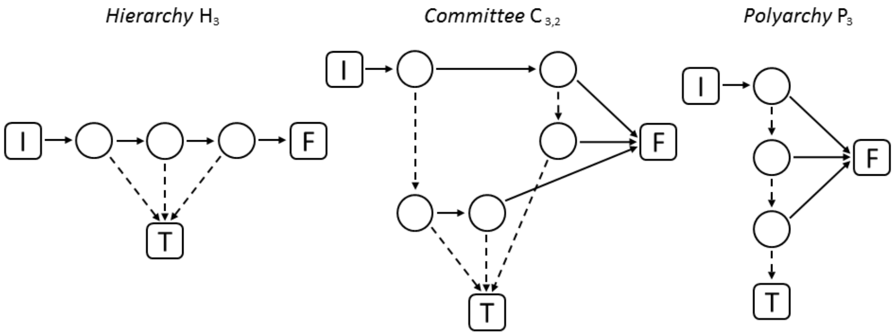
**Table 1.** Decision paths through the organization derived from Figure 1

| Destination of Path | Path Label | Probability | Evaluations |
|---|---|---|---|
| **F** (follow through, acceptance) | $A^+C^+$ | $f_A\ f_C$ | 2 |
| | $A^-B^+C^+$ | $(1\text{-}f_A)\ f_B\ f_C$ | 3 |
| **T** (termination, rejection) | $A^+C^-$ | $f_A\ (1\text{-}f_C)$ | 2 |
| | $A^-B^+C^-$ | $(1\text{-}f_A)\ f_B\ (1\text{-}f_C)$ | 3 |
| | $A^-B^-$ | $(1\text{-}f_A)\ (1\text{-}f_B)$ | 2 |

The probability that the organization as a whole will accept a project and thereby commit to its implementation and consequences is denoted the *graph screening function*. It is derived by weighting the indicator function for final acceptance of each path (1 if ending at F, 0 if ending at T) with the probability for the same path to realize (i.e., it is the sum of the two first paths in Table 1). The graph screening function represents the aggregate decision quality of the entire organization. It is important because it can help achieve desired improvements by a comparative analysis of the status quo and any changes relating to the abilities of employees, decision rights, and organizational redesign.

Another example of organizational properties is the number of evaluations required to reach a decision regardless of outcome, since this quantity is an indicator of the time and cost of making the decision. This is obtained by weighting the number of agents on the path with the probabilities of the paths.

A serious objection to the above compounding method is that the agent screenings may depend on the position or role of the agent. Employees may engage in "games", the bias of satisfying personal over organizational objectives. Evidence from case studies and laboratory experiments indicates, however, that alignment of incentives can be achieved when the task environment is fairly stable. Add the fact that limited abilities (or limited information) on the part of the agent can also impact the agent's ability to play such games. Considering these empirical factors, it seems rather unlikely that (slightly) misaligned incentives will completely negate the effects of the organization. Unfortunately, however, we know comparatively little about the adaptive behavior of agents engaged in decision processes in changing environments. We will return to the matter of "changing environments" in the section on guidelines for practitioners.




$F_{H_n}(\alpha) = \alpha^n$ $F_{C_{3,2}}(\alpha) = 3\alpha^2 - 2\alpha^3$ $F_{P_n}(\alpha) = 1 - (1-\alpha)^n$

**Fig. 3.** A hierarchy, a majority rule committee, and a polyarchy

When agents, for all practical purposes, are identical or homogenous, the expression of the graph screening function can be considerably simplified. For example, this would be the case when employees participate in job rotation or for other reasons have similar experience. In that case, all agents are treated as if they have an identical screening function, f(x). The graph screening function then reduces to a polynomial of the common agent screening function, α=f(x). As an example, the organization G of Figure 1 has a *reduced* graph screening function, $FG(\alpha)=\alpha^2(2- \alpha)$. The reduced graph screening should be compared to the agent screening $F_A(\alpha)=\alpha$ of the average agent A. If $F_G<F_A$ for $\alpha<\alpha_0$, the value of the agent screen at the reservation level (e.g. zero quality), then the organization G makes fewer Type II errors than the individual. Alternatively, if $F_G>F_A$ for $\alpha>\alpha_0$, then the organization makes fewer Type I errors. The decision structures that serve as fundamental building blocks are illustrated in Figure 3, along with their reduced screening polynomial. The structure on the left is a hierarchy with three members (Sah & Stiglitz, 1985, 1986); the structure on the right is a polyarchy with three members (Sah & Stiglitz, 1985, 1986); and in the middle is the smallest symmetric organization that is more discriminating than the single agent (denoted $C_{3,2}$). The decision structure shown in the middle of Figure 3 is a stylized representation of the three-member committee of consensus two (i.e., if at least two out of three members agree, their decision is carried). It is the most discriminating structure that applies no more than three evaluations for each decision, and it plays a special role because it always increases the discriminating ability of decision teams. The hierarchy is the most rejecting structure (reducing Type II errors at the expense of increasing Type I errors) with maximal evaluation count of three. The polyarchy is the most accepting structure (reducing Type I errors at the expense of increasing Type II errors) with maximal evaluation count of three.

## ORGANIZING TO COMPENSATE FOR INDIVIDUAL MISTAKES

Organizations can be designed to remove some consequences of the fallibility of its members, but what are the limits of this approach? Just how much of the individual fallibility can be countered by good organization design? According to Christensen and Knudsen (2010), organization design can substantially counter individual fallibility, but the cost is an increasingly elaborate decision process. Whether the decision structure under consideration is to be responsible for purchasing equipment, hiring employees, making acquisitions, forging alliances, or even for (re)designing the organization, it is paramount that the designer balances error rates against the costs of increasing organizational performance. Which decision makers should be involved? How should they communicate? How should the decision flow be structured? How should decision rights be delegated? Again, the work of Christensen and Knudsen (2010) provides constructive approaches to counter different types of mistakes made by members of the organization. Polyarchies and hierarchies, and networks composed of these structures, can potentially remove any inherent biases that appear in individual screening functions. The special structure $C_{3,2}$ can be used to increase overall discriminating ability and reduce the stochastic behavior of the decision structure. And, by nesting combinations of the various structures within each other, it is possible to simultaneously reduce both Type I and Type II errors to an arbitrary level.

The specific choice of a decision-making structure depends on the screening abilities of organization members, the distribution of projects, and the value of projects. Let us illustrate by revisiting the bank example. The empirical agent screening function is plotted in Figure 4 along with the extremely conservative four-member hierarchy that this bank used to assess credit applications. As indicated in Figure 4, the agents have a fairly low ability to discriminate (i.e., the slope of the agent screening function around the mid-point is not very steep). The agents are also noisy (i.e., they accept one-third of the most risky loan applications and reject one-third of the most promising ones). The bank's choice of a hierarchical structure ($H_4$) is a testimony to the importance of avoiding risky loans in the form of Type II errors.

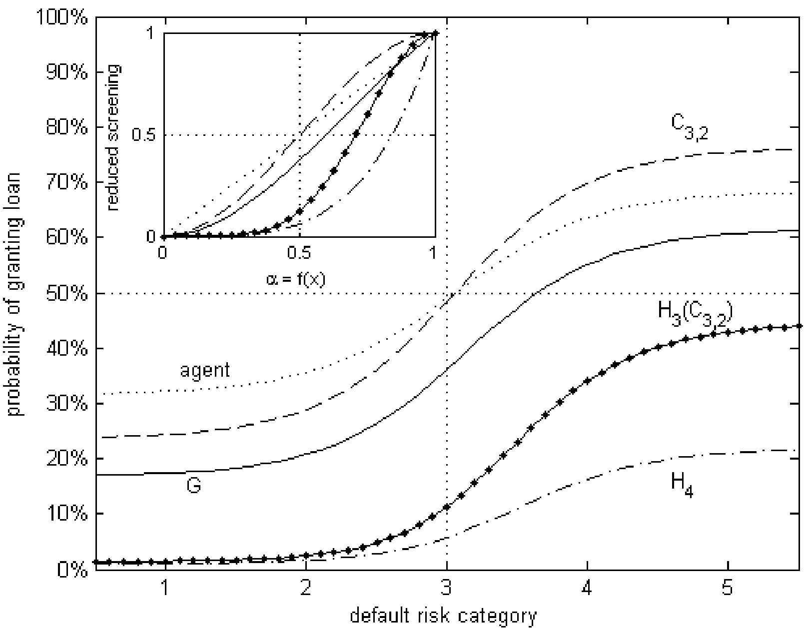



**Fig. 4.** Agent and organization screening abilities from the bank case

An organization designer might experiment with alternative structures to see if other forms of organization could increase performance. Clearly, the three-member majority rule ($C_{3,2}$) is more discriminating and reduces the noise at the extremes from one-third to one-fourth. However, the use of $C_{3,2}$ would lead to a notable incidence of Type II errors. Our previous example G from Figure 1 is also more discriminating than the individual agent and more conservative than $C_{3,2}$. Even so, the use of G would result in too many Type II errors (one-sixth). Only when combining a smaller version $H_3$ of the current structure with the special structure $C_{3,2}$ does the venture start to look promising. The net effect is a significant relative gain in the volume of profitable loan applications that get accepted (of course, the cost of extra evaluations must be subtracted). In case some of the uncertainty stems from uncontrollable processes in the environment, the larger volume will also serve to reduce fluctuations from the mean (i.e., reduce risk).

## GUIDELINES FOR PRACTITIONERS

The framework and tools we have presented comprise a design approach to improve the quality of the decision process in organizations. Our proposed approach consists of four steps:

1. *Visualize* the decision process as a graph.
2. *Enumerate* all the decision paths.
3. *Aggregate* the relevant properties.
4. *Compare* alternative designs.

Application of Steps 1-3 provides insight into the intricate workings of the decision process under consideration. The value of Step 4, however, hinges on the available information regarding projects and agents. The more accurate the data are on those factors, the more elaborate and detailed are the design questions that can be addressed. If little is known regarding the properties of agents and the project distributions they evaluate, more generic properties relating to the incidence of Type I and Type II errors can still be assessed.

At the other end of the spectrum, where detailed knowledge is available regarding the project distribution and the agent abilities, accurate measures of success regarding economic performance and error rates can be calculated to guide the fine-tuning of the organization (evaluation structure). In this case, the Christensen and Knudsen (2010) framework provides a systematic approach to the design of the decision-making process. The collection of such detailed historical information is only relevant if it is indicative of the future. Thus, accuracy depends on the environment to be relatively stable, to change continuously, or to change so rapidly that much of the noise averages out. We provide below a set of guidelines that practitioners can use under the assumption of gradual or slow environmental change:

- Set design objectives. This requires a valid assessment of the organization's task environment with respect to error rates, economic value, and risk.
- Map out the decision process. Any decision structure, no matter how complex, can be mapped. A visible structure is more likely to be reliably followed, and it supports more direct and detailed analysis. Be sure to include relevant decision paths that emerge from the informal organization. Are undesirable decision outcomes (forgetfulness, delays, missed deadlines, etc.) included, and are they occurring at acceptable levels?
- Collect data on organizational performance. Are there any indications that the organization has surprising or undesired properties? To some extent, deviations from expected performance can be used to identify weak spots in the decision process. For example, if the employees we hire tend to disappoint, is it because the hiring committee uses a different rule than we gave them?
- Set objectives at the individual level. It is particularly important to design incentives that eliminate organizational games that could systematically misalign objectives and bias screenings.
- Collect data on individual performance. What are the characteristics of the projects that are considered? How do individuals perform (error rates, economic returns on projects, risk estimates, etc.)? Are corrections needed?
- Seek to eliminate correlation between evaluations. Correlations undermine the effect of organization design because they tend to make evaluations superfluous. Useful procedures that might help in this respect are: separate evaluations and decisions, use anonymous voting, submit evaluations prior to discussions, and do not disclose information relating to the progress of the decision.
- While, empirically, humans are good at meeting targets on average, their performance

often varies more than is desired. Seek to reduce this variation by setting up small teams organized as majority rule committees. Let two individuals take a look, and if they disagree, include a third person to break the tie.

- In situations where the consequences of a faulty commission (omission) are highly problematic, consider organizing the evaluators in a small hierarchy (polyarchy) such that all must agree to accept (reject) in order for the final organizational decision to follow.
- Consider the use of teams *of* decision teams, since nesting decision structures allows for the reduction of both types of errors (omission and commission) at the same time.
- Consider the cost of the evaluation itself. Can the improved decision quality uphold the extra man-hours spent? If fast decisions are crucial, most evaluators should work simultaneously even if some are redundant.

Changes in project distributions or agent abilities can have a substantial impact on performance. Monitoring decision-making organizations is therefore an important task of the organizational designer, since it allows detection of and proper response to new market conditions, improved workforces, new technologies, or society's conjunctures in general. The designer's job is not necessarily to pick the best-performing structure but rather to pick a robust structure that performs well under varying conditions. As the frequency of change increases, the focus shifts from the design of fixed structures to the design of reconfigurable structures and perhaps even to the design of the very mechanisms of organizational change.

## CONCLUSION

Our conceptual framework provides tools for the design of decision processes. We introduced a four-step method of visualization, enumeration, aggregation, and comparison. Based on this four-step method, we developed managerial guidelines for the design and redesign of evaluation structures. Our method moves the design process into the quantitative arena by relating structural and procedural changes directly to performance measures. The organization designer can use these tools and guidelines to examine the consequences of both *structural* design, where the connections among organization members are rewired, and *capability* design, where the impact of altering the members' abilities is analyzed. It is our hope that we have inspired practitioners and researchers to further consider how decisions can be organized and why it matters.

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