

Discovery, entropy, organisation and trust

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In this chapter, I discuss the dynamics of knowledge: how do ideas develop, how does innovation take place? I discuss the ‘cycle of discovery’. That I presented earlier in Nootboom¹: it is a theory of discovery on the individual and on the collective, organisational level. Can it be compared to the ancient cycle of Yin and Yang from Taoism? How does it relate to another principle that I proposed, of the organisation or communities within them as ‘focusing device’. Can the notion of ‘entropy’ help in the analysis?. I add **connectedness** to entropy, and, in connection with that, trust.

1. Individual and organisational discovery

In Nootboom¹, I presented a ‘cycle of discovery’: a cyclical process of the development of intelligence and cognition. Here, the question is **whether** it is on the level of the individual, on the level of the organisation, or both. Originally, it was a model for the individual development of ideas, inspired by the work of the developmental psychologist Jean Piaget. The arguments and evidence are discussed in Flavell.² The reasoning is largely qualitative, as it usually is in a process theory, Process is often difficult to measure. It was mainly oriented at the qualitative development of intelligence in children, in different stages.

I developed and applied it on the level of the organisation. Here again, the evidence was casuistic, concerning the internationalisation of business firms. A central feature of the process is ‘generalisation’, which, in evolutionary terms, serves to subject a given idea, practice or product to a

new 'selection environment', where it is subjected to unfamiliar challenges to its survival. For a firm, this can be export to a new market, with different demands and competitors. For science, it can be a new field of application. This forces adaptations to the product. First, as the easiest change, this can be a modification of the composition of familiar elements, in 'differentiating assimilation'. When that does not work, one adopts, assimilates elements from local practices that succeed where one's own practice does not, in what is called 'reciprocation', in hybrids of familiar and new elements. This often yields inefficiencies, complications, duplications and bottlenecks or inconsistencies that need to be circumvented in 'workarounds' which give the incentive for a new structure of the whole, in 'accommodation'. The reciprocation stage gives the opportunity to find out where the real strength of new and old elements and design principles lies, and hints of where in the structure, and how, one might do things differently. This then leads to trials with new designs that may yield something more radically new. In the beginning that is still hesitant and tentative, with alternative forms, to settle in a new 'dominant design'. Then we are back at the beginning of the cycle.

On both the individual and the organisational level, learning is here seen as an alternation of 'assimilation', **absorbition** of perceptions in existing frames of mind or practice, and in the process, when that fails, 'accommodation' of the framework. This is consistent with the idea, of Thomas Kuhn in the philosophy of science, and the economic principle, that one does not surrender something until the weight of anomalies becomes 'excessive'. Generalisation, shift of the environment of application, is consistent with the principle of 'allopatric speciation' in evolutionary theory, that a novel 'species' develops in a new 'selection environment'. It is also reminiscent of the idea from the philosopher Hegel, that one learns by one's failure.

Initially, the move to a new market was intended to escape from the saturation of a home market, to find new sales in an export market, but later was used as a deliberate innovation strategy. This came out in a conversation with a former CEO of Shell. This recognition is important, because the adaptation of a product to a new market disturbs the economies of scale of familiar practice, and the home office of the

multinational may block that, until the procedure of adaptation is recognised as an innovation strategy.

The point I now want to make is that this procedure has similarities to the ancient cycle of 'Yin and Yang' from Taoism.³ That also is circular, with an alternation of the two principles of Yin and Yang. The 'feminine' principle of Yin is associated with softness and darkness, the defensive, yielding to the present order, and the second 'male' principle of 'Yang' is associated with hardness and light, the aggressive, enterprising. In the cycle of discovery we find the subjection to the novel order, in the new environment, which may be seen as yang. Then, the assimilation, in differentiation and reciprocation, can perhaps, be seen as yin. The action of more radical renewal, in accommodation to a new order can perhaps be seen as yang. The settling of the novelty in a 'dominant design' can perhaps be seen as yin. Is it legitimate to compare assimilation to yin, and accommodation to yang?

2. Entropy

Let us consider the notion of entropy. Entropy is the number of alternative compositions of components that a system with given properties can have. The mathematical formula for entropy E of a system of n elements i of probability p_i is $E = -\sum_i^n p_i \log p_i$. For a system of 2 units of equal probability $\frac{1}{2}$, $E = 1$, called a 'bit'. For a system of four elements of equal probability, $E = 2$ or two bits. For a system with 8 elements of equal probability $E=3$, or three bits. For a system with n states of equal probability, $E = \log n$. A computational advantage of the log function is that $\log 1/n = \text{minus } \log n$.

E increases with the number of elements n and with their 'evenness', equality of p_i , which is their probability of occurrence or prominence or weight or legitimacy. The effect of the number of elements is illustrated above, with n going from two to eight elements. The decrease of E with the 'unevenness' of p_i is as follows. For the case with three elements n with equal $p_i = 1/3$, $E = 1.58$ with $p_1=2/4$, $p_2=1/4$, $p_3=1/4$, $E = 1.50$. This appeals to the intuition that in an organisation not everything has the same importance or 'weight',

Theil⁴ used the entropy measure as a measure of concentration of sales in markets or production in industries. P_i here is the share of seller or producer i . If there is only one seller or producer, there is maximum concentration, $E=1$, i.e. least entropy

The log function $\log n$ increases less than proportionally with n : it increases at a decreasing rate, its derivative is $1/n$. The increase of entropy has 'decreasing returns'. As disorder increases, the resistance to further rise increases. Further increase of 'evenness' becomes more difficult.

A puzzle then is the following. Nature and culture are rife with 'Complex Adaptive Systems' (CAS), systems that are composed from subsystems, such as:

neutrons, protons and electrons composing atoms, atoms composing molecules, molecules composing organs, organs composing bodies, bees composing colonies, people composing organisations, firms, consumers and institutions composing markets, people and institutions composing nations, nations composing supranational entities like the EU. The puzzle is this.

On the one hand CAS produce order, organisation ('complexity'), in the coherence of subsystems and thus they decrease entropy. On the other hand they constitute new units of the system and thereby increase entropy. How can that be? The solution of the puzzle is that while the subsystems integrate into a new order, they lose autonomy. To create the unity or coherence of the higher system, with its new functions, the subsystems are constrained in their operation, losing some functions or narrowing their range, and that constitutes less entropy. In a bee colony, bees are highly specialized as food seekers, gate keepers, soldiers, feeders of the queen bee.⁵

The formula of entropy is incomplete. One should consider not only the number and 'unevenness' of units, but also their relations. It is through internal and external relations that identity is constituted, order is created. If relations break down, this is also a feature of decay, of entropy. The formula for entropy could be extended as follows:

$E = -\sum_{i=1}^n p_i \log p_i + |1 - C/M|$, where C is the number of direct connections between units, and M is its optimum, and the vertical slashes indicate absolute value. That depends on the purpose of the system. The maximum number of connections is $n(n-1)/2$. That is not necessarily

optimal, as in an organisation where if all people connect with all, there is noise that distracts from work. If $C=M$, i.e. the number of connections is at its optimum, the addition to entropy is 0. If $C=0$, if there are no connections, the addition is 1. If the number of connections is lower or higher than the optimum, there is addition to entropy. One can picture this as an $n \times n$ matrix with along both axes the n units, and a surface above the matrix that represents the value of interaction. It is likely to have a bulge, at the optimum. It can have several bulges, multiple optima.

Entropy yields a way of looking at the issue of authenticity and conformism: people lose some freedom of action for the sake of the coherence of a community or nation. It applies also to language: in the order of a sentence, the disorder of potential meanings of a word shrinks to a specific meaning determined by **the sentence and** its context. In addition, when people get disconnected, as is the case in current society, entropy increases.

In the literature on freedom, a distinction is made **between** ‘negative’ freedom, in the absence of external constraint, and ‘positive freedom’ in access to resources. Here, the subsystem loses negative freedom in constraints of fitting in the higher system, but gains positive freedom in **access** to new functions offered by the higher system. There is loss of one freedom, and gain of the other.

3. Politics

In politics the trade-off between positive and negative freedom is a big issue. Formerly colonised countries are eager to establish a homogeneous, more equal nation and remove the former colonisers, but thereby they lose the resources built up by them. Maalouf⁶ gives examples, such as Egypt under Nasser, in the 1950’s. An exception was Mandela, who did not chase out the former oppressor, and even asked him to stay in order to contribute. An example of a non-colonized country is France in 1685, where in an attempt to establish a more homogenous religious society Louis XIV renounced the Edict of Nantes, in which Henri IV had accorded liberty of religion to protestants, besides Catholicism. This renunciation of the edict led to a massive move of protestants (Huguenots) to Amsterdam and other

places to the North, which enriched the culture and economy there, to the detriment of France.

If the bane of nature is the thrust to evenness, the bane of society is the **opposite**, the push towards more unevenness. In capitalism, the ideal is 'perfect competition', with many small competitors, but it led to an inexorable march **towards** inequality, dominance, concentration, in monopolies, oligopolies, and increasing inequality of income and wealth. As Maalouf shows, this occurs again and again in political history.

Like many others, Maalouf narrates the conservative revolution that started, in the West, with Margaret Thatcher, followed by Ronald Reagan in the US, in 1978-1979. It was motivated by resistance and revulsion with respect to excesses of socialism, exhibited by the miners' strike that caused a blackout, feelings that the indigent were being 'pampered' by social security, while being 'shy of work', and loss of traditional values of family and nation. The conservative revolution sought more 'evenness', in the sense of self-**sufficiency**, less dependence, less government intervention, less social security, more market, in liberalisation and privatisation. Politically it was engendered by the collapse of the **Sovjet** Union and communism, **which** discredited the socialist drive towards egalitarianism. The Soviet Union combined evenness of **ownership**, access and rights, formally at least, with evenness also in ideas, lack of variety and freedom of initiative and lack of opportunity for connecting them. That prevented dynamism and innovativeness, which broke up the union.

The Iranian revolution, at the same time, was also anti-communist, but also anti-capitalist, and was conservative in seeking a return to traditional religion, values and habits. This spread to other muslim countries.

The best society has a combination of evenness, egalitarianism, in access, rights, and legitimacy, with unevenness in ideas, allowing for diversity of views and initiative, and connectedness to produce cross-fertilization of those ideas, enabling **further** cognitive and spiritual development. The first two have been characteristic of liberalism, but with the conservative revolution the connectedness of people unraveled. Maalouf traced that to the revival of Adam Smith's 'invisible hand', which led to a surge of disconnection and egoism. This was not only a matter of greed for possessions, entertainment, power and attention, but also an urge to **esconce** oneself in a fort of identity and fight others. It is also due to a

lack of external threat that unifies. During the initial wave of the virus Corona people came together, to some extent, in conformance to shared order, but now that the virus is receding, in some places, people revert to their urge for individuality and diversion. What to think of Dutch youngsters who seek diversion in the Belgian resort of Knokke, and create ruckus by violating the distancing imposed because of Corona, and engage in scuffles with the police, in protest against the closure of pubs at one 'o'clock at night.

Suppression by authorities of diverging ideas and their dissemination has gained enormous power with the use of new technologies of surveillance, for monitoring phones and hacking computers, desirable to fight terrorism and crime, but threatening privacy and opening up opportunities for the control of thought and behavior. More heinous even, is the disarming of diverging ideas by breaking down ideas in general, after the crumbling of truth, with fake news. Control is hardly needed then.

4. Knowledge

The second law of thermodynamics says that the entropy of a closed system can only increase, such as in the cooling off of a container of hot water in a cool environment: the movement of molecules, which constitutes temperature, becomes more equal, in the transfer to molecules in the environment, and the energy gets distributed. Energy dissipates.

An organism can only survive and stay alive when it is not a closed system, combating the process of increasing entropy by taking in energy in the form of food, and excreting refuse. Increasing entropy has been seen as loss of order, as when a body decays when no longer being fed. When left alone, an organisation also dissipates, in a chaos, dissolution of order, with information getting misunderstood, ties falling apart. A task of management is to prevent this, maintaining some order. Scientists try to create order by reducing rich phenomena to a few principles.

A question I have in the theory of knowledge is this: does new knowledge increase or decrease the entropy of a stock of knowledge? At first thought one may think that it increases entropy because it adds to the stock of possibilities. But this is not so if in fact the new knowledge

invalidates much of existing knowledge, reducing the number of relevant elements, yielding integration and unification, reducing the number of laws, which is what physics, for example, is continually trying to do, to increase order. The endeavour of the present book may be seen in that way. In trying to find connections, similarities, underlying fundamental principles, I try to reduce entropy. This does not apply to cultural products such as literature, music, and pictorial art. We still marvel at old cultural productions and treasure them.

In turning to a knowledge system, such as an organisation, let us distinguish the use of existing knowledge and the production of new knowledge. When the number of people n in an organisation increases, the totality of knowledge produced and used by all people has decreasing returns to scale, as in the log function of entropy, due to information overload, gradually exhausting individual absorptive capacity, especially in present times, with a diversity of media, including social media, explosion of content, sources and channels, due to ease of access, so that the efficiency of information use increases less than proportionally to n . As according to the logarithm of n , in the formula for entropy.

The production of new knowledge, on the other hand, arises from the interaction between people, so what counts is the number of connections between them. The number of possible direct connections between n components, is $C=n(n-1)/2$. On the one hand, this may clog up communication to the detriment of action and decision making, but that may already be included in the increase of entropy. On the other hand, the number of possible connections increases the potential for novelty by interaction. The derivative, a measure of the increase of the number of possible connections, is $n-1/2$. Beyond the minimum of $n=2$ the increase of potential combinations is greater than the increase of entropy, whose derivative is $1/n$. Thus, innovation potential increases faster than entropy, the loss of order. Chaos gives opportunities. Perhaps this is a way to look at the difference between democracy and authoritarianism. In the latter, order is greater, but opportunities for renewal are smaller. The price for the higher order is more rigidity.

The model should be further refined. In other research, I proposed 'optimal cognitive distance'. Higher cognitive distance increases misunderstanding, but at the same time increases the potential for

innovative ‘novel combinations’. The conclusion is that for innovation one should seek an ‘optimal’ distance: large enough to yield innovative potential, but not too large to realise it, due to lack of understanding. If understanding decreases linearly with distance d , and novelty potential increases linearly, productive outcome is a quadratic, inverse-u shaped function of distance. If understanding decreases according to $1-ad$, and novelty potential increases with bd , then optimum innovative performance I is achieved when $d=1/2a$, and $I= b/2a(1-1/2a)$.

If we take this into account, an increased number of potential combinations at too high a distance, in a fragmented society of people thinking differently too much, holes arising in the fabric of society, innovative potential decreases, and democracy will not realise its potential.

5. Organisational focus

I now further apply the notions of cognitive distance and entropy to organisations.

Tsoukas and Chia⁷ take a process view of an organisation, as a continual process of change, in interaction with its environment. Organisations are not to be seen as static objects that change, but, on the contrary, as constructs to stabilise change, decay, that occurs continually anyway, such as in organisational structure and procedures. This stabilisation often overshoots in organisational inertia, and institutionalised myopia.

Organisational purpose is said to require ‘organisational culture’. I find that a bit too vague. I propose⁸, that purpose is achieved by means of an organizational ‘cognitive focus’, which has both intellectual and moral/emotional features, concerning how to deal with the dissolution of order, uncertainty or risk of relations; how to deal with each other. It plays the same role as a ‘paradigm’, directing thought and action in science. To function as a coordinated system of actions, organizations need some more or less specialized shared language or jargon, perceptions, understanding and morality, as part of organizational culture.⁹ Without such focus of shared perceptions, meanings, understandings and values, too much effort,

time and aggravation would have to be spent to disambiguate meanings, eliminate misunderstanding, set priorities, establish directions, coordinate activities, align incentives and negotiate the terms of collaboration. This is the view of organization as a system for ‘sense-making’¹⁰, ‘collective mind’¹¹, system of ‘shared meanings’¹². Witt¹³ offered a related view of entrepreneurs and managers as providing ‘cognitive leadership’.

The focus includes fundamental assumptions concerning the human being and its environment, concerning, for example, whether the human being is more self-centred or altruistic, risk is seen as a threat or opportunity, the world is to be mastered or submitted to, is predictable or uncertain, nature is to be exploited or saved.

A wider organizational focus, with more cognitive distance has greater entropy. This is another puzzle: a wider focus entails more ‘evenness’ in the sense of less concentration in a dominant perspective or practice, and hence larger entropy. On the other hand, there is more variety of perspective, which seems to indicate less evenness, and hence less entropy. Apparently we should distinguish between difference in ‘content’ and difference in ‘weight’, ‘dominance’, access or ‘legitimacy’. With wider focus, there is less dominance of one or a few perspectives, a wide variety, but with more variety of content. With more different perspectives of equal weight, or ‘legitimacy’, hence higher entropy, there are more possibilities of achieving ‘novel combinations’, and hence higher innovation potential. And when new knowledge is produced, in interaction, in ‘novel combinations’, entropy is reduced again, in invalidating old knowledge, in ‘creative destruction’. In other words: the higher entropy of more elements can yield novel combinations that when successful reduce entropy.

In the system of many small, independent firms, i.e. ‘the industry’ or ‘the market’, entropy is large, and in a production department within a firm, oriented at efficient production, focus is tight and entropy is small. Within the firm one can have different communities, some with narrow focus (production departments), and some with relatively wide focus, constituting ‘corporate entrepreneurship’ (in marketing, or R&D). It has the advantage of using the resources of the large firm, where risks are spread, but is more constrained in its scope than an outside, independent entrepreneur.

There is a stream in the literature of seeing entropy as overload of communication between units, crowding out work, increasing with the number of units n of an organization.¹⁴ I think this requires a different model than that of entropy.

With n units, the number of potential bilateral links between them is $n(n-1)/2$, which increases quadratically with n , thus more than proportionately with n , while $\log n$ increases less than proportionately. As the number of links increases, communication explodes and may crowd out work. That is why communication has been constrained by inserting hierarchical levels, restricting communication to the next higher and lower level, at the price of less contact between top and bottom of an organisation, and higher management becoming 'footloose'. An alternative is the 'hub and spoke' structure, with all communication going through the hub, apportioning only relevant information to others, not to unduly disturb work, in the spokes. That has the drawback of potential information overload in the hub.

If entropy does not include this effect of ties, is it sufficient? As discussed, it results from overload of information throughout the system, exceeding the absorptive capacity of its units, creating missed information, misunderstanding and distortion of work.

Now, If we weigh the cognitive distances between any pair of links with a quadratic, inverse-u shaped function of the cognitive distance, we might obtain a measure of innovative potential.

How does focus work, and how is it implemented? On the competence side, focus is needed to enable people to understand each other and connect complementary knowledge, without unduly restricting variety and creativity. On the governance side, focus is needed to motivate people to collaborate and share and connect knowledge, without unduly limiting autonomy, ambition and competitive spirit. Organizational focus also has a function of both selection and adaptation of people. In selection, it selects people, in recruitment but often on the basis of self-selection of personnel joining the organization because they feel affinity with it, and adaptation, in socialization into the firm, and training, of incoming personnel. To facilitate these functions, focus must be embodied in some visible form. Such form is needed for several reasons. One is to function as a signaling

device to outsiders. That is needed as a basis of the (self)selection process of incoming staff, and for recognition and identification by other stakeholders, such as customers and suppliers. Organizations develop their own specialized semiotic systems, in language, symbols, role models, metaphors, myths, and rituals. This is what we call organisational culture. It differs between organizations to the extent that they have different goals and have accumulated different experiences, in different industries, technologies and markets. The central difference between firm and market is that in the former such focus is made and in the latter it is not, or to a much lesser extent (there still is a remaining, shared cognitive focus from shared industrial and market structure, and national or regional culture), or to some extent in forms of collaboration with some shared understanding. Thus the market has the higher potentiality of variety of performance, and the firm has the higher actuality of performance.

Cognitive activities in an organization require some embodiment to crystallize, and to direct and stabilize cognition and communication within the organization. Here we find symbols, such as logo's, and style of advertisement and external communication. More for the internal function of coordination, we find the exemplary behaviour of organizational heroes, often a founder of the organization, corresponding myths, and rituals. More formalized forms of organization are procedures, for reporting, decisionmaking, recruitment, contracting, and the like.

6. Science

Biological evolution entails carriers of genes. Those carriers are called 'interactors' because they interact with a selection environment on the basis of properties, derived from the genes, called selectors because they generate properties on the basis of which the interactor is selected out or not

Concerning the evolution of knowledge, in particular **science**, there are problems for evolutionary theory. It is not directly clear what the success criterion of evolutionary selection is for knowledge. In biology it was survival. What does that mean in science? Do knowledge workers die when their ideas fail? No: the ideas die out. So, if ideas are selectors, they are also interactors.

How does entropy work here? When interactors are selected out, this decreases entropy, replication initially increases entropy, but enables novel combinations that may again reduce entropy. In sexual reproduction in biology, these combinations are chromosome crossovers

Kuhn¹⁵ famously claimed that scientists do not seek falsification of theory, as Popper¹⁶ said they should. That is too much to expect. Their scientific achievements form the basis for reputation and rewards in the form of further careers and room for further research, and they often seek to protect that by trying to confirm rather than falsify their theories. Falsification is more a matter of competition between scientists in the ‘forum’ of a scientific **community**, mostly via journals. Popper later granted that it is rational to hold on to theories and milk them for all they are worth and to find out where their real limitations lie.¹⁷

In evolutionary terms, communities of scientists, in ‘research programmes’, proposed by Lakatos¹⁸, would be ‘species’, and, for **evolutionary** theory to work, there must be ‘isolating mechanisms’ between them to prevent the species from mixing. In industries there is some evidence of that, with distinctive industry structures and logics. But it is a known source of innovation when boundaries between industries are crossed, in ‘novel combinations’, as professed by Joseph Schumpeter. A prime example is the internet, as a combination of the formerly separate industries and technologies of computing and communication.

Here also, replication in communication, in publications, meetings at conferences and seminars and PhD training, is more a matter of cognitive reduction, amplification and reconstruction than a matter of replication. As in the case of organizations and their capabilities, the survival and replication of purported replicators is not entirely dependent on success of interactors under selection. Here, in some disciplines more than in others, (even) more opportunities exist to mold the selection environment than in the case of firms in markets, in opportunities to create a selection environment of dedicated scientific associations with their proprietary journals.

Scholarly societies, or disciplines, schools of thought, or research programmes, may perhaps be seen as species. What, then, would be the ‘isolating mechanisms’ here? Like organizations in general, scientific societies have a shared cognitive focus of basic assumptions and views. Different research programmes do seem to have such mechanisms, in ‘protective belts’, and this generates misunderstanding and disagreement concerning what is relevant between such programmes. That is an effective isolating mechanism. Scientific journals are often attached to such schools, and are not open to submissions from rival schools. Rejected or ignored groups then often institute their own proprietary journals. In this way, there are obstacles to interdisciplinarity. From an evolutionary perspective that is a good thing, in the separation of species. But this is perhaps one of the reasons to doubt the validity of evolutionary theory concerning science. There is symbiosis between species, but in science it is rare. Scientists want to tender to their turf.

A case that I know of is ‘behavioural economics’, which employs insights concerning un-reflected, subconscious choice, on the basis of non-rational behavioral heuristics. However, I have heard from applied psychologists that they turn away, because there also economists want to force everything into the framework of rational optimising choice, while the point is that this is not and cannot be done.

7. Trust

Fruitful relations require trust. Trust is a complex notion, and cannot be fully treated here.¹⁹ I give a survey of some crucial notions and the sources of trustworthiness. Trust is a disposition to trusting behaviour, which entails giving room for the conduct of another, and that gives risk or uncertainty to the extent that you are dependent on that other. Trust then is being vulnerable to the conduct of another, and yet believing that ‘it will be alright’.

There is positive and negative freedom. In negative freedom there are no outside constraints to action, in a hierarchy or contract, so that one can ‘go one’s own way’. Trust, gives negative freedom to the other. That creates risk for you, and that requires the virtue of courage. Without risk

no relations. Positive freedom goes further than absence of constraints, in giving means, access to resources. Fruitful relations give both negative and positive freedom.

There are corresponding notions of negative and positive power. In negative power one limits negative freedom, constraining the other's choice. Positive power gives more freedom and options of choice, enhancing both negative and possibly positive freedom.

Power depends on the capital one has. That can be economic capital, or social, cultural (including intellectual, technological) or symbolic capital (Bourdieu) An example of social capital is reputation, or authority, from position., or connectedness in networks.

There is a difference between trust in competence, the ability to execute an agreement, and intentional trust, in the intention and commitment to execute the agreement to the best of one's ability. Also, there are different levels of trust: one can have trust in things, individuals organisations and wider systems, such as the economy or the political system. One must have trust on all levels. Trust in an individual who is not supported by his boss or organisation is risky. Trust in an organisation with internal violation of rules or principles, also. Trust in an organisation at odds with its institutional environment is not reliable.

The problem is that when something goes wrong one does not directly know the cause. It can be due to an accident that is no one's fault, it can be due to carelessness, lack of attention, or to outright opportunism. Especially the cheater will claim that it was an 'error'. In other words, there is 'causal ambiguity'. That uncertainty is of fundamental importance. One must now also trust someone's openness about what is going on. That uncertainty is of fundamental importance. One must now also trust someone's openness about what is going on', in communication. Trust also depends on circumstances. One is more competent in some things than in others, and cheating depends on the extent of temptation. What is the pressure of punishment and moral dedication? What restrictions are there in the form of multiple roles and obligations to family, the community, friends? What loyalty will take precedence?

In short, trust is a predicate with four 'places': someone (subject) has trust in someone (object, person, organisation, system) in some respect

(competence, intention) under some conditions. Trust is also both the cause and the consequence of a relation. It functions as the basis for the relation, but must also be built up in it. Intentional trust has several sources.¹⁹ Those are given below.

Table 1: Sources of (intentional) trustworthiness

	In the environment of the relation.	Inside the relation:
Control on the, basis of self-interest	contract, institutional oversight, reputation	Hierarchical oversight, dependence, incentives, hostages
ethics, altruism	norms, values, habits	empathy, identification, friendship, routine.

Source: Nootboom¹⁹

This is about intentional trustworthiness, not competence. There is a distinction between trust and control. There are sources of both, inside and outside the relation, in the institutional environment.

One can control a relation with means outside the relation, such as a legally enforceable contract, institutional supervision and reputation. Reputation depends on involvement of a community. Within a relation there can be hierarchical supervision, and dependence. 'Hostages' is explained later.

Beyond control there can be trust., outside the relation institutional trust in people in general, based on morality and ethics, associated with culture. Ethics is theory about good and bad, and morality is specific rules. Within the relation there can be a more personal bonding on the basis of family and friendship, or tribe or clan and in experience of people with each other, that may be routinized, no longer reflected.

The table can be used as a diagnostic, to analyze what sources might be present, and as therapeutic, to craft or elicit a source.

References

1. B. Nootboom. *Learning and innovation in organisations and economies*. Oxford University Press (2000).

2. J. H. Flavell. *The developmental psychology of Jean Piaget*. Princeton, NJ: Van Nostrand (1967).
3. Wilhelm, R. *I Ching or book of changes*, Penguin (2003).
4. H. Theil. *Economics and information theory*. Chicago: Rand Mc.Nally (1967).
5. B. Testa and L. B. Kier. Emergence and dissolvence in the self-organization of complex systems. *Entropy*, (2), 1-25 (2000).
6. A. Maalouf. *Le naufrage des civilisations*, Grasset (2019).
7. H. Tsoukas and R. Chia. On organizational becoming: Rethinking organisational change. *Organization Science*, **13**(5), 567-582 (2002).
8. B. Nooteboom. *A cognitive theory of the firm; Learning, governance and dynamic capabilities*. Cheltenham UK: Edward Elgar (2009).
9. Schein, Edgar H, *Organizational culture and leadership*, San Francisco: Jossey - Bass (1985).
10. K. F. Weick. *Sensemaking in organisations*. Thousand Oaks CA: Sage (1995).
11. Weick, Karl F. and K.H. Roberts, 'Collective mind in organizations', *Administrative Science Quarterly*, (1993), reprinted in Michael D. Cohen and L. S. Sproull (eds), *Organizational learning*, 1996, London: Sage, pp. 330-58. .
12. L. Smircich. Organization as shared meaning', in L. R. Pondy, P. J. Frost, G. Morgan and T. C. Dandridge (eds), *Organizational symbolism*, Greenwich Conn: JAI Press, 55-65 (1983).
13. U. Witt. On the proper interpretation of 'evolution' in economics and its implications for production theory. *Journal of economic methodology*, **11**, 125-146 (2004).
14. R. Janow. Shannon entropy applied to productivity of organisations. *IEEE Xplore* (2003).
15. T. Kuhn. Trust also depends on conditions. (2nd edition), *The structure of scientific revolutions*. London: University of Chicago Press (1970).
16. Popper, Karl.R, *The logic of scientific discovery*, London: Hutchison (1959).
17. I. Lakatos and A. Musgrave. *Criticism and the growth of knowledge*. Cambridge: Cambridge University Press (1970).
18. I. Lakatos. *The methodology of scientific research programmes*. Cambridge: Cambridge University Press (1978).
19. B. Nooteboom. *Trust: forms, foundations, functions, failures and figures*. Cheltenham UK: Edward Elgar (2002).