The Application of Living Systems Theory to the Analysis of Organisations

M.Sc. Dissertation

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I certify that all material in this dissertation which is not my own work has been identified and that no material is included for which a degree has already been conferred upon me.

Signed...

Key words: Living systems theory, organisation analysis, method, description techniques

Abstract

Living systems theory provides a conceptual model the use of which might help to improve the understanding of an organisation and its problems, thus helping analysts to find solutions to these problems. A method to guide the application of living systems theory to the analysis of organisations is needed. In this work, a number of methods based on living systems theory are analysed, and a method for analysing organisations that consists of nine steps based on fundamental living systems theory concepts and, to some extent, the aforementioned methods is proposed. The steps of the method range from the initial problem, i. e. the reason to undertake the analysis, to the evaluation of the final solution. The method is iterative – the analyst will have to go back and forth between the steps of the method – and is also supposed to be continually applied. Together with this method a number of description techniques are proposed. Several of these description techniques are graphical, which will hopefully enhance readability and maintainability.

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1. Introduction

Miller's (1995) living systems theory is a general theory relating to all living systems, regardless of level (see below). Its generality makes it applicable to any situation where living systems, e. g. cells, organs, organisms, and organisations, are involved, and Miller (1995) mentions its plausible use as a diagnostic tool and as a design tool, and claims that it should be applicable on every level. He thinks that it, among other things, could help in developing administrative systems. However, this generality also poses a problem, since it is difficult to apply the theory (Taormina, 1991), causing it to be used mostly by researchers familiar with the theory (Holmberg, 1995).

Stafford Beer's Viable Systems Model suffered from a similar problem, i. e. it was difficult to apply. This incited Beer to write *Diagnosing the System for Organizations*, a guide intended for those who would want to practically apply his theories, presenting a way to diagnose malfunctioning systems and construct viable ones (Beer, 1985).

Even though this work is not intended to be a handbook, its aim is similar: to make Miller's living systems theory applicable, to describe how it could be applied in practical terms – as Holmberg (1995, p. 52) expresses it, make it "more operational and application oriented." My main interest in this respect is its application to the analysis and design of organisations and to problem solving. In fact, it is my intention not to consider its applicability to other living systems, except when it is beneficial to my investigation of its applicability to the analysis and design of organisations.

2. Background

2.1 Living Systems Theory and Organisations: Concepts and Ideas

Miller (1995) has presented a general living systems theory, in which he identifies eight levels of living systems (cell, organ, organism, group, organisation, community, society, and supranational system) and twenty critical subsystems (reproducer, boundary, ingestor, distributor, converter, producer, matter-energy storage, extruder, motor, supporter, input transducer, internal transducer, channel and net, timer, decoder, associator, memory, decider, encoder, and output transducer). (The subsystems are described in Appendix A.) In the sense that living systems do not need to perform the functions of these systems by themselves, none of these are essential, except for the decider – without which there is no system. Instead, they can rely on other systems not necessarily on the same level for these functions (like parasites); the functions are dispersed. Nor is every living system able to perform all of the functions performed by the twenty critical subsystems nor to use any other system to perform these functions. (E. g., a mule cannot reproduce.) All of these critical subsystems, however, can be found at all levels, according to Miller (1995), yet he has not identified all of them at all levels. Therefore, it might be wise to consider this uncertain.

The critical subsystems are critical because the processes they perform are “essential for life” (Miller, 1995, p. 1), but reproduction is only necessary for the birth of new organisms, i. e. the survival of the species. Single organisms can survive without being able to reproduce.

Other important concepts used by Miller are *space*, *time*, *matter*, *energy*, and *information*. Living systems are open, i. e. they exchange matter/energy with their surroundings, and they occupy some space. The critical subsystems handle matter/energy and information. Time is important in more than one way, but this is emphasised by the addition of the subsystem timer.

One aspect of living systems theory is that it is concerned not only with the functioning of healthy living systems, but also with possible malfunctions (Tracy, 1992). In establishing a set of normal values, living systems theory makes it possible to determine whether the condition of a system is pathological (Miller, 1995). This makes it interesting as a tool for diagnosing systems. According to Miller and Miller (1991, p. 247)

> *"A pathological (abnormal, unhealthy, maladjusted, or inefficient) state in any living system is one in which, for a significant period, either one or more of its critical variables remain beyond the normal steady-state range, or excessively costly adjustment processes must be used to avoid this. Either malfunctioning on the system's own subsystems, or stresses, e.g., unfavorable conditions in the environment or suprasystem, can force variables out of their normal steady-state range."*

They suggest that living systems analysis can help us to understand and solve these problems.

Miller and Miller (1991) have identified eight causes for pathological conditions:

1. Lacks of matter or energy inputs,
2. Excesses of matter or energy inputs,

3. Inputs of inappropriate forms of matter or energy,
4. Lack of information inputs,
5. Excess of information inputs,
6. Inputs of maladaptive genetic information in the template,
7. Abnormalities in internal matter or energy processes, and
8. Abnormalities in internal information processes.

Systems usually make local adjustments to cure a pathological condition, and involve other parts when that proves ineffective. This conceptual system can be used to analyse problems in companies (Miller and Miller, 1991).

A few examples of the pathologies:

1. Lacks of matter or energy inputs: The car manufacturer did not receive enough material from its supplier to produce enough cars.
2. Excesses of matter or energy inputs: The factory was struck by lightning.
3. Inputs of inappropriate forms of matter or energy: The voltage in the new office abroad was not the one required by the office machines.
4. Lack of information inputs: The board was not informed that they would be visited by an important customer.
5. Excess of information inputs: The many reports received by the manager were so detailed that he did not have time to read them.
6. Inputs of maladaptive genetic information in the template: It would synergistically have brought several advantages to the company to produce the new product, but the charter forbade it.

7. Abnormalities in internal matter or energy processes: A short-circuit blew the fuses.
8. Abnormalities in internal information processes: The letter was sent from one department to another and back again several times before it was answered.

There are five types of flows in organisations:

1. MATFLOW (a flow of matter, e. g. a flow of marble from the quarry to the stonemasonry),
2. ENFLOW (a flow of energy, e. g. a flow of electricity from the power station to the factory),
3. COMFLOW (a communication flow, e. g. reports from an employee to his manager),
4. MONFLOW (a monetary flow, e. g. the flow when a customer pays the company), and
5. PERSFLOW (a flow of persons, e. g. employees travelling from one site to another) (Miller and Miller, 1991).

Miller and Miller (1991) consider it important that the structures performing the subsystem processes be identified. The reason for this is not explicitly stated, but it may rest on the notion put forth by Miller (1995, p. XVI) that “It is important not to separate functional, that is, process, science from structural science.” However, there is not necessarily a one-to-one relationship between process and structure (Banathy, 1989). The functions are often closely related. Hence, it would not be a good solution to have separate structures for every function, according to Tracy (1992).

2.2 Grounds and Previous Work

2.2.1 Why Miller's Model?

2.2.1.1 Models and Theories

It seems that according to van Gigch (1991) we need theories to build models. Metaphors can be useful as models, and one metaphor for an organisation is that of a living system. (Miller (1995, p. XXVIII) even states that "The organic analogy ... is the dominant metaphor of our time in scientific analyses of complexity.") In fact, organisation is one of the levels identified in Miller's (1995) living systems theory. Following van Gigch's line of thought, a theory such as Miller's theory of living systems ought to be useful when analysing and modelling organisations, especially since, as mentioned above, this theory explicitly deals with organisations as well as living systems more generally.

Unless we possess some sort of a priori knowledge of reality, it will be necessary to make observations in order to be able to create a model of something real. According to Popper (1979), we cannot make any observations without theories. He claims that "*all observation involves interpretation in the light of theories*" (Popper, 1979, p. 295). All observation is preceded by problems, which do not arise without a theory or a hypothesis, and without a theory nor a hypothesis we do not know what to observe. Even if our observations lead us to reject our hypothesis, *"what made the observations interesting and relevant and what altogether gave rise to our undertaking them in the first instance, was the earlier, the old [and now rejected][1] hypothesis."* (Popper, 1979, p. 346)

2.2.1.2 The General Role of Theories

"Theory-building can be said to serve two purposes. One is to predict *the occurrence of events or outcomes of experiments, and thus to anticipate new facts. The other is to* explain, *or to make intelligible facts which have already been recorded"* (von Wright, 1975, p. 1).

Consequently, unless Miller's theory is severely flawed (and I do not have any reason to believe that it would be), it does not only increase our ability to understand organisations, but it could also help us predict the effect of changes in organisations, i. e. serve as a tool for designing organisations.

In what way does Miller's theory help us to understand organisations, and in what way could it aid our analysis?

1. A theory serves the purpose to explain. Although *explanation* and *understanding* are not the same thing, "Practically every explanation … can be said to further our understanding of things." (von Wright, 1975, p. 6) It can also make facts intelligible. The mere fact that something is made intelligible means that it is made understandable. An important part of analysis is to structure information in order to make it intelligible and understandable. Miller's living systems theory provides a conceptual framework to help us to structure our recorded facts. It can also aid us in gathering information. If the analyst is

[1] Popper's own addition.

aware of important concepts and structures described in the theory, he may search for these things. E. g., living systems theory assumes that there are flows of matter/energy and information in living systems and between living systems and their environment. This may lead the analyst to try to identify these flows. In such a framework, the analyst may find vital aspects of which he lacks knowledge or would not have considered otherwise.

2. Theories help us to predict events. This enables us to foresee future malfunctions, thus allowing us to see problems in organisations before there are any symptoms.
3. Theories help us to predict outcomes of experiments. Typical design activities are to create a new organisation or to modify an existing one. These activities can be seen as equivalent to the manipulations made by an experimentalist, except that the degree of control is smaller. To some extent, therefore, a theory can help us to predict the result of our design activities. This should clearly be advantageous, since it allows us to tell beforehand whether a design should be implemented or not.

2.2.1.3 The Role of Living Systems Theory

Tracy (1993, p. 218) describes Miller's theory as providing "an elegant and elaborate conceptual framework for studying the behavior of human organisms, groups, and organizations." Among other things Ashmos and Huber (1987, in Tracy, 1993), calling for researchers in organisational behaviour and management to use living systems theory more than they have done before, mention that the typology of subsystems in living systems theory is useful for organisation research.

2.2.2 Purpose

What is my purpose, then? It is, for the aforementioned reasons, to study in what way Miller's theory can guide and be applied to the analysis of organisations. There seems to be many aspects that could be considered. I will mention three possibilities, which, although interconnected, can perhaps be studied more or less separately; it should also be possible to study them together.

2.2.3 Previous Work

Miller's theory has already been applied to the areas of organisational structure and design, and the design and diagnosis of organisation structure could be aided by the use of the set of Miller's subsystems. Two methods that have been developed are *living systems process analysis* (LSPA) and *qualitative living systems analysis* (QLSA). Nonetheless, living systems theory has been applied only to a small extent by researchers in organisational behaviour and management (Tracy, 1993). (QLSA is described in Taormina (1991). Unlike LSPA it is a qualitative method. It was created because LSPA is too difficult to apply for non-scientists and because new assessment instruments had to be designed for every organisation being analysed.) Miller and Miller (1991; 1995) describe a couple of other applications and conclude that "Throughout the broad range of organizations on earth and in space, it seems that analyzing and dealing with pathology in terms of living systems theory may be useful." (Miller and

Miller, 1991) A military application is described in Ruscoe *et al.* (1985). Bryant and Merker (1987) have studied a public transit system, while Merker and Lusher (1987) studied an urban hospital. Holmberg (1995) gives an account of the applications of living systems theory in Sweden. The areas being covered are software engineering, geoinformatic systems, urban management systems, living systems monitoring and tutoring, sea rescue systems, and system modelling and simulation. Almost all works that are referenced by Holmberg make use of the symbols developed by Samuelson for modelling living systems.

Merker (1985) has developed a framework consisting of seven steps to analyse and manage organisations. These steps are:

1. Identifying the system.
2. Identifying the system's purpose.
3. Identifying inputs and outputs.
4. Identifying the nineteen subsystems. (Only nineteen critical subsystems had been identified when Merker wrote his article.)
5. Identifying subsystems' inputs and outputs.
6. Quantifying inputs and outputs.
7. Managing the system.

Concerning point number four, one might note what Tracy (1992, p. 20) says: "Managers and consultants should be concerned that all critical processes are adequately served by the organization"; if they are not, they should at least be efficiently dispersed.

When considering point number one, one should keep in mind that “If one cannot clearly determine whether something is within the boundary or not, then no clearly defined system exists.” (Tracy, 1992, p. 6)

2.2.4 Problems

Although Holmberg (1995) writes favourably about living systems theory, he identifies four problems, two of them being that it has only been applied by researchers and

> *“little work [has been done] for developing supporting methodologies and tools. That is, LST [living systems theory] is a versatile and powerful theory, but it still needs to be made more operational and application oriented.”* (Holmberg, 1995, p. 52)

And further, “LST-based tools and methodologies which can easily be used by practitioners” (Holmberg, 1995, p. 53) need to be developed.

Taormina’s (1991) method to apply Miller’s living systems theory considers only the information processing critical subsystems. This has to be considered to be insufficient. Although it may suffice to consider the information processing systems in some cases and even though Taormina (1991) explicitly considers information processing problems, there is no guarantee that a problem will not be connected to or mainly related to the subsystems processing matter and energy, nor is there any guarantee that the best solution can be found if one neglects the more physical aspects of an organisation. Four of the eight causes for pathological conditions identified by Miller and Miller (1991) concern the processing of matter and energy. Indeed, Miller (1995, p. 15) warns against considering only information, and says: “Systems theory is more than information theory, since it must also deal with energetics.”

2.3 Concepts and Assumptions

2.3.1 Relevant Levels

Preliminarily, one might assume that the most relevant levels identified by Miller are group, organisation, community, and society – i. e. most relevant for my purpose – since every level mainly consists of systems at the level below it, and since the suprasystem of a system (minus the system) is the immediate environment of the system. The environment includes all higher levels (Miller, 1995). (Tracy (1993), too, considers these levels relevant to the fields of organisational behaviour and management, but also mentions the organism level.) The suprasystems of organisations are usually communities, except for suprasystems of agencies of governments; the suprasystem of a governmental agency is society (Miller and Miller, 1991).

The reason to exclude the organism level is the need to restrict myself. Also, it is uncommon to study individuals internally in great detail when analysing an organisation. Of course, individuals are important. They are a resource. They can cause problems, and they can help remedy them. Individuals have their own free will, that is not always in agreement with the objectives of the group, organisation, community, or society. Their goals are not necessarily those of the organisation. Still, the organism level would lead us to far into the areas of psychology and physiology. Individuals are still not ignored, but seen as members of a group, interacting with other members. In other words, their external properties as group members will be regarded, but not their internal ones (see below).

2.3.2 The Purpose of Analyses

I shall consider the purpose of analysing and describing an organisation to be to gain an understanding of the organisation, its goals and objectives, and its problems. It is assumed that in the process of analysing the organisations, models are created. It is also assumed that the final models ought to be useful when trying to solve the problems identified.

Organisations are complex, and without a proper understanding it is difficult to solve a problem; it is likely that only the symptoms but not the causes are treated.

2.3.3 Understanding

What does *understanding* mean? There are several meanings, but in this case I think that it is reasonable to say that “Verstehen … [ist] das Erfassen von Zusammenhängen” (Brockhaus Enzyklopädie, 1994, p. 272). A similar definition in English would be: Understanding is awareness of connections. To understand an organisation would thus be to be aware of the connections between it and other objects in its environment and between its parts. A connection is a relation or an association.

2.3.4 Internal and External Properties

I shall consider Langefors’ (1995) internal and external properties to be useful conceptual tools. External properties are those properties of a system that are “visible” to systems outside it. Internal properties are those properties of the inner workings of a system. Some internal properties are also external properties. External properties depend on the internal properties. Not all external properties can be derived from the internal ones.

One might say that we are usually most concerned with (a subset of) the external properties of a system. As a customer, you do not care about the bureaucracy or the administrational details of a company. You want it to perform the services it has promised at the price that was agreed at the fixed time. You do not care about when the police officers are on vacation. You want the police to protect you and your property. You do not care about the behaviour of the electric currents in the CPU of your pocket calculator, but you do want it to give correct answers.

It is quite possible to specify the desired external properties of something (what it should do) without specifying the internal ones (how it should work). Still, the performance of your pocket calculator is very much dependent on how it works inside.

Some external properties can be derived from the internal ones. The strength of a bridge can be derived from its construction.

2.4 What to Study and Accomplish

2.4.1 Three Aspects

The three possible aspects that could be studied and were mentioned earlier are:

1. What should the results of analysing an organisation be? I. e., what knowledge should one have gained about what? What does one want to know about the organisation? What aspects of it should one pay one's attention to?

2. How should an organisation be analysed? What steps are needed to give the desired results? In what order are they performed?

3. What techniques could be used to describe (model) and analyse an organisation?

Point number one is at a higher level of abstraction than number two and three, which cannot be entirely separated from each other. It would, at least, it seems, be impossible to investigate point number three without considering point number two. Although point number two depends on point number one, it should be possible to accept some other framework that does not have its roots in Miller's living systems theory. Whether this is desirable is, however, uncertain.

2.4.2 Other Bases

There are two ways to investigate how Miller's living systems theory can guide and be applied to the analysis of organisations. One way is to use methods of one or several organisation theorists and amend it according to Miller's theory. Another way is to presuppose only Miller's theory and let it guide the analysis according to what is important according to that theory. Since Miller's theory is a general theory I consider the latter approach to be preferable.

2.4.3 Expected Results

One possible result of my investigations might be a list of what should be modelled and a suggestion how the resulting model could be presented, i. e. a set of description techniques. Obviously, it will be necessary to take into account Taormina's (1991) and Merker's (1985) work.

I think that commonalities in the methods used in those investigations that have used living systems theory to analyse organisations and the works by Taormina (1991) and Merker (1985) can provide a starting point which could be extended.

3. Method

In order to answer my questions, I will examine and describe the methods used in some articles describing analyses of organisations in terms of living systems theory. These methods should then be compared; similarities and differences should be shown. Since there will be little time to conduct any full empirical investigations this will give some valuable information about earlier practice and experiences. Some important questions here are: What steps were followed? What information was retrieved/sought (cf. point number 1 in ch. 2.4.1)? How was an understanding of the analysed organisation gained?

The study of Ruscoe *et al.* (1985) is one of the more extensive ones, and should therefore be used. The article by Bryant and Merker (1987) and that by Merker and Lusher (1987) should also be useful, as well as the article by Johnstone (1995).

Then Taormina's (1991) work should be compared with Merker's (1985), and the result of that comparison should then be compared with that which is described above. Together with Miller's (1995) recommendations regarding organisations, they should be synthesised into a more complete recommendation.

Against this it might be objected that Merker, whose method (Merker, 1985) will be compared to the methods used in the other articles, has co-authored two of the articles, and that this might bias the investigation. The material is, however, sparse, and it is not necessarily the case that Merker follows his own recommendations in his article from 1985, and even if he does, his analyses might fill in some details. There is, however, usually some uncertainty concerning exactly how the authors of an article have performed their investigations, since not everything is fully described.

It is possible that before that could be done some questions that remain unanswered or have been unsatisfactorily answered need to be further investigated. If so, these questions might be answered by interviews of some kind with persons experienced in the process of analysing organisations. Since these questions are not yet known, however, it is impossible to predict how they could be answered, should they arise.

One should be aware that in the studies where the followed method is not clearly accounted for (at least not from those aspects that are of interest in this work), the description of that method is an interpretation made by me, an interpretation that will necessarily be influenced and guided by my pre-knowledge. That means that any division of the perceived method into steps (and, indeed, even the idea of a division into steps) and what I perceive as relevant aspects of the studies will be influenced by my familiarity with systemeering methods and models like the waterfall model, the spiral model, and the SESAM model. To that it might be added an inclination for using semi-formal methods as a way of improving understanding.

It is necessarily so that I will use my knowledge of Miller's theory and of systemeering practices when I interpret the descriptions of the studies in order to decide what those who committed the study did, possibly on a higher level of abstraction than they described it. As Popper (1979) explains one cannot just observe. The question about *what* ought to be observed will immediately rise, and one's pre-knowledge will determine what is interesting to observe. Still, even though there may be expectations of sorts, I do not work in a way that means that I have a hypothesis about how a method should be constructed and try to verify (or falsify) it by examining the studies and the methods that have been developed.

4. An Interpretation of Johnstone's Study

4.1 A General Description

Johnstone (1995) has studied a special kind of health care organisation, IPA (Independent Practice Association) model HMOs (Health Maintenance Organisations). An HMO of this kind contracts with a group of medical practitioners (that have their own practices). They then treat patients whose medical care the HMO pays.

The study

"*attempts to initiate an understanding of organizational structure by applying systems thinking, specifically living systems theory as developed by Miller (1978), to identify the subsystems and potential critical processes within a specific type of social system known as an independent practice association (IPA).*" (Johnstone, 1995, p. 305)

These organisations have difficulties implementing quality of care programs.

This particular study concerned an IPA model HMO in California.

4.2 Steps

Johnstone's problem concerning quality of care programs must be seen as the starting point of the process. He has then chosen an organisation to study, and in his article he gives a broad description of how the HMO is organised. This could be seen as him identifying the system. He has then interviewed the IPA presidents and produced a (possibly incomplete) list, containing Miller's critical subsystems, the equivalents of those in the IPA, and the critical processes performed by these. (E. g.: The producer has its counterpart in the health care providers of the organisation. The critical process performed by them is producing profits. The computer system serves the role of memory, and the critical process performed is storing information.) This can be seen as gathering information about the system (which can be done by, e. g., interviewing members of the organisation), and structuring information, or, more specifically, identifying the critical subsystems and their components, and the critical processes performed by them. He has then analysed how the problems arise. Since the argument contains references to information flows in the organisation, one must assume that he has previously identified the information flows in the organisations, at least partially. Johnstone concluded that the problems were not due to the structure of the organisation, but instead “result[ed] from inadequate critical processes within the organization” (Johnstone, 1995, p. 311), i. e. he identified the problem. The organisation he studied had all subsystems and components, but not every critical process needed. He goes on to say: “Clearly a quality of care program could be incorporated into other subsystems and vital processes of the IPA.” (Johnstone, 1995, p. 311) It seems clear that Johnstone considers the possibility of designing a solution to the identified problem and implementing it.

The whole process is diagrammed in Figure 1. The process is presented in more detail in Figure 2.

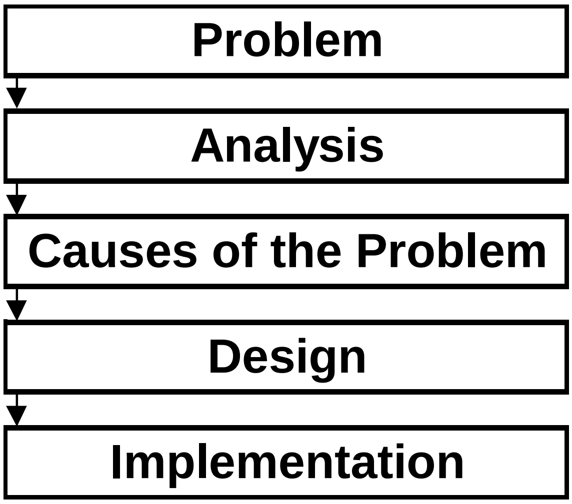


Figure 1: The basic steps in Johnstone's (1995) study.

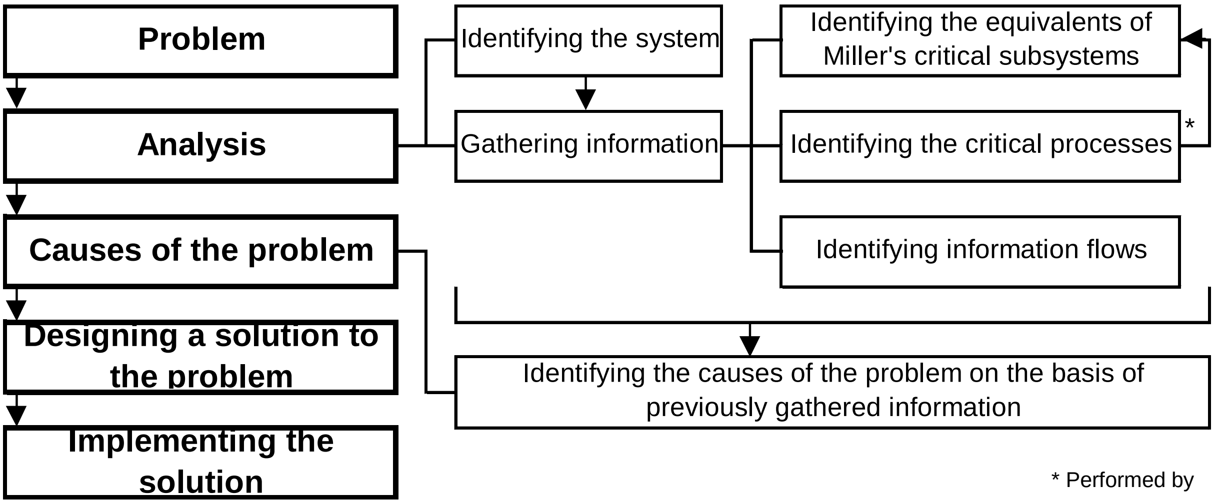


Figure 2: A more detailed sketch of the steps in Johnstone's (1995) study.

4.3 Collected Information

The information about the system collected in the study is:

- The structure of the system
    - Subsystems/components corresponding to Miller's subsystem
    - The critical processes performed by the components corresponding to Miller's subsystems.
- Information flows
    - What information flows between subsystems/components?

- Between which subsystems/components does the information flow?

4.4 Result

One result of the study is a description of the organisation. The description contains the information described in ch. 4.3.

The result of the study is also that Johnstone found the problem (i. e. the problems causing the problem that concerned him). He found this by examining the collected information, and concluded, among other things, that some critical subsystems that should have been involved in the process were in fact not involved and that some pieces of information that should have been spread to other subsystems were in fact not spread to those subsystems.

4.5 Comments

It should be noted that even though my description of Johnstone's method might perhaps make it appear as if it was in accordance with the waterfall model this should not be taken for granted. The description of his method in his article is not detailed enough to be conclusive.

5. A Description of the Methods Used by Bryant and Merker, Merker and Lusher, and Ruscoe *et al.*

The methods used in the following three articles are essentially the same. One of them has been chosen to illustrate how they were conducted. An important part of these studies was to estimate the effectiveness of departments and battalions. The assessment of effectiveness is related to the practice of analysing in order to take measures. Hence, it is reasonable to give a description of these studies here, but since they are not directly related to my problem, the description will be brief, and they will be excluded from any further comparisons.

5.1 Bryant and Merker

5.1.1 Description

Bryant and Merker (1987, p. 293) writes about how

> *"living systems theory can be applied at the level of the organization to assess the effectiveness of an urban public transit authority. Living systems process analysis was utilized to survey and analyze department ratings of information and matter/energy processing. Evaluations were compared among departments which rated high and low on effectiveness criteria, such as meeting goals and objectives."*

The organisation being evaluated was a public transit system, situated in a metropolis and having 674 employees. Only 92 of these employees and managers completed a survey.

The living systems processes that were considered are input transducer, internal transducer, channel and net, decoder, associator, memory, decider, encoder, output transducer, ingestor, distributor, converter, producer, storage, extruder, motor, and supporter. They were explained in “layman’s terms” (Bryant and Merker, 1987, p. 297).

The questionnaire was constructed with the purpose of obtaining “evaluation ratings on process quality, importance and performance, and how much time is spent on the process” (Byrant and Merker, 1987, p. 297). It was divided into six parts.

5.1.2 Steps

Because Bryant and Merker (1987) in their article very much concentrate upon a questionnaire of theirs, no account of the steps will be presented here.

5.1.3 Collected Information

Bryant and Merker (1987) concentrate on seventeen living systems processes in their questionnaire.

In the first part of the questionnaire, the respondents indicated on a scale how well each of the seventeen processes (in the organisation as a whole) was performed.

In the second part, the respondents had to state how much of their time they spent on the information processes, and how much on the matter/energy processes. Then they were asked how much of the time spent on the information processes they spent on each of the information processes, and how much of the time spent on the matter/energy processes they spent on each of the matter/energy processes.

In the next part, they had to select the six most important processes, and the six least important ones. They were ranked within their respective categories, and the remaining processes were also ranked. The criterion used when ranking them was how important the processes were for the employees when they do their job.

Next, the respondents were asked how important/useful each process was, to what extent the information/matter/energy was accurate/undistorted/undamaged/not wasted in the process, to what extent it was done on time, what amount of information/matter/energy was processed, and the time and effort required.

In the second last part of the questionnaire, the respondents rated 27 statements on a scale (ranging from definitely disagree to definitely agree). The statements very much concerned how the respondents felt about their job and the organisation and effectiveness.

The following statements, that were not a part of the questionnaire, were rated by the assistant general manager and the department managers for every department:

1. "Employees in (*name*) department are well prepared to do their job." (Bryant and Merker, 1987, p. 298)
2. "Employees in (*name*) department do a good job." (Bryant and Merker, 1987, p. 298)
3. "(*Name*) department does not achieve its goals." (Bryant and Merker, 1987, p. 298)

The sixth part of the questionnaire contained questions about, e. g., gender, education, how long they had been employed, department, and positions.

5.2 Merker and Lusher

Merker and Lusher (1987) present a study of a

> *"large metropolitan hospital. As in the previous studies (Merker and Lusher, 1987, and Ruscoe et al., 1985), the intent was to examine process differences between departments considered effective and others considered less effective."* (Merker and Lusher, 1987, p. 304)

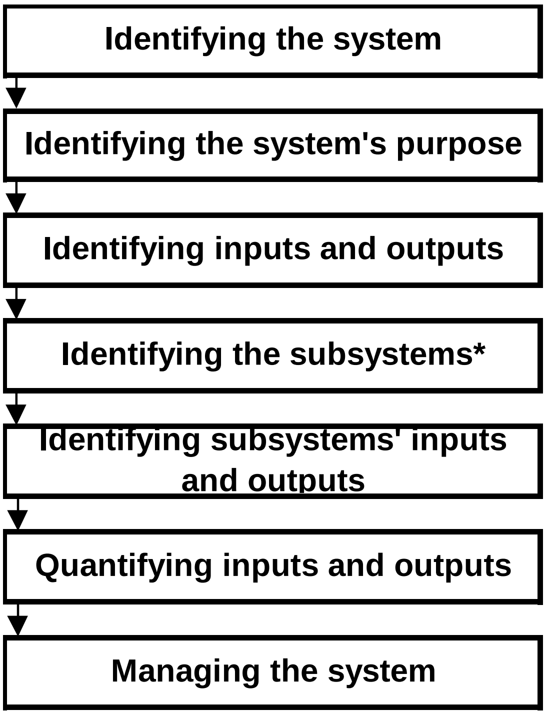
The method is essentially the same as the one used in Bryant and Merker (1987), although a few of the questions have been slightly modified to be better suited for the organisation being analysed in this article. As in the previous article, they rely heavily on the use of statistics and try to measure efficiency.

5.3 Ruscoe et al.

The two methods above are very much based on the one used in the three extensive studies in Ruscoe et al. (1985), where the efficiency of army battalions was measured.

6. Merker’s Method

6.1 A General Description



* Merker considers only the 19 subsystems that were identified when he wrote his article. However, it should not be a bold assumption that he intendend all subsystems, even those that would be identified later.

Figure 3: Merker’s seven steps of analysis and management.

Merker (1985, p. 187) describes his method as a “seven step approach to applying the living systems concepts to businesses in order to achieve effective organizational management.” It is intended to help managers manage their organisation effectively. The first six steps are used to gain understanding of the organisation. The seven steps are sketched in Figure 3.

6.2 Steps

In the first step (*identifying the system*), the analyst should clearly identify the system. The decider is the only essential critical subsystem, i. e. the whole decider cannot be dispersed, although parts of it can. The key to identifying the system, Merker (1985) says, is to identify the decider echelon, i. e. the highest director and those reporting to him or the stockholders and those reporting to them. Merker (1985, p. 190) advises us to ask the following questions in order to identify the decider: “Who does the deciding?” and “What is the decider’s span of control?” If a company consists of other organisations, e. g. factories, they can be considered systems in themselves, and the company is then regarded as their suprasystem.

In the second step (*identifying the system’s purpose*), the analyst should identify the purpose of the system, the reason that the system exists. It can often be found in its charter, where one can also find

> *“a clue to the organizational system’s living systems role in a larger system (suprasystem). Both the specific purpose and LST role (e.g, producer) must be identified for effective LST management.” (Merker, 1985, p. 191)*

The purpose of an organisation can change, and the charter does not necessarily reflect these changes. Sometimes one should also study the role of the organisation in its suprasuprasystem. “Generally, the more levels understood in relation to an organization the better the overall understanding and the more successful the application of LST will be”, Merker (1985, p. 191) says.

The third step (*identifying inputs and outputs*) consists of identifying the matter/energy and information inputs and outputs that are critical to the system, i. e. what information and matter/energy the organisation needs and what matter/energy and information the system has to deliver. (According to Merker (1985) all inputs and outputs must be identified, no matter how trivial or irrelevant they may seem.) Not only the system but also its suprasystem is dependent on its outputs and inputs.

In the fourth step (*identifying the subsystems*), the analyst should identify the critical processes of the organisation that Miller has identified. The fact that it exists is a sign that these processes are performed. The processes are identified by identifying their structures, or, in other words, who performs the processes.

In the fifth step (*identifying subsystems' inputs and outputs*), critical inputs and outputs to each and everyone of the subsystem processes by considering each process separately, determining what matter/energy and information inputs and outputs are necessary for the subsystem to be able to perform its role in the system. (Information inputs/outputs to every subsystem have to appear in the channel and net. Similarly, matter/energy inputs/outputs appear in the distributor.)

In the sixth step (*quantifying inputs and outputs*), the analyst is supposed to quantify the critical inputs and outputs for the subsystem processes, each and everyone separately, and the system (i. e. the organisation) itself in terms of:

- Cost
- Volume
- Lag
- Distortion
- Rate

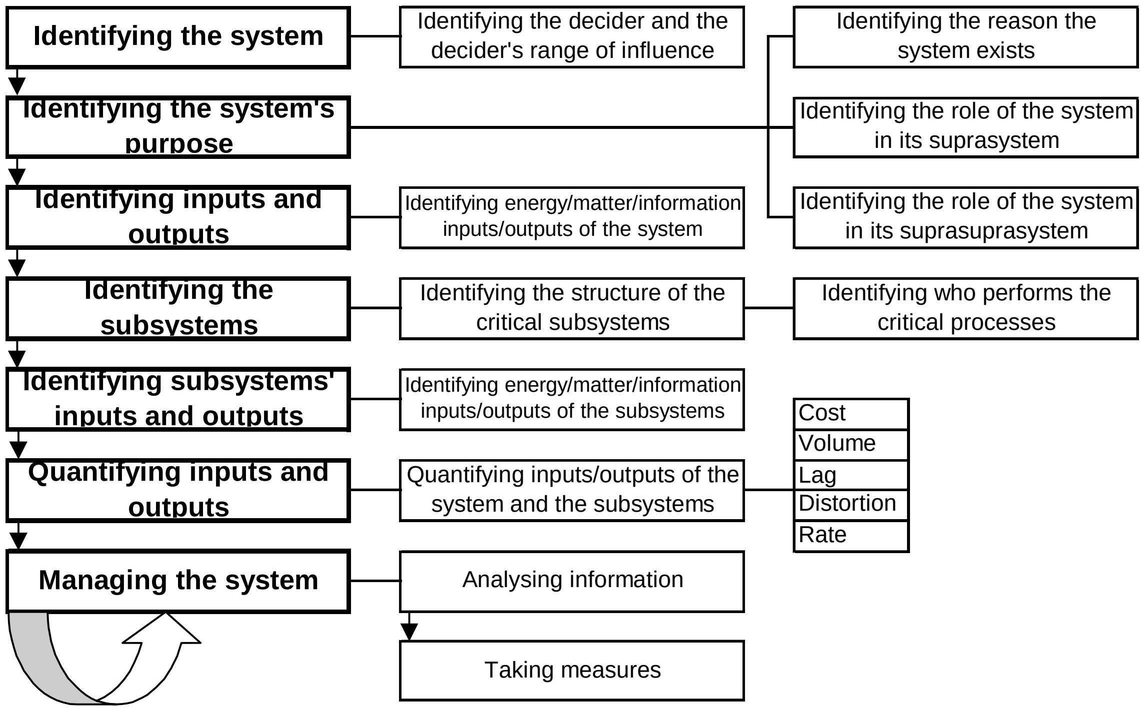


Figure 4: An overview of the steps of Merker's (1985) model showing what is done in the separate steps.

The reason for this is that

"it is possible to ascertain what volume of information can be relayed in the channel-and-net, what is the cost (man-hours, dollars) related to the volume, and how much distortion or lag is involved in this process."

(Merker, 1985, p. 193)

Depending on what is needed, one may choose between quantifying all information in great detail or the critical flows only. The variables can be quantified in terms of normal operating levels, allowable fluctuations, or current operating levels.

According to Merker (1985), it is not necessary to perform the first six steps again, if the information is maintained.

In the seventh step (*managing the system*), the information is analysed, and decisions are made. If the inputs or the outputs of the organisation or any of its subsystems are not within the steady-state range, then the system is pathological.

The seventh step should be performed continually.

See Figure 4 for an overview of the process.

6.3 Collected Information

Using Merker's (1985) method the analyst collects the following information:

- Information about the structure of the system (in the first and the fourth step).
    - Who is the decider?
    - Who reports to the decider?
    - Who performs the critical processes identified by Miller?
- Information about the role of the system (in the second step).
    - Information about the purpose of the system.
    - Information about the role of the system in its suprasystem.
    - If necessary, information about the role of the system in its suprasuprasystem.
- Information about the flows of information in the organisation (in the third, fifth, and sixth step).
    - Information flowing to and from the organisation.
        - What information is it?
        - In what quantities (in terms of normal operating levels, allowable fluctuations, or current operating levels) does it flow?
            - Cost

        - Volume
        - Lag
        - Distortion
        - Rate
    - Information flowing to and from the subsystems of the organisation.
      - What information is it?
      - In what quantities (in terms of normal operating levels, allowable fluctuations, or current operating levels) does it flow?
        - Cost
        - Volume
        - Lag
        - Distortion
        - Rate
- Information about the flows of energy/matter in the organisation (in the third, fifth, and sixth step).
  - Energy/matter flowing to and from the organisation.
    - What energy/matter is it?
    - In what quantities (in terms of normal operating levels, allowable fluctuations, or current operating levels) does it flow?
      - Cost
      - Volume
      - Lag
      - Distortion
      - Rate

    - Energy/matter flowing to and from the subsystems of the organisation.
- What energy/matter is it?
    - In what quantities (in terms of normal operating levels, allowable fluctuations, or current operating levels) does it flow?
    - Cost
        - Volume
        - Lag
        - Distortion
        - Rate

6.4 Result

The result of the first six steps is a description of the organisation (that Merker (1985) considers complete). This description is used in the seventh step, the result of which is an identification of the problems of the organisation and a decision about what measures should be taken in order to solve these problems.

6.5 Comments

It is uncertain whether Merker (1985) really intends his method to be a waterfall model method, even though it does show some resemblance in that his description makes it seem like the analyst should carry out one step, then the next one, etc.

It seems that his method concentrates on what information to collect about the system. Six steps address that. Only one addresses the analysis of the information that has been gathered and the decision-making that has to take place based on the analysis.

To identify all inputs and outputs, no matter how irrelevant they might seem, is problematic. It is true that the importance might not always be readily obvious. On the other hand, the volume of the information potentially flowing into the organisation via its employees is immense.

7. QLSA

7.1 A General Description

Taormina (1991) describes a method (QLSA, Qualitative Living Systems Analysis) for solving problems in the information processing subsystems of an organisation, consisting of a questionnaire and four steps. The questionnaire, Taormina (1991, p. 196) claims,

> *"has the advantages of being readily comprehensible and functionally employable by busy managers, executives, and analysts as a user-friendly device for identifying, defining, and solving problems of information processing in organizations."*

He says further that it is qualitative and does not require that its users should have scientific knowledge of living systems theory. Quantitative approaches have been found to require much time, a great deal of scientific skill and knowledge of living systems theory, he says. Only the ten information processing subsystems are analysed, not the matter/energy subsystems. The same questionnaire should be used for every organisation. Taormina (1991) also provides a case analysis for a multinational Japanese corporation.

7.2 Steps

Taormina (1991) describes a four-stage method (s. Figure 5). It seems that Taormina (1991) assumes that one should proceed to the next step when one step has been satisfactorily completed, i. e. "waterfall thinking" is applied. That is a reasonable way to interpret Taormina's (1991, p. 199) statement in the description of stage I saying that “Once the company’s case history has been given, the analysis proceeds to the next stage.”

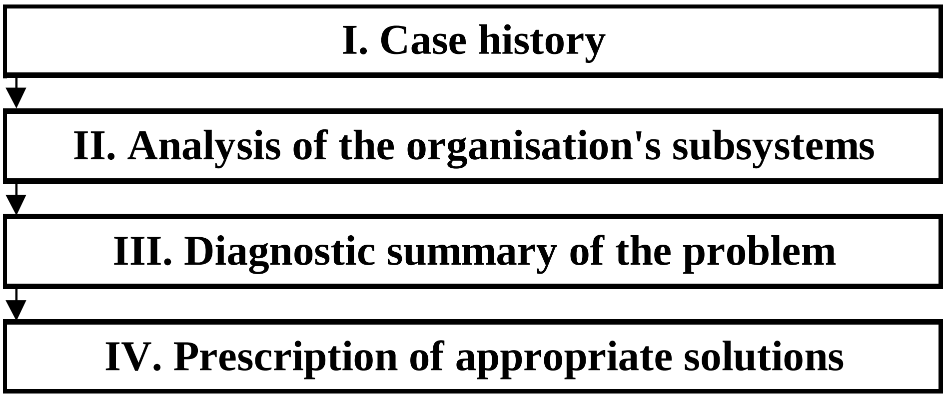


Figure 5: Taormina’s method consists of four stages.

7.2.1 Step I

In the first step, the organisation is described.

> *“This includes background information about the organization, such as statements about what type of company it is, its history, its objectives, number of employees, and other relevant information… [A] full description of the company’s problem(s) is given.”* (Taormina, 1991, p. 199)

7.2.2 Step II

The analyst should perform the following steps for every subsystem (Taormina (1991) does not mention that the subsystems should be identified first, but it seems that it would be difficult to analyse the subsystems, should they be unidentified):

1. “Perform a (qualitative) structure analysis”.

a. “Note the recommended structure of each system.”

b. “Describe the existing structure of each subsystem.” (Taormina, 1991, p. 199) “The *structure* of a system is the arrangement of its subsystems and components in three-dimensional space at a given moment of time.” (Miller, 1995, p. 22)

2. “Perform a (qualitative) process analysis”.

a. “Note the recommended process of each subsystem.”

b. “Describe the existing process of each subsystem.” In this step, one should describe how the processes are performed by the organisation.

3. “Identify pathologies affecting each subsystem.”

a. “Ask the relevant pathology questions for each subsystem.” Being based on which malfunctions can occur in the critical processes of a living system, these questions are supposed to be used to determine whether these processes are actually performed.

b. “Answer each question as objectively as possible.” (Taormina, 1991, p. 199)

7.2.3 Step III

The analyst should summarise the differences between processes and structures in the organisation and those that are recommended that he has found in the previous step, and relate the answers to the questions asked in step II.3 to any detected problems concerning process or structure. The recommended and the actual structures and processes are compared for every subsystem. If any structure or critical process is missing, there could be a problem, unless the function is dispersed to another system.

7.2.4 Step IV

Taormina (1991, p. 200) claims that the previous steps will result in “an integrated picture of the organization’s problems and their causes”. Based on that, it will be possible to recommend solutions aimed at the real problems of the organisation.

7.3 Collected Information

In step I, information about the type of company, objectives, problems, history etc. are gathered in order to get an overview picture of the company. The other information being gathered is best summarized in the questionnaire provided by Taormina (1991) (s. Appendix B).

7.4 Result

The results include a general description of the organisation and its problems obtained in the first step. In the following steps, a description of the information processing of the organisation, the problems associated therewith, and the discrepancies between the ideal structures and processes and those that actually exist in the organisation, is made. The final result is a recommended solution to the problems based on that information.

7.5 Comments

There are a few problems with Taormina's method, QLSA. As was discussed in ch. 2.2.4, it is problematic that the method only considers information-handling subsystems. The concept of "recommended structure" and the application thereof are also problematic. The recommended structure seems to be a description of common arrangements, not a recommendation. Taormina (1991, p. 199) writes:

> *"As regards the term 'recommended', the present author takes full responsibility for any complications arising from its use, since this term was not employed in this way by Miller."*

It is also unclear exactly how this recommended structure should be compared to the existing structure in order to find discrepancies.

He is unnecessarily vague regarding the information that should be gathered in the first step; “other relevant information” (Taormina, 1991, p. 199) could be anything.

On the positive side, a practical feature of the method is that there is a fixed set of questions to be used for every problem, which makes it easier to follow the method.

8. A Comparison between Two Methods: Merker's and QLSA

8.1 The Purpose of the Comparison

This comparison should demonstrate what the two methods, Merker's (1985) and QLSA, have in common and also how they differ.

8.2 Purpose and Focus

The purpose of Merker's (1985) method is to help managers manage their organisation effectively. Therefore it is perhaps not surprising, albeit not necessary, that it is very much quantitative. It also considers both aspects of information and of matter and energy.

Taormina's (1991) QLSA aims to be a useful tool of analysis to managers and others who are non-scientists, and to help them solve problems concerning information processing. (This, in fact, is a somewhat narrower scope than that of Merker's.) Taormina (1991) thinking that quantitative methods require much time and considerable scientific skills, QLSA is quantitative. Since the problems considered are information processing problems, only the information processing subsystems are considered in order to make the method easier to apply.

Clearly, the greatest differences between the two methods are 1) that QLSA is qualitative and Merker's (1985) quantitative, and 2) that QLSA considers information processing problems only.

Method:	Merker's	QLSA
Who applies it?	Managers	Managers and others without scientific skills
What problems does it address?	All problems	Information processing problems
What kind of method is it?	Quantitative	Qualitative

8.3 Steps

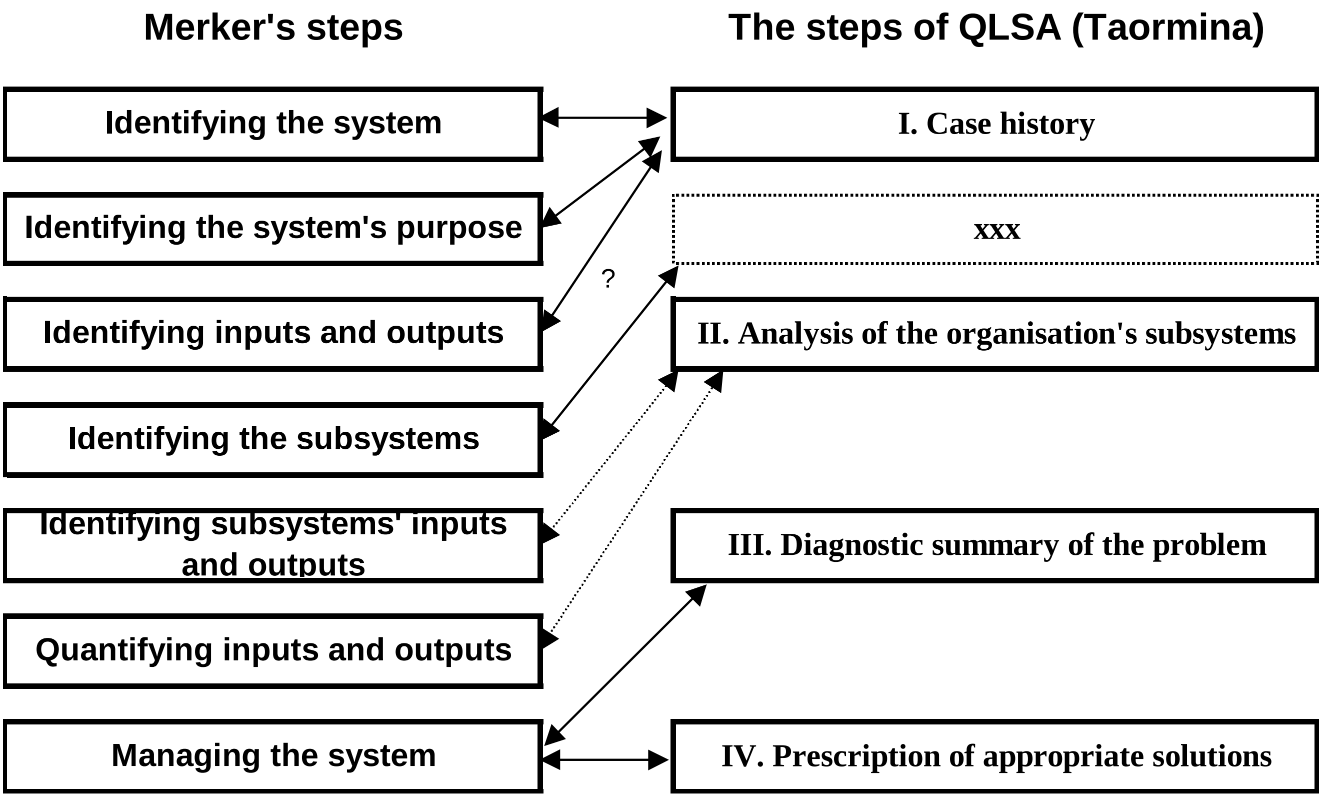


Figure 6: How the steps in QLSA and Merker's method partially correspond.

If one tries to see which steps in QLSA and Merker's method correspond and which do not correspond to any step in the other method, one might find the following to be the case (as the outline in Figure 6 shows):

- While Taormina (1991) does not explicitly mention that the system should be identified in the first step, it seems that this is exactly what is done in the first step, when the organisation is described.
- In Merker's (1985) second step, the analyst identifies the purpose of the system and the role of the system in its suprasystem. This is more or less done in the first step of QLSA, or, at least, it is done in this step, if it is done. This seems to be one of the purposes of step one.
- In Merker's third step, inputs and outputs of the system (the organisation) are identified, i. e. the information and matter/energy the system needs and what information and matter/energy the system has to deliver. Since QLSA deals with information only, users of it would not strive to identify requirements concerning matter/energy. However, information inputs and outputs might be identified in the first step. It is part of a description of the organisation, and it would certainly fit into Taormina's (1991, p. 199) broad description: "…and other relevant information". *If* one should regard this as a part of QLSA too, one has to consider it a part of the first step.
- In Merker's fourth step, the subsystems are identified. There is no such step in QLSA. However, since in the next step the subsystems are analysed, this must have been done in some way.
- The second step of QLSA is radically different from Merker's fifth and sixth step, not least since Merker performs a quantitative analysis, although not exclusively, but they do mean an "analysis of the organisation's subsystems".

- The last two steps of QLSA corresponds rather closely to Merker's last one.

8.4 Waterfall Models?

Although there is no conclusive evidence, it seems like both methods are waterfall models (s. the respective descriptions of the methods).

8.5 Information

In QLSA and Merker's method, no difference is made between the different kinds of information and matter/energy flows that have been previously mentioned.

8.6 Miscellaneous

8.6.1 External and Internal Properties

In ch. 2.3.4, I mentioned the concepts of external and internal properties. Taormina (1991) and Merker (1985) do not explicitly refer to these concepts, but are they reflected in their methods?

In Merker's case, the answer is yes. He considers the outputs and outputs (the external properties) of the system before considering the internal properties of the system. When he considers the subsystems he also first considers the inputs and outputs of them.

When it comes to QLSA, the concepts mentioned above are not clearly reflected. There is no clear division between "from the inside" and "from the outside", although this seems to depend very much on those who apply it.

8.6.2 Pathologies

Taormina's (1991) pathology questions (s. Appendix B) do indeed cover the pathologies described in Miller and Miller (1991).

Applying especially the fifth and sixth step of Merker's (1985) method, the analyst should be able to identify at least the following pathologies:

- Lacks of matter or energy inputs
- Excesses of matter or energy inputs
- Lack of information inputs
- Excess of information inputs

8.6.3 Roles

In ch. 2.1, it was said that it is important to identify the structures performing the subsystem processes, but there is not necessarily a one-to-one relationship between process and structure. An individual can have several roles to play in an organisation. He might perform – wholly or partially – the processes of several subsystems, of which he is a part. The janitor might, for example, be part of both the boundary and the extruder. The individual's role in one system might affect his actions as a part of another subsystem. The janitor might, for example, be so busy performing his duties as distributor that he cannot work effectively as extruder. Taormina (1991) found that some employees were so busy that some important tasks were performed too seldom.

In the case of QLSA and Merker's method, no effort is made to describe who play which role and which roles are played by whom.

9. A New Method

9.1 Underlying Assumptions

As was written earlier, it is assumed that the purpose of analysing an organisation is to gain an understanding of the organisation, its goals and objectives, and its problems, and that the final result should be an aid when trying to solve the problems that have been identified.

It is assumed that a waterfall model or a similar model is an inappropriate approach in many respects (s. e. g. Loucopoulos and Karakostas (1995) for a survey on the disadvantages).

As has been made clear, there are aspects of Miller's living systems theory and related works that have not generally come to use. This method should pay attention to those aspects. Such aspects are:

- Langefors' concept of internal and external properties,
- the different types of pathologies,
- the concept of roles,
- and the different types of information and matter/energy flows.

9.2 Of what Parts does the Method Consist?

My suggestion for a method consists mainly of two parts, namely nine steps of analysis, and a set of description techniques focusing on some important aspects. Making these descriptions should be considered as a help, but one should not expect that these descriptions on their own are enough to convey a full understanding of the organisation. They may make certain relationships more obvious, but there is still a need to write down explanations and in other ways describe details that cannot be described by the use of these techniques.

9.3 The Steps

Since waterfall methods have several disadvantages, this method (s. Figure 7) is iterative. It is not assumed that the analyst should completely finish one step and continue to carry out the next one using the result from the previous one. Instead, it is assumed that the work performed in one step might shed some new light on the previous step, and vice versa. There is a constant re-evaluation of the gathered information and the decisions that have been made. It is always possible to go back, and it is not necessary to complete the work in one step before considering the next one.

9.3.1 Initial Problem

The whole process starts with an initial problem. It could be a problem that the organisation experiences or it might be some other reason to evaluate the organisation. In short: The initial problem is the reason that the analysis is performed. This reason will also be used in the following steps to motivate the level of detail in the analysis.

9.3.2 Identify the System

In the next step, the analyst should identify the system. It goes without saying that he cannot analyse something that he has not identified. However, it might not be that easy to identify the whole system at once. Information gathered in the following steps might be useful. Merker (1985) recommends that one should investigate who reports to the decider and who obeys it.

9.3.3 General Description of the System

In this step, description No. 1 is made (s. below).

An organisation is a system that exists in an environment which affects it (Ackoff, 1981; Miller, 1995). It is therefore necessary to consider the relations the organisation has to other systems in its environment.

In this step, the analyst should obtain a general description of the system, its purpose, objectives and goals, its role in its suprasystems, and its inputs and outputs. It is necessary to be aware of the objectives, goals of the system and its purpose to be able to see what is a problem. (A problem is not necessarily a threat to the existence of the system, but it might be the cause that its goals and objectives are not reached.)

Some kind of basic understanding of the nature of an organisation will guide the analyst in the subsequent steps.

9.3.4 Describe the Organisation

Descriptions No. 2-7 are made in this step (s. below).

The analyst should describe the organisation by identifying the critical subsystems and the inputs, outputs, and parts of those subsystems, and also the groups of which the system consists and the inputs, outputs, and parts of them. The notion of a set of critical subsystems is fundamental to Miller's (1995) living systems theory, but one should be aware that subsystems can be dispersed. However, if one of these critical processes is not performed – or is not properly or efficiently performed – there are probably some serious problems. Miller (1995) considers these processes to be vital.

9.3.5 Describe the Problems that have been Found

In this step and in the next step, description No. 8 is made (s. below).

When obtaining and considering the information that was obtained in the previous steps, it is likely that the analyst will find some problems in the organisation. He should describe them in this step.

9.3.6 Find Causes for the Problems

Making use of the eight pathology types of which Miller and Miller (1991) mention (cf. ch. 2.1), one should identify the pathologies that the organisation suffers from, and correlate them to the problems. In this way, the way to correct a problem is to cure the pathological condition.

9.3.7 Design a Solution

The analyst should now make description No. 9, which is a description of what measures to take and what problems they will remedy. This is the step where a solution should be designed. The analyst should make sure that all problems (or at least all urgent ones) are addressed. The same description techniques that were used to describe the organisation can be used to describe how the new organisation should look.

9.3.8 The Solution

The solution should then be implemented. When it is implemented it is time to evaluate the solution. Should it prove to be unsatisfactory, the process can be repeated. Even if the solution is satisfactory the organisation still exists in an environment, and there are no guarantees that there will not arise any new problems because of that. After a time, it might be necessary to repeat the process.

The first six steps of the method can be used to evaluate the solution, if one so desires.

The analysis of an organisation using this method (or most other methods) is a laborious task. To continually repeat the analysis has the advantage of reducing the effort needed to perform this task. There are two reasons for this. Firstly, the experience gained and maintained will make the process easier. Secondly, if this sort of analysis is rarely performed, the information gathered in the previous analyses will be largely obsolete and be of little use in the new analysis. If, on the other hand, the previous analysis was performed not too long before the new one, then much of the information will still be valid, and the process will be a process of updating instead of being a process of mapping a virtual terra incognita.

9.3.9 Quantitative Measures

Above it was mentioned that certain flows should be identified, but it was not required that they should be quantified. While it is not required that the information flows and the matter/energy flows be quantified, the analyst can do so if he thinks that it will improve his understanding – e. g. in those cases when structure alone does not seem to provide enough information for the analyst to see and solve the problems.

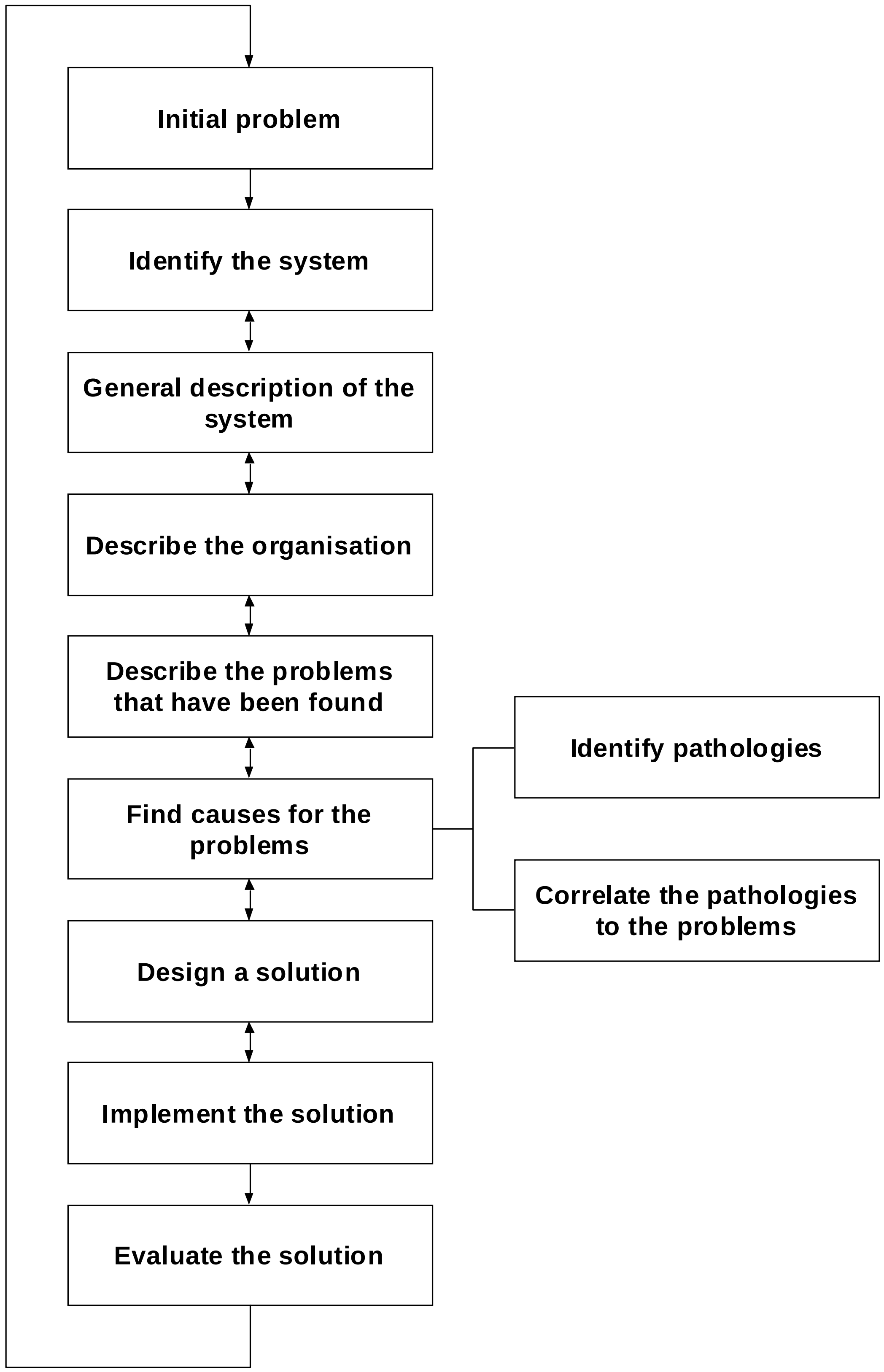


Figure 7: The method and its basic steps.

9.4 Descriptions

In Figure 8, the basic description technique is presented. All examples given are simplified, and should not be considered to be complete models. Parts of it are a model of a fictional company growing plants. It has one single customer and a small staff.

Some additional explanations are necessary, though. A system or a unit is drawn as an ellipse. There are also *iterations* of several kinds. In my example (s. below), the company only has one customer. Even if there were more customers, it would be possible to draw them and model the relationship to them all separately. However, if the company had 1000 similar customers this would seem highly impractical. Therefore, I have introduced the iteration. A normal iteration is unspecified, i. e. it is not known how many systems/units/entities of this kind there are. When using the *specified iteration* one specifies exactly the number of systems/units/entities of that kind. The *limited iteration* can either limit the number of systems/units/entities to be less than a certain number (e. g. < 6) or more than a certain number (e. g. > 500). If one makes use of the *specified interval*, there are more than x and fewer than y systems/units/entities of that kind.

The passing-by relation indicates that the matter only passes through the system. The system does not really interact with it (e. g. a guard acting as boundary for a factory). This construction can also be used with information.

The triangles symbolise information, while the rectangles symbolise matter/energy. The previously mentioned distinction between different kinds of information flows and matter/energy flows has been observed.

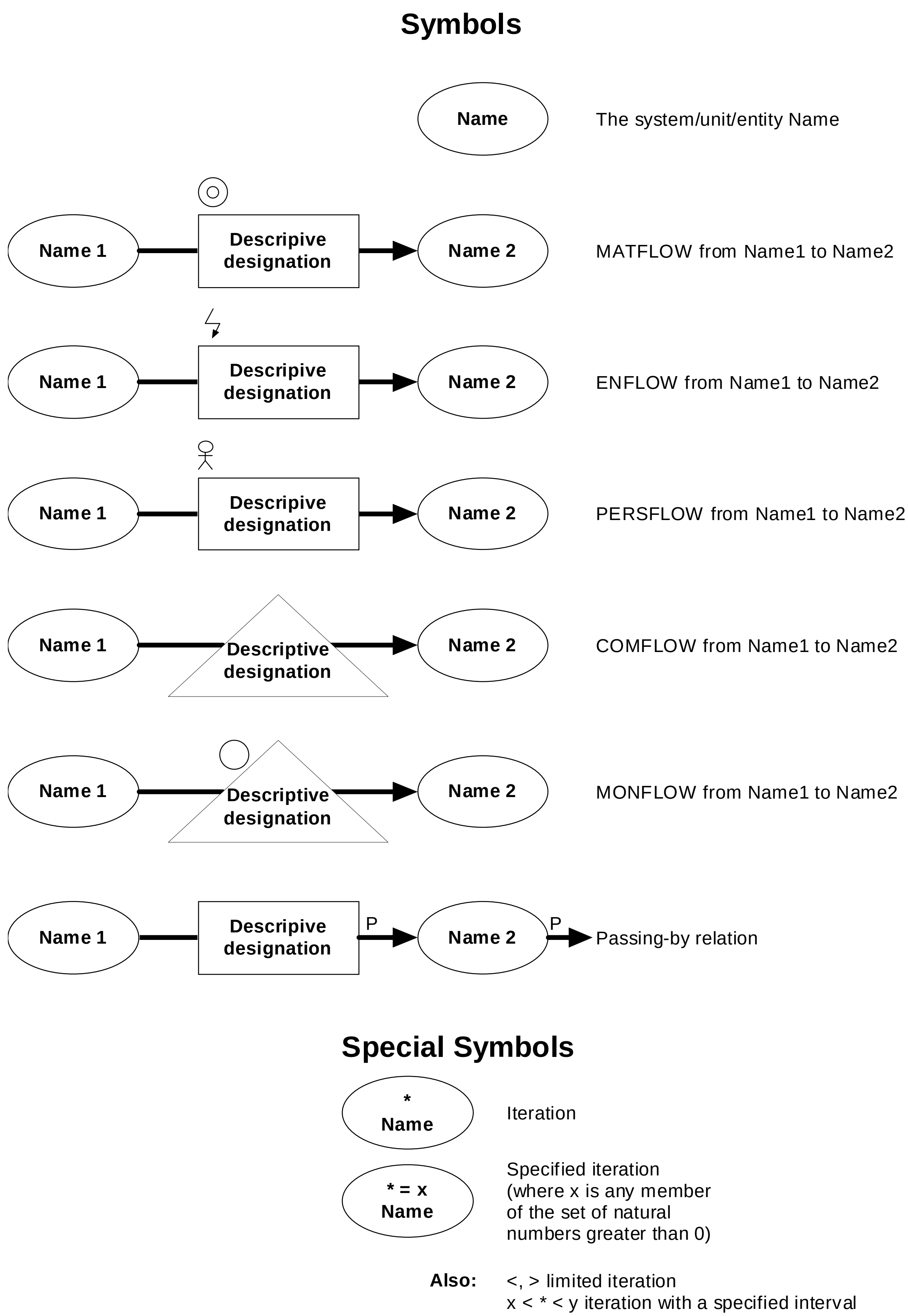


Figure 8: The symbols used in the graphical descriptions.

(It might be mentioned, for pedagogic purposes, that the small circle is a stylized coin. The two concentric circles were originally a very simple atom model, which was rather impractical if one drew it by hand.)

It might be asked why Dr. Samuelson's symbols (in Miller, 1995) were not used. Firstly, simplicity is desirable. His symbols are too many to be easily learnt and identifiable when a diagram is to be created. Secondly, it is not unusual to draw the first diagram(s) by hand, and it seems that his symbols would be too difficult or laborious to draw by hand (especially for those who are not very artistic). However, the specific set of symbols is not the most important aspect of this method, and they may be chosen ad libitum.

It should be noted that PERSFLOW involves matter, energy, and information.

9.4.1 Description No. 1: The Relations between the System and its Environment

In Figure 9, it is shown how a small company interacts with its environment using the different kind of flows of which Miller and Miller (1991) spoke. The description is incomplete, of course, but it should illustrate the principle. It buys electricity (a form of energy) from the power plant, and pays for it. A customer places an order, a plant is delivered, and payment is received. Our company needs soil. It places an order, the supplier delivers the soil, and the company pays.

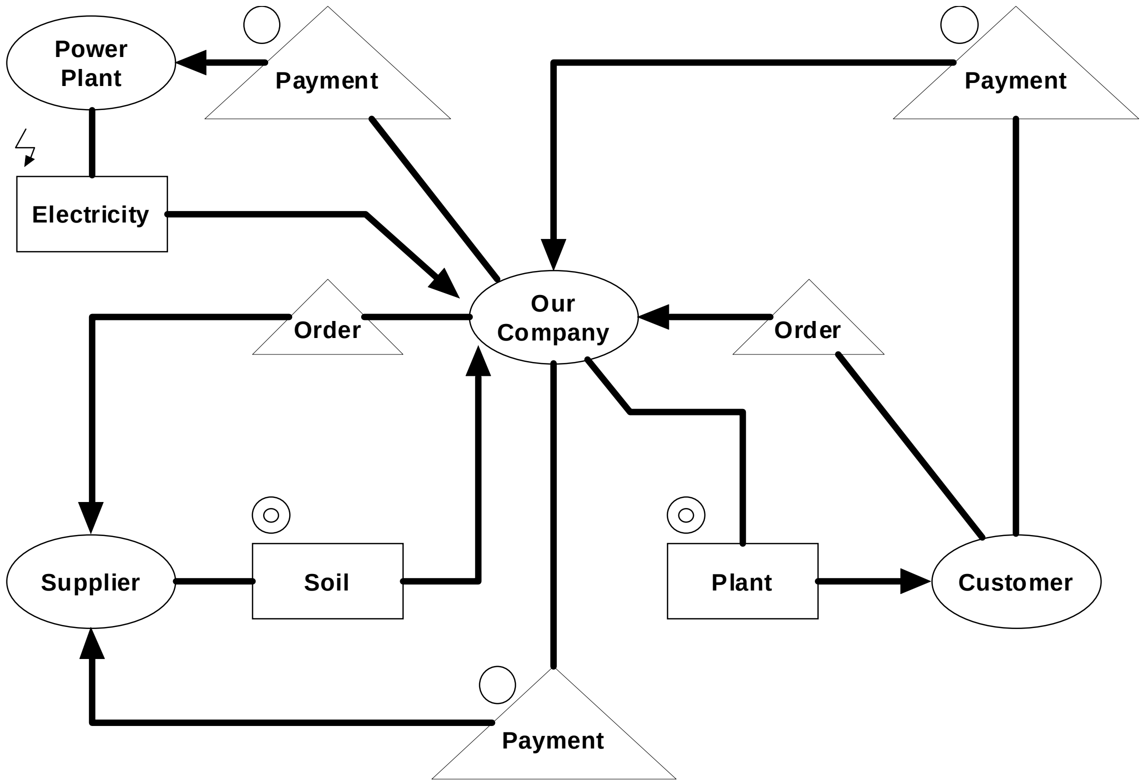


Figure 9: How a small company relates to other companies in its environment.

9.4.2 Description No. 2: The Relations between the Critical Subsystems

After having considered the external properties of our company in description No. 1, we now turn our attention to the internal propertied of our company and the external properties of the critical subsystems. An example of this is seen in Figure 10.

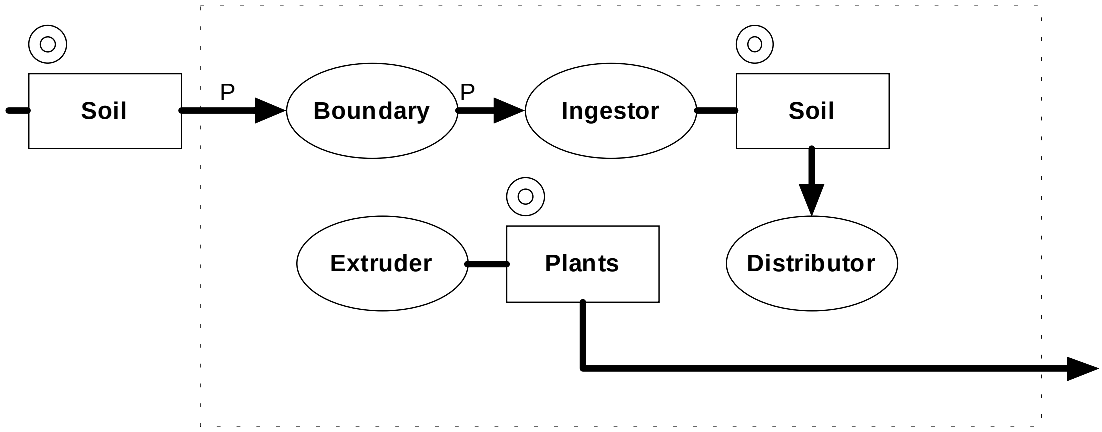
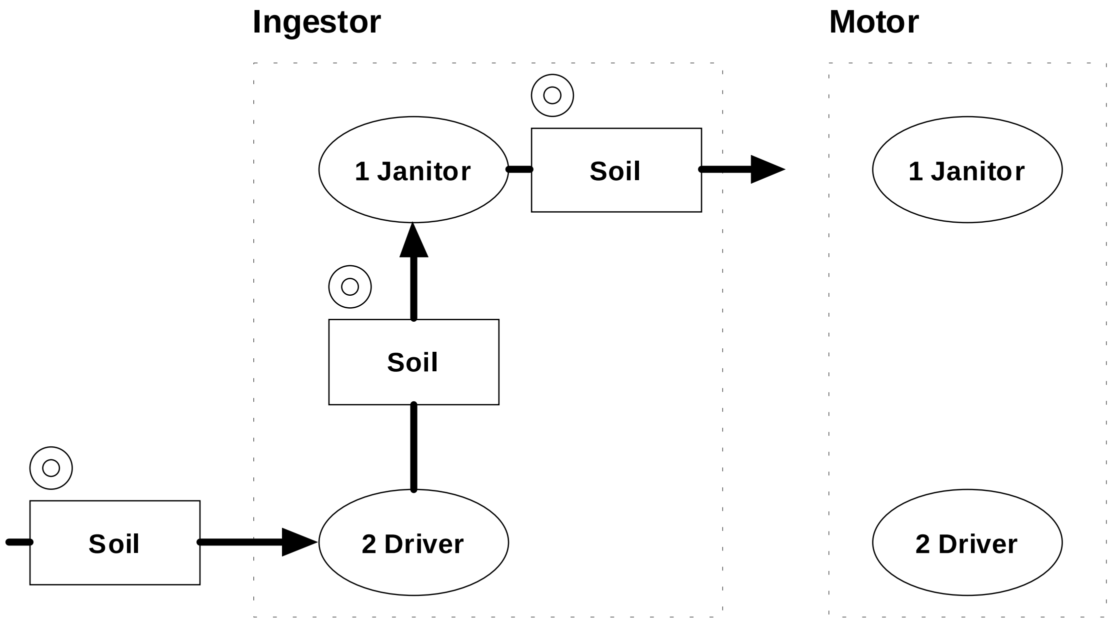


Figure 10: How the critical subsystems work together (highly incomplete sketch).

9.4.3 Description No. 3: The Inner Workings of the Critical Subsystems

In Figure 11, we see three incomplete descriptions of how the critical subsystems work internally. It is important to note that the units are numbered and that units in different subsystems have the same number. The number is unique; the description, however, is not. Not only does this serve to help separate different individuals, it also helps the analyst to know when the same individual appears in different subsystems. There are many roles that an employee can have.



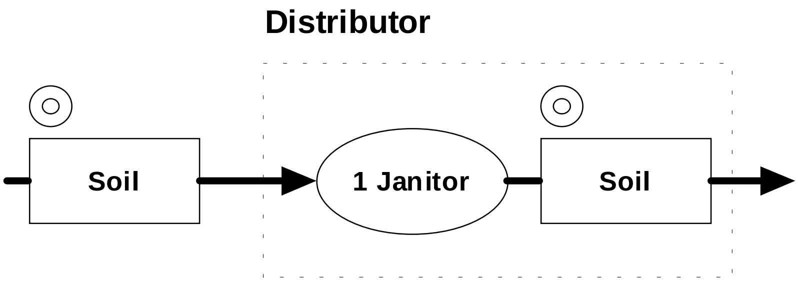


Figure 11: Three examples of descriptions of the way the critical subsystems work internally. Do note that the units are numbered.

9.4.4 Description No. 4: The Subsystems in which the Components are

To make this information more available, the analyst should make a table that describes in what subsystems an individual appears and what his roles are. In Figure 12, individual No. 2 not only appears in different subsystems, he (or she) also performs different tasks and has different roles.

Designation	Subsystem	Role
1	Ingestor	Janitor
1	Motor	Janitor
1	Distributor	Janitor
2	Ingestor	Driver
2	Motor	Driver
2	Producer	Gardener

Do note this!

Figure 12: A table to help keeping track of where individuals appear and what their roles are.

9.4.5 Descriptions No. 5 and 6: Groups

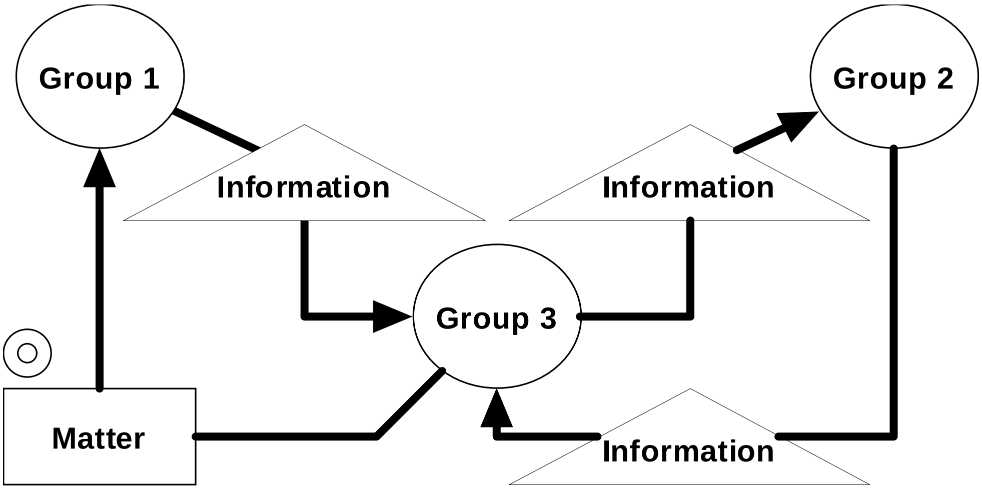


Figure 13: A description of how different groups interact.

In Figure 13 (illustrating description No. 5, “The relations between the groups of which the system consists”), we see how another important living systems concept, the group, is used. Organisations consist of groups, and it is therefore necessary to analyse their interactions and inner workings, just as with the critical subsystems.

Since the group-level is a part of Miller’s living systems theory (Miller, 1995), the most consequent approach to analyse their internal workings would be to analyse them in the same way as the organisation, i. e. identify the critical subsystems and model them as above and then identify the individuals (the organisms) of which the groups consist and their interactions just as in description No. 2 or description No. 5 (as demonstrated in Figure 13).

Description No. 6a (“The relations between the critical subsystems of the group”) – which will have to be made for every group – looks like description No. 2, and description No. 6b (“Description of the inner workings of the groups of the organisation”) looks like description No. 3.

9.4.6 Descriptions No. 7, 8, and 9: Components and Problems

Individual	Group
1	1
1	2
2	1
3	2
3	3
4	1
4	2
4	3

Figure 14: A list to keep track of in which groups a component appears.

As is the case with description No. 4, description No. 7 (“The groups to which the components belong”, s. Figure 14) helps the analyst to keep track of the roles that an individual plays and also in what contexts an individual appears.

In Figure 15 (description No. 8), there is a short demonstration of how the problems of an organisation are correlated to the pathology types. Every problem is numbered (so that it may be referenced with ease), given a description, and diagnosed using the pathology terminology. Furthermore, if a problem is caused by another problem on the list, this is noted. It is also noted if the problem causes or contributes to another problem on the list. In this way it is easier to see what is just a symptom and what problems one should take measures to correct (and subsequently also the symptoms).

Number	Term	Causes/contributes to	Caused by	Description
1	Lack of matter inputs	39 (or the plants are dying)	12	Not enough soil is delivered
2				
etc.				

Figure 15: A list of problems and pathologies used to correlate the problems to the pathologies and to see what is cause and what is effect.

Measure	Is Directed towards Problem #
New supplier	1, 12, 39, …

Figure 16: Measures. The design of a solution.

In description No. 9 (s. Figure 16), the analyst writes down the measures that should be taken and towards what problems these measures are directed. This helps the analyst not to forget to attend to any problem.

9.4.7 A Note about Descriptions Nos. 4-8

Although the individuals and groups are numbered in the examples above, this is not required. It is required, though, to use some sort of unique designation. Names are not acceptable. If the secretary, Mr. Smith, resigns and is replaced by Mrs. Jones, then there should be no reason to change the model, provided that they perform the same tasks in the same way, and it would obviously not be acceptable to refer to Mrs. Jones as Mr. Smith in the model; that is a possible solution but would be highly impractical.

9.5 Why Use Graphical, Semiformal Description Techniques?

According to Pohl (1994), there are three categories of description techniques, informal, semiformal, and formal, each of them having certain advantages. Informal descriptions (like natural language and drawings) are flexible, and can be used to describe almost everything. Semiformal descriptions, which are widely used in the area of requirements engineering, “are based on a structured graphical visualization of the system. The representations are clear and provide a good overview of the system” (Pohl, 1994, p. 6). Formal representation languages are semantically well-defined (as in predicate calculus); semiformal ones are less so.

While natural language descriptions are powerful, they also easily become ambiguous (Loucopoulos and Karakostas, 1995), and in general there should be no guarantee that they “provide a good overview”. Formal descriptions can be difficult to understand.

Because of all this, semiformal methods seem attractive to use in this method. Hopefully they can also, to a certain degree, help the analysts to communicate with the members of the organisation or to communicate among themselves.

One would also expect a structured graphical description to be easier to maintain than a large text describing the same thing, which is essential when applying the method repeatedly.

10. How does the New Method Relate to Earlier Methods?

10.1 In General

Before saying anything about in what ways the construction of the other methods resemble that of the new method described above, it is appropriate to mention something about the differences concerning the intentions.

It was earlier noted that Merker's (1985) method was intended to be used by managers, while QLSA was mainly intended for managers and others without scientific skills. The new method, that will henceforth be called ESV (*explicatio societatis vivae,* analysis of the living organisation), is intended for any analyst that is to some extent familiar with the basics of Miller's (1995) living systems theory.

As was mentioned earlier, QLSA addressed only information processing problems, which, as was also mentioned earlier, must be deemed insufficient. ESV aims to address all kinds of problems, i. e. it aims to be a general method dealing with both matter/energy and information.

Merker's (1985) method is quantitative, and QLSA is qualitative. It was said earlier that – in this work – the purpose of analysing an organisation is considered to be to gain an understanding of the organisation, its goals and objectives, and its problems. If this is sufficiently well accomplished without any measurements being done (one has to weigh the benefits against the costs), then no measurements have to be done. If, on the other hand, this is not satisfactorily accomplished without measurements being done, they should be done. ESV does not prescribe any specific course of action in this respect, but leaves the decision to the discretion of the analyst. The reader might think that there is a certain bias towards a qualitative approach, since no description technique explicitly supports quantitative measurements of the flows. While this might have some merit, it should not be expected that the description techniques should capture every aspect of an organisation that one wishes to describe; they are rather helpful tools. Also, this does in no way hinder the analyst from quantifying the flows that he has identified.

Method:	Merker's (1985)	QLSA	ESV
Who applies it?	Managers	Managers and others without scientific skills	Any analyst that is to some extent familiar with the basics of Miller's theory
What problems does it address?	All problems	Information processing problems	All problems
What kind of method is it?	Quantitative	Qualitative	Qualitative/quan-titative

10.2 Steps

While it was sometimes unclear whether or not some methods were waterfall models, ESV is clearly not a waterfall model. It is iterative.

ESV also assumes that when the solution has been evaluated it is time to go through the process again (although the pre-knowledge is now more extensive). It is not clear from the other methods that this will be necessary (although Merker's (1985) method requires the user to apply the seventh step continually).

Below follows a description of how steps in ESV correspond to steps in other methods, which have, to some extent, inspired it. The use of the word *correspond* is not intended to imply that the steps in the other methods cover all activities in the ESV steps, nor that these activities are identical.

The first step of ESV is *Initial problem*. There is no corresponding step in Merker's (1985) method nor in QLSA. Johnstone's (1995) method, as it is interpreted in this work, however, has a step equivalent to the first step of ESV, i. e. *Problem*.

The next step of ESV is *Identify the system*. There is no such explicit step in QLSA, but it seems that this is actually done in the first step, where the organisation is described, as was argued above. Merker's (1985) method has a step for this, *Identifying the systems purpose*, and this is also done in the second step (*Analysis*) of Johnstone's (1995) method.

The steps corresponding to the third step of ESV (*General description of the system*) in Merker's (1985) method are called *Identifying the system's purpose* and *Identifying inputs and outputs*. The QLSA correspondent is *I. Case history*, and in Johnstone's (1995) this is the activity identified as *Analysis: Identify the system*.

The fourth step, *Describe the organisation*, corresponds to the step *Analysis: Gathering information* in Johnstone's (1995) method. It partially corresponds to step II in QLSA. In Merker's (1985) method, it corresponds to *Identifying the subsystems*, *Identifying the subsystems' inputs and outputs*, and *Quantifying inputs and outputs* (ESV does not require the flows to be quantified, but if the analyst does so, the third and the fourth step are the steps where he should do so). In no step in the other methods the groups of the organisation are modelled.

The next step in ESV is to describe the problems that have been found. One could say that the diagnostic summary in step III of QLSA corresponds to this step, even though this step of ESV is more than a summary. There is no corresponding step in Merker's (1985) method. In the step *Causes of the problem* in Johnstone's (1995) method, the causes of the problem are identified on the basis of previously gathered information. This is not exactly the same as the ESV step, but it is similar.

The step *Managing the system: Analysing information* corresponds to the step *Find causes for the problems*, even though it cannot be said to correspond to any of the substeps, *Identify pathologies* and *Correlate the pathologies to the problems*. There is no equivalent step in Johnstone's (1995) method. The first substep corresponds to step II in QLSA, while the second one in some respects corresponds to step *III. Diagnostic summary of the problem*. Firstly, it is a kind of diagnosis. Secondly, answers to the pathology questions are related to the problems of the organisation in the third step of QLSA. However, this is not quite the same thing as relating the problems of the organisation to certain pathology types.

ESV has a separate step for designing a solution. The only step where this can be done in Merker's (1985) method is *Managing the system*. QLSA and Johnstone's (1995) method have the steps *IV. Prescription of appropriate solutions* and *Designing a solution to the problem*, respectively.

The implementation of the solution, in the second last step of ESV, takes place in the step called *Managing the system*, in Merker's (1985) method and in the step *Implementing the solution* in Johnstone's (1995) method. There is no such step in QLSA.

The last step of ESV, *Evaluate the solution*, does not really have any corresponding steps in the other methods, if one does not consider the repetition of *Managing the system* in Merker's (1985) method to be a kind of evaluation.

It is interesting to note that the last two steps are poorly represented in the other methods. The last but one appears in Johnstone's (1995) method, but that could depend on my interpretation of his study. The same is true regarding the first step.

ESV	**Merker's (1985) Method**	**QLSA**	**Johnstone's (1995) Method (as described here)**
Initial problem	No corresponding step	No corresponding step	Problem
Identify the system	Identifying the system	I. Case history	Analysis: Identify the system
General description of the system	Identifying the system's purpose Identifying inputs and outputs	I. Case history	Analysis: Identify the system
Describe the organisation	Identifying the subsystems Identifying the subsystems' inputs and outputs Quantifying inputs and outputs. (This is not necessarily done in ESV.)	Partially corresponding to *II. Analysis of the organisation's subsystems*	Analysis: Gathering information: • Identifying the equivalents of Miller's critical subsystems • Identifying the critical processes • Identifying information flows

Describe the problems that have been found	No corresponding step	III. Diagnostic summary of the problem	Causes of the problem
Find causes for the problems: Identify pathologies	No corresponding step (although the seventh step, *Managing the system: Analysing information*, corresponds to the description "Find causes for the problems").	II. Analysis of the organisation's subsystems	No corresponding step
Find causes for the problems: Correlate the pathologies to the problems	No corresponding step (s. above)	Reminding of *III. Diagnostic summary of the problem*	No corresponding step
Design a solution	Managing the system	IV. Prescription of appropriate solutions	Designing a solution to the problem
Implement the solution	Managing the system	No corresponding step	Implementing the solution
Evaluate the solution	No corresponding step (or possibly *Managing the system*)	No corresponding step	No corresponding step

10.3 Information

The information gathered when using this method is:

- Information about the limits of the organisation.
    - How far does the power of the decider reach?
        - Who reports to the decider?
        - Who obeys the decider?
- What kind of organisation is the organisation that is studied? What does it do?

    - What are the purpose, the goals, and the objectives of the organisation?
    - What is the role of the organisation in its suprasystem?
    - What are the inputs and outputs from and to the organisation (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs)? To and from what other systems do these flows flow?
- Information about the critical subsystems of the organisation.
    - What are the inputs and outputs of the critical subsystems (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs)? To and from what other systems do these flows flow?
    - Of what parts do the critical subsystems consist?
    - What flows (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs) flow between these parts, and to and from what parts?
- Information about the groups of which the organisation consists.
    - What groups are there?
    - What flows (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs) flow to and from what groups, and between the groups and the environment?
    - Of what parts do the groups consist?
    - Information about the critical subsystems of the groups.
        - What are the inputs and outputs of the critical subsystems (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs)? To and from what other systems do these flows flow?

    - Of what parts do the critical subsystems consist?
    - What flows (in terms of MATFLOWs, ENFLOWs, PERSFLOWs, COMFLOWs, and MONFLOWs) flow between these parts, and to and from what parts?
- Information about what roles the individuals in the organisation play.
- What are the problems of the organisation?
- What causes the problems of the organisation?
    - From which pathologies does the organisation suffer?
    - Which problems do the pathologies from which the organisation suffers cause?
    - Does a problem cause or contribute to another problem? Which one?
- Information about the solution.
    - What measures should be taken?
    - Which problems are the measures supposed to remedy?
- Is the solution satisfactory?
- If desirable: quantitative measures of all flows.

11. Results

Which goals were reached? The initial aim of this investigation was to make Miller's living systems theory applicable, and to describe how it could be applied in practice, i. e. how it could be applied to the analysis and design of organisations.

The ESV method provides the practical means to analyse an organisation making use of living systems theory concepts.

It was assumed that the purpose of analysing and describing an organisation is to gain an understanding of the organisation, its goals and objectives, and its problems. The method considers the goals and objectives of the organisation and tries to explain the problems in terms of pathologies. As was earlier stated, "Practically every explanation … can be said to further our understanding of things." (von Wright, 1975, p. 6) Understanding of an organisation was defined as awareness of the connections between it and other objects in its environment and between its parts. Using the ESV method the most important relations are identified, more specifically the interactions between the organisation and other systems and between the parts of organisation.

Three aspects that should be studied were mentioned:

1. What should the results of analysing an organisation be? I. e., what knowledge should one have gained about what? What does one want to know about the organisation? What aspects of it should one pay attention to?

2. How should an organisation be analysed? What steps are needed to give the desired results? In what order are they performed?
3. What techniques could be used to describe (model) and analyse an organisation?

These three questions are all answered by the method, which in itself is a kind of prescription concerning the steps, the description techniques, and what information should be gathered.

There was no time to make any interviews.

12. Discussion

12.1 What is the Value of ESV?

Living systems theory is vast and complex. Using it as it is to analyse an organisation is no easy task. The ESV method contributes to make living systems theory, as Holmberg (1995, p. 52) expresses it, "more operational and application oriented." It gives directions how to work, and it can also be considered as some sort of checklist that an analyst can follow, providing a structured method of working and answering questions like: What is important? What does one need to know? What should be done? How should it be done? In other words, it helps the analyst to focus on the relevant aspects of the organisation, (hopefully) without the analyst necessarily having a deep and thorough knowledge of living systems theory. It provides a guidance.

There are a few other methods, but they are not explicitly iterative, nor do they include all the steps included in ESV, nor do they make use of all the concepts that ESV does. ESV is also a rather detailed method, compared to, for example, Merker's (1985), and, contrary to the other methods, it provides an extensive set of description techniques.

12.2 What Important Concepts are Incorporated in ESV?

The division of living systems into levels is partially taken into consideration, since not only the organisational level but also the group level is considered.

The fundamental critical subsystems are indeed considered, since the analysis of their interactions and their inner workings is one of the cornerstones of ESV, just as the notion of critical subsystems is to living systems theory.

The eight causes for pathological conditions play an important part in the problem solving process in ESV.

Matter, *energy*, and *information* are also thoroughly considered. Indeed, the fundamental modelling concepts make use of the five types of flows in organisations, which include matter, energy, and information.

Attention has been paid to the implications of the concepts of internal and external properties, though not explicitly. For every system that is studied, the external properties are considered before the internal ones are (perhaps it is not even always necessary to consider the internal properties).

12.3 What Concepts have not been Considered or are Weakly Supported?

Important concepts in living systems theory are *space*, *time*, *matter*, *energy*, and *information*. While the flows of matter, energy, and information are modelled, space and time have not been given a great deal of attention, although the timer has not escaped attention.

The division into levels is partially considered, since the groups of the organisation have been regarded, and the environment of the organisation is also considered. However, the levels of community and society, for example, have not been explicitly considered. On the other hand, too careful an analysis of these levels might prove to be far too laborious for it to be feasible. This topic requires further consideration.

12.4 Future Work

In order to perfect the method and evaluate it, it will be necessary to apply it to the analysis of a real organisation. This will have to be done in some future work. It is quite possible that that would reveal that some aspects of the method could be improved. It is also possible that it would then be easier to answer the question about how the different levels above the organisation should best be handled.

A few concepts were not employed to any significant extent, e. g. time and space. How to amend the method by adding these concepts is another question that further research might answer.

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Appendix A: Miller’s Twenty Critical Subsystems

Miller defines the critical subsystems in the following way:

- **Reproducer** is "the subsystem which carries out the instructions in the genetic code or charter of a system and mobilizes matter, energy, and information to produce one or more similar systems." (Miller, 1995, p. xix)
- **Boundary** is "the subsystem at the perimeter of a system that holds together the components which make up a system, protects them from environmental stresses, and excludes or permits entry to various sorts of matter-energy and information."
- **Ingestor** is "the subsystem which brings matter-energy across the system boundary from the environment." (Miller, 1995, p. xix)
- **Distributor** is "the subsystem which carries inputs from outside the system or outputs from its subsystems around the system to each component." (Miller, 1995, p. xix)
- **Converter** is "the subsystem which changes certain inputs to the system into forms more useful for the special processes of that particular system." (Miller, 1995, p. xix)
- **Producer** is "the subsystem which forms stable associations that endure for significant periods among matter-energy inputs to the systems or outputs from its converter, the materials synthesized being for growth, damage, repair, or replacement of components of the system, or for providing energy for moving or constituting the system's outputs of products or information markers to its suprasystem." (Miller, 1995, p. xix)

- **Matter-energy** storage is "the subsystem which places matter or energy at some location in the system, retains it over time, and retrieves it." (Miller, 1995, p. xix)
- **Extruder** is "the subsystem which transmits matter-energy out of the system in the forms of products or wastes." (Miller, 1995, p. xix)
- **Motor** is "the subsystem which moves the system or parts of it in relation to part or all of its environment in relation to each other." (Miller, 1995, p. xix)
- **Supporter** is "the subsystem which maintains the proper spatial relationships among components of the system, so that they can interact without weighting each other down or crowding each other." (Miller, 1995, p. xix)
- **Input transducer** is "the sensory subsystem which brings markers bearing information into the system, changing them to other matter-energy forms suitable for transmission within it." (Miller, 1995, p. xix)
- **Internal transducer** is "the sensory subsystem which receives, from subsystems or components within the system, markers bearing information about significant alterations in those subsystems or components, changing them to other matter-energy forms of a sort which can be transmitted within it." (Miller, 1995, p. xix)
- **Channel and net** is "the subsystem composed of a single route in physical space, or multiple interconnected routes, over which markers bearing information are transmitted to all parts of the system." (Miller, 1995, p. xix)

- **Timer** is "the subsystem which transmits to the decider information about time-related states of the environment or of components of the system. This information signals the decider of the system or deciders of subsystems to start, stop, alter the rate, or advance or delay the phase of one or more of the system's processes, thus coordinating them in time." (Miller, 1995, p. xix)
- **Decoder** is "the subsystem which alters the code of information input to it through the input transducer or internal transducer into a 'private' code that can be used internally by the system." (Miller, 1995, p. xix)
- **Associator** is "the subsystem which carries out the first stage of the learning process, forming enduring associations among items of information in the system." (Miller, 1995, p. xix)
- **Memory** is "the subsystem which carries out the second stage of the learning process, storing information in the system for different periods of time, and then retrieving it." (Miller, 1995, p. xix)
- **Decider** is "the executive subsystem which receives information inputs from all other subsystems and transmits to them information outputs for guidance, coordination, and control of the system." (Miller, 1995, p. xix)
- **Encoder** is "the subsystem which alters the code of information input to it from other information processing subsystems, from a private code used internally by the system into a 'public' code which can be interpreted by other systems in its environment." (Miller, 1995, p. xix)

- **Output transducer** is “the subsystem which puts out markers bearing information from the system, changing markers within the system into other matter-energy forms which can be transmitted over channels in the system’s environment.” (Miller, 1995, p. xix)

Reproducer and boundary process both matter/energy and information.

Ingestor, distributor, converter, producer, matter-energy storage, extruder, motor, and supporter process matter/energy.

Input transducer, internal transducer, channel and net, timer, decoder, associator, memory, decider, encoder, and output transducer process information.

Appendix B: The Questions Asked by Taormina

Taormina's (1991, p. 198) questionnaire contains the following questions:

"A. Input Transducer

1. Structure
    a. What is the recommended structure?*
    b. What is the existing structure?
2. Process
    a. What is the recommended process?*
    b. What is the existing process?*
3. Pathologies
    a. Is the incoming information being adequately sensed?
    b. Is the incoming information being accurately changed?
    c. Is the information being efficiently transmitted?

B. Internal Transducer

1. Structure
2. Process
3. Pathologies
    a. Is the operations information being adequately sensed?
    b. Is the operations information being accurately changed?
    c. Is the operations information being efficiently transmitted?

C. Channel and Net

1. Structure
2. Process
3. Pathologies
    a. Are the channels open?

b. Are the channels operating efficiently/effectively?

i. Can the information be transmitted?

ii. Is the information being purposely withheld?

iii. Is the information being deleted?

iv. Are messages being delayed?

v. Are messages being distorted?

vi. Is appropriate information being transmitted?

vii. Is conflicting information being transmitted?

viii. Can the information be received?

ix. Is the information being purposely avoided?

D. Timer

1. Structure

2. Process

3. Pathologies

a. Can information about the start of processing be sent?

b. Can information about the stopping of processing be sent?

c. Can information about the rate alterations be sent?

d. Can information about change of phase in processing be sent?

E. Decoder

1. Structure

2. Process

3. Pathologies

a. Is the information being decoded (explained)?

b. Is the information being decoded correctly?

c. Is the information being decoded completely?

F. Associator

1. Structure

2. Process

3. Pathologies

a. Are there feedback mechanisms for information to be associated?

b. Is the information being associated?

c. Is the information being correctly associated?

d. Is the information being associated adequately?

G. Memory

1. Structure

2. Process

3. Pathologies

a. Is the information being correctly read into the storage?

b. Is the information being maintained in storage?

c. Is the information being appropriately altered (updated)?

d. Is the information being appropriately deleted?

e. Is the information being appropriately retrieved?

H. Decider

1. Structure

2. Process

3. Pathologies

a. Are problems/opportunities being recognized?

b. Are problems/opportunities being defined?

c. Are alternative options being generated?

d. Is information on the alternatives being gathered?

e. Are the alternatives being evaluated simultaneously?

f. Is the optimal alternative being selected?

g. Is the selected alternative being correctly implemented?

h. Is the effectiveness of the implementation being evaluated?

i. Is there a feedback mechanism for reevaluating the problem?

I. Encoder

1. Structure

2. Process

3. Pathologies

a. Is the information being encoded/altered/translated?

b. Is the information being appropriately encoded/altered/translated?

c. Is the information being completely encoded/altered/translated?

J. Output Transducer

1. Structure

2. Process

3. Pathologies

a. Is the outgoing information being adequately transmitted?

b. Is the outgoing information being accurately transmitted?

c. Is the outgoing information being efficiently transmitted?

*The structure and process questions are repeated for every subsystem.”