6 Work, Task Design, and Agents

Introduction

How should an organization be designed to perform its work? At the most basic level, one can think of an organization as performing a very large task, which must be broken down into smaller and smaller tasks in order to get the work done. Suppose you manage a software design company. Should you divide the work into processes such as design, development, sales, and service; or might it be better to divide the work according to client type: individuals, small business, large business, and government? These are the two main choices of the functional or the divisional configurations discussed in Chapter 4. Once a firm selects a way in which to organize the work at the highest level (the big task), there is the question of how work should be divided inside each of the sub-tasks. Within sub-tasks, the work is further divided, until it reaches the lowest task level of the organization. *Agents*, human or *robots*, perform the tasks and do the work of the organization.

Prior to the information age, *task design* was sometimes called "technology design" by organizational designers. In the traditional setting of manufacturing, technology design was a matter of figuring out whether work should be arranged sequentially (as in assembly lines as the classic design for automobile assembly); in parallel (as jet engines and health care at GE); via teams that continually passed work back and forth among individuals (as with marketing and R&D for new product development or design-as-build projects); or in some other way.

Today, the word "technology" has a broader meaning, so we use the simpler label of task design; but the essential design question remains the same, which is how the big task of a firm is broken down into smaller tasks and how these smaller tasks interconnect with one another so that the big task is successfully completed. As we shall see, a firm's approach to task design is related to its choice of efficiency and effectiveness goals, as well as to the structure and strategy of the firm, as shown in Figure 1.3. Task design determines the coordination requirements for the firm's work, and thus it is vital that there is fit between task design and the other components of organizational design. Given a firm's strategy and structure, some approaches to task design will fit better than others.

Task design is decomposing work into sub-tasks while considering the coordination among the sub-tasks to meet organizational goals. There are two complementary task

As you design your organization, you must decide not only whether to employ many people or a few, but also what types of people are needed, given your strategy, structure, and task design. It makes a difference if the employee is engaged in a transformation or transaction task, a judgment task, a social task, or a creative task. Education, training, and experience can increase the skills, knowledge, and capacity to both generate and process information and, thus, individuals can perform tasks that are more varied and connected – or, more complicated, lengthy, and cognitively difficult. The individual's knowledge is the basis for what they can do. This knowledge may be explicit, which means it can be codified. Or it may be tacit, which means it is not readily codified or documented. Explicit knowledge is easier to capture and transfer around the organization; tacit knowledge is far more difficult to transfer and requires rich forms of social interaction in order to be shared (Polanyi, 1966; Nonaka and Takeuchi, 1995).

Whether explicit or tacit, knowledge is the basis for the skills, as well as the routines and other capabilities, people apply in doing the work of the organization. It seems obvious that each of us cannot do all things perfectly and instantaneously. We have limited information, which we interpret reasonably well, but imperfectly; and we communicate only a fraction of what we would like to communicate and, again, imperfectly. The bounded rationality of people is at the heart of why we need an organization. At the most fundamental level, we need configurations, task designs, and information systems to permit us to reach large goals in the face of our bounded rationality. Individuals are boundedly rational, and the organization is a way to cope with that limitation, while at the same time harnessing the skills and capabilities that people collectively offer in performing their work tasks.

Digitalization further changes the tasks in an organization. Automation in production has been going on for decades, reducing and changing the task done by humans. *Robots* and information systems have taken over many, if not most, of the transformation and transaction tasks in production. Now, AI embedded in machinery and tools again changes the way in which tasks are performed – not only in production, but on a more widespread basis across the organization – and robots are beginning to perform judgment and social tasks.

As a result, employees collaborate with, rather than merely control, the technology in use, and organizational designs have to encompass both human and robot or digital agents (Snow *et al.*, 2017).

Tasks and Robots

In economics and organizational design research, organizations have been modeled as agents with specific characteristics. To be sure, they are simplified abstractions of individuals, but can also be considered as intelligent robots or AI agents.

There are a number of different *robots*. Industrial robots are automatically controlled, reprogrammable, multi-purpose, manipulative, and programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications. Service robots perform useful tasks for humans or equipment, including industrial automation applications. *Intelligent robots* refers to robots capable of performing tasks by sensing their environment and/or interacting with external sources and adapting their behavior. *Social robots* are designed to interact with humans and to operate in human environments with people (Ulhøi and Nørskov, 2019).

Intelligent robots and individuals have different capabilities for organizational work. An intelligent robot can process information more quickly and more accurately than many individuals. Individuals can detect systemic or gross errors that an intelligent robot may not. Individuals have emotions that enter decision-making, but intelligent robots do not – at least not yet. In short, intelligent robots have advantages in some task designs and individuals in other information tasks. Nonetheless, there can be substitution between robots and individuals as we now see it in banks; or the two can complement each other in work – for example, an individual writes an essay and a robot checks the grammar and spelling in said essay.

At Tesla's manufacturing facility in Fremont, California, technicians work alongside robots to assemble the electric cars. By using AI, "reinforcement learning algorithms," the robots are able to switch tools and perform certain tasks far better and faster than their human co-workers (Snow *et al.*, 2017).

Usually, we assume that robots are the helpmate of the individual – from the desk calculator to the desk computer to the large-scale transaction system of Amazon and many others. Intelligent robots work for individuals to help them. In contrast, there are situations where the relationship is reversed. That is, the individuals work for the system as the individuals take orders or accept the intelligent robot's decisions, and do as the system tells them. At Uber, many, if not most, drivers do not communicate with an individual – only an intelligent robot who keeps track of where they are, asks whether they want to accept a ride, and then directs the driver to the customer; all "paper" work is done automatically by intelligent robots (Rosenblat, 2018). It may be a stretch, but not much, to say that the individual's boss is the intelligent robot.

Task design for intelligent robots and individuals should match the task with the capabilities of the intelligent robot and the individual. Intelligent robots as well as individuals have limited capabilities: in speed, in dealing with the complexity of the multiplicity of considerations, in the level of judgment, beyond a program, of what to do; and in emotions about effects of the results. Together, intelligent robots and individuals can work as a team to realize more efficient and effective outcomes. Today, we cannot design tasks for an information-processing organization by ignoring the role that robots can assume in the organization. Intelligent robots, as individuals, can perform the basic functions of who talks to whom when and who decides which decisions to make.

Robots are not new. For some time, industrial robots have been used in manufacturing, especially in assembly: weld, rivet, or bolt. Robots follow lines in the floor to move parts and sub-assemblies in automatic warehouses. Now the intelligent robot includes very advanced cameras and other sensors with algorithms that have face and language recognition. Robots here are information-processing machines that communicate, coordinate, and make decisions, as do individuals. These robots are different from traditional industrial robots, just as were Taylor's (1911) man as machine and Simon's (1955) man as information-processor and decision-maker. Thus, these intelligent robots are active agents in an information-processing view of organization and might be included on the organization chart, as well as a process chart of who does what when, who communicates, and who makes decisions.

Today, we design tasks for robots or agents as well as individuals. The Danish journalist intelligent robot writes articles for newspapers on sports and finance. Searching structured data (e.g., game results, annual reports, press releases, and stock market announcements), the intelligent robot writes a "standard" small article. This requires fewer journalists and the tasks for remaining journalists are different from before. At the new Danish financial news service, Lasso.dk, all articles are written by an intelligent robot. An intelligent robot can write these standard articles up to 100 times faster than a journalist. At Lasso.dk, the articles are updated instantaneously when you search for an item; so, the news is always up to date.

In the information-processing view of organizations where we design who talks to whom when and who makes which decisions, intelligent robots are explicit agents or information processors. Intelligent robots can perform most transformation and transaction tasks, but fewer undertake judgment tasks, while humans to a great extent are performing social and creative tasks.

Amazon is an example of a large-scale transactions organization. Product or service orders are received. Then a very large number of small information tasks are undertaken to deliver the product, such as a book, a grocery item, or a service. A large number of intermediate tasks are necessary to realize the large task of product or service delivery. These transactions can be accomplished by individuals, intelligent robots, or a combination of the two.

Judgment tasks involve reciprocity, a dialogue back and forth between or among organizational agents who can be individuals or intelligent robots. Such interaction includes responding to questions, analysis, evaluation, decision-making, and advice giving. Previously, all telephone inquiries to a bank were handled by an individual, who would ask questions about you and your question in order to give you an answer. You might use your keyboard for the same inquiry. But now, intelligent robots can mimic an individual in a telephone conversation with you. The development of sensing and interpretation devices is advancing rapidly and we can expect intelligent robot substitution for individuals to increase reliability and decrease costs in many judgment tasks.

The social task is interacting with other people to exchange information, to create trust, and to establish a social network. These tasks are mostly done by humans, but robots like the humanoid robot Pepper show that a number of social tasks may in the future be performed by robots. Pepper is designed with the ability to read emotions – it detects emotions by analyzing expressions and voice tones. Pepper is intended to "make people enjoy life," enhance people's lives, facilitate relationships, have fun with people, and connect people with the outside world. Pepper is used in over 1,000 homes in Japan. It is also used as a receptionist at several offices and hotels and is able to identify visitors with the use of facial recognition, send alerts for meeting organizers, and arrange for drinks to be made. Pepper is able to chat autonomously to prospective clients.

The category of creativity is performed largely by individuals. Here, higher-level cognitive processes such as slow thinking (Kahneman, 2011) are required. Individuals can go beyond pre-set algorithms for query, analysis, and perhaps decision-making to provide a response. It is "thinking outside the box." Creativity involves slow thinking across different contexts and possible solutions, intuition, reframing of questions and issues, and perhaps most importantly, emotions. Today, individuals have a decidedly strong advantage in this area at present and for the indefinite future.

The task categories can be thought of as a continuum where the combination of individuals and intelligent robots changes. Transformation and transaction tasks can be accomplished reliably and quickly by intelligent robots at lower costs. Individuals will continue to do fewer of these tasks, with intelligent robots being used more. Judgment tasks have traditionally been accomplished by individuals. But this is changing rapidly and will continue with more use of intelligent robots for interaction services. For creativity tasks, the substitution here of intelligent robots for individuals has been limited and will remain so. Individuals have a distinct advantage in these tasks, as higher-level cognitive skills are required. Along the continuum: transformation and transaction tasks can be accomplished reliably at low cost by intelligent robots; judgment tasks utilize intelligent robots and this will continue and grow; creativity tasks remain within the domain of the individual.

Intelligent robots can communicate and can make decisions. In many situations, intelligent robots and individuals can make the same decisions. For example, in banks, the ATM can determine who you are and give you money from your account or pay a bill; a bank employee can do the same task, and traditionally has done so. At some banks, an intelligent robot can answer the telephone, answer your question, and give you advice about your account or a given transaction; you may not know whether it is an intelligent robot or a person. The Nordic bank, Nordea, is substituting intelligent robots for 3,000 employees to deal with advice, transactions, and accounts. CitiBank has announced that they will substitute 20,000 individuals with intelligent robots.

The substitution of people by intelligent robots will do away with many jobs, as the task is done by the robot. It is not new that technology makes jobs obsolete. In the past, a typographer had a very important job in producing the daily newspaper, but new printing technology made the job obsolete. Now, many tasks and jobs in auditing, accounting, law, and health care may in the near future be taken over, or made obsolete, by new IT, including AI, image and face recognition, and prediction algorithms.

Should we include the robot as an organizational member in the organization chart? We include intelligent robots in process charts in a project organization to depict who talks to whom and who makes which decision; but should we also include these intelligent robots in the usual organization chart? It would be appropriate to do so when the social robots are performing judgment, social, and creative tasks, but less relevant for transformation and transaction tasks. It would make the organization chart more meaningful as a picture of the organization and how it operates.

This also raises the issue: Can we blame a robot for making errors or having bad judgment? It could be doing something wrong and even hurting people. No matter whether a robot is interacting with people in the home, in an office or industrial setting, at an elderly care or a childcare facility, or in a hospital, robots will inevitably cause harm to humans through hardware malfunctions and programming errors. Interestingly, the robot itself seems not to be perceived by humans as merely an inanimate non-moral technology, but as partly, in some way, morally accountable for the harm it causes and the errors it makes.[1] In the legal community, it is discussed how to proceed in such cases and the question is raised about whether you can sue a robot.[2]

1 See www.roboticsbusinessreview.com/rbr/shall_we_blame_the_robot/.
2 See www.newlawjournal.co.uk/content/how-sue-robot.

Tasks have traditionally been designed for people who work in manufacturing jobs. However, tasks in offices or bureaus also have a long tradition. In his essay on bureaucracy, Weber (1948) emphasized the rules or "what to do in a given situation," or "what if" rules in the management of the organization. He also emphasized the role of hierarchy and authority to deal with exceptions to the rules. Nonetheless, rules were at the heart of work and they define the tasks to be accomplished. Weber did not explicitly consider information in his model, but rules are clearly information-based, as no rule can be applied without information. The bureaucracy could deal well with simple rules or even connected rules, but it dealt less well with varied situations where the rules were rather limited and inflexible, i.e. not agile.

Intelligent robots or algorithms are usually "what if" rule-based. They might be thought of as the perfect bureaucrat. All of us have experienced frustration with bureaucracies. They have been accused of being slow and inflexible. With the ability to process information fast and to self-generate rules by machine learning, the intelligent robot may revitalize the bureaucracy. AI and prediction algorithms may allow the reduction of the perceived environmental uncertainty and thus the information-processing demand. This will, as we shall discuss in Chapter 8, allow for rule-based activities and rule-based decision-making. AI robots will be perfect agents in such an organization.

Task Design

Researchers have described the approaches to task design in several different ways. Woodward (1965) in her classic studies of organizations categorized tasks as unit, mass, and process production, where each had a different task design. Unit is more craft-like; mass is assembly line; and process is continuous and automated as a refinery. These represent distinctly different ways of organizing and managing work. She found a non-linear relationship between task design and other components of the organization's design. The unit and process approaches had many components in common, whereas the mass production approach was different. Compared to mass production, the unit and process production had higher-skilled workers, lower organizational complexity, lower formalization, and lower centralization. The work pace of mass production was very precise and so required more detailed coordination than the less clock-driven unit production and the maintenance-oriented process production. Woodward's studies were the first to link task design to other dimensions of organizational design and to show that successful firms tended to be those that had typical configurations of structure and technology. Even if new developments have occurred in manufacturing technologies that have led to considerable changes, particularly in continuous and mass production technologies (e.g. computer-integrated manufacturing and information networks), her framework still applies.

The unit production organization utilized technology to help the individual workers do their job, such as make a spindle using a latch in a shop. The mass production organization is the reverse, where the system of production gives orders to the individuals about what to do and when to do it. That is, the individual works for the robot system and the latter is therefore the individual's work boss. The idea that the production system or robot is an agent in the organization is not new; it begins with Henry Ford and the mass production of the Model T early in the twentieth century.

Thompson (1967) categorized the relationship between tasks as sequential, pooled, or reciprocal. Sequential tasks are coordinated by standardization of the tasks; pooled tasks are coordinated via planning and task allocation; and reciprocal tasks are coordinated by mutual adjustment. Carroll *et al.* (2005) examined the dynamics of changing these task relationships and found in a project setting that transforming sequential tasks into parallel and reciprocal tasks decreases project time initially, but increases project time over time as more reciprocal tasks demand much greater coordination and costly mutual adjustments. Scott and Davis (2006) described task design along three dimensions: complexity of items requiring simultaneous consideration; uncertainty or unpredictability; and interdependency, where a change in one requires a change in another item. (Note that these task design characteristics are similar to the environmental characteristics described in Chapter 3.) Greater complexity, greater uncertainty, and greater interdependency all require greater information processing to obtain the coordination required to get the work completed.

Summarizing the above discussion, an organization's task design can be categorized along two important dimensions: *variability and connectedness*.

If a task is well defined such that it is undertaken again and again, then it has low variability. Notice that standardization in execution of the task enables low variability. If the task is not standardized and varies in how it is done, then it has high variability. A low variability or highly repetitive task has low uncertainty, whereas a task high in variability has higher uncertainty.

When a bigger task is broken down into sub-tasks which require little coordination (i.e. the sub-tasks are independent), it has low connectedness. On the other hand, if the sub-tasks require high coordination with one another (i.e. they are interdependent), then the task has high connectedness. Note that this definition of connectedness is related to Thompson's categories of sequential, pooled, and reciprocal interdependency. With these two dimensions, we have four basic task designs which we call: orderly, complicated, fragmented, and knotty. The four task design categories are shown in Figure 6.1. We will discuss the four categories briefly before considering each in detail.

The *orderly* task design has low connectedness and low variability; it requires relatively little coordination among the sub-tasks to accomplish the work. The *complicated* task design is highly connected, but has low variability. It requires more coordination of the connected and repetitive tasks. The *fragmented* task design has low connectedness and high variability. It requires a different kind of coordination to adjust to ongoing variations within the sub-tasks, but adjustments for connectedness among sub-tasks is not required. The *knotty* task design is both highly connected and highly variable; it is the most difficult to coordinate as adjustments to both connectedness and variability are required simultaneously.

For your unit of analysis, try to think about a big task that must be designed in your organization. How is it defined? How is it currently designed? For example, if your chosen organization is a bank, the work of the bank could be divided into sub-tasks based on specialization such as handling investments, money transfer, lending, etc. Alternatively, the work of the bank could be defined in relation to customer groups:

private customers, institutional investors, small business customers, etc. The first is a functional configuration; the second is a divisional configuration, as discussed in Chapter 4. The bank may define the work so that it can be repeated, by standardizing transactions for all specializations or customer groups. Alternatively, it may take pride in customizing the work, deliberately avoiding standardization so that interactions with customers or others are managed uniquely. Each task can further be designed and categorized to be a transformation, transaction, judgment, social, or creative task. When we talk about task design, we are thus talking about the overall design, not just the design of the individual sub-tasks. The coordination requirements are very different in the task designs just presented (Burton and Obel, 1980). Task design is also related to business process re-engineering, as well as process management methods and philosophies, such as just-in-time and supply chain management. The particular tasks and their design are also highly influenced by modern IT. For example, many routine tasks in banks are now either done electronically or the task is performed by the customer who talks with a home-banking system that may be an intelligent robot. Part of task design is highly related to choice of information system.

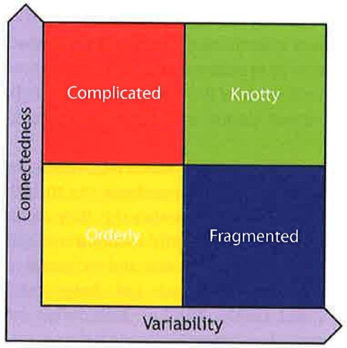

Figure 6.1 Task design space

A careful analysis of workflow and flow of information and decision-making is therefore an important part of the organization's design. Basu and Blanning (2000) present a formal approach to workflow analysis. They integrate the informational entities involved in the process, the structure of these entities, and their interrelationships. Further, they take into account which tasks are being performed and which informational elements are involved in these tasks. Duvald (2019) in her estimation of the information-processing demand and capacity in an emergency department also used flow charts – see Figure 6.2. Leavitt *et al.* (1999) depict the workflow design at the project level in SimVision, a simulation tool that enables calculations of project duration and quality, depending on how tasks and workflows are designed. Additionally, which agents/resources are involved in each task, where information entities are stored, and what communication is needed between agents/resources are also incorporated.

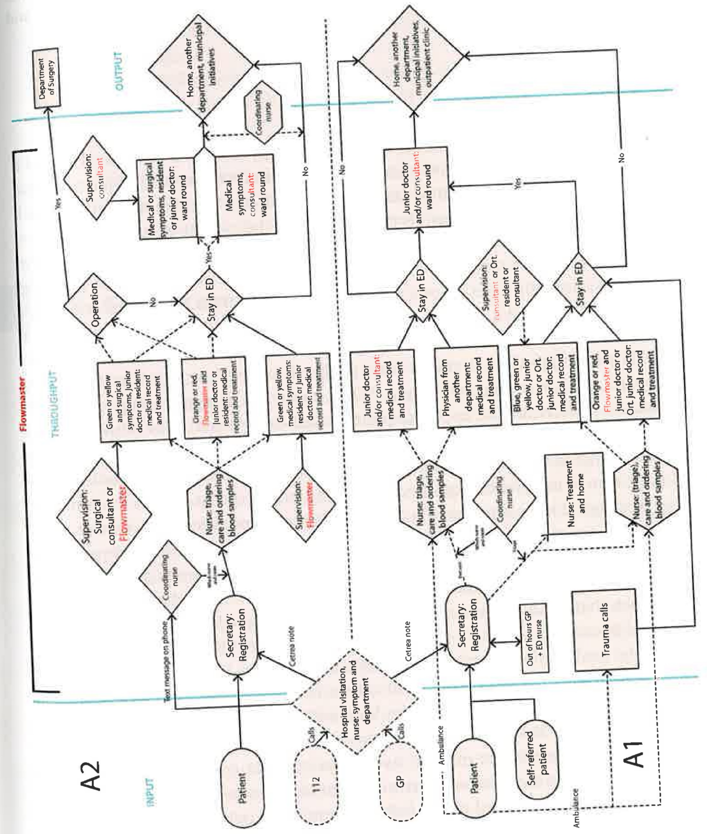

Figure 6.2 Flow chart of tasks in an emergency department
Source: Duvald, 2019.

Next, we consider the four task designs in more detail. In Figure 6.1, we begin in the lower-left corner for an orderly task design and move to a complicated, fragmented, and finally knotty task design. As we go through these task types, it is important to bear in mind where we are in the organizational design process. Task design follows design of strategy and structure. As an executive, you have a choice about how to design the work of your firm. The choices described below must fit with the firm's strategy and structure.

Orderly

If you choose an orderly task design, then you are organizing your firm's work so that it has low connectedness and low variability. You break up the work into pieces so that you can direct each work unit to perform independently of other units. When each unit completes its work, the results flow back up to the executive level, and then you assign a new piece of work to that unit. Units that experience problems or difficulties turn to you to resolve problems. An obvious advantage of this task design is that slow-downs or other difficulties in one unit do not prevent other units from continuing progress on their tasks. Within each unit, the tasks are standardized as much as possible so that they can be readily repeated. To the extent that workers in each unit are able to develop skills to do the tasks assigned to their unit, the specialization of tasks can yield very high efficiency. When tasks are designed using the orderly approach, there is almost no coordination required between units performing the sub-tasks of the organization and no need for them to adjust to one another. Piece-work, whether in the manufacturing or service industry, has these characteristics. The work of a law firm could be organized in this fashion. As clients contact the firm, they may be assigned to an attorney who handles their case independently. Once a case is closed, the attorney is assigned another case. The attorneys operate independently, processing cases, taking as much time as needed before moving on to the next case. As another variation on the orderly approach, the attorneys might be grouped by specialty such that customers with family law needs are assigned to the family law group, clients with criminal law needs are assigned to the criminal litigation group, and so on. Again, the work of the organization is divided across units such that individual units perform their work independently of the others, completing the entire task assigned to them (high divisibility). Completing the "big task" work of the firm is accomplished as the work is more or less standardized and the individual units gain expertise to do their assigned work in an efficient manner. As another example, consider mill workers who do hand sewing and are given an inventory or list of things to do. Each worker takes an assigned garment to sew and places finished items in an out-basket. These in-process inventories help to create the divisibility of work. The worker may have fixed productivity targets to meet, and these are monitored at the executive level. The executive has little to coordinate, except to ensure that assignment and completion of work is done in a satisfactory manner.

The robot is particularly designed for orderly tasks. It is relatively easy to program a robot which is not connected with other robots or individuals and follows a given program or algorithm. Robots in production, such as Woodward's unit production and

Thompson's parallel processes, are orderly. Here, individuals can perform the orderly task design, but this also goes for intelligent robots. Today, more orderly tasks are done by intelligent robots than in the recent past. Intelligent robots are substituting for people. In many manufacturing tasks, the robots are not only cheaper, but also yield more consistent high-quality outputs – parts and products – even with regard to services including customer voice interaction. People have the advantage when the orderly process requires agility or adaptation in the short term. Individual crafts and art are examples.

Yet, individuals and intelligent robots can work together in an orderly task where some part of the task is done by an individual with another aspect by the intelligent robot.

When tasks are orderly, most of the tasks are transformation and transaction tasks. There are fewer judgment tasks and most of them are located at the higher levels in the organization. Similarly, there are most often fewer social and creative tasks in the orderly quadrant than in the other three quadrants.

Complicated

If you choose to design your organization's task so that it is high on connectedness, yet has low variability or remains highly repetitive, then you have a complicated task design. Complicated tasks require a high degree of coordination due to high connectedness; that is, the sub-tasks can be performed by different units of the firm, but they are interdependent to get the work done. Going back to the classic studies, Woodward's mass production and Thompson's sequential technologies have similar features. As an example, suppose you manage a hospital emergency ward. You might divide the work into four sub-tasks: (1) admissions; (2) triage screening; (3) focused care; and (4) release. Patients move sequentially through these processes, with different groups of people (sub-units) responsible for each of the four sub-tasks. The work processes are repetitive and the services remain quite standardized once the diagnosis is determined (at least at the level of the "big task" design). The complicated task design suits processing of large volumes of work. There are many examples of a complicated task design in manufacturing, the most classic being the automobile assembly line. McDonald's is an example in the restaurant industry. The sub-tasks of order processing have low variability and are highly connected, as the completion of an order for a customer requires that each part of a meal is assembled correctly. Every order is unique within a limited set of possibilities, so that the tasks become very repetitive. Mass production requires not only the skills of orderly production, but also precise coordination among the units responsible for the sub-tasks. The production processes must be timed to avoid bottlenecks and to meet efficiency goals in which inventories between processes are minimized. A well-designed complicated task requires that these work processes are repetitive and ongoing.

The executive level overseeing the firm's work focuses on the coordination of the connected processes, which require continuous attention. Given the high connectedness, a breakdown in any one small task can shut down the whole operation, which can be very costly. Detailed and ongoing coordination requires a high level of information processing. Intelligent robots in supply chain management, together with the embedding of IT into manufacturing processes, have increased organizational success in using complicated task designs. Firms that use these designs can compete based on their capability to process work with great speed and sophistication. The Amazon order-taking and delivery system is an example of a very complicated design that is highly connected. The coordination is done by automation of transaction tasks using a platform organization set-up (Zysman and Kenney, 2018). Intelligent robots are increasingly being utilized in customer service organizations, such as banks, airlines, and order and delivery firms – for example, Amazon, Walmart, and others.

The complicated design can be very large, such as Amazon, or small, such as a McDonald's store. But the complicated design is not agile; it cannot change quickly with grace. It takes substantial resources and time to adapt, especially to do something new and different. Whether the complicated design is people- or robot-driven, it follows the rules that are programmed into the organization as in Weber's (1948) bureaucracy. In the complicated quadrant, most tasks are transformation or transaction tasks. There are usually more social tasks than in the orderly quadrant. The creative tasks are normally focused on increasing effectiveness.

It can be argued that LEGO is in the complicated quadrant. What they do is highly repetitive. They run a machine to get everything ready for the Christmas sales all over the world. It is very complicated and connected, but the uncertainty is relatively low. They know when to ship what to which part of the world.

All five task categories of transformation, transactions, judgments, social, or creative tasks usually exist in a complicated set-up. However, the judgment and social tasks will be at the higher levels in the organization. The creative tasks will primarily be focused on efficiency.

Fragmented

If you choose to design your organization's task so that it has low connectedness yet high variability, then you are using a fragmented task design. Fragmented tasks require less coordination than complicated tasks due to their low connectedness. By reducing coordination needs, each sub-unit can process work at its own pace; it doesn't have to wait for other units to complete their work in order to proceed. Further, the sub-units can take creative approaches to completing their tasks, perhaps soliciting their own customers or clients, since bottlenecks are not a concern. Woodward's unit and Thompson's parallel have these features. By breaking down the big task of the firm, the sub-units are likely to be more innovative and aggressive. Some may outperform others or contribute more to the firm's overall work completion. GE is an example, with its jet engines, health services, and other products and services. Consider a technology development firm, such as a software developer, that is trying to grow its business. The needs of its customer base (individuals, small business, large business, and government) are quite different; that is, they are highly variable. The work of each sub-unit is conducted independently.

Alternatively, the firm might divide the work according to the type of software, such as desktop software and network-based software. In either case, if the big task can be broken down into low, connected sub-tasks which are also variable, then the task design can be fragmented. Within each sub-task, the work could be further fragmented, or another task design might be selected. The fragmented task design means that the firm divides its work so as to accommodate the varied nature of its business. Viewed by the professor, the university is a fragmented design where each professor works independently on their own research and is not connected with other individuals. Yet, each professor can work on very different or highly varied questions, research, and teaching. This applies among professors in a given discipline, such as within psychology and economics, but also across the different disciplines.

Although it is tempting to think that task design is inherent in the work itself, it is important to recognize that in many cases the same work might be designed in different ways. Thus, task design is a matter of managerial choice. Suppose your organization is an investment bank. You might choose a fragmented approach, dividing your big task into sub-tasks, such as investment counseling, trust services, and estate planning. The university can be organized by disciplines of psychology, economics, etc. or by professional school, such as Engineering, Business, Medicine, etc. Each group is free to solicit its own customers and design its services to meet customer needs. There may be low variability of work within each of these sub-units, but at the level of the big task design of the bank, there is high variability among sub-units; that is, customers are directed to one group or another, and work is accommodated to meet their unique needs. The high variability approach to task design requires a large number of adjustments (i.e. execution of work is not standardized); but as these adjustments are not connected, the coordination requirements are quite minimal. The fragmented design can be quite agile as each sub-unit can adjust quickly to changing technology or customer preferences without coordination with other sub-units. This is a distinct advantage in a highly changing world. To manage a fragmented task design, the executive needs to ensure that the sub-tasks (i.e. the sub-units) have resources and a reading on the environment, but the executive need not be involved in detailed coordination. All five task categories of transformation, transactions, judgments, social, and creative usually exist in a fragmented set-up. However, the judgment and social tasks will be at the lower levels in the organization. The ratio of creative tasks will be the highest compared to the other quadrants and will primarily – as a prospector – be focused on effectiveness.

In the case of the investment bank, the fragmented design may not be the ideal choice, especially if customers prefer that the sub-tasks be coordinated – for example, if they want their estate planning to involve their trust accounts. This is the downside of designing tasks to have high divisibility. The investment banker might consider a knotty task design instead.

Haier has had a view that put them into the fragmented quadrant. They have separated the tasks into self-organizing units that must have a very focused view on customer demand. They serve different markets with regard to both product lines and geographical regions.

Knotty

The knotty task design is highly connected and has high variability. If you choose a knotty task design for your organization, then you will have to invest in ways to coordinate work among the sub-tasks and at the same time support the varied approach to doing the work. Knotty tasks are not standardized similar to Woodward's process and Thompson's reciprocal categories. This approach to task design encourages those responsible for sub-tasks to develop innovative (or at least adaptive) ways to do their work, accommodating the unique demands of each customer, while at the same time those performing sub-tasks must integrate their work with other units in the firm. Knotty tasks are likely to lead to the greatest customer satisfaction since production is customized, but they are the most demanding type of task to manage. A customer-oriented gourmet restaurant is an example, in contrast to McDonald's, which is complicated, but not knotty.

When products are new, the knotty approach to task design is often favored by managers. High-tech innovative products and services are illustrations – such as a new and short-lived video game, a biotech entity, or a new global financial instrument. The executive focuses on the coordination of the connected processes, which are continually changing. Given the low divisibility, a breakdown in any one small task can shut down the whole operation, which can be very costly. Given the varied approach to task design, the information-processing demands increase greatly. In Galbraith's terms, the uncertainty is much greater, which requires greater information-processing capacity. Taken together, the information-processing demands go up non-linearly, with executive overload possible. Therefore, this task design is the most demanding on management.

New product development (NPD) in automobiles at Toyota or Renault, pharmaceuticals at Eli Lilly, or household products at Unilever, requires high coordination and adjustment of the tasks to the emerging technology. NPD tasks are often designed according to a knotty approach, but a knotty approach can be applied in more routine industries for competitive advantage. For example, a gourmet restaurant may create new food offerings each day, with each new offering requiring unique production and high coordination among the kitchen staff. Since the task is designed to be non-repetitive – providing a new dining experience each time customers visit the restaurant – the organization must have highly skilled staff who can continually innovate and coordinate with perfection. In this quadrant, transformation, transactions, judgments, social, or creative tasks are fairly balanced, but with more social tasks than in any of the other three quadrants.

Microsoft has a mixture of tasks. They have tasks related to providing a standard product like Windows 10 to a massive number of users. On the other hand, they also offer tailor-made systems to large clients, although based on standard components, which are specific to the customer requirements.

All five task categories of transformation, transactions, judgments, social, and creative usually exist in a knotty set-up. However, the judgment and social tasks will be at all levels in the organization. The ratio of creative tasks will be focused on both effectiveness and efficiency.

Fit and Misfits

Table 6.1 is the table from Chapter 4 with the task design row added. Again, there is fit among the design elements of your chosen firm if the entries for each row fall into the same column. Misfits are deviations from a common column.

TABLE 6.1 Fit and misfit for task design

Corresponding quadrant in organizational design space	A	B	C	D	
Task design	Orderly	Complicated	Fragmented	Knotty	
Configuration	Simple	Functional	Divisional	Matrix	
Environment	Calm	Varied	Locally stormy	Turbulent	
Strategy types	Reactor	Defender	Prospector	Analyzer with innovation	Analyzer without innovation
Organizational goals	Neither	Efficiency	Effectiveness	Efficiency and Effectiveness	

The orderly task design is appropriate if your firm's goal is neither efficiency nor effectiveness. There can be some efficiencies in the orderly task design due to its repetitiveness, and for this reason managers may find this approach to task design appealing. The orderly task design approach works well so long as the environment is calm and the corresponding strategy is a reactor which is also unfocused. A simple configuration works well for the orderly task design as it breaks down the total task into smaller tasks which require very little coordination from the executive. Knowledge can be exchanged on an ad hoc basis. So long as things are calm, the organization with the simple configuration using the orderly task design creates minimal information-processing requirements. The executive is not overloaded with detailed coordination problems – unless the environment changes. The risk for the firm occurs if new business causes a shift in the type of work needed such that high repetitiveness is not possible. Then the orderly approach is a misfit and the task design inappropriate. Organizing work so that it is divisible and can be executed as independent sub-tasks puts a high load on the manager if there is any change in the environment.

If your organization adopts an orderly task design approach, then you should be aware that this is a misfit with an efficiency strategy of a defender or an effectiveness strategy of a prospector. Any deviation from a calm environment creates difficulty, as adjustments will be required. Functional, matrix, and divisional configurations are costlier and are not needed to achieve the required coordination for the highly divisible and highly repetitive task. For most organizations, an orderly task design is not sustainable except for the most routine operations, making these types of tasks good candidates for automation or outsourcing.

The complicated task design is focused more on efficiency than on effectiveness. The corresponding strategy is a defender, where the efficiency of repetitiveness helps to achieve profitability through low cost. The varied environment, which is complex but predictable, is a good fit for the complicated task design. So is the functional configuration, since it has the capacity to coordinate detailed and standardized processes which rely heavily on rules and procedures. The long-time automobile assembly line is a classic example. But many modern services are complicated. Banking services from ATMs to automated small loan approval are other examples. Amazon sells many products and services beyond books using its sophisticated online purchasing systems. Even partner-matching services can be highly complicated, i.e. highly repetitive and with low divisibility based on established characteristics and patterns of its clients.

The complicated task design is a misfit with an analyzer strategy, which requires innovation and introduces non-repetitive processes. Similarly, turbulent and locally stormy environments require adjustments which are extremely difficult to make if you have designed your organization using a complicated task design. The executive will be overloaded with the coordination details.

The fragmented task design is focused more on effectiveness than on efficiency. This approach to task design works well if you are pursuing a prospector strategy, seeking high degrees of effectiveness and continual innovation. New product creation and basic research are examples of activities which can be fragmented. Special services such as fine dining and innovative architectural designs are fragmented. As discussed earlier, the task design for jet engines and health services can be fragmented at GE. If your firm faces a locally stormy business environment, i.e. high unpredictability, then it makes sense to design work so that it is high in divisibility and low in repetitiveness. The divisional configuration is a good fit; here, management focuses on providing resources and policy, but not detailed coordination. The cellular configuration is also a good fit.

The fragmented task design is a misfit if your firm has the dual goals of both efficiency and effectiveness. Fragmented task design breaks the big task into sub-tasks which are relatively independent and optimal in the use of resources. It is therefore hard to achieve efficiencies for the big task if the fragmented task design is adopted.

The knotty task design is appropriate if your firm has the dual goals of both effectiveness and efficiency. The turbulent environment which is complex and unpredictable is a good fit with a knotty task design. New product creation can also be knotty if we have low divisibility or high technological interdependency, as well as low repetitiveness. The corresponding strategy is an analyzer with innovation. The matrix configuration is a good fit because it emphasizes coordination across multiple dimensions and ongoing coordinated adjustments of the work to meet organizational goals. The knotty task design customizes work and so, if done well, can yield high customer satisfaction for a range of customer demands. Innovative design as you build, whether a new building, automobile, banking service, or Internet service, is a knotty task design. The time requirements of an innovation can change the task design from fragmented if sequential to knotty if simultaneous. As we shall see in the next chapter, conducting the knotty task requires highly skilled employees and management that can simultaneously support autonomy, control, and learning as tasks are executed.

The knotty task design is a misfit with any strategy, environment, or configuration which has a dominant focus on either efficiency or effectiveness. If your chosen firm

is pursuing a defender or prospector strategy, then you should avoid the knotty approach to task design because it is too complex and expensive and so not the best fit for your goals.

DIAGNOSTIC QUESTIONS

How is the task drawn up in the organization you have chosen to design? As in prior chapters, use the same unit of analysis that you selected in Chapter 1 to answer the following questions. In answering these questions, it is very important to take a top-down approach and limit the analysis of the task to the "big task" of your unit analysis. (Remember, sub-tasks, once created, have their own designs.)

Where do you find the task design information? Contrary to previous chapters, top management may not be a good place to begin. You should seek out the managers who actually design and implement these tasks. The managers, engineers, and chefs can explain exactly how things work. Examine job descriptions which contain explanations of task design. Further, the scientists and engineers who design or modify new products, services, and processes are task sources. Then develop a description of workflow using the supply chain processes or value chains within the firm. If the organization has an enterprise resource system (ERP) like SAP, Movex, Oracle, or Navision, you may obtain a large amount of information from these systems and how they are implemented in the organization. Simply, you want to go down one or two levels of detail on products and services to understand the task design.

1. What is the degree of variability of the task in the firm, i.e. low to high?
   a. Does the firm treat each work task as unique (high)?
   b. Does it execute the task today much as it did yesterday (low), or is there a good deal of variation (high)?
   c. To what extent does it standardize the task (low) rather than customize it (high)?
   Score the variability on a scale from 1 to 5 as follows:

1	2	3	4	5
very low		moderate		very high

2. What is the degree of connectedness of the task in the firm, i.e. low to high?
   a. Does the firm divide its big task into sub-tasks that are independent of one another (low), or are the sub-tasks connected, requiring a large amount of coordination (high)?
   b. Does it manage the task as a set of specialized independent functions (low) or as a process flow (high)?
   c. To what extent are the units that perform the sub-tasks free to design their work as they wish (low) rather than as instructed (high)? Score the degree of connectedness on a scale from 1 to 5 as follows:

1	2	3	4	5
very low		moderate		very high

You can now locate your firm on the graph in Figure 6.3 and determine the firm's task design.

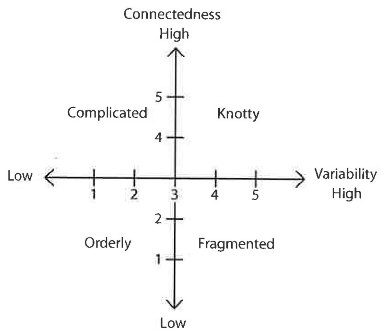

Figure 6.3 Locate your firm in the task design space

SUMMARY

This chapter on task design further completes the description of a firm to find a design that fits with its goals, strategy, and structure. In this chapter, you described an organization's task design in terms of variability and connectedness, and categorized it as: orderly, complicated, fragmented, or knotty. If the firm's current approach to task design does not fit its organization's goals, strategy, or structure, it should consider adjusting the task design so that it is aligned with the other dimensions. Next, we turn to the human resource requirements that are needed to support a firm's task design.

GLOSSARY

Agents: can be human or robots who perform the work of the organization.
Complicated task design: an organizational task design in which work is organized in a way that it is highly connected and not variable; usually requires a high degree of coordination among the sub-tasks.
Connected task: a task where the sub-tasks are interdependent with regard to resource utilization and time dependency.

Fragmented task design: an organizational task design in which work is not highly connected and is highly variable; usually requires less coordination compared to complicated task design.
Intelligent robot: robot capable of performing tasks by sensing its environment and/or interacting with external sources and adapting its behavior.
Knotty task design: an organizational task design in which work is organized in a way that is both connected and variable; usually requires not only coordination among sub-tasks, but also support for the non-repetitive nature of sub-tasks.
Orderly task design: an organizational task design in which work is organized in a way that is not connected nor variable; usually requires relatively little coordination among the sub-tasks.
Robot: device which can be automatically controlled, reprogrammable, multi-purpose, manipulative, and programmable for application in organizations.
Social robot: device designed to interact with humans and to operate in human environments with people.
Task categories: transformation, transactions, judgments, social, and creative.
Task design: decomposing work (the big task) into sub-tasks and then coordinating among the sub-tasks to meet organizational goals.
Variability: degree to which a task is well defined such that it is low if it is undertaken again and again or standardized; if the task is not standardized and varies in how it is done, then it has high variability.