

Faults, errors and failures in communications: A systems theory perspective on organisational structure

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Abstract

Abstract communications systems theory may be a valuable tool for the description, prediction and control of organizations. An organization is conceptualized as an abstract system of inter-human communications; humans are the main organization 'communication units' which produce and receive communications (but humans are not part of the abstract system). Organization systems tend to grow in complexity, enabling a more complete modelling of their environment and a greater range of adaptive responses. Growth of organization systems is facilitated by appropriate structures, which can be seen as constraints on organisational communications. Organizations are prone to failure (when a system's communications do not continue) due to 'faulty communications' and 'errors' in communication. We analyse faults, errors and failures of organisations in systems theory context. Faulty communications do not fit the lexicon of the system's language and typically fail to lead to continuation of communications. For example, a sentence or text which makes no sense in organizational terms. Errors are communications which fit the system's language but which are in conflict with the environment, so that the system cannot respond adaptively to the stresses placed on it by the environment. For example, an organization may fail when a product is made but cannot be sold. Organizational failure may be made less likely by increasing the complexity of the organization through evolving appropriate internal structures. These could include 'management' subsystems (eg. accounts, sales, personnel) each with functionally specialized languages having precise meanings. Management subsystems may perform identity-checking of communications to minimize the damage from faulty communications, and self-modelling of the organization and its environment to allow early detection and remediation of communication errors. We discuss how structures can reduce the effects of faults, errors and failures, if they increase the environmental fitness of the organisation, and how they increase their negative effects, if they fail to increase the environmental fitness of the organisation.

1. Introduction

Organisations are plentiful in the modern social environment. They involve a number of humans purposefully coordinated (although an organizations joint goal may be perceived only partially, and by a minority of human participants; [1]). Given their importance in contemporary societies, there have been many attempts to understand organisations over many decades [2].

One way to understand organisations is to analyse their internal structures and the role of these structures. Organizational structures may be defined by their distinctive rules, which limit the range of activity of some members of the organisation [3]. Sometimes the structures involve physical separation of members of organisation involved in separate spatial units (e.g., offices). But the most important aspect of organisational structures is that they describe the *information* flow within the organisation, and the rules that define structures channel the behaviours of the organisation [4]. Therefore the organizational structures may become most obvious when the organisation is 'in trouble' and the causes of problems are being sought.

Faulty behaviours and errors are a common source of trouble within organisations [5-8]. Examples include the mishandling of social benefit applications, operating on the wrong patient, convicting the wrong person, buying the wrong stock, or neglecting to disclose crucial information [9-11]. Such

mistakes may lead to collapse of the organisation, inadvertent killing of people, or many other kinds of damaging organisational outcomes [12-15].

The theory of abstract social communication systems [16,17] conceptualizes social structures and organisations as systems of inter-human communications. In this interpretation the system is made of communications, but the humans who produce communications are *not* part of the system. In organizational systems humans are termed *communication units*. Communication units (such as humans in organizations) receive, process and transmit communications, but communication units are not themselves communications. (An analogy is that a computer may consist of many communication units that process information in a systematic fashion, but the computer hardware is distinct from the information being processed.). Humans are communication units in numerous other social systems, as well as any specific organization under analysis (e.g., the political system, the family, religion, mass media etc.), and humans are also communication units for the individual system of subjective consciousness and numerous (non-conscious) physiological monitoring and control systems.

Abstract communication systems theory offers powerful tools to analyze social systems, uncover their underlying logic and structure, and to understand their interactions [16-20]. We note that Barnard [21] and his followers (e.g., [4]) used a similar theory to describe organisations and analyse management. Another similar approach is the social rule system theory of Burns and Flam [22], and comparable ideas can be also found in various interpretative theories of organisations [23].

In this paper we apply the theory of abstract social communication systems to analyse organisations. In particular we aim to reveal the role of structures within organisations, with a specific focus on their role in terms of dealing with the faults, errors and failures that occur within organisations¹. We argue that structures can be seen as a set of constraints on communications that constitute the organisation. We also demonstrate that structures have a vital role in handling organisational faults, errors and failures, being able to limit their damaging effects within the organisation. Section 2 introduces the basic concepts of abstract communications systems theory, Section 3 discusses the interpretation of organisations in terms of this theory, Section 4 focuses on the structures of organisations in the abstract communications systems framework, Section 5 analyses the role of structures in dealing with organisational problems and Section 6 draws some conclusions.

2. Abstract communication systems

In this section we introduce fundamental concepts of abstract communication systems theory following the work of Luhmann [16,17]. Each introduced concept is explained in theoretical terms supported by practical examples highlighting the relevant features of the concept.

Abstract communication systems are made of sequences of symbolic communications between communication units. As described above, the communication units are not themselves a part of the system – because the system is constituted by communications and the processes they undergo. Communications are not simple atomic units of information since they *reference* other communications. Referencing means that the sequence of symbols contained in a communication is dependent on the content of other earlier or simultaneous communications, and thereby refer to them. A dense cluster of inter-referencing communications surrounded by a sparse set of communications constitutes a communication system. In other words, a system is constituted by significantly denser communications than its environment.

For example the system of science contains all communications which reference earlier scientific communications and which follow the rules of scientific communications (e.g., allowing the possibility of falsification, using logical reasoning etc.). Most scientific communications are scientific papers, which explicitly reference other scientific papers, and use the conclusions of earlier papers as premises of the logical reasoning presented in the paper. Note that according to systems theory, the human scientists are *not* part of the system of science, only their scientific communications are part of this system.

A communication system is defined by the regularities that specify how referenced communications determine the content of a referencing communication (for example the regularities which define how already-published scientific papers influence later scientific publications which cite them). All

¹ We note that our definitions of the concepts of fault, error and failure are to some extent overlapping, but also to some extent different from standard definitions of these concepts accepted in the literature of dependable computer-based systems [24].

communications that follow the set of rules defining the system are part of the system. Other communications that do not follow the rules of the system are part of the system's *environment*. Therefore from the systems perspective the world is constituted by the binary distinction between the system and the system's environment.

The set of regularities of referencing constitutes an abstract grammar, which defines an abstract *language*, characteristic of the system. For example economics and medicine have distinctive specialist languages, with distinctive lexicons and processes of evaluation; and scientific communications belong to one or other of these sciences according to whether they follow the rules of the specific language of economics or medicine.

System reproduction

Communication systems reproduce themselves by recruiting new communications, which follow the referencing rules of the system.

For example, the growth of the system of science can be seen in the increased numbers of scientific papers (in practice, these extra communications are produced by increasing numbers of scientists, but it is the increase in communications which defines the growth of the system.). The recruitment of new communications depends on earlier communications generated by the system, and the potential for reproduction depends on how well a system is adapted to its environment. The better adapted the system, the greater its potential for reproduction.

Adaptation is a consequence of the system modelling the environment. The system's model of the environment may be more or less complex. A more complex model of the environment contains more information on the environment and therefore constitutes a more detailed *description* of the environment. A more detailed description of the environment is potentially a more useful description in that it can sample and monitor more aspects of the environment, can process this information in more complex ways, and can lead to a greater range of system responses.

A system can be understood as a set of self-describing communications, which at the same time describes its environment in a complementary sense. This implies that the system's only 'knowledge' of its environment is within the system itself. A system has no direct access to its environment; rather the system models the environment – just as the human mind has no direct access to the content of other minds, but must model the contents of other minds. In this sense a human's knowledge of another person is 'complementary' because describes the ways in which other people are distinct and different. A system's model is the sum of its knowledge of the environment, and the system's model of the environment is complementary to the system's model of itself. More complex and more precisely-predictive descriptions of the systems environment enable a greater success of the system in recruiting new communications, and more rapid reproduction and expansion of the system.

For example a growing economy is a system of monetary transactions which describes the economic environment relatively faithfully – that is, the right price is paid for goods and services with the right value. Such an economy is characterized by a moderate and predictable increase of prices. But in an economy where prices fluctuate widely and without close reference to the value of goods and services, the monetary transactions are characterised by significant *inflation*. In such economy the system of monetary transactions does not describe the economy faithfully, and the economy gets smaller instead of growing – the economy is not reproducing itself. Economies with low inflation generally grow faster than economies with high inflation.

In both cases, the monetary system describes the economic environment through generating new transactions by applying its own rules that define how new monetary transactions follow earlier transactions (e.g., a bank may provide loans if it has enough reserves). The information provided by prices is a description of the economy. If the monetary description fits the economic environment, then there is little inflation. If there is not so good a fit between monetary and economic systems then this is characterised by high inflation.

Systems communicate about themselves

The system communications are about the system itself. This means that system communications reference other system communications, where 'reference' means that system communications derive-from and are caused-by other system communications. This referencing is done in order to prove that communications are part of the system and not part of its environment. System communications must be 'correct' according to the rules of the system. This means that all systems entail a 'checking' of

communications to allocate communications in a binary fashion: either as being included within the system, or excluded as outside the system.

If communications lead to continuation of communications, then (in effect) the system continues on the basis that communications are being accurately checked and correctly identified. There is an implicit assumption that the system is well-adapted. If a system is able to generate/recruit new communications according to the rules of the system, this therefore does not lead to any pressure for change.

In general, it is not possible to prove the *correctness* of system communications – correctness is assumed so long as communications are continuing. Indeed all communications are almost certainly incorrect, in the absolute sense, because the environment of a system is infinitely complex (all the rest of the world) while systems are necessarily physically and temporally constrained in their complexity. Correctness of communications is therefore only relative and contingent. Communications are ‘relative’ in the sense of some communications being more correct than others, some communications are more successful at leading to further communications. Therefore, correctness of communications is defined in terms of how many continuations result from a communication compared with other communications. (An incorrect or ‘faulty’ communication typically leads to no further communications – see below.) Communications are ‘contingent’ in the sense of communications not *yet* having been shown to be incorrect. A communication may be contingently defined as correct, because it has led to further communications, but at some point in the future these communications may cease and the communication may be retrospectively re-defined as incorrect (‘faulty’).

But there is an asymmetry to correctness *versus* incorrectness. While communications are never explicitly classified as ‘correct’, a system may nonetheless classify communications as incorrect, and their incorrectness can be ‘proven’ (‘proven’, that is, within the constraints of the system). (Indeed, detection of incorrect communications, and adaptive responses, is a vital aspect of system functioning.) Incorrect communications are proven by the failure of further continuation of communications derived from the original (incorrect) communication. This may be termed the Popper Principle, due to its similarity to Karl Popper’s argument that scientific hypothesis can be shown to be false, but not to be true. We will discuss the implications of incorrect communications in detail below.

Differential growth of systems – expansion *versus* extinction

Systems vary in their complexity and adaptedness. Those systems which reproduce and expand faster than other systems may cause the contraction and eventual extinction of more slowly reproducing systems.

The limits of system expansion are determined by the probabilistic nature of referencing rules. A communication may reference several earlier communications indirectly through other referenced communications constituting referencing *sequences* of communications. The indeterminacies of referencing rules determine how long can be such referencing sequences of communications before the later communications become a random continuation.

This phenomenon is akin to the party game of ‘Chinese whispers’ – in which a phrase is whispered from one person to another and gradually changes its meaning, with frequently amusing results - demonstrates that long sequences of quiet, once-heard, verbally transmitted linguistic phrases can only preserve information for short serial sequences of transmission before they deteriorate to random ‘noise’. (For instance the apocryphal story of a message being passed along a trench in the 1914-18 world war which began as ‘send reinforcements we’re going to advance – and ended as ‘send three-and-fourpence, we’re going to a dance’).

By contrast, linguistic phrases written and copied on scraps of paper from person to person would be able to support much longer sequences of transmission before the probability that the message would have degenerated to unrelated noise. The point is that some sequences of communications have greater stability than others, but that the ‘copying error’ of each step in communication is always compounded with each step in the transmission until the noise exceeds the signal.

Yet longer referencing sequences of communications contain more information and potentially allow more detailed descriptions of the systems and its environment. The optimal size of the system (i.e., the maximum number of simultaneous communications being part of the system) is also determined by the indeterminacies of referencing rules. (Systems that overgrow their optimal size may split into smaller systems.)

For example, we may consider the introduction of electronic storage and management of information in companies. In the earliest companies information was mainly stored in the minds of people, and transmitted verbally. The long ‘chain of command’ in large companies would then generate a Chinese whispers problem. First paper, then later electronic, storage and data management greatly

increases the accuracy of communications, and the longevity of records allows for checking. The implication is that the environmental descriptions of companies using electronic data are potentially greatly more complex than those of companies that lack electronic data. Indeed, companies adopting electronic data typically out-compete companies that use paper based data systems. But whatever the data system, there are limits to the length of communicant sequences it can handle. When companies overgrow their optimal size (optimal, than is, in relation to their rival competitors), they typically split, and create subsidiaries (e.g. regional offices).

Memory sub-systems

As communication systems grow, the overall system may develop sub-systems that are systems within the system, i.e., sub-systems constitute a denser inter-referencing cluster within the dense communication cluster of the overall system.

Communications that are part of sub-systems follow overall system rules with additional constraints that are characteristic of the sub-system. More constrained referencing rules decrease indeterminacies and allow the system to generate better complementary descriptions of the environment and expand itself faster than systems without sub-systems. For example, within the overall system of biology, the subsystems of molecular biology and neuroscience share the general vocabulary and rules of biology, but each subsystem has an extra and more specialized vocabulary and mode of experimentation and argument.

Systems may also change by simplification of the set of their communication symbols (i.e., by reduction of the number of such symbols). This may lead to reduction of indeterminacies in the referencing rules. Consequently systems with simpler sets of communication symbols may expand faster than systems with larger sets of communication symbols. This apparent paradox is that simplification and short-term contraction of a system often leads in the longer term to greater growth and complexity.

For example in the case of very small companies, all activities (e.g., marketing, production, accounting, planning) may be done by each member of the company. In larger companies, people may specialize into subsystems each of which is involved in a restricted set of activities (e.g., individuals work in marketing or 'accounts'). Within each subsystem of a company, the scope of information is limited, which means that equivalently informative communications can be shorter and more precise (eg. within the marketing department, most communications are pre-classified as being about marketing, and individual communications do not need to be individually referenced as such). Small companies are therefore often characterized by more complexity in their language, and by greater indeterminacy in their communications, and therefore cannot support such long sequences of communications. Consequently small companies tend to grow more slowly than large companies which contain specialized sub-systems (this applies only when the companies are below their upper size limit caused by the constraints of the communication system).

Another way of generating more reliable descriptions of the environment (i.e., non-random sequences of referencing communications) is by retaining records of earlier communications - i.e., by having *memories* of earlier communications. Memories are relatively long-lasting communications that can be referenced by later communications. Memories can be viewed as new communication units (or the recruitment of communication units) that produce special longer-lasting memory communications which can be referenced in place of some other shorter-lasting communication which is the product of a longer continuation sequence.

In other words, memories reduce the indeterminacies in referencing by allowing *direct* referencing of much earlier communications, instead of referencing early communications only via a long chain of references. So, instructions arising from a meeting may be referenced by A, who attended the meeting, telling B, who asks C to instruct D. Or else, D can be asked to refer directly to the minutes of that meeting – the record of which represents a memory. Systems with memory can become more complex and expand faster than systems without memory.

The effect of printing on science is another example. Before printing was invented science grew slowly, since it was based on the difficult and time consuming reproduction of scientific texts by handwriting. After the invention of printing, the system of science was able to expand much faster than before, with written texts serving as memory communications.

Systems with memory may develop a specialized memory sub-system with the memory system containing longer-lasting communications referenced to the past of the system. A memory sub-system allows a wide range of evaluative functions such as the summarization of memories, the combination of memories, and the comparison and selection of memories in order to make them mutually consistent.

This comprises the generation of new, complex (and longer lasting) descriptions of the environment, which are potentially more adaptive than in systems without memory sub-systems.

As an example we may consider a self-employed individual who has a part-time job repairing domestic appliances at his home. If he was to keep files of his work and expenses these would constitute the memories of the system constituted by his part time job – but they would not be a memory subsystem. However, if he turned his part time job into a full-time business, these files could be used to make longer-term plans about matters such as buying supplies, storage and the need for employees. Typically, this would entail the creation of a memory sub-system of the new business – and such a memory sub-system would potentially enable a complex business to grow more rapidly than the much simpler filing system of part time jobs.

Identity-checking sub-systems

The memory sub-system may evolve into what could be termed an ‘identity-checking’ sub-system, the function of which is to specialize in the intrinsic system function of evaluating whether a given communication is part of the system or not. Determining the identity of a communication as system or non-system may entail an observational system which samples both current communications and memory communications, and checks the validity of current communications by reference to memory. An identity sub-system may therefore decrease the likelihood of generating wrong communications that cannot be referenced according to the rules of the system and which would (if wrongly accepted as valid communications) endanger the future continuation of the system. Reducing the likelihood of wrong communications also helps the expansion of the system, by providing greater assurance that system communications are correctly classified as being part of the system, and can be referenced by future system communications.

For example in the context of the political system political decisions are formulated as laws or regulations, which are precisely codified and classified by the legal system in long-lasting media (eg. written files). These laws are referenced by later political communications to help ensure that new political communications are not in contradiction with existing legislation. If individual laws are mutually contradictory then the legal system does not constitute a single complex system that is usefully descriptive of the environment, but instead a number of smaller and much less complex systems of limited applicability.

The specialized legal system, as with any memory subsystem, performs a wide range of evaluative functions such as the summarization, combination, comparison and selection of laws in order to make them mutually consistent – in other words to make them a single system with a consistent logic of evaluation. When society is changed such that a law does not, any longer, provide a useful description of the environment – then the legal system may need to remove or modify this law. Countries characterised by stable laws typically have complex political systems with long-lasting political institutions. By contrast, countries in which laws are changed frequently, and which lack complex legal systems with internally consistent legal evaluation processes frequently find that new political decisions are not compatible with earlier political decisions. This in turn prevents the political system from expanding as evolving in its complexity - and political institutions are relatively unstable.

Faulty communications

Faulty communications may occur in systems. Faulty communications are defined as being a part of the system (i.e., they reference system communications), but faulty because they do not fit the lexicon of the system’s language or they have zero probability of production according to the rules of the system’s grammar. For example in human language the pronunciation of a meaningless phoneme such as ‘belf’ in the context of ‘I am wearing a belf to keep my trousers up’ is a faulty communication in English, since ‘belf’ is not a word. Similarly, the phoneme combination ‘belch’ would be a faulty communication in the context of ‘I am wearing a belch to keep my trousers up’; since, although belch is a word, a belch cannot be worn, and there is zero probability of producing this word in this context according to the grammar of English communication.

It is an important function of the system to differentiate between faulty system-communications, and non-system communications (i.e., communications from outside the system), since these have different implications. Discriminating between faulty system communications and non-system communications requires a consideration of the referencing set of the communication being checked. When the referencing set of a communication contains predominantly system communications, and when the communication in question is produced *instead of* a regular system communication that should follow by application of some system rules (e.g., ‘belf’ or ‘belch’ instead of ‘belt’), the

communication in question is a faulty communication. However, someone might overhear what is (from the perspective of the English language) a ‘meaningless’ phoneme, but this comes from a conversation between two people using the Chinese language – such a communication is not faulty, rather it comes from another system, and is referenced to that other system.

Typically, a faulty communication will not lead to any continuation of communication within the system – that line of communication will then cease, and the root cause of this cessation may be located in the faulty communication. For instance when the word ‘belf’ is used in conversation, other people will not understand the word ‘belf’, so that further communications referenced to ‘belf’ cannot occur (eg. they may be ‘stunned into silence’). Another example would be when a genetic mutation is lethal, leading to the death of a cell or organism, and therefore the stopping of further communications.

But in rare instances, communications may reference faulty communications, and this may lead to further problems within the system which can be traced back to the faulty communication. For example, if heard ‘belf’ and understood that trousers were being held up by something called a belf, and falsely concluded that it was a loop of transparent – hence invisible – polythene – then tried to purchase a ‘belf’ for their own use. Communications would continue as the pointless search for a ‘belf’ continued until finally it was concluded that the ‘belf’ did not exist – this maladaptive search could potentially be traced back to the faulty communication of ‘belf’. In other words, most continuations from a fault are not a useful description of the environment, and tend to lead to damage to the system, eventually leading to a requirement to exclude a set of communications from the system – for example the deletion from the system of all communications concerning ‘belfs’ except those that mark it as a fault.

Even more rarely, a faulty communication can have positive, adaptive consequences – when a faulty communication is ‘misunderstood’ or misinterpreted by the system in a way that – by chance – happens to benefit the adaptiveness of the system relative to systems that have not experienced this fault. Indeed, biological evolution by natural selection is based on the fact that – while the vast majority of genetic mutations (ie faulty communications – due to mistakes in copying DNA which are not detected and corrected by the DNA repair mechanisms) are deleterious, a minority of genetic mutations increase the reproductive success of organisms (ie such mutations increase the number of communication continuations).

Errors in communication systems

Errors are problems that are encountered by systems which are due to the limitations of the system, even when the system is working properly. Since the environment is infinitely complex, any system’s modelling of the environment will be highly simplified, and contingencies may arise in which the system behaves (relatively) maladaptively. All systems necessarily have highly simplified models of the environment and the environment is more complex than the system. Therefore ‘incorrect’ descriptions of the system’s environment are inevitable and all systems are prone to errors.

Errors of communication systems are therefore cases of system maladaptiveness where communications happen according to the rules of the system, but they cannot lead to continuation because of environmental constraints. From the internal perspective of the system, communication units that are expected to produce continuations of communication do not in fact do this. For instance, a ‘perfectly functioning’ factory may be producing fully functional drinking glasses according to proper procedure is nonetheless running at a loss and is in danger of bankruptcy. The implication is that when a system is working according to its rules and is nonetheless contracting, then there is something wrong with the system’s description of its environment such that relevant aspects are not being modelled. In this case perhaps the drinking glasses are not being delivered to shops (but deliveries are not being monitored by the system) or nobody is buying the drinking glasses (but this is not known because sales are not being monitored).

System errors are therefore signs of a *mismatch* between the system’s description of the environment, and the actual environment. Mismatch errors imply that some of the rules defining the system are damagingly wrong (i.e., they do not fit the environment well enough to permit the continuation of the system). The system’s action on finding errors is the generation of communications that check the validity of communications that led to the communication triggering the error. These checks aim to find communications that constitute the root of the error, and terminate the continuations of communications branching out from the root of the error. For example, in case of natural sciences hypotheses and theories are built, when the experimental results falsify the theories by not confirming their predictions, the science is revised. The root of the wrong theory is invalidated, together with scientific communications branching from this root – for example, alchemy and astrology were eliminated from science.

This ‘purging’ of the system after an error has been detected may have a damaging short-term effect on the system communications. The deletion of a maladaptive subsystem (such as the deletion of alchemy from chemistry, or astrology from astronomy) may shrink the system considerably. If sufficient shrinking of the system happens, it will be vulnerable to the failure to maintain communications, and extinction of the system. For example, the medieval Roman Catholic church was a system which incorporated practices such as the sale of indulgences that were maladaptive for the environment, the excision of such communications had ramifications which consequently eliminated the Roman Catholic church in many part of Northern Europe for some centuries. In (simplified) systems terms, the religious system which forbade sale of indulgences was better suited to the environment of Northern Europe, and out-competed and displaced the system which included sale of indulgences in the environment of Northern Europe (but the reverse was the case in Southern Europe).

A system experiences failure, when frequent or simultaneous errors (i.e., lack of continuation of communications) happen in a significantly large part of the system. The system failure implies a significant contraction of the system and may lead to the termination of the system. For example when a computer crashes the system of communications between program units experiences simultaneous errors, i.e., inability to continue communications according to the rules of the system. This leads to the failure of the system culminating in the termination of the system (i.e., all communications halt, and the computer need to be restarted).

3. Organisations as abstract communication systems

Humans communicate with other humans using linguistic and other behavioural modes of communication (facial expression, gesture, intonation etc). According to abstract communication systems theory, the totality of all human communication is global human society [17]. Global human society constitutes a communication system with many subsystems – for instance those societies defined by the various human languages (eg German-speaking Central Europe), or by national borders (eg Germany, Austria, Switzerland). In accordance with this theory, the actual biological human beings are *not* part of this system of communications; rather human beings are communication *units* which generate the communications composing the system.

Each human society also contains other social subsystems, such as the political system, legal system, health care system, economic system and others. Each of these systems has its own ‘language’ defined by a characteristic logic, and based on a binary evaluation. For example the legal system is defined by its specific legal procedures and its core logic of legal / illegal used to classify communications within the system. By contrast, the system of economics is governed by a profit/ loss logic, and functions by the rule of the marketplace. System communications are identified as such by their referencing of communications concerned with the characteristic logic of the system – only such self-referencing communications are part of the system. For example, scientific communications typically make explicit reference to other scientific communications (indeed, these are termed ‘references’) – and this identifies scientific communications as such.

Organisations are part of various major subsystems of the human society, for example political parties are organizations which form part of the political system, companies are part of the economic system, and universities are part of the (higher) education system. Organisations are defined in terms of their communications; constituting dense, inter-referencing *clusters* of communications. These organization communications are mainly from humans (eg spoken and written language and mathematical symbols) but also include communications from other communication units such as machines and computers. This implies that organizations are abstract, not concrete: organizations are not the people who work in them, nor the buildings they work in – but instead the correct description of an organization is in terms of the communications by which they are constituted.

Like all systems, organisations function to maintain, reproduce and expand themselves. The environment of the organisation is constituted by all other communications which are not part of the organisation system. The ‘environmental’ communications for an organisation contain many communications from other social systems (legal, political, economic etc.), the natural environment (weather, temperature, day-night etc) and also many other non-social communications such as subjective communications within the minds of those human ‘communication units’ that provide the constituting communications of the organisation (eg. private fantasies going-on in the mind of a sales executive are not a part of the organization system – they are part of the environment of that system).

Communication units may participate in many systems. For example a person working for an organization may think about himself, in doing so communicating with himself, and thereby motivating himself to enthusiasm - or de-motivating himself into a state of depression. These individual subjective

cognitions are part of the systems of ‘consciousness’ of organization members, and subjective cognitions are therefore aspects of the *environment* of an organization. Furthermore, each human may act as a communication unit for more than one social organisation (for example a human employee may also generate communications for their family, their church, a political party and a charity).

Organisations are defined by their own ‘language’ with characteristic procedures, lexicon and the underlying binary logic which they share with the social system in which they participate. Organizational communications have referencing rules that apply to the communications constituting the organisation. As in all communication systems, organisational communications check the identity of the communications which constitute the organisation. These identity checks take the form of generating new communication continuations referencing earlier communications which belonged to the organisation – when such continuations follow the correct logic, procedures etc, then they are assumed to be a part of the organization system.

Specific checking subsystems may provide a second check in which new communications are compared with memory communications. According to the Popper principle, it is only possible to prove that a communication is *not* part of the organisation system (e.g., a fault or an error), and this conclusion can be reached only retrospectively – after the communication has been checked. For example, a communication is determined not to have been part of the system when it has not led to any further communications which reference it (i.e., a faulty communication). This can be seen in science. When a scientific communication is being evaluated, the first identity check is to determine whether it references the system of science, and follows the correct logical procedures of science (peer review of submitted scientific articles may perform this identity check), later checks evaluate whether the new communication has been ‘used by’ and referenced by later scientific communications (for example, citation analysis).

Organisations exert their actions on the environment in terms of generating organisational communications. Such communications may take the form of producing and delivering a product, providing a service, or - in general terms - inducing communications in the environment of the organisation as when a scientific paper on pollution is followed by media coverage and political reform. All organisational communications happen within the organisation system, and can be seen (from outside of the organisation system) as actions of the organisation. Organisations also have perceptions about their environment. Such perceptions happen in terms of differences between the expected pattern of organisational communications (i.e., according to the rules of the system), and the actual communications which happen within the organisation. For example, a new car is produced by a manufacturer. This action may influence a rival company to produce a rival new car (i.e., the communication influences the environment). The perception of the manufacturer’s system takes the form of measuring the difference between the expected expansion due to the production of the new car and the actual experienced expansion (or even possibly contraction, if the cars stay unsold). This perception may trigger further communication within the manufacturer company to adjust its system to the environment (e.g., increasing or decreasing the production of the new car, partial redesigning of the new car, etc.).

The actual communications reflect the effects of environmental communications on the communication units (i.e., humans), and in response to these effects they may change to some extent their behaviour within the organisation, deviating from their expected behaviour (e.g., seeing the advertisements of the competing company may change the direction of the advertising campaign of the company). It is important to note that actions and perceptions of organisations depend on each other in a circular manner, and all communications constituting these happen within the organisation, with the aim of maintaining and reproducing the organisation.

Organizational subsystems

Organisations may develop subsystems, which are dense clusters of inter-referencing communications within the organisation. Subsystems have their own language, which is a subset of the organisation’s language which is further defined by *additional constraints* on the continuation rules.

Subsystems specialize in some functional aspect of the organisation, and often take the form of geographically separate branches and functional units within the organisation which employ non-overlapping personnel and are physically separated (e.g., accounting department, logistics department, etc.) – however, since systems are defined in terms of communications, such geographical separation is neither necessary nor sufficient to define a subsystem.

One important subsystem of organisations is their memory subsystem. The memory subsystem provides the means for referencing directly earlier communications, and may lead to the emergence of an information subsystem. In advanced economic organisations the memory system usually consists of

the various types of 'files' referring to the past communications within the organization. Memory system files are generated, classified and used according to a specific set of procedures. The memory subsystem turns into an *information* subsystem when new communications are generated purely on the basis of memories. For example, examination of files may lead to a recognition that a government inspection is due, and further examination of files may be used to make an appropriate organizational response to this forthcoming inspection.

The information subsystem of an organization may generate identity definition communications and an identity check subsystem. The identity check subsystem specializes in analysing the memories in relation with the identity definition communications (for example to determine whether a recent communication has been performed according to established procedure, and whether it is therefore to be accepted as part of the organization or deleted as a faulty communication). The information system therefore aims to detect and delete faulty communications using the system identity check, with the implicit purpose of maintaining and increasing the correctness of the system. In this way, by avoiding the communication failures stemming from faulty communications, an information subsystem can increase the reproduction and expansion potential of the system.

The identity check subsystem of organisations can be seen as the system of formal rules, regulations and statutes, which define what the organisation is and is not; and what the permitted communications (behaviours) are and are not. Having such subsystems in organisations - in particular this kind of memory, information and identity check subsystems - increases the adaptiveness of the organisation by increasing the complexity of an organisation's description of itself, and in complementary sense the description of its environment.

Interpenetration of organizations

Organisations evolve in their environment by expanding and changing. They compete for new communications within the environment, in the sense that they try to produce communications, which match the environment such that communication units are likely to produce new communications that follow the rules of the system. Such new communications can then become part of the expanding system. For example, computer manufacturers produce hardware which is bought by customers, this process generating many new communications within the organisation (accounting, buying, marketing, planning etc).

Organisations and social systems may inter-penetrate each other. Inter-penetration refers to the phenomenon whereby organisational communication may increasingly reference the communications of another system; and may come to follow rules and procedures derived from another system. For example, a hospital (concerned by the threat of litigation) may increasingly make reference to legal matters in its internal communications; and hospital procedures may increasingly come to adopt legal procedures – for example a detailed procedure for obtaining post-mortems is employed even when this increases stress and thereby damages the mental health of participants. The legal system has then penetrated the health system, because the legal system grown in size and complexity by generating new legal communications in the health system. By contrast, the health system has ceased to deploy its characteristic health/disease logic in relation to obtaining post-mortem permission – essentially these post-mortem related communications have left the health system and been absorbed into the legal system.

Interpenetration between organisations is built up by actions and perceptions of organisations, and it drives the evolution of organisations. The effects of interpenetration include the disappearance of the organisation (e.g., the assimilation of the Social Democrat Party by the Liberal Party in the UK in the late 1980s). Interpenetration may also lead to the emergence of a new organisation at the interpenetration interface of the organisations. For example, the university organizational system of human genetics emerged at an interpenetration interface between departments of molecular biology and obstetric sciences.

4. Structures in organisations

Spontaneous and formal organizational structures

According to the abstract communication system theory, the structures of specific organisations take the form of specific constraints on the language defining the organisation. Constraints make referencing rules and continuations of earlier communications more precise, and leave less scope for deviations.

Subsystems such as organizational structures have the potential to simplify the organisation's language (i.e., by subdivision of an organization into subsystems such as sales and accounting, the language of each subdivision can be more selective, precise and standardized – hence simpler). Such simplification of organizational language (sometimes termed 'rationalization') usually increases the tendency of an organization to expand and reproduce since it allows resources (time and energy) to be saved and invested elsewhere. For example, accounts clerks can be replaced by computers, and their salaries invested in R&D or sales. Structures imply also specialisation in parts of the organisation, supporting the expansion of the organisation. But organizational structures would not help the reproduction and expansion of the organisation if the new structural constraints reduce the (relative) correctness of environmental descriptions by the organisation. For example, a new simplified structure which merged accounts and sales (to create the 'salesman-accountant') would very probably impair organizational growth.

The argument for the efficiency-increasing potential of language simplification and sub-specialization is essentially the same as was made familiar by Adam Smith in *The Wealth of Nations*. One major constraint of organizations concerns the cognitive constraints of humans – how much information they can take in and process accurately. In systems theory terms, one significant benefit of specialization and simplification is that restrictions on the range of possible continuations following from a communication reduces the need for referencing, and enables communications to be more concise and precise. When staff of organizations need to multi-task, as in some small simple firms where a single individual may perform many roles. In such a situation, any given communication can be followed by a wide range of possible other communications – so the communications continually have to include references to the nature of current communications, and further references when current communications switch topic and function. If the organization tries to expand, this necessity for referencing of communications will increase, and will make communications longer and more resource-consuming in an 'exponential' fashion which will limit the possibilities of expansion. For example, as a painter-decorator attempts to expand his one-man business and do more jobs, the increasing need for billing, record-keeping and travel between jobs, may interfere with his ability to do the practical work. For a one man business twice as many jobs may lead to four times as much work. By contrast, when communications are highly specialized, the effect of expansion on workload is only linear – which allows work to be increased much more easily so that twice as many jobs is only twice as much work.

Structures may emerge in organisations by spontaneous grouping of communications into dense inter-referencing clusters, such that communications of these clusters follow tighter continuation rules than the whole organisations. These self-organized structures emerge as spontaneous specialisations of parts of the organisation because they result in greater efficiency (saving time and/ or money). For example, some members of a voluntary organisation may have better skills in dealing with talking to the media, and others are better at fund-raising. The organisation spontaneously structures into 'public relations' and 'fundraising' groupings – these may later become formalized.

Structures may also be imposed on the organisation by its identity subsystem – as when management imposes 'restructuring' reforms. (The identity subsystem in organisation is part of the management subsystem of the organisation; [18].) The efficiency-enhancing function of such restructuring is to attempt to improve the coherence of the organisation, to increase its reproduction and expansion ability. In order to achieve the higher coherence the identity system may generate communications that need to be referenced in system communications, in other words management may impose constraints on the communications within the organization such that management can monitor the communications – for example when management insists of regular summary reports of activity. Constraints generated by the identity subsystem may include orders, regulations, statutes and other normative communications. The identity system generates these constraints in terms of organisational memories (e.g., written regulations, stored in structured filing systems), which can be referenced by future communications within the organisation.

Spontaneous or informal structures become explicit and formal when imposed constraints create a nominal clustering of communications within the organisation – for example the formal enumeration of departments as demonstrated in official communications such as handbooks or documents for the inspection of auditors. The communications between the individual human 'communication units' in an organization may align with these nominal clusters corresponding to the explicit formal structure, but this is not necessarily the case. If there is little alignment between actual communications and the 'official' structure of an organization, this facilitates the generation of faulty communications or errors within the organisation. For example, if new departmental boundaries are defined, and members of the organisation ignore these boundaries, unwanted, unrecorded, unprocessed information flows may occur

in the organization, and systems of identity checking may not function optimally such that faults are increasingly generated (and remain undetected), and errors are neither detected nor remediated.

For example, two university departments might be joined by a new regulation (a structure constraint communication generated by the management – the identity subsystem of the university). The members of the department are constrained to communicate frequently within the newly created department, e.g., the teaching duties, examination issues, research assessment are discussed jointly with the involvement of all members of the new department and recorded in organizational memories in joint documentation. At the same time a group of top researchers from one of the departments continue to communicate extensively (but informally) in officially unrecorded interactions that nonetheless have significant implications for the strategy of the new (nominal) department – for example the planning of major new grant applications. The new nominal ‘head of department’ does not have access to these informal communications; consequently the strategic planning of the nominal department is based upon incomplete information, ultimately causing the department to deliver research output below its potential. Misalignment between formal and informal structures therefore typically causes problems to the functioning of an organisation.

Formation of new subsystems

Structures within organisations may induce the emergence of a subsystem within the organisation. The threshold for emergence of subsystems typically happens when identity-checking begins.

If a subsystem emerges then (by definition) the communications satisfying the corresponding structural constraints form a dense inter-referencing cluster of communications within the organisation. Identity checking entails this cluster ‘questioning’ its own existence as a system. In other words, when the cluster generates self-descriptions, and begins checking the correctness of its communications with respect to the self-described identity of the cluster, the subsystem emerges from the cluster and begins to grow in complexity.

For example, in a company the marketing department grows as the company grows and focuses on selling products produced by itself and by other companies. As the department grows it generates self-descriptions which may be both informal and formal. Formal self descriptions could include the scope of information dissemination, for example who receives and acts-upon e-mail distribution lists announcing seminars on marketing, or comparative information on sales performance. Potentially, members start to define themselves informally by social meeting, topics of conversations, styles of dress etc (e.g., ‘sales’ staff meet for a drink after work, joke about sales performance, and wear pinstriped blue suits). Such self definitions take the form of constraints that also serve as an identity reference check. If individuals do not adopt these rules, his communications will ‘not be taken seriously’ - i.e., they will not be referenced in further continuations with respect to sales. There is a tendency for this kind of self-describing, identity-checking cluster to become a subsystem of the organisation.

Specialist organizational structures represent the adaptation of the system to its environment. Appropriate structures fuel the expansion of the organisation, while structures that do not fit with the actual environment of the system decrease the survival potential of the system. For example, the reorganisation of a university such that the most successful teaching and research departments are given more autonomy and resources to expand, while the less successful departments are dismantled or merged, may help a university to attract more teaching and research funding. But if the new structure amalgamates more-successful and less-successful departments in order to create large average departments the university may lose staff, students and research funding, and experience contraction rather than expansion.

The growth of organizational subsystems may be actually maladaptive and damaging, since increased complexity created inevitably increased costs in communications. If the increase in cost of communications is not exceeded by an increase in efficiency, then the overall system will tend to contract. For example, if a large but functionally ineffective structure of ‘staff counselling’ emerged in an organization, and consumed resources without in any way enhancing organizational performance – then this would tend to cause the overall organization to contract in competition with rival organizations who had not created such expensive and ‘parasitic’ sub-structures. However, when the environment imposes only weakly competitive factors then maladaptive subsystems can survive and grow for long periods. This can be seen when in the public sector of the economy a poorly-performing organization (e.g., a university which cannot attract enough students or research funding to pay the salaries of its employees) is not allowed to become extinct, but instead is subsidized and ‘propped-up’ by the more successful organizations in the system.

Maladaptive growth happens in particular when there is a single organisation in an environmental niche (e.g., healthcare communications within a society), and the organisation experiences frequent faulty communications, errors and failures, due to pressures from the environment. The organisation responds naturally by generating more structural constraints, and expanding its structures in the hope of fitting better the environment (more structure implies more simplicity – at least locally –, more simplicity implies better growth perspectives). Because there is no competition by other organisations (the organisation is the only one in the respective environmental niche), there is little chance that any new structure will repair the mismatch between the system and its environment. This is mainly because imposing fundamentally new structures may imply large scale failures within the organisation (i.e., large parts of the organisation may need to be cut off, because they are based on communications that do not satisfy the new constraints), and consequently the preferred new structures will imply only small changes, which are not sufficient to increase significantly the fit between the organisation and its environment. Large state systems of service provision are usual examples of maladaptive growth. These organisations grow large bureaucratic heads because of the lack of competition, while remaining unable to solve the problems intended to be solved by adding more formal structure to their management subsystem (e.g., the NHS in the UK).

5. Faults, errors and failures

Faults in organisations are communications that reference other organisational communications according to the grammar of the organisation, but do not fit the organisation's lexicon. For example, when an office worker receives and reads a set of reports, collates them and generates a summary from them in form of an electronic document stored on his computer, and then deletes the file containing the summary and sends a picture file instead of the summary to the office manager. The worker is supposed to keep the file, and send it to the manager of the office, instead of this expected behaviour he deletes the report from his computer and sends a completely unrelated document to the manager, a behaviour which should not happen according to the rules of the organisation.

Faulty communications happen in organisations. Their reasons can be found in the effects of the environment on the communications generated by humans, who generate the communications constituting the organisation. In the above example, possible reasons can be that the file names were similar, or the office worker thought that he would make a good joke by sending the picture instead of the summary, or many other reasons. Faulty communication may not generate any continuation within the organisation. The manager may ignore the picture sent by the office worker, and use data from another summary report with the same content. In other cases faulty communications may generate continuation communications within the organisation. The manager may take the case more seriously, especially if the picture did not appear particularly funny for him (e.g., the picture was showing a drawing, which could be seen as a malicious caricature of him), and may talk to the office worker, or may even initiate disciplinary action against him. In an alternative scenario, the missing information may lead to the distortion of information reported by the manager to his superiors, if the manager under pressure chooses to ignore any information that could have been contained in the report sent by the office worker. In the latter cases the faulty communication leads to further communications within the organisation, with a damaging potential for the reproduction and expansion capacity of the organisation.

Errors occur in the organisation when communications, which follow the rules of the organisation, lead to communications, for which it is impossible to find continuation communications according to the system rules. The simplest errors are the faults, which have no continuation within the system. Faults are also likely to cause errors, if there are continuation communications that reference faulty communications. For example, a company produces mobile phones, which are heavy and with only a few basic features, while the competition produces light and feature packed mobile phones. According to the rules of the company the mobile phones should be sold to mobile phone dealers, but they are unwilling to buy them. By the rules of company, the packaging of the mobile phones should be followed by communications with representatives of dealers, but these communications do not materialize. In other words, the organisational communications happen according to the rules leading to the generation of packaged mobile phones, ready for delivery, but it is impossible to find continuation communications according to the rules of the organisation.

Errors trigger identity check communications of the organisation, which try to find the roots of the error, i.e., the communications which provided the original reference for communications that led to the occurrence of the error. Finding the roots of the error implies the invalidation of other communications, which branched out from the same root by referencing their root (possibly indirectly).

The identity subsystem of the organisation eliminates the communications leading to the error and those related to the error's root, and may impose new constraints on the language of the organisation, possibly leading to new formal structures. In the above case the management of the company (which generates the identity subsystem) will analyse the roots of the error, and in order to save the company will eliminate the wrong phone designs, possibly fire the designer team, restructure the marketing team, and make sure that market signals are taken seriously when phones are designed and prepared for the market.

Failures in organisations follow frequent errors and consist of significant shrinking and possible dissolution of the organisation. Errors imply a revision of a part of the organisation following revised identity checks, which may result in elimination of a part of active organisational communication from the organisation. If the eliminated communications constitute a large part of the organisation, the organisation experiences a failure. For example, a computer games company invests in a new game developed for a gaming console. The company hires a large number of developers, testers and other technical personnel, who have experience in using the selected technology. The gaming market changes by arrival of a new console generation from a new entrant company in the field of consoles. The game developed by the computer games company cannot be played on the new console and consequently cannot be sold in the expected volume. The company experiences a large number of errors (i.e., many communications leading to the new game for the old console cannot be continued), which has at its root the decision of developing for the outdated game console platform. The company will have to fire many of the specialist technical personnel, possibly may face financial difficulties in paying its debts, and in a more extreme case may go bankrupt and face liquidation. The large number of simultaneous errors triggers a failure in the organisation, which may lead to the termination of the organisation.

Organisational communications are assumed to be correct until they generate further continuation communications. When an organisational communication leads to an error (i.e., no continuation) this is a proof that the communication is wrong or false in the context of the organisation. The communication may have followed the rules of the system (i.e., error without a faulty communication at its origin), but system rules prove to be false, in the sense that they do not describe correctly the system and in a complementary sense its environment. Errors are followed by revisions of the rules of the system initiated by the identity system by imposing new constraints / structures on the system. In the context of organisations the Popper principle means that no organisational communication can be proven to be correct, they can only be proved to be wrong, if they lead to an error within the organisation. As the organisations are less complex than their environment, necessarily there will be organisational communications which prove to be wrong by leading to errors. Consequently there is no organisation that fits perfectly its environment (which is impossible on the basis of complexity comparison considerations), and all organisations are prone to have errors.

Structures in organisations are sets of constraints, which restrict the set of possible continuation communications. Simplifying the language of the organisation in this manner, structures contribute to the increased reproduction and expansion capacity of the organisation. By imposing more constraints, and simplifying the continuation rules of the organisation, structures reduce the likelihood of faulty communications going 'unobserved'. In other words, structures help the identification and isolation of faults, preventing system communication from referencing faulty communications, and preventing the emergence of later errors in this way.

Let us consider a university department running many projects, which creates a project support unit, by hiring a project management advisor and a secretary. Before creating the unit the projects were managed by related academic staff with more or less success. It happened that reports were not filed in time, that project budget overruns caused holes in the departmental budget, and that projects missed visibility events. The department added new constraints to its grammar, which apply specifically to project related communications. The new constraints materialized in the form of the new formal structure, the project support unit. After adding the new structure the projects were tightly monitored for reports and finances, and the project unit kept an eye on publicity opportunities and prepared materials for them in time. Although all possible faults cannot be eliminated (e.g., key research associate leaving because of family problems), many faulty communications (e.g., lacking report submission, intent for not allowed spending, etc.) can be readily recognised and corrective or preventive actions (i.e., sets of communications) can be taken.

Organisational structures may also help in early finding of errors, by imposing restrictions on continuation rules. Sharper continuation rules imply that the range of possible continuations is more restricted than in the system without structure constraints. Having a more restricted range of possible continuations increases the likelihood of experiencing inability to find continuation communications. This means that sequences or branches of communications triggering errors lead to the occurrence of

the error sooner in the case of presence of structure constraints. Finding the errors sooner reduces their potential damaging effects on the organisation.

For example, in the case of the above described department, communications leading to project budget overruns were detected late before the creation of the project support unit, and caused regular holes in the departmental budget. After creating the project support unit the budget overruns were detected instantly and signs indicating a likely overrun were identified in order to prevent the actual budget overrun. Adding a set of structure constraints (materialized in the project support unit) decreased the time to discover budget related errors and reduced the negative effects on the departmental budget of such events.

Organisational failures are the cases when many simultaneous or frequent errors cause the elimination of a large part of the organisation after new identity checks are put in place. The identity checks implement new constraints on the organisational communications and effectively change the rules of the organisational grammar. Communications which do not satisfy the new rules are eliminated, and the roots of wrong communications are searched (e.g., using memories of earlier communications) and communications referencing primarily wrong communications are eliminated from the organisation. Organisational structures impose constraints on continuation communications and limit the range of new communications referencing earlier communications under the effect of the structure constraints. This means that if a communication satisfying the structure constraints leads to an error (lack of continuation), and the root communications which led indirectly to the error are also among those which satisfy the structure constraint, then it is likely that most communications which branched out from the wrong roots are among those, which comply with the structure. In this way the structure limits the effects of the failure caused by the error to those communications which relate to the structure. In the case of formal structures, these may limit the range of the failure to the formal structure, guarding the rest of the organisation from the shrinking effects of the failure.

For example, let us consider a local government, which has several directorates, including and environmental directorate dealing with environmental problems on the territory of the locality. A series of newspaper articles and radio talk shows present the discovery that the local government overlooked important safety issues when the building of a new energy plant was approved. The environmental policy of the local government and the directorate for environment is criticised heavily, the opposition and the mass media ask for resignations. The organisation of the local government experiences a many errors (lack of continuation of communications according to the rules of the organisation). It is impossible to communicate with the media about its environmental policy and activity in ways that are expected by the organisation, there are no continuations for its environmental policy communications. The cabinet decides to find the root of the errors, and orders the major revision of the environmental policy application guidelines. The roots of the error are found in lax communications within the environmental directorate, and these communications are eliminated from the system by applying the revised policy application guidelines. In the end the head of the environmental directorate and other members who contributed to negligent communications of the directorate leave the local government. Having a structure (set of restrictions that apply to environmental communications, e.g., environmental regulations, decisions establishing the environmental directorate, etc.) in place restricted the effects of the error to the formal structure in relation to which the error occurred. The failure of the organisation had a major impact on the part of the organisation affiliated with the structure, but left mostly unharmed the rest of the organisation.

Structures may also have negative effects on organisations. If the imposed structures do not fit the environment of the organisation they reduce the correctness of the description of the organisation by itself and also the correctness of the description of the organisations environment (in complementary sense). Wrong structure constraints may increase the occurrence of faulty communications, although they help in quick identification of them. Structure constraints reduce the range of allowed continuation communications, if this reduced range is very different from the communications generated by humans under the actual environmental constraints, the likelihood of generating faulty communications is increased.

Wrong structures may lead to errors. By constraining the allowed continuation communications the structures constrain the descriptions of the environment by the organisation. Facilitating the generation of wrong descriptions, the wrong structure increases the likelihood of generating errors, communications that cannot be continued according to the organisational language rules. For example, a hospital may have a special management unit, which elaborates methodologies to keep the patient waiting lists short by administrative measures (e.g., scheduling interventions for holiday time, and re-registering as new patients the patients who cancel the interventions due to their holiday plans). This structure may help in generating the expected communications from it, but these do not decrease the critical attitudes of patients and regulators towards the hospital. Such critical attitudes may mean that

the communications of the hospital cannot be always continued as expected by the hospital organisation. In effect, the hospital keeps a structure that helps in generating errors and does not help in eliminating them.

Organisations change under the effect of interpenetrations with other organisations. These changes may mean the change of the rules of the organisation, of the lexicon of the organisation's language, the emergence of a subsystem within the organisation, or the emergence of a new system at the interpenetration interface of the organisations. Such changes may imply that communications which were faulty before, become acceptable, communications that were heading to become errors, fit into the new environment of the organisation, and possible failures are avoided by avoiding their triggering errors. Of course, these may happen with the reverse sign as well (i.e., encountering new faults, and previously unexpected errors and failures). This means that the role of organisational structures should be considered in the context of organisational dynamics (as described above), and such changes need to be taken into account when the positive or negative effects of an organisational structure are analysed.

6. Conclusions

Systems theory offers a view of organisations that is fundamentally different from other current ways of analysing organisations [1]. This approach treats organisations as abstract systems of dense inter-referencing clusters of communications, separate from the human 'communication units' which generate most of these communications. Humans, according to this theory, are not themselves a part of organisational systems – although human brains and bodies perform much of the information processing which constitutes organizational systems.

Systems theory conceptualizes structures of specific organisations in terms of specific constraints that apply to the information-processing language of the organisation. This analysis also describes the role of management as essentially an identity checking subsystem of the organisation that imposes constraints on the organisation in form of new structures and new rules for referencing communications. New structures are typically functionally specialized subsystems, within which the communications are focused and simplified. Such structures can potentially enhance the expansion of an organisation, if the formal and informal structures are well aligned, and when formal structures trigger the formation of subsystems of the organisation with their own identity. By contrast, misaligned informal and formal structures are likely to be damaging for organisations.

The identity checking managerial function may take the form of rules and regulations that are referenced regularly to check the correctness of current communications (eg. procedures and behaviours) within the organisation which may serve to detect and control the effect of faults and errors, so as to avoid organizational failure. The systems theory analysis leads to a novel principled way of defining faults, errors and failures within organisations. Faults are mistakes in communications, which do not fit the lexicon of the system's language, or which contradict the constraining rules of the grammar of the language (i.e., faults are communications which occur, when their likelihood of occurrence is zero). Errors are cases when communications do not lead to continuation communications according to the system's grammar, due to the system being inadequate as a description of its environment. In complex systems, the root cause of errors are searched-for (e.g., by applying new identity check communications against memory communications as references to constrain the continuation distributions). When errors are found, all related communications are eliminated from the system. If such deletions cause major shrinking of the system the system is facing a failure when it loses its identity as a dense cluster of inter-referencing communications.

Our analysis shows the role of organisational structures in terms of dealing with faults, errors and failures. Structures are subsystems of the organizational system that function to increase the fitness of the system in its environment (ie to increase the probability of its growing in complexity). Organizational structures may function to limit the effects of faults, reduce the likelihood of errors, and restrict the effects of errors and failures. Structures which do not fit the system's environment may conversely increase the likelihood of faults, errors and failures, and reduce fitness.

We believe that our work on the analysis of organisations in terms of abstract communication systems theory, and in particular on the analysis of organisation structures and their relations to organisational faults, errors and failures will lead to continuations in the form of further research along similar lines. The theory and the ways of analysis that we propose strongly support abstraction in the context of analysis of organisations. They help the formation of useful concepts that highlight the nature of complicated aspects of organisational behaviour, and allow rigorous analysis of organisations.

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