Chapter 16: Organizational Structure and Teams

Using effective reliability-creation strategy is the start of achieving world-class reliability. Second, and more important is having the sure capability to implement the strategy quickly and correctly throughout your company. Designing a new business paradigm of what to do and how to make an operation into a world class performer is ten percent of the whole transformation project. Installing the right quality standards and work practices throughout its processes and procedures is a further twenty percent. But to get world class reliability from your operating equipment, it is necessary to have an organization with the knowledge and skills to deliver it. Creating an organizational structure that can do that and training its people to be that good is fifty percent of the transformation. The remaining twenty percent is giving yourself and your people the time and experience to let the right paradigm, knowledge, methods, and skills work until they become success habits.

People run organizations and use their processes. High reliability requires correct practices to be masterly applied in each process of each phase of the life cycle. The production group in an operating plant is an example. They are responsible for running and managing the facility. They know the production process and how to make the products. They can use the equipment to get production. They are accountable for delivering the budgeted operating profit. But do they have the full engineering understanding to operate assets most safely, most reliably, and most profitably? If they have limited design knowledge and mistaken reliability beliefs, they will cause unnecessary failures and waste. Operations groups need the support of cross-functional experts with finance, engineering, and maintenance wisdom to get the best performance from their plant and equipment at the optimal profit.

Management structure and management style impact business performance. Dominating managers who mastermind their team's activities create compliant, close-minded team members. On the other hand, transformational managers who allow team members to make appropriate decisions for themselves breed future leaders.[1] Companies that want plant and equipment reliability need to engage the people in the workplace and give them a large degree of responsibility for improving the performance of their equipment. Senior managers require effective ways to help the people across their organization perform at higher levels sooner. Companies need an organizational structure that rapidly improves knowledge and skills to expert levels and gives wise stewardship to their people.

The Reliability Improvement Value of Autonomous Teams

A person working alone and making decisions by himself or herself in a series process is at serious risk of causing failures. One error of judgment or one wrong choice at any step will fail the entire outcome—perhaps not immediately, but eventually. Working solo in any series process is a high-risk activity. It is a classic dilemma faced by all managers and supervisors. Their position requires them to provide guidance and make choices that the organization follows. It is impossible to get all things right if you decide them alone. In complex, high-risk situations with high mental pressure and high physical stress, you're unlikely to get much right if you make decisions solo—you simply cannot know everything that needs to be considered, nor can you ever fully appreciate all the future implications and effects of what you decide—you can easily become one of the "random agents" in Chapter 12 that causes future troubles and problems. From the board room to the shop floor, every time a person comes to a decision point in their work, there is a risk of making a serious mistake or creating a defect. The opportunity for future failures ranging from inconvenience to disaster is present with every choice.

To protect people making decisions, put them into a parallel activity in which they must get more information and be better informed about the options. Figure 16.1 shows a decision requiring several parallel activities to reduce the risk of conclusion errors and bad outcomes.

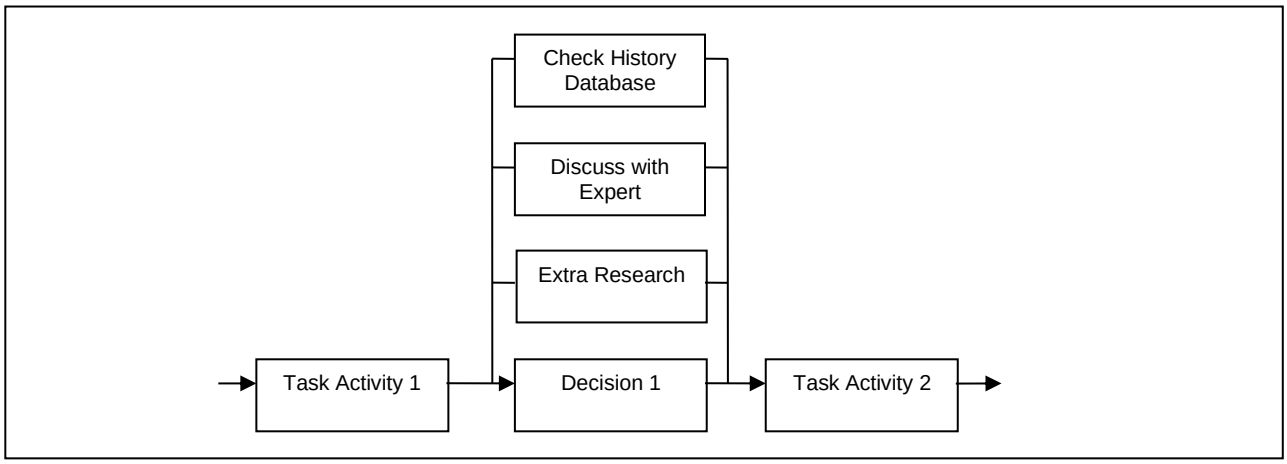

Figure 16.1 – Increase Reliability of Decisions by Making Them a Parallel Activity

Figure 16.2 is a process map of a pump delivering water to equipment. To get maximum reliability from the pumping system, the plant engineering of the equipment must be correct, the duty selection of each item must be done correctly, and the equipment must be installed accurately, operated stably at design duty, and maintained precisely. Similarly, the electrical and control engineering need to be properly designed and then selected, installed, operated, and maintained correctly. A good operator typically will know how to do only one of those 10 activities—operate it correctly. Some operators may dabble in the pump's mechanical maintenance, but none is an expert. Operators working with the plant will make many mistakes during their career if they do not have expert help immediately to ensure they are making the right choices.

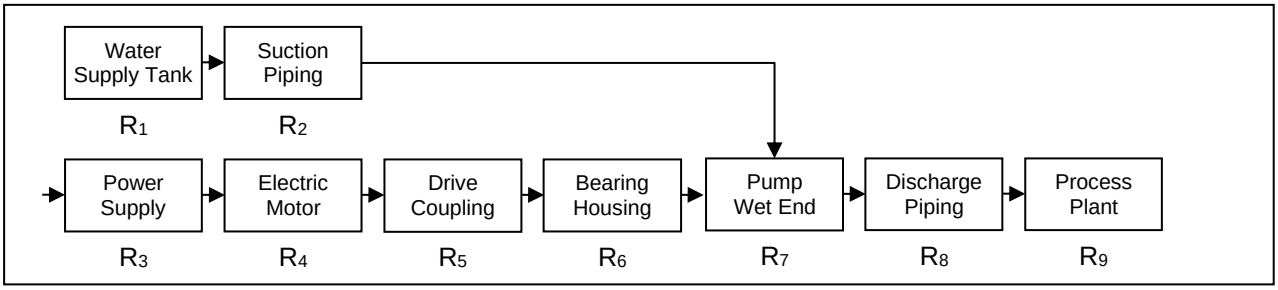

Figure 16.2 – Water Delivery Process Map

Equipment reliability increases with use of competent skills and knowledge in the selection, operation, and care of assets. No one has the knowledge and skills in everything that must be done to achieve exceptional equipment reliability—there is far too much for one person to know and to be able to expertly do alone. But in a team in which each member is proficient in his or her area of expertise, those abilities and know-how become available to all members. Setting up autonomous work teams of people with the right abilities and awareness to increase reliability is a Series Reliability Property 3 activity—now expert know-how is used everywhere across your operation. The use of skilled cross-functional teams will magnify the reliability of every asset because teams combine members' knowledge and skills to make better decisions.

The benefits of a team approach to running business activities become clear when you realized that a team is a parallel arrangement of knowledgeable and proficient people. Figure 16.3 shows the parallel structure that teaming up produces for a pumping system. A maintenance mechanic and an electrician are a part of a team within the operations group. They bring their specialized equipment knowledge and trade skills to the team. Professionally qualified engineers are also appointed to work on the team. The engineers bring their technical knowledge and design understanding. The team gains the engineering skills, experience, and information needed to achieve high reliability. Each team member learns to call on the situational expert for advice and information before making decisions. This does not mean that people move to new job roles or

change offices; rather, they are appointed to fill a team function and become team members who work together and develop a team approach to running and caring for plant and equipment.

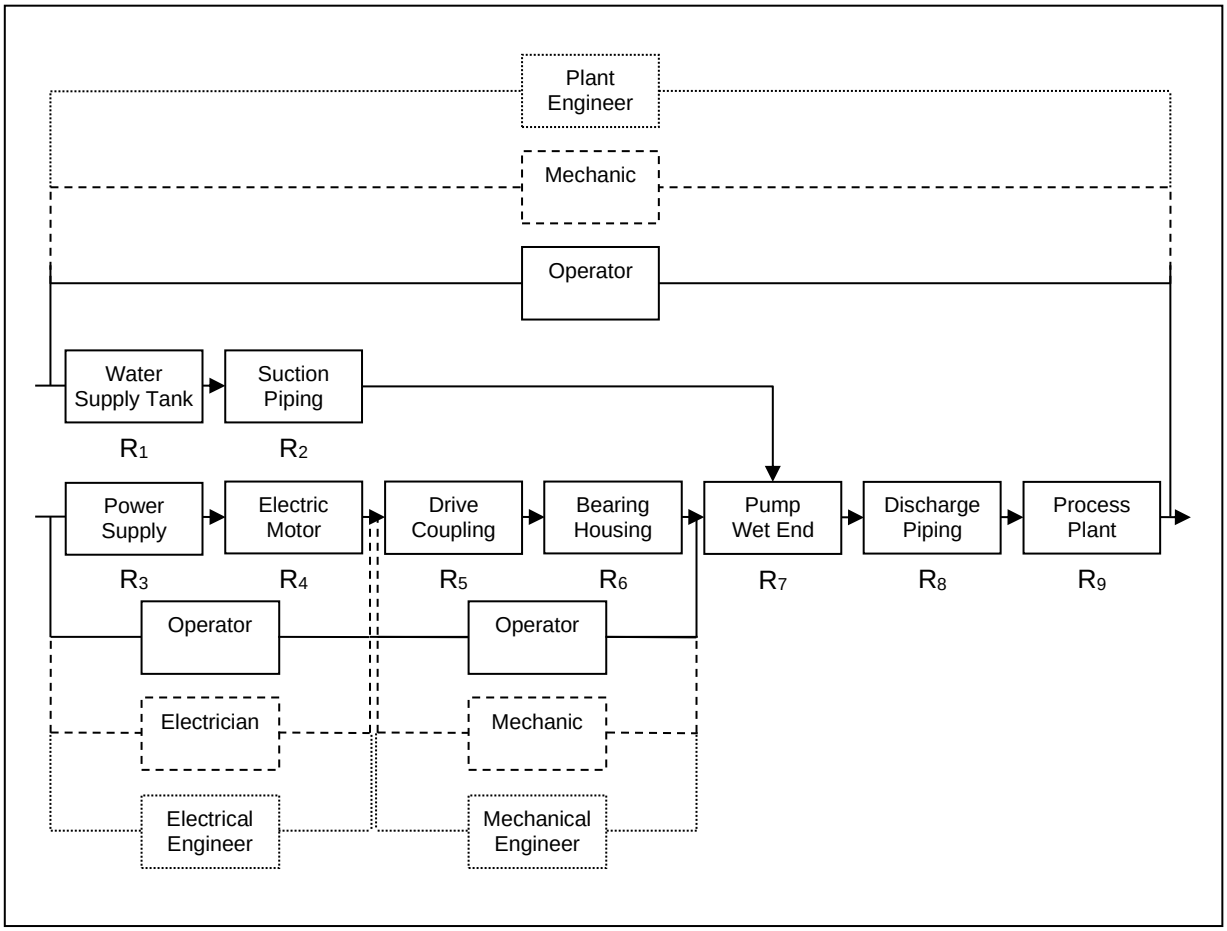

Figure 16.3 – Teams Parallel Skills and Knowledge to Produce Reliability Improvement

Using Reliability Principles to Create Organizational Structure

Something great happens when the team structure and dynamics work. Managers who want higher reliability, top-quality production, and fewer problems need to understand why teams are so powerful and how to gain that power for themselves. Reliability concepts can be used to design organizational and business department structures. Paralleling people to get greater reliability stems from two parallel reliability principles.

1. The more components are in parallel, the higher the system reliability.
2. The reliability of a parallel arrangement is higher than that of the most reliable component.

The hierarchy structure shown in Figure 16.4 is a silo organizational design that is typical in business. It is the structure developed in the military for fighting battles and wars. But it is a poor structure for helping companies achieve their goals because it requires managers to make decisions alone, often in a hurry and under stress. It is a high-risk design for long-term business success. It encourages managers to allow their egos and ambitions to drive their decisions rather than making choices based on correct analysis and understanding of a situation. It promotes human conflict because the person at the top has final authority, yet that person may be incompetent, ignorant, or duplicitous. In organizations that want top-quality products, high equipment reliability, and world-class production, such a structure is unsuited to the purpose.

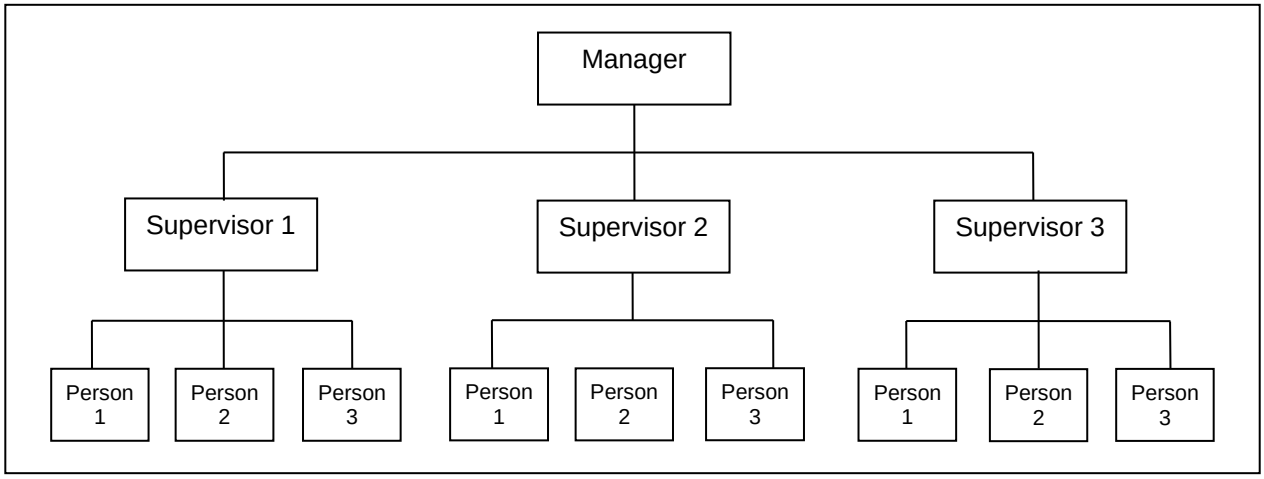

Figure 16.4 – Silo Organizational Structure

There is a mathematical reason why teams improve the chance of success. A team-based decision cell structure is a probabilistically better design for a business than the militaristic

hierarchy structure. Group decisions are more likely to be better choices if the conditions are established to promote mutually beneficial interaction.[2] Reliability math offers insights into why and how teams get better outcomes—especially why they are a powerful structure for achieving business goals.

To understand the science of how teams and teamwork deliver improved quality, reliability, and risk control, it is necessary to understand first how work gets done. In Chapter 1, work was identified as a series of activities performed one after the other. The sequence of activities makes up tasks. The accumulated tasks make up jobs. This arrangement forms a series job process, like that depicted in Figure 16.5, which shows a five-task job that produces a desired output.

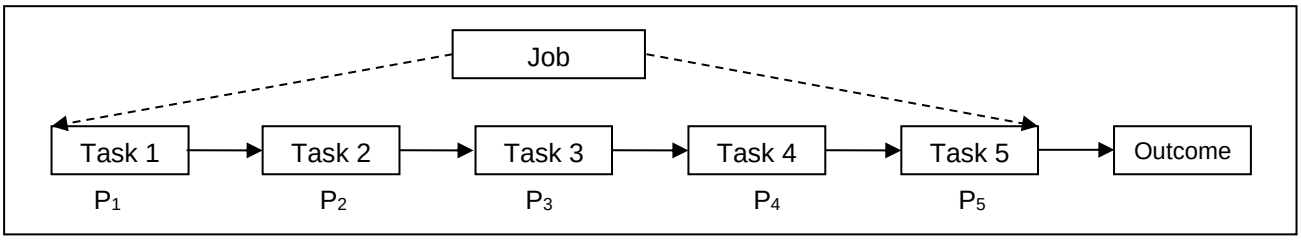

Figure 16.5 – A Series of Tasks Are Performed in a Work Process

Each task has a probability (P_n) of success between 0 and 1, with 1 being certainty and 0 total failure. Figure 16.6 shows that within each task, there are many individual activities. These also form a series arrangement. When you have a series of activities following each other, with the next activity building on the work performed by the previous ones, it only takes one error for the whole job to go wrong. Getting this job done right the first time requires each of the 25 activities to be done correctly. If one activity in one task is wrong, the job outcome will be wrong, and the job will need redoing—it may even have to be scrapped. If it's the sort of work in which it's

impossible to correct a task that has been done wrong, such welding, pouring concrete, or forming metal into shapes, every error is a mistake that scraps a job or installs a defect.

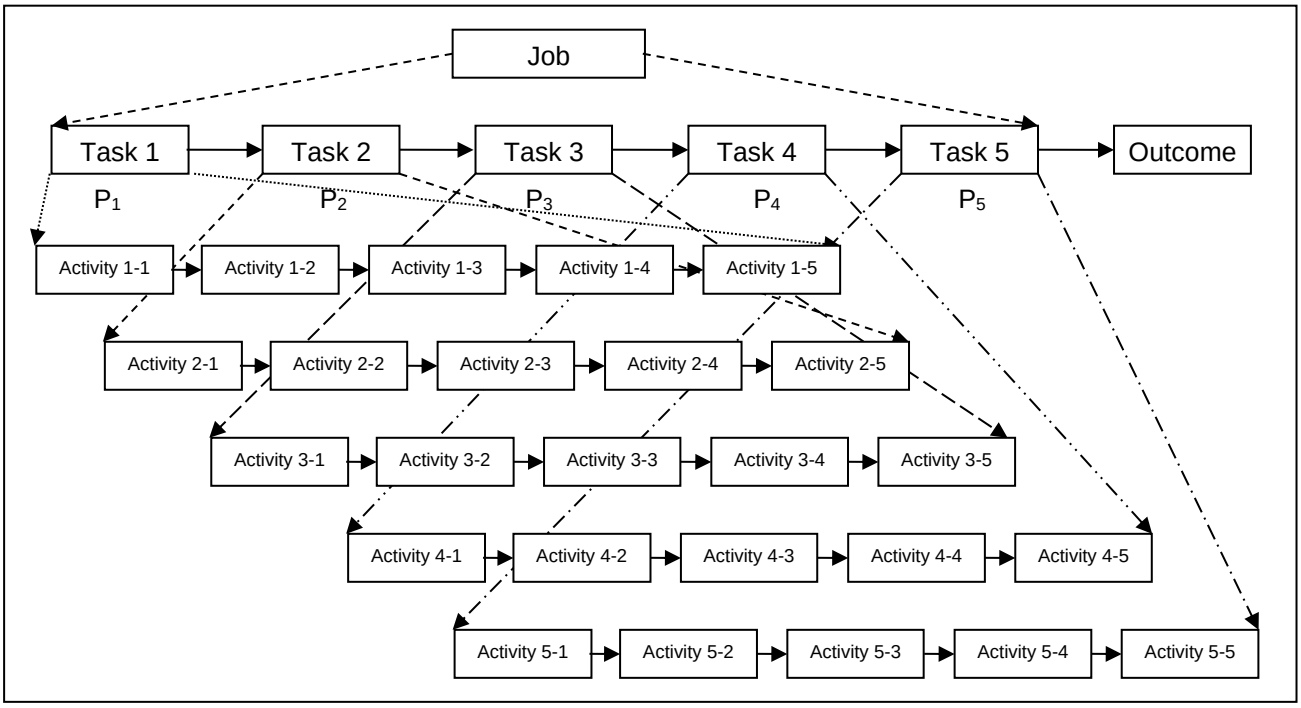

Figure 16.6 – A Series of Activities Occur within Each Task of a Work Process

The reliability of series processes warns us that without correct results in every task, the whole job will go wrong. What is the chance that all 25 activities in the imaginary job will be done right and the work will always be 100% right? The error rate depends on the task difficulty and the stress of the situation.[3] Difficult, involved, and demanding tasks that are done infrequently have higher error rates. You need to remove the chance of error in each activity if you want to stop waste and loss in a job.

The people on a team work collaboratively. When one person is uncertain about a decision, he or she asks other team members for advice. If the team is a mix of subject matter experts, then each person is a knowledgeable resource, and team members help one another work with less

chance of error. An example is an autonomous work team composed of operators, maintainers, and quality control staff in a production department. The maintainer can advise the other team members on equipment reliability issues, the operator has experience in using the production equipment, and the quality control staff can advise on the product's properties. Each member contributes know-how and experience to the decision-making processes of the others. Instead of one person working alone, a team has several people guiding each other in their work. The team interaction improves the chance that things will go right more often for everyone.

How does a well-functioning team affect the chance of a job going right? Figure 16.7 shows the five-task job as a team might do it, with everyone helping each other get the best result. Person 1 is responsible for doing the work with support from two others on the team. Each person adds his or her useful contribution at each step. The arrangement of each task is now a parallel activity. For a fully active redundant arrangement in which team members support each other, the reliability formula below can be used to estimate the chance that a parallel task will be done right.

Formula 16.1

$$P_{Parallel} = 1 - [(1 - P_1) \times (1 - P_2) \times \ldots . (1 - P_n)]$$

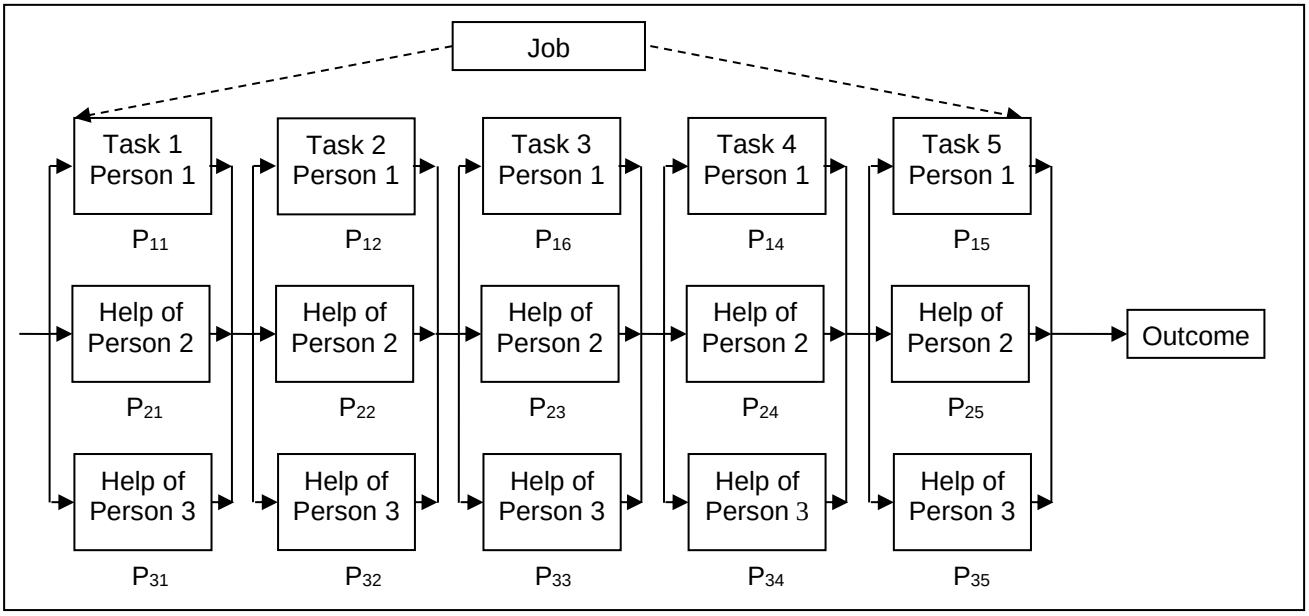

Figure 16.7 – Working as a Team Puts Subject Matter Experts in Parallel

We do not need the formula to see that each task now has three people watching over it. If the person responsible for the work makes an error, there are two others observing and helping them. When one of them notices a mistake, he or she acts to correct it. If we use the parallel reliability formula for three people working as a team, with each person having a 90% chance of accuracy, the parallel combination will deliver individual tasks that are correct 99.9% of the time. The five-task job, then, is correct 99.5% of the time. By paralleling the tasks with a team, the chance of the job being done right goes from a poor 59% for one person working alone to 99.5% for a team of subject matter experts working together. That is why teams are so powerful.

Once people are paralleled in well-functioning teams, the odds of getting better results rises markedly. Teams bring high success rates to organizations. They can help people increase their individual chances of doing outstanding work and greatly improve the odds of delivering correct results the first time. In companies that want high quality, high reliability, and fewer risks, teamwork is far likelier to produce many more favourable outcomes.

How reliable is a cross-functional team structure compared with a militaristic structure in doing the work? The answer is critically important to an organization that is looking to be more successful. We need to compare the reliability of the silo structure with that of the team structure and see what difference there is. Figure 16.8 shows the silo structure drawn as a functional block diagram, assuming that work is passed from one operator to the next in the work process.

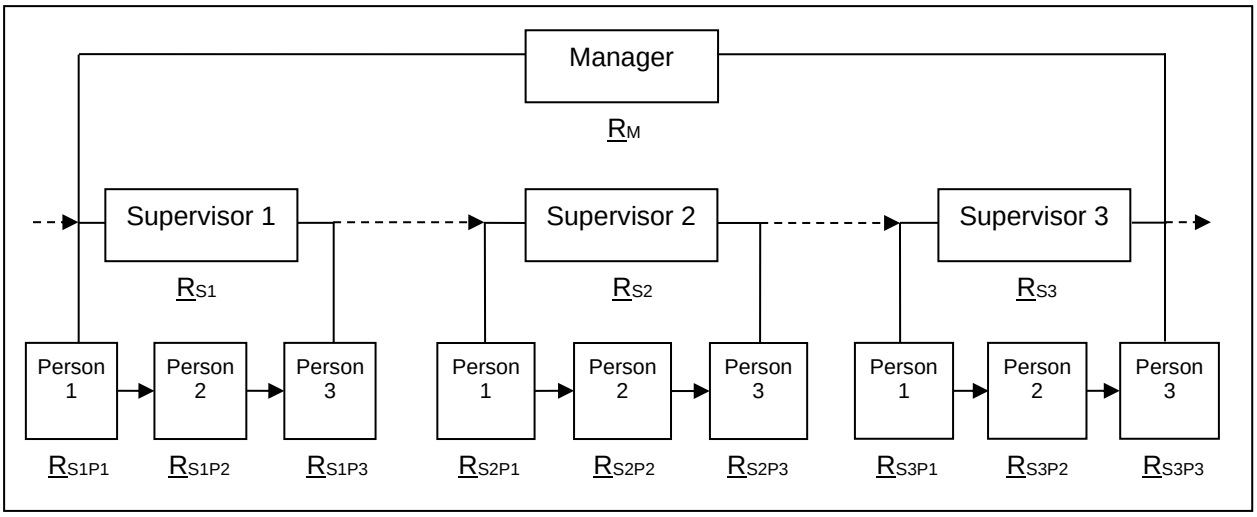

Figure 16.8 – Workplace Silo Groups Formed as Series Structures

For the sake of the example, assume that the people are working in a complicated industrial process without strict quality control. They make 10 errors in every 100 opportunities, which means that 90 in every 100 opportunities are done right—a 0.9 probability of doing an activity correctly. An indicator of defect rate is the number of standard deviations of the result from the ideal, also called its sigma level. As the frequency of defects reduce the results that are defects become less probable and their sigma value increases to show the events are becoming uncommon outliers of the range of expected result. If shown on the quality characteristic's distribution curve, the result is at one or other extremity of the curve, indicating it does not happen as often is the more common outcomes. For 10 errors in 100 results the failure rate is about 2.5-sigma quality (3-

sigma quality would be 7 errors per 100 opportunities and 4-sigma would be 0.6 errors for 100 opportunities[4]). The chance of success for the whole militaristic process can now be analysed. Starting with the three individuals working alone, the reliability of a group's work process is calculated as follows:

$$\underline{R} = \underline{R}_{S1P1} \times \underline{R}_{S1P2} \times \underline{R}_{S1P3} = 0.9 \times 0.9 \times 0.9 = 0.729$$

With a supervisor in parallel arrangement to oversee the group, each group's reliability becomes,

$$\underline{R} = 1 - [(1 - 0.729) \times (1 - 0.9)] = 1 - [(0.271) \times (0.1)] = 1 - [0.0271] = 0.9729$$

The supervisor's activity paralleled to the workers' activities lifts the group's performance. The three groups in the department are sequentially feeding work to the others producing a series reliability expressed as follows:

$$\underline{R} = 0.9729 \times 0.9729 \times 0.9729 = 0.921$$

With the manager placed in parallel to manage the operation, the department reliability is,

$$\underline{R} = 1 - [(1 - 0.921) \times (1 - 0.9)] = 1 - [(0.079) \times (0.1)] = 1 - [0.0079] = 0.992$$

The department has a theoretical reliability of 0.99, or 1 error in every 100 opportunities—nearly 4-sigma quality. Yet industrial organizations that produce 4-sigma performance in their operations and workshops are rare. Businesses without a quality control system produce outcomes

typically around 2.5 sigma.[5] Those with a working quality system can be 3 to 3.5 sigma. The assumption of 90% reliability for people doing uncontrolled tasks is too high because the calculated results do not happen. Let us repeat the calculations with a task reliability of 70% for everyone—2-sigma quality, or 30 errors in every 100 opportunities.

For the individual workers doing series steps, the reliability of their process is as follows:

$\underline{R} = 0.7 \times 0.7 \times 0.7 = 0.343$

With a supervisor paralleled to oversee the work, each silo group reliability becomes,

$\underline{R} = 1 - [(1 - 0.343) \times (1 - 0.7)] = 1 - [0.197] = 0.803$

The three work groups have the following series reliability:

$\underline{R} = 0.803 \times 0.803 \times 0.803 = 0.518$

Placing the manager in parallel over the operation, the department reliability is,

$\underline{R} = 1 - [(1 - 0.518) \times (1 - 0.7)] = 1 - [0.145] = 0.855$ (about 2.5-sigma quality)

The department output is now 2.5-sigma quality, which is what is expected from a typical business without an inspiring quality system. The difference in results using different error rates warns us that poor departmental performance is the accumulated effect of poor individual task performance.

One troubling aspect of the silo organizational structure is that the manager improves department performance by 65%, and the supervisor improves stand-alone workers' results by 134%. The results from the silo organizations seem to depend on how knowledgeable the supervisors and managers are, and whether they can effectively use their peoples' efforts. The manager and supervisor are key to the success of the silo structure, and if their mistake rate is high, the business suffers badly from their many errors. A militaristic structure is fraught with many risks of failure, as great managers and supervisors are few.

Figure 16.9 shows a block diagram of the people from the silo structure reconfigured as a team structure. The team puts people in a parallel arrangement. Each team is responsible for a process, and each person works with 0.7 task reliability. The supervisors disappear and become team players who coach the workers, and the manager parallels the teams in the department and works with them to help them succeed. There is no supervisory position in the team, since the team makes its own decisions, the "speaker" role is the team's representative.

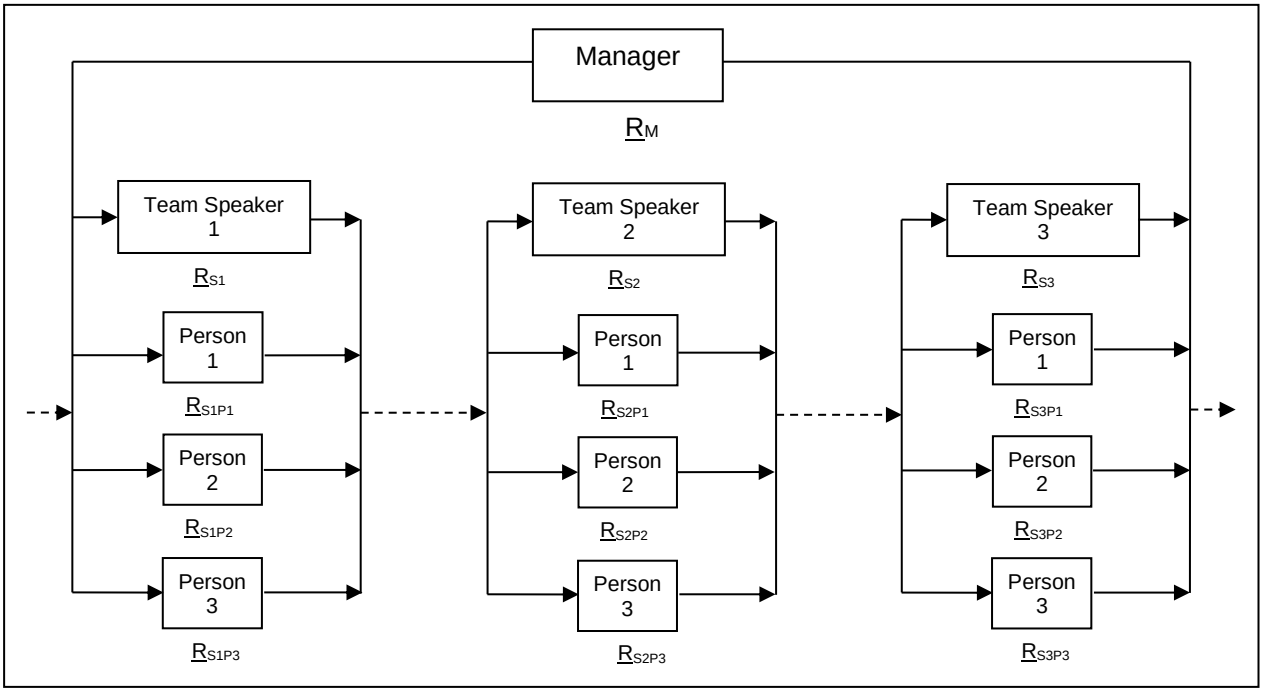

Figure 16.9 – Workplace Groups Teamed in Parallel Structures]

For a team of four people the team reliability is as follows:

$\underline{R} = 1 - [(1 - 0.7) \times (1 - 0.7) \times (1 - 0.7) \times (1 - 0.7)] = 1 - [(0.008)] = 0.992$

The groups work in series, feeding their output to the next group. The combined reliability is expressed as follows:

$\underline{R} = 0.992 \times 0.992 \times 0.992 = 0.976$

With the manager (also at 0.7 reliability) included over the teams, the team structure's reliability is as follows:

$\underline{R} = 1 - [(1 - 0.976) \times (1 - 0.7)] = 1 - [(0.007)] = 0.993$ (near 4-sigma quality)

With the same people doing work with 0.7 reliability, the silo structure produced 2.5-sigma quality, whereas the team structure delivered 4-sigma quality. The manager improves the silo arrangement by 65% and achieves 0.86 departmental reliability. In a team structure, the manager's influence on departmental performance is only 2%, but departmental reliability rises to 0.99. It seems that most of the reliability benefits of a team structure are attributable to the team and not to company management.

The modelling of the silo hierarchical organization and the cross-functional team structure in the foregoing calculations do not represent how real organizations behave. The examples are constructs for the sake of exploring the effects of each structure on the outcomes of an organization. The investigation indicates that people organized in a team arrangement allow the team to produce better results than putting those same people in a hierarchical structure.

The big assumption is that the people in a team will work together as a team to get the benefits of a parallel arrangement of subject matter experts. This requires that all team members and managers have multiple skills and are willing to help each other in a spirit of friendship, trust, respect, learning, and support for the mutual benefit of all.

Organizations with hierarchical structures have the potential to deliver reliable outcomes, but they mostly perform poorly. Too often in a hierarchical business, the outcomes are wrong. What happens in such organizations to ruin their performance? One possibility is that these companies employ people with variable abilities from a pool of available workers, such as persons from the local community or from those already within the industry. These employees simply do their jobs as best they can. Few are experts in what they do, and so it is likely that errors and defects

result from variable work quality. Where there is no work quality control, each person does the work in his or her own way. Because there is no standard accuracy-controlled method, there are a wide range of outcomes, some of which must be wrong because the process allows errors.

This is another example of the Crosshair Game effect seen in Chapter 3: the design of the process causes its own problems. Where there is a weak employee selection process coupled to a weak quality management system in a silo organizational structure you have a design that cannot deliver the results required of a high-reliability organization. Yet some businesses can take the same people and deliver world-class performance. Choosing the right organizational structure is vitally important for operational excellence success.

FOOTNOTES

1. Nathan C. Wright, “What Is the Correlation between Transformational Leadership and the Profitability of Arizona Copper Mining Companies?” *Engineering & Mining Journal,* August 2014, 70–75.

2. James Surowiecki, *The Wisdom of Crowds: Why the Many Are Smarter than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations* (New York: Doubleday, 2004).

3. David J. Smith, *Reliability, Maintainability, and Risk: Practical Methods for Engineers,* 7th ed. (Boston: Elsevier, 2005), Appendix 6.

4. Mike George, Dave Rowlands, and Bill Kastle, *What Is Lean Six Sigma?* (New York: McGraw-Hill, 2004).

5. Jay Arthur, *Lean Six Sigma Demystified* (New York: McGraw-Hill, 2007).