Technology and the Stability of Society

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Abstract. The word "society" can have a wide range of meanings. Here we shall understand it to have its most encompassing meaning and consist of all the people in the world and their institutions, technology, and other artefacts; essentially everything these people have created. Through the interactions between these elements they form a system, and due to the number and diversity of both the elements and the interactions, this is indeed a very complex system. It is also obviously a self-organising system, unless one admits some form of divine guidance.

In this paper we develop a *view* (in the sense of systems engineering) of this system that is derived from a consideration of the evolution of the system over the last 10,000 years or so. Central to this view is assertion that the driving force behind this evolution is the *intelligence* of the individual, and this assertion is justified on very general grounds. A simple model of intelligence leads to the identification of *knowledge* as the entity characterising this view, just as components and functions characterise well-known views in system engineering. In this view, a category of fluctuations in the evolution of society can be related to fluctuations in knowledge resulting from manipulations of information, and three simple models are developed in order to investigate some of the main characteristics of these fluctuations. The significant role of technology and its applications is discussed, leading to a concern about the risks associated with the future evolution of society.

1 Introduction

1.1 Purpose

From the start, it is important to have the purpose of the work presented here clearly in mind: To provide a high-level (and correspondingly highly simplified) view of society as a system, in order to investigate the influence of information exchange between individuals on the evolution of society, as represented by the system dynamics. The developments of information technology (IT) offer unprecedented means of information exchange, but also unprecedented means of manipulating and controlling the information being exchanged, which has the potential to result in severe fluctuations in the evolution, as compared to the "normal" evolution based on a free and unrestricted information exchange.

The purpose of the work can therefore be made more precise by saying that it aims to provide an insightful description of the relationship between the quality of the information exchange and the severity of the fluctuations. It does so by developing a model of the system that, despite its great simplifications, is able to present a reasonable account of its dynamics, and thereby, hopefully, to provide some substantiation for the view that the manipulation of information constitutes the greatest danger for society in our technology-enabled world.

1.2 Earlier Work

In an earlier publication (Aslaksen 2015a) it was argued that evolution is now essentially the evolution of society, as the product of extent and rate of change of anything else is so small that it can be neglected compared to the impact and speed of change of society. And it was suggested that the driving force behind this evolution is still what it has been since the beginning of life on

Earth - survival. That was based on a consideration of the history of evolution so far and on extending the basis of Darwin's argument to the human species, and also on what might be considered a process of elimination; nothing else seems to withstand rational scrutiny. Accordingly, the process involved in promoting survival has remained the same; it involves sensing and analysing changes to the environment and taking goal-oriented adaptive action, with the goal being survival. This immediately raises the question: survival of what? The individual, the species, or, in terms applicable to humans: the individual, the family, the belief, or the organisation or nation? We provided an answer that was sufficiently general to cover all of these, saying that what is to survive is *form*, in the sense of a specific structure of interacting elements, be these molecules, organisms, humans, or processes. That answer was adequate for the purpose of that work, which was to focus on the importance of the quality of the information which enters into determining the adaptive action. We also discussed, briefly, the fact that enhancing the probability of survival had become much more complex than taking a single adaptive action; human behaviour is the reflection of a sophisticated strategy. What was not pursued any further was the development of a deeper understanding of what "form" means in the case of humans, and how that form related to the evolution of society.

In that same earlier publication the interaction between engineers and society was examined from the point of view of the nature of the interaction rather than its effect, with an emphasis on the philosophical and sociological aspects. But even this limited and fairly general view made it clear how very complex the interactions in society are, and we would expect that these interactions will lead to a very complex behaviour and development of society. An often used approach to handling and understanding anything of such complexity is to apply the *system concept*, a particular mode of description that views the complex entity as a system, i.e. as a set of interacting elements, and then to model the complex entity through a sequence of systems with an increasing number of elements with an increasing level of detail (Aslaksen 2013). In other words, it is what might be considered a *successive approximation* to the full complexity through a series of steps of increasing complexity, what is often called a *top-down* approach. We shall adopt this approach in the next section, but first we need recognise that, no matter how we choose to partition society into elements, these elements will always be defined in terms of the individual members of society; as particular groups of individuals. Therefore, even if we want to start with large, simple elements, we first have to have a correspondingly simple model of the individual (simple being used in a relative sense here), and the development and description of such a model is the purpose of the next section.

In the following section we shall develop our understanding of what drives the evolution of society and what this evolution aims to preserve; i.e. the nature of the form that survives. This will involve consideration of various areas within sociology, philosophy, cultural studies, and the like, where there exists a significant body of knowledge and that are the subject of ongoing work by numerous researchers. We shall refer to such work where it appears directly relevant; however, our aim is neither to advance such work nor is it to provide a literature review, but to focus firmly on the very limited issue of the influence of information exchange on the stability of the evolution of society, and the role of technology in this regard. The same limitation is also true for the models we introduce; they are by no means general models of information or innovation propagation, but simply illustrations of the central idea put forward in this paper.

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2 Society as a System of Individuals

2.1 Society, Evolution, and Survival

When we speak of "survival", it means on the one hand that something persists in time; on the other hand that it does so in spite of something that is detrimental to its persistence. As individuals we speak of surviving an ordeal or a challenge, but when we speak of the survival of the human race, the species *homo sapiens*, or human *society*, it must relate to something other than the survival of individuals, which is severely limited. Maybe it is one or more characteristics of individuals that survives, such as the genetic code? But we can already see the possibility of modifying the genetic code; for example, to eliminate a disease or to make people smaller in order to reduce their ecological footprint and make space travel more economical. So, by this definition, the species would become extinct, but there clearly is something that persists. Another characteristic used to define a species is the ability to produce fertile offspring. But we could conceive of a future where all offspring is produced in a factory environment, so again the species would become extinct, but something persists.

We should also consider that we are likely to become increasingly characterised by a combination of what we might consider purely human characteristics and those of applications of technology; that is, we will become hybrids or cyborgs. That development has already started; the behaviour of a person in our society today is significantly affected by technology. And embedding applications of technology into the human body is well under way; currently only replications of human organs and parts, but additional and/or supporting capability will follow. So, if we want to say that we, the human race, is surviving through all of this, what is it that survives? What survives in all of the foregoing examples is *the continuity of the evolution of society*, where by society we understand all humans and their artefacts, the interactions between these, and the environment in which they operate. This continuity means that, at any point in time, the changes taking place in society in the next time increment are completely determined by the previous history of society. We can express this symbolically by the differential equation

$$\frac{dS(\boldsymbol{a};t)}{dt} = \int_0^t f(\boldsymbol{a};t)S(\boldsymbol{a};t)dt \qquad (2.1)$$

where S(**a**;*t*) represents society, described by a set of parameters, **a**, that are all functions of time, and *f*(**a**;*t*) is a function expressing both a weighting of the parameters in determining the future development and the fact that recent developments are more significant than ancient ones. That is, *f*(**a**;*t*) is a rapidly decreasing function as we go back in time, which is why the choice of the point $t = 0$ is unimportant; starting, say, 5000 years ago should be sufficient.

We now see that what we introduced as "form" is, in the case of humans, not a particular physical structure; that is, a particular ordering of physical elements in space, such as the molecules in the genome, or relationships between humans, such as a particular social structure, but a particular ordering of events in time, as expressed by Eq. 2.1. And we see that the meaning of "survival" in the context of humans is much more complex than what we might at first think of as the most immediate manifestation: the survival of the individual. We certainly have a strong personal survival instinct; we will fight anyone that tries to eliminate us, we will go to great pains and expense to avoid succumbing to an illness, and do our utmost to survive disasters and persecution. But on the other hand, there are numerous examples of where we are willing to give up our lives for our children, for our country, for a religious belief, and so on. And then there is the very deep desire to survive death in some form, again, in our children, but also in works that will remind posterity of our existence, such as a handprint on a cave wall, a poem, a scientific discovery, a world record, actions that will gain us a place in history, or a great monument, such as the Taj Mahal or the pyramids. But it is even more subtle that this; for those of us who cannot on our own produce something that will endure, there is a desire to be part of something that will. An example of this is the dedication and sacrifice of those who built the great cathedrals.

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Under this perspective of survival we see that our actions can be ordered according to the extent to which they depend on the individual, and that ordering is closely correlated with the extent to which the action involves an interaction with society. At the one end of the scale we find bodily functions, such as breathing, eating, and sleeping. Then we have the actions that do involve an interaction with society, but where this interaction is largely one way, in that society provides an infrastructure in which our actions take place and are fashioned. These are the actions that are, except for details, common to us all, and that make up the greater part of our daily lives, and their ability to change society is very small. And then, at the other end of the scale, we find those actions that express the individual's unique relationship to society and a desire to have an influence on society. Depending on the strength of the interaction between the individual and the relevant part of society, that is, the environment in which the individual finds itself, the behaviour of the individual will vary considerably. That interaction can be characterised in terms of *the things that matter* to the individual, the things for which the individual is willing to make an effort or a sacrifice. They are the things that, together with the individual, make up *the individual as an element of society*, they are the things in society with which the individual *identifies*.

Before going on to characterise the individual as the basic system element, we need to clarify our use of "society" and "system" in this paper. When we speak of society, without any further identification, we mean the following:

Society — A set of individuals, their organisational entities (educational, judicial, defence, etc.), and their artefacts (devices, equipment, technological systems, knowledge repositories, and built environment).

However, in order for these various elements to form a *system*, they must interact, and it is the individuals that interact (neglecting any future interaction of autonomous technological agents), often using these other elements to mediate the interaction. Consequently, when we are considering a society as a system and denote it by S, we take this symbol to represent the interacting set of individuals included in the society. That is, $a \in S$ means a is an individual in S. The largest possible society is that encompassing all the people in the world, and it will be denoted by S_0.

The members of a society may be grouped into what we identify as sub-societies, S_i, i=1,2, ….,k; how this identification is done is discussed in Section 3.

2.2 Intelligence and Evolution

Society evolves because individuals are able to respond to changing circumstances, and we shall adopt a common definition of intelligence to cover this:

Intelligence — The ability of an individual to respond to external stimuli with goal-oriented adaptive actions.

As was argued in the earlier work referenced above, the goal is, in the final analysis, always survival, and there we also introduced a particular model of intelligence. A diagrammatic representation of the model in terms of its main elements and their interactions is shown in Fig. 2.1. The organism responds to the external stimuli representing a new situation by performing an adaptive action. The action is performed by the actuators (feet, vocal chords, etc.) available to the organism, which are controlled by the processes taking place in response to the signals provided by the sensors. The processes are dependent on the knowledge accumulated by the

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organism through experience and education, and on inherent mental (i.e. instincts) and physical (agility, strength, reach, etc.) features of the organism.

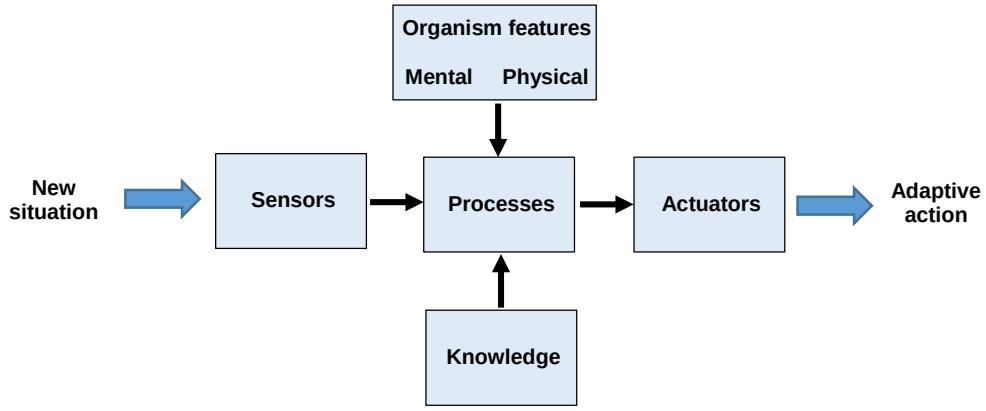

Figure 2.1 Diagrammatic representation of the high-level model of intelligence.

With reference to this model, we can define the following concepts:

Knowledge A set whose elements comprise all knowledge, concepts, information, data, and beliefs accumulated during the lifetime of an individual, to which the processes require access in formulating adaptive actions

This definition is somewhat lacking in at least two respects. One, the limitation to that part of all the knowledge an individual possesses that is required for formulating adaptive actions is imprecise. By "adaptive" actions we understand actions taken in response to inputs that challenge our current understanding and beliefs, and the knowledge required to formulate those actions does not include the knowledge involved in performing our normal work and activities. Such knowledge as the value of π or the names of the planets is obviously not included in this definition of knowledge, and odes not enter into our understanding of "intelligence". The relevant knowledge in the current context is clearly only a small part of our total knowledge, and while we can have a good conceptual understanding of this limitation, the boundary is not well defined. In the next subsection we shall define an even more restricted set.

Two, the concept of a knowledge "element" is not further defined. However, as we shall never require actual numerical values for the size of knowledge sets, but only relations between sets, this lack of precision should be acceptable.

Instincts A set whose elements comprise all information, data, and beliefs transmitted to an individual through genes and to which the processes require access in formulating adaptive actions.

Again, the same lack of precision is evident here as was the case for "knowledge", but it will not be important, as instincts play less of a role in what follows.

2.3 A New Meaning of Identity

The things individuals identify with include, in addition to their own bodies, the family, friends, clans and tribes, and various types of organisations that, through their structure, technological embodiment, or rituals, provide a focal point for interaction. However, what an individual considers an item that matters is not determined only by the generally accepted characteristics of

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this item, such as family relationship, a written constitution, rules and laws, but by the individual's perception of the item, by additional features that are important to that individual. The relationship with each of these things that matter is peculiar to each individual, and it is something the individual establishes as it goes through its life cycle. This web of relationships is what we shall, in the present context, call the individual's *identity*. Note that "truth" does not enter into this definition.

With reference to the model of intelligence in Fig. 2.1, the identity is stored in the element called "Knowledge", and forms a central part of the basis on which the individual evaluates sensory inputs and takes goal-oriented action. In effect, the identity determines what the goal is and what the meaning of "survival" is for that individual, and constitutes a subset of knowledge. If the set constituting the identity of individual *a* is denoted by A, the number of elements is termed the *size* of the set. The size is usually an increasing function of time (age of the individual) up to a certain time, and then fluctuating and eventually declining. The increase is due to the interaction of the individual with its environment; at first parents and siblings, then teachers and school friends, then spouse and children, people in the workplace and people in various organisations (sports, political, etc.), and so on. But the decline is not due to interaction with other people; it is due to the deterioration of the memory function and of the flexibility of the brain to accept and process new information. In Section 3 we shall, at least initially, neglect this physical effect, and simply assume that the size of the identity has a fixed upper limit.

How does this meaning of "identity" relate to the meanings given to this word in other contexts? Within psychology, a distinction may be made between *ego identity*, the sense of continuity and the issue of persistence; *personal identity*, the behavioural features that distinguish one person from the next; and *social* or *cultural identity*, the collection of social roles that a person is able to play. Within this framework, our use of the concept is clearly close to "personal identity", to the extent that behaviour is an accurate reflection of the survival criteria, an issue we shall return to shortly. Anthropologists may use "identity" mainly in the sense of "belonging to"; that is, as consisting of characteristics that define membership of a group, such as ancestry, skin colour, or language group. This is therefore a meaning that is relatively constant over the life cycle of an individual and what we might think of as external in character. It is , therefore, on a first glance quite different to our concept. However, the "belonging to" could also relate to such characteristics as performing certain rituals in response to natural occurrences, such as floods, storms, or draughts, in which case the difference between the two meanings or uses of the word is reduced.

Philosophers take a different approach again; an approach rooted in ontology and what exists. What does it mean for a person to exist? What does it take for a person to persist from one instant in time to another? What are the consequences for identity if all or a part of the brain is removed or transplanted? These, and many other similar questions occupy a considerable body of work, but it would appear that they have little bearing on our meaning of identity as what matters for survival.

The process illustrated by the block diagram in Fig. 2.1, that is, the exercise of intelligence, is a complex decision-making process with several interacting sub-processes. And, what is not displayed in the diagram, it is a *dynamic* process, in the sense that the process parameters and the decision criteria themselves change during the life cycle of the individual. In order to gain an understanding of this process we start out by proposing a simplified, high-level view of the block in Fig. 2.1 identified as "Processes", as shown in Fig. 2.2.

The descriptions of the processes in Fig. 2.2 are as follows:

Process inputs. If we take our lead from Kant (Kant 1781), the signals from the sensory organs are processed through the two faculties of representation and understanding. The former turns the sensations into intuitions, and the faculty of understanding processes the intuitions and

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generates concepts. Concepts are classes of intuitions, and when we say we understand what an observed object is, it means that we know to which concept it is related. In that sense, a concept can also be considered to be a rule for the reproduction in imagination of a set of intuitions.

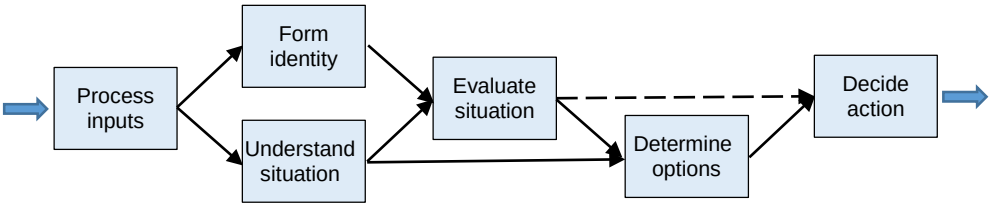

Figure 2.2 A high-level partitioning of the block "Processes" in Fig. 2.1 into sub-processes.

Form identity. In this process, the stream of concepts resulting from the interaction with our environment is considered from the point of view of its relationship to our identity, to the things that are important to us. This stream might reinforce our existing identity, or it might change it; at any point in time the identity consists of a collection of things that are important to us (beliefs, people, social structures, etc.) and for each one, an indication of how important it is to us, in the sense of what we would be willing to sacrifice to support or defend it. The concept of an importance ranking is somewhat similar to that developed by Maslow (Maslow 1943 and 1954), but whereas Maslow's hierarchy identified five broad classes of needs, the identity consists of specific things that are important to the individual, and while many of these could be fitted into Maslow's classes, that hierarchy lacks the survival perspective proposed in the present paper.

Identity is peculiar to each person and, while a large part of the identity may be common to persons within certain groups, there might be things that are perceived to be very important by single individuals. What is considered important is a matter of perception, and is developed in each individual as it goes through its life cycle and processes all the sensory inputs; in particular, all the inputs received through interactions with other individuals. This process of forming the identity raises a fundamental question: Is it a random process, in the sense of having no universal or common feature of the evaluation, or is there an inbuilt bias that skews the evaluation towards a particular outcome? The answer put forward in (Aslaksen 2015a) and forming the basis for the view of evolution developed by the author, is that there is indeed an inherent feature of all forms of life that their responses to perceived changes in their environments are influenced by a common meta-criterion, which is survival. The appearance of the meta-criterion is somewhat analogous to Kant's introduction of categories. He argued that concepts are not formed in an arbitrary manner; they have certain characteristics or categories, which are pre-existing (*a priori* of any sense input) in our mind. Categories are to concepts what space-time is to (empirical) intuitions. Intuitions exist within a space-time framework; concepts exist within the framework of categories. Now we are saying that identity is formed subject to the meta-criterion of survival.

The idea that there can be a guiding principle which is not divine in nature, but is built into humans as an intrinsic feature of their inherited nature, was discussed by Luc Ferry in his book *What is the Good Life?* (Ferry 2005), where he gave it the very appropriate name of "horizontal transcendence"; it transcends what is given to us through perception, but is not given to us by any divine authority. However, there is a significant difference between what Ferry puts forward and survival as a met-criterion. For example, Ferry would consider our basic idea of what is right and what is wrong to be such a transcendent concept, whereas what is proposed here is that our idea of what is right and what is wrong is generated by each individual as a result of experience (i.e. perceptions) and reflects the meta-criterion of survival in the society in which the individual finds itself.

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The significance of "influence" and "meta-" is perhaps best explained by a few examples, in order of increasing complexity. The first example is a plant; say, a tree. A tree has effectively no knowledge, its sensors can detect the direction of sun and wind and the presence of moisture underground. Its identity, the things that matter to it, consist of the instincts that tell it to grow towards the sun and to extend its roots towards moisture, and the influence of the meta-criterion of survival is very direct. The only actuators are, correspondingly, directing the growth of branches and the extension of roots. Because of its limited awareness of its environment, it can easily make an unfavourable response to a change in its environment, say, by extending its growth towards a source of water, not realising that this is the landowner's new vegetable garden, and will result in it being chopped down.

The next example is a more complex organism, say, a bird. Its sensors include sight and hearing, the actuators are wings, legs, and sound generator, knowledge could include information about flight path between summer and winter habitats, the behaviour of food sources (worms, fish), and instincts include procreation, shying away from larger moving objects and loud noises, among others. The processes are correspondingly complex, allowing the bird to make more considered responses to changes in the weather, detect the location of food, etc. In particular, birds can change their responses, that is, the criteria on which they evaluate situations, as a result of experience, such as feeding out of a person's hand. The built-in criteria for survival are still present, as any rapid movement of the hand will demonstrate, but they are influenced by the evaluation of the current situation based on experience. The underlying principle, i.e. the meta-criterion of survival, is realised both in the criterion evaluating the sudden hand movement and in the criterion evaluating the opportunity of food.

The final example is a human being. Now the environment, in the form of society, has become many orders of magnitude more complex, both in its components and in their dynamic behaviour, and the processes by which individuals assess the environment and decide what matters to them, i.e. develop their identities, as well as the processes used to decide on a response to a new situation have become equally complex (we are reminded of Ashby's Law of Requisite Variety (Ashby 1956)). The meta-criterion is still survival, but its realisation in decision criteria for determining adaptive actions is greatly modified through individual experience, gained through observation and through interaction with other persons.

Understand situation. As already mentioned, this is also a complex process, or set of processes, if we would care to go to a greater level of detail. It cannot be expressed as a logical process, in the sense of a computer algorithm, and it is peculiar to each individual, in that it relies on the individual's education, training, and experience. Three features of this process are of importance to the developments in the next section: Firstly, while there is some scope for checking of the input data for self-consistency and comparison with known (or accepted) facts, the evaluation of the input data leading to an understanding of the situation they represent is largely through a comparison with similar sets of data experienced in the past. As a result, erroneous understandings (e.g. prejudices) tend to persist. Secondly, the amount of data received in a given situation is usually much greater than the interpretation part of the process can handle, and so we carry out a selection pre-process, eliminating the data we consider irrelevant to interpreting the data and understanding the situation. As the capacity of this pre-process is limited, the probability of eliminating relevant data increases with the amount of data received, leading to a state of indifference due to input overload. Thirdly, an increasing proportion of the data we receive regarding a particular situation is not by direct observation, but second or third hand through various media. So, in addition to interpreting the data as received, the process needs to try to assess the veracity of the data, essentially through plausibility and correlation with existing knowledge.

Thus, the picture that emerges is one of a process that does not contain any intrinsic judgement of truth; the understanding of a situation is almost completely dependent on the available

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knowledge. Only in the simplest situations can the question "Is it true that…" be answered unequivocally with a "yes" or "no".

Evaluate situation. With regard to this process, we need to keep in mind that we are considering only evaluation (and possible adaptive action) with regard to the survival criteria that make up the identity. The great majority of the evaluations and decisions we make do not fall into this category (or, more correctly, are only extremely remotely connected to it) and occur in a manner we consider "automatic", such as brushing teeth, crossing the street, driving a car, and so on. These are not actions through which the individual influences the evolution of society, which is what we are ultimately concerned with and shall consider in the next section. So, in the overwhelming majority of situations, the outcome of the evaluation is that they are not relevant to survival. However, in those cases where the evaluation finds that the situation does impinge on one or more of the things that matter, the outcome is a realisation of the importance of the situation and the start of the process of searching for options for an adaptive action.

Determine options. Having identified a situation as one that impinges on one or more of the items that matter for survival, this process considers what options are available for responding to this threat. One might expect this to be a rational process of identifying possible options and estimating the cost and/or effort and the effectiveness in achieving the desired result for each option, but in reality it is often what is termed an emotional response. That is, the most immediate option is chosen without much consideration, in order to relieve the emotional pressure that results from an unresolved threat. It appears that, in general, the greater the threat, the less rational and more instinctive the response, with the instincts provided by the block termed "Organism features" in Fig. 2.1; they form an intrinsic, inherited core of decision criteria.

Decide action. Most of us probably realise that there are many actions we ought to take, ranging from participating in a protest march and writing to the newspaper to starting an action group, but actually doing it is another matter. It requires the *will* to do it, and that is part of the identity; a measure of how much something matters *to the individual*. For example, I might realise that a grave injustice is being done to another individual or group of individuals, and that I should voice my protest, but as it does not affect me directly, I do not have the will to do anything about it. This particular aspect of the identity is what is indicated by the dashed line in Fig. 2.2.

From the above description of the process we need to take away two of its important features, and they are both related to the fact that the process is a *dynamic* process. One, it is dynamic in that the process itself, as it is depicted in Fig. 2.2, changes with time; both the identity and the evaluation are influenced by the information being processes, as we will return to in Sec. 5. Two, the process is dynamic in the sense that it takes time into account; time is a variable in the situations being evaluated, and the decisions and adaptive actions are based on predictions of future effects. This introduces additional variability; two persons with exactly the same moral precepts and understanding of right and wrong may take different adaptive actions because they predict different futures in which the actions will take effect.

2.4 Identity as a Social Product

The picture developed in the foregoing is of an individual identity that consists of the criteria for deciding on the importance of perceived situations for survival, and that is developed throughout the life cycle of the individual. The inputs to that development occur through the interaction of the individual with its environment; that is, with society. This can be an interaction with Nature, with other people, or, increasingly, with applications of technology. The relative importance of these types of interactions will vary, depending on the local environment, but for the majority of people the most important one will be the interaction with other people. This can take place

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through a variety of media: one-on-one, either face-to-face or through some medium (phone, email, letter, etc.), or in a broadcast manner, through print, radio, television, and social media. The reach of this interaction will also vary greatly. For some this might be quite a limited reach, restricted perhaps to an extended family or a small tribal group, but for the overwhelming majority of humans today the reach is effectively all of humanity. We are becoming a world society.

The interactions with applications of technology are, of course, in the final analysis, interactions with the people that designed them, but there is at least one significant difference: the interactions with technology applications *enforce* a particular response. As an example most of us are familiar with, consider getting cash from an ATM. The machine displays a series of questions in a fixed sequence, and to each one you must provide the appropriate response. Now, you might say "Well, that is very convenient, I would not want it to be different from machine to machine", but that is not the point. The point is that you have no choice as to the format and content of the interaction; you are forced to conform to a set procedure, if you like it or not. This fashioning and controlling of our behaviour and responses by means of technology applications is the subject of a body of work with inputs from philosophy, sociology, and psychology, exemplified by (Foucault 1977 and 2000), (Ihde 1990), (Latour 1992), (Verbeek 2005), and (Dorrestijn 2012). But it is important to recognise that this is one of several aspects of the interaction between technology and society, and two of the other ones are relevant here. One is the way in which the ubiquitous presence of technology influences the way in which we view our environment; both Nature and society. This is the critical theory developed by Heidegger (Heidegger 1977) and reflected in (Marcuse 1964), (Habermas 1970), and (Arendt 1958), and more recently in (Negri and Hardt 2000) and (Feenburg 2002), and basically it argues that our human nature and the environment in which we act as humans is being invaded by a world of power and consumerism that is driven by and based on technology; a world in which everything is considered a resource, something to be used, but that has no value in itself.

The second aspect is that we are being conditioned to accept and, in many cases prefer, the interaction with technology applications and whatever they provide. The issue here is not with every individual interaction; for example, we accept that we should stop at a red traffic light. We know why, and we find this an acceptable solution. The issue is that we get conditioned to accept the dictates of technology without critical assessment. This is one reason why Internet scams are so successful; people accept a request to provide information from what looks like an official source without thinking "can this be true?". Technology has come to embody a certain authority.

The evolution of society is driven by the interaction between each individual and society, and it is one in which each party influences and is influenced by the other. This is illustrated in Fig. 2.3, which shows the individual receiving information by observing society through various channels and evaluating this based on the criteria making up the individual's identity. This evaluation may result in an adaptive action, and this action is carried out in the forum provided by society; that is, as an interaction with other elements of society. The new state of the society is again observed by the individual, and so on.

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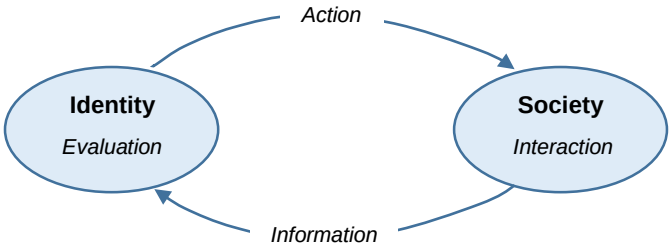

Figure 2.3 Illustration of the mutual interaction between the individual and society. Society provides the means for realising the actions of the individual, the individual provides the means (the identity) for evaluating the performance of society.

However, not only does society change, but the identity of the individual changes also; *identity is a social product*. Through observing its environment, the individual continuously assesses what matters for survival, and the evaluation criteria that make up the identity undergo an evolution that is related to that of society; the two are coupled. The coupling mechanism is a statistical one, in that the evolution of society is influenced, to some degree, by the actions of every individual. The degree of influence, or *power*, varies greatly from person to person, and the process by which power is developed is a highly non-linear one, in that power provides the means for its own increase through the feed-back inherent in the loop illustrated in Fig. 2.3. Consider for a moment, as a very simplistic picture, a society in which the individuals are all equal and indistinguishable with regard to the influence of their actions and their access to information. However, due to the fact that local sources of information are accorded a greater importance that distant ones, and the actions of individuals have greater impact locally than on distant events, each individual is associated with a local environment, and society is the system consisting of all of these local environments. Let the state of society be characterised by a single parameter, say, x, which is the average of that parameter in each local environment, then x will change with time as a result of the feed-back process indicated in Fig. 2.3. In terms of the behaviour presented by Eq. 2.1, the parameter x is a representative of the more detailed set of parameters, **a**; x might be some high-level concept like happy life years or the richness of life. The dependence of x on time is shown as the smooth curve in Fig. 2.4, where x changed as humanity progressed from the cave to life in a developed society today, and at each point in time, the change in x, that is, the value of dx/dt, is what human intelligence, on the average, judged to be optimal. Any deviation from this curve is detrimental; it is not the case that the greater the value of x at any point, the better. This is, of course, the problem with different parts of the global society being on different points on this curve at the same time; what might be likened to a non-equilibrium situation in physics.

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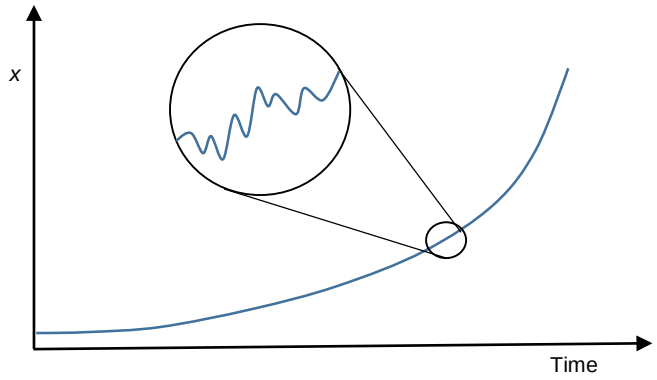

Figure 2.4 Illustrating how the evolution of society is not a smooth progression when looked at in detail. The parameter *x* is some measure of the richness or complexity of society.

If, in this utopian society, we would look at the value of the same parameter, but averaged over only a part of society, we would find that it fluctuates around the value for the whole society, and the fluctuations are greater the smaller the part under consideration is. Consequently, if we look at the curve in Fig. 2.4 with a greater resolution, we would find that it is not a completely smooth curve, but one with fluctuations (also called "sampling fluctuations" and discussed e.g. in (Cavelli-Sforza and Feldman, 1981)), as indicated in the figure. But because these fluctuations are detrimental, and are recognised by the rest of society as such through the evaluation process, they do not persist. However, if the evaluation process is perverted, usually by withholding or falsifying the information which is the input to the process or by restricting the ability to undertake action, the fluctuations can become significant, and recent and current examples of this are not difficult to find. That is the subject of the later part of this article.

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3 Structure and Dynamics of Society

3.1 Identity as the Structuring Agent

The individuals making up a society relate to each other in various ways, forming such entities and organisations as families, clans, interest groups, political parties, and nations.

In the Sections 3 and 4 we shall use the following notation:

i. A society is denoted by S; it is a set of *n* individuals. If there are several societies, e.g. as sub-societies of a larger society, they will be identified by a subscript, S_i, each with n_i individuals.
ii. Individuals will be denoted by the lower-case Latin letters *a*, *b*, and *x*, and their associated identities by upper-case letters A, B, and X.
iii. For convenience, the size of a set of identity elements is also denoted by the same upper-case letter as the set itself, e.g. A. That is, A can be either a set, on which the set operators of union, intersection, and complement apply, or a number, on which arithmetic operators apply. Which interpretation applies will be obvious from the context.

We shall now define a number of quantities that will be useful in our investigation of the properties of societies as systems. As the first one, the *alignment between two individuals* is defined as follows:

Alignment between two individuals

With $a \in S$ and $b \in S$, let A be the identity of *a* and B be the identity of *b*. Then the alignment between the two individuals, α_{ab}, is defined by

$$\alpha_{ab} = \frac{A \cap B}{A \cup B},$$

and it is a number in the range 0 – 1.

An illustration of the concept is shown in Fig. 3.1, and we see immediately that $\alpha_{ab} = \alpha_{ba}$, and that $\alpha_{aa} = 1$. Hence, there are n(n-1)/2 distinct combinations (*a*,*b*), $a \neq b$, and we shall use the symbol $\Sigma_{a,b}$ to mean the sum over these distinct combinations of *a* and *b*.

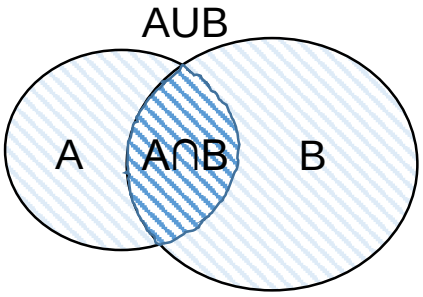

Figure 3.1 The alignment α_{ab} of two identities, A and B, as the ratio of their intersection (heavily cross-hatched) and their union (total cross-hatched area).

We can also define a *global alignment within a society*, which expresses the extent to which the individuals have the same identity on the average:

Global alignment within a society With $a \in S$ and $b \in S$, let A be the identity of a and B be the identity of b. Then the global alignment within the system, α_S, is defined by

$$\alpha_S = \sum_{a,b} \frac{\propto_{a,b}}{n(n-1)/2},$$

and it is a number in the range 0 – 1.

Alignment can also be used to characterise a society through the concept of a *core identity*, Z, of a society, S, as follows:

Core identity With $a \in S$ and $b \in S$, let A be the identity of a and B be the identity of b. Then the core identity, Z, of the society S is defined by

$$Z = \{z | z \in A \cap B \; \forall \, a \in S, b \in S, a \neq b\} = \bigcap_{x \in S} X \, .$$

It follows that, in a society with a core identity Z,

$$\sigma_{ab} \geq \sigma_{ab}^{min} \equiv \frac{Z}{A \cup B} \, .$$

We now have two measures of the extent to which the individuals in S have identity elements in common, α_S and Z, but they are quite different. On the one hand, $\alpha_S > 0$, whereas the core identity is zero if only one of the identities has no element in common with all the others. That is, a single deviant individual would make the core identity of the society vanish. On the other hand, α_S is a number that says nothing about which elements are shared or how the shared elements are distributed, whereas Z identifies the common elements. The advantage of α_S is that it is the sum of simple terms, so that if we can determine the dynamics of these terms, we have a characterisation of the dynamics of the society. The difference between α_S and a measure based on Z is reduced if we make the assumption that the identities of all the individuals in S have at least some elements in common, and, indeed, we shall consider this to be a necessary condition for an individual to be a member of S. The difference is further reduced if we assume that α_{ab} is greater than a significant value, say 0.1, for all a,b in S, and that will be our approach in considering the stability of society.

Consider now the following thought-process: In a given society, S, with n individuals, pick any individual, a. Then pick that individual, b, from the remaining n-1 individuals who provides the largest value of σ_{ab}. Then pick the individual, c, from the remaining n-2 individuals who maximises Z{a,b,c}, and so on. The result is a function Z(m), with $m \leq n$, with a shape as shown in Fig. 3.2 for the case of $S = S_0$, which is the whole world. The basic shape, as a succession of steps, results from the structuring of society into various sub-societies, such as families, clans, political parties, nations, and cultural regions (e.g. western, eastern, and middle eastern). The two curves shown illustrate the effect of choosing different individuals to start the process: no. 1 is a person with strong ties to a large number of people, such as a political leader, whereas no. 2 is a person that has only family ties and maybe some relatively weak ties to a sporting society or something like that. However, as m increases and both curves encompass more and more individuals with a certain part of their identities in common, the difference vanishes.

We see, then, that the concept of a core identity can be used to subdivide society into sub-societies at various levels. With each level we can associate a *critical core identity size*, Z_i^c, with Z_0^c being the core identity size for the world society, as indicated in Fig. 3.2. At any one level there is a number of sub-societies, or simply societies, at a higher level, such as nations at level 2 in Fig. 3.2, which we denote by S_i, i = 1,2,…,k, and each of these societies has a core identity, Z_i. We can then define the similarity of two societies as follows:

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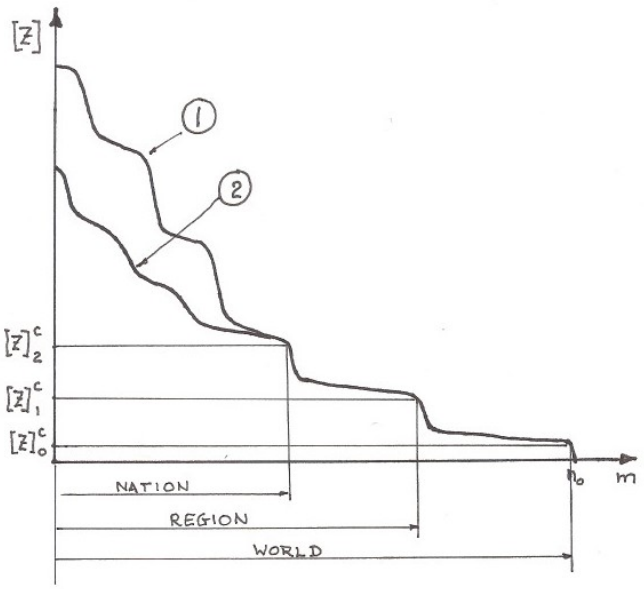

Figure 3.2 The development of the size of the core identity, Z, for a society S, stating from a single individual and increasing the number of persons included in S, until all the individuals in the world, n_0, are included. Curve 1 starts with an individual with a close relationship to large groups of society; curve 2 starts with an individual with limited personal relationships. The notation [Z] is used here to emphasize that it is the size of Z we are considering.

Similarity

In a set of societies, S_i, spanning a society, S, each with a core identity Z_i, the similarity of two societies, S_i and S_j, is denoted by $\zeta_{i,j}$ and defined as

$$\zeta_{i,j} = \frac{z_i \cap z_j}{z_i \cup z_j} .$$

It is a number in the range 0 – 1, and $\zeta_{i,j} = \zeta_{j,i}$.

An illustration of the concept is shown in Fig. 3.3.

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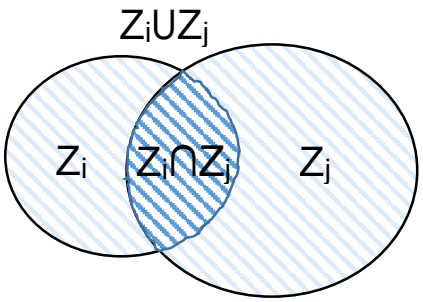

Figure 3.3 The two sets, $Z_i \cap Z_j$ and $Z_i \cup Z_j$, involved in forming the similarity $\zeta_{i,j}$ of two societies.

Extending this concept to the whole society, S, we can define the *homogeneity* of the system, Φ, as follows:

Homogeneity In a society, S, composed of k sub-societies, there are $k(k\text{-}1)/2$ distinct values of similarity, $\zeta_{i,j}$. Denoting the sum over these values by $\Sigma_{(i,j)}$, the homogeneity, Φ, is defined as

$$\Phi = \frac{\Sigma_{(i,j)}\, \varsigma_{(i,j)}}{k(k-1)/2}\,.$$

The homogeneity is a number in the range 0 – 1, and it expresses the extent to which the members of the society share a common identity base. Or, we might say that the quantity 1-Φ is a measure of the *tension* within the society.

What we have done above for sub-societies is a replication of what we did for individuals, with core identities replacing individual identities, and the comments we made about the measure α_S now apply in similar fashion to Φ.

3.2 Binary Interactions

So far, we have not allowed for any interaction between the individuals, and we have supressed any time dependence. The structuring introduced above is valid at any one point in time; it is in this sense static. But the identity of an individual is a dynamic set of knowledge elements and, as already noted, the size of the identity is usually an increasing function of time (age of the individual) up to a certain time, and then fluctuating, and then declining towards the end. However, even if the size is declining, the elements are changing, and so the alignment of the individual with other individuals will generally not be the same function of time as the size of the identity, and may be increasing even as the size is decreasing. Be this is it may, the point is that all the quantities defined above will be functions of time, and this time-dependence arises because of the interaction of individuals with other individuals. In order to develop this concept of interaction further, it is useful to make two simplifications (or approximations) and one assumption. The first simplification uses the fact that the number of elements in any identity set A is a very large number, as are the numbers of the elements in the other sets introduced above, so we may, for convenience, consider these numbers to be continuous functions of time. With this understanding, we can use the differential operator d/dt to denote “the rate of change”, even though, in the strict sense, it is always zero.

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The second simplification arises from considering that changes to the identity occur through the processing of two types of inputs – those resulting directly from the individual's observation of its environment, and those resulting from interactions with other individuals. In the former, individuals may well make up part of the environment being observed, but it is a passive role; unintentional as far as the observation is concerned. In the latter, it is possible for the input to result from an interaction with a number of other individuals simultaneously, as can be observed in crowd behaviour (e.g. stampedes, mass hysteria), but these are relatively seldom events; the vast majority of interactions are between two individuals. Furthermore, the ratio of observation to interaction is only large in the early years of life, say, up to age 6 or so, during which time the increase in knowledge has relatively little to do with what we have defined as identity; they fall into what we shall define as the framework of accepted inputs in the next Section. After that age, interaction, both direct and through media, becomes dominant, and our second simplification is therefore to, at first, only consider interactions between two individuals, *binary interactions*, as contributing to changes in identity. A modification to this simplification is introduced in sec. 3.6.

The assumption is that there exists a well-defined and measurable quantity that can be identified as the *strength* of the interaction between two individuals, *a* and *b*, in a society, and we shall denote it by μ_{ab}. We want the strength to somehow express the ability of *a* to get *b* to accept elements of *a*'s identity, and to that end we introduce the concept of *acceptance*. We previously introduced the concept of alignment, but that did not imply that there was any interaction involved. Two individuals can be strongly aligned without there being any interaction between them, and alignment does not have a direction, $\alpha_{ab} = \alpha_{ba}$. Acceptance implies both an interaction and a direction, and in order to capture this, we divide an identity, e.g. A, into three parts:

A1 The part of the identity common to the two interacting individuals that is not dependent on the interaction. This might be thought of as part of the culture of the society to which the two individuals belong.
A2 The part of the identity originating with the individual *a*,
A3 The part of the identity acquired through the interaction with *b*,

where A = A1 + A2 + A3. We also have A1 = B1 , and it is important to realise that this part of the identities is defined by the particular interaction, in the sense of not being dependent on it; it is not a characteristic of an individual's identity alone.

With this, the acceptance by *b* of identity elements from *a*, β_{ab}, is a measure of the extent to which *b* acquires identity elements from *a*, and is defined as follows:

Acceptance With $a \in S$ and $b \in S$, let A be the identity of *a* and B be the identity of *b*. Then *b*'s acceptance of *a*, β_{ab}, is defined by

$$\beta_{ab} = \frac{B1+B3}{B}, \tag{3.1}$$

and it is a number in the range 0 – 1.

The extent to which *b* accepts the identity of *a* can be increased either by eliminating elements of B2, or by increasing B3, or a combination of both. Correspondingly, the strength of an interaction has two components; μ_{ab}^{+}, which relates to the ability of *a* to add elements from A2 to B3, and μ_{ab}^{-}, which relates to the ability to remove elements from B2. Note that, as elements of A2 are added to B3, A2 shrinks correspondingly, because in this model A2 represents those elements of A that are not found in B, and a given element of A2 cannot be added to B3 more than once. Then, considering only the interaction between the two individuals *a* and *b*, the four components of the strength are related to the changes in the identities through the following equations, which also effectively provide the definitions of the components:

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$$\begin{aligned}
\frac{d}{dt}A2 &= -(\mu_{ab}^{+} + \mu_{ba}^{-})A2\ ;\\
\frac{d}{dt}A3 &= \mu_{ba}^{+}B2\ ;\\
\frac{d}{dt}B2 &= -(\mu_{ba}^{+} + \mu_{ab}^{-})B2\ ;\\
\frac{d}{dt}B3 &= \mu_{ab}^{+}A2.
\end{aligned} \tag{3.2}$$

The strength of the interaction, μ_{ab}, is determined by three factors. The first is a characteristic of individual *a*, and may be described by such terms as charismatic, magnetic, persuasive, or dull, uninspiring, and so on. The second is the communications channel between *a* and *b*, the access *a* has to *b*, such as through the media, through an organisation (e.g. religious group, political party, union, business affiliation), or through informal groupings based on friendship or common interests, and so on. The third is the nature of the individual *b*, in the sense of receptiveness to changes in identity. That depends on the extent to which the suggested changes resonate with (or conflict with) the identity elements already present in *b*; something that was identified as "cognitive advantage" in (Simpkins et al 2010). While that work is concerned with interaction between communities rather than individuals, and with idea networks rather than identities, many of the characteristics identified and discussed there can be reflected onto our binary interactions, e.g. the fact that the interconnectedness of the identity elements is a significant factor. Strong interconnectedness presents less opportunity for new elements to intrude and be accepted. However, we need to realise that most of the literature on network-enabled interaction is focused on the effect this has on cognition, as in *The Extended Mind and Network-Enabled Cognition* (Smart et al 2008) or in (Clark & Chalmers 1998), whereas we are concerned with a particular subset of this - persuasion rather than cognition, as in conversion of belief.

Accounting for differences in these three factors on an individual basis in a society of any significant size would be practically impossible, so our further development will have to make use of statistical methods and consider the individuals to be members of a society, S, with *n* members. In particular, with regard to the third factor, we shall represent the nature of the individual *b* by an average nature, and thus eliminate any dependence of this factor on *b*. This is somewhat similar to the use of *per capita* measures in economics.

With regard to the second factor, the communications channel, it is sometimes useful to characterise it in terms of a *distance*. This is not necessarily related to a physical distance, but is a measure of the intensity of the communications channel. A short distance indicates relatively intense communications, such as daily face-to-face, whereas an occasional encounter or public address would be represented by a long distance. Our approach here is as follows: Seen from any individual *a*, the *n*-1 other members of the society are evenly distributed on a circular surface with *a* at its centre and a radius of $r = 1$. Thus, the density of individuals equals n/π. The intensity of the communications channel, $s_a(r)$, is a monotonically decreasing function of the distance, *r*, with $s_a(0) = 1$ and $s_a(1) = 0$. The interaction strength components shall then be composed as follows:

$$\mu_{ab}^{+} = m_a^{+} s_a(r_b) \text{ and } \mu_{ab}^{-} = m_a^{-} s_a(r_b)\ . \tag{3.3}$$

The parameters m_a^{+} and m_a^{-}, which we might call the *strength coefficients*, are positive real numbers with no upper bound; the issue of a scale will be discussed later. The shape of the function $s_a(r_b)$ will be somewhat similar to the function $Z(m)$ shown in Fig. 3.2, but the two will, of course, not be identical, not least because of the difference in the two arguments, $m = 1,2,\ldots,n$ and $0 \le r \le 1$. In the remainder of this paper, we shall not be making use of the distance concept. While intuitively attractive, its practical use is limited to situations where a central control function is being maintained, a situation it is intended to investigate in a forthcoming paper. For our purpose, the interaction strengths will be constant within a society or a component of a society.

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The two strength coefficients may often have the same, or nearly the same, value, as both depend on the persuasiveness of the individual. But they may not have, as in those cases where the identity elements in A-B do not detract from or interfere with those in A∩B, and in cases where there is an asymmetry in the effort required to develop the two components of the dependence. Moses was successful in getting the Jews to accept the new god and forsake all others, whereas missionaries often had some success in getting indigenous people to accept the Christian god as an additional god, but could not get them to completely renounce their old ones.

The relationship between two individuals may be symmetrical, $\mu_{ab} \approx \mu_{ba}$, as between two friends, or asymmetrical, with $\mu_{ab} >> \mu_{ba}$, as between an emperor and his subjects. In the latter case, it might sometimes be useful to speak of an asymmetry coefficient, $\varepsilon = (\mu_{ab} - \mu_{ba})/(\mu_{ab} + \mu_{ba})$.

To get a feel for the behaviour expressed by the set of equations, Eq. 3.2, we can solve them for the following initial conditions: A3 = B3 = 0; and B1 + B2 = A1 + A2 = 1. Solutions are provided by a small numerical integration routine (in VBA), and the first case is $\mu_{ab}^{-} = \mu_{ba}^{-} = 0$, and $\mu_{ab}^{+} = 0.2$, $\mu_{ba}^{+} = 0.1$. We see that the attractions β_{ab} and β_{ba} end up being equal, as is obvious from the definition, Eq. 3.1 and the equations 3.2, only the rate of attaining the end value differs. The solution shown in Fig. 3.4 is for A1 = B1 = Z = 0.1, but the end value is independent of Z.

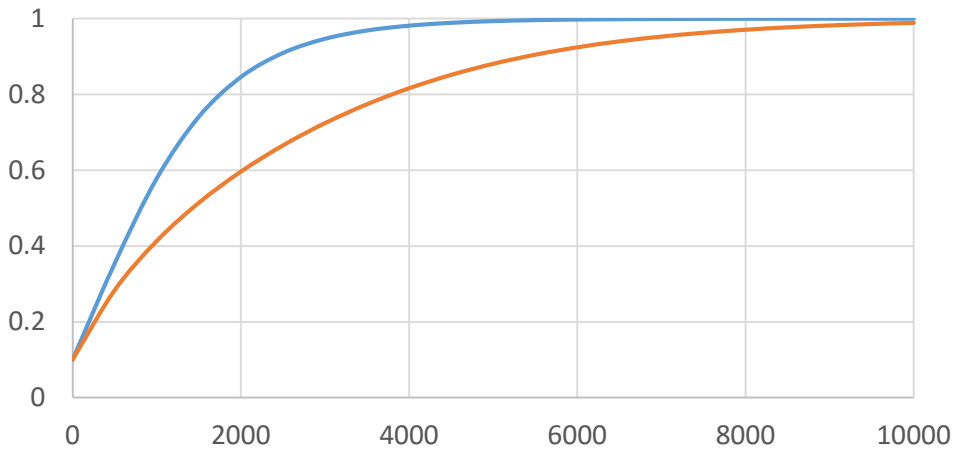

Figure 3.4 The upper curve is $\beta_{ab}(t)$, the lower curve $\beta_{ba}(t)$, for the case of Z = 0.1, $\mu_{ab}^{-} = \mu_{ba}^{-} = 0$, $\mu_{ab}^{+} = 0.2$, $\mu_{ba}^{+} = 0.1$. For $t \rightarrow \infty$, both curves take on the value 1.0, irrespective of the values of the interaction strengths. The interaction strengths only influence the rate of change. The time axis is labelled in integration steps, and the step size is 0.01 units of time.

The second case is one where the two positive interaction strengths are equal, μ^{+}, but one of the negative ones, μ_{ab}^{-}, is non zero (in this case equal to the positive strengths). This splits the two functions of time, but the final value remains equal to 1 for both functions, as shown in Fig. 3.5. Again, Z = 0.1.

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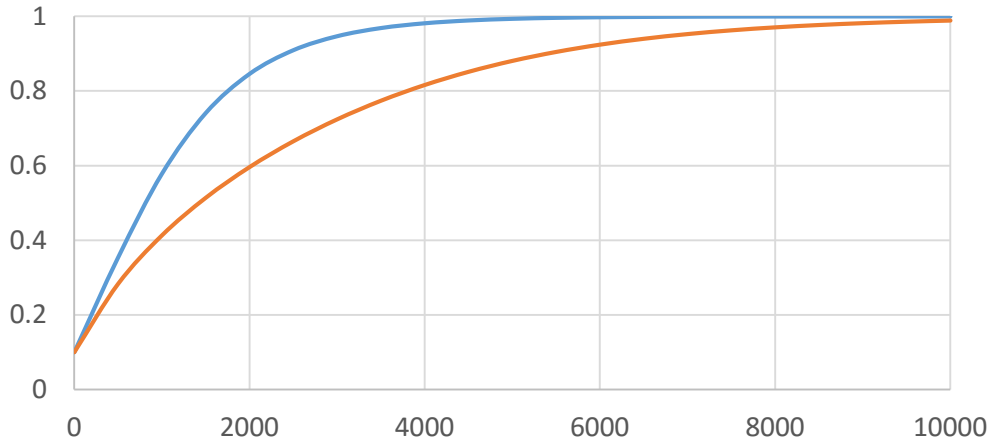

Figure 3.5 The upper curve is $\beta_{ab}(t)$, the lower curve $\beta_{ba}(t)$, for the case of $\mu_{ab}^{-} = 0.05$, $\mu_{ba}^{-} = 0.0$, $\mu_{ab}^{+} = \mu_{ba}^{+} = 0.05$, and Z = 0.1.

Interpreting the above results of our simple model in terms of an interaction between two individuals, the first case shows that, if there is no attempt on the part of either to convince the other person to give up any of its identity elements, the two will end up being equally attracted to each other. But in the process, the person with the stronger interaction (more persuasive, better mode of communication, more supporting evidence, etc.) will be more attractive for a period of time. And, of course, the interaction may be terminated long before equality is reached.

A difference in the rate of change will also result if one individual is more successful that the other in convincing its counterpart to give up some of its identity elements, and the extent of this split, as illustrated in Fig. 3.5, will depend on the ratio of the difference in negative strengths, $\mu_{ab}^{-} - \mu_{ba}^{-}$, to μ^{+}.

3.3 Individuals as System Elements

In a society, S, with *n* individuals, there will be $n(n\text{-}1)/2$ distinct binary interactions, and the change to the identity of an individual resulting from such an interaction will depend on the particular interaction. Consequently, the description of the identity needs to be able to reflect this, and to that end we shall identify the individuals by an index, *i*, with $i = 1,2,\ldots,n$, and define the identity, X_i, of individual *i*, as consisting of two sets:

i. The initial core identity, Z_0, of S; and
ii. a set, W_i, consisting of *n* disjoint subsets, $W_{i,j}$.

This is analogous to the subdivision of the identity we introduced in the previous subsection, with a symbolic correspondence as follows,

$A1_i$	Z_0
$A2_i$	$W_{i,i}$
$A3_{i,j}$	$W_{i,j}$

and the expression for the acceptance taking the form

$$\beta_{i,j} = \frac{Z_0 + W_{j,i}}{Z_0 + W_{j,i} + W_{j,j}}. \qquad (3.4)$$

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At an initial time, t_0, we impose the following initial conditions:

i. $W_{i,j\neq i} = 0$; and
ii. $W_{i,i} = 1-Z_0$.

These initial conditions are completely unrealistic, in the sense that no real society would ever be in this state, but they are not impossible, in the sense of not contradicting any other feature of our model of the society as a system. And they will allow us to display some main characteristics of the dynamic behaviour of the society.

In the next two subsections we shall be considering the behaviour of the society under the following simplifying conditions:

i. The strength coefficients, μ_{ab}^{+} and μ_{ab}^{-}, are independent of the values of *a* and *b*, except for μ_{1b}^{+} and μ_{1b}^{-}, which may be different, but independent of *b*; and
ii. the initial core identity, Z_0, remains unchanged.

In view of later expansion of the model, as well as for programming, we shall use the notation $\mu_{ab}^{+} = \mu_{2}^{+}$, $\mu_{ab}^{-} = \mu_{2}^{-}$, $\mu_{1b}^{+} = \mu_{1}^{+}$, and $\mu_{1b}^{-} = \mu_{1}^{-}$.

3.4 Equal Society Dynamics

We now need to digress for a moment and recall our basic knowledge of thermodynamics. The equations connecting the variables describing a system assume that the system is in equilibrium. This might seem to be a contradiction, because how can we speak of thermo*dynamics* if the system is in equilibrium? Bur we remember that the equilibrium referred to the microscopic processes, such as collisions between molecules, and that the contradiction disappeared when the rate of change of the thermodynamic variables was very much less than that of the microscopic processes, and that the relationship between the two domains is provided by statistics.

The same situation is now present in our view of society as a system of interacting individuals; the exchange of knowledge between individuals and the processes that modify individual identities take place in a much shorter time frame than changes to a society as a whole; typically days compared to years. Accordingly, we expect that we should be able to find relations governing the dynamics of a society by taking a statistical approach to the dynamics of individuals. However, even if we treat all the members of a society as identical (i.e. equal to an "average" member), a society is very different from the systems normally considered in thermodynamics, such as a gas of molecules, in that the members do not move around at random in a given space and interact equally with every other member. Society has a complex, multi-dimensional structure, and correspondingly our statistical methodology will need to reflect this, even if it is in a simplified manner. As a first building block in such a structured approach, we consider a small group of equal individuals (that is the significance of "equal" in the heading of this subsection), no greater than one hundred members, for which we can postulate that they all interact with each other within a (short) time period, which we shall take as the time-step in our numerical calculation of the dynamics of this system.

The equations governing the system follow from the equations for the binary interactions, as in Eq. 3.2,. However, when extending the binary interaction to more than two individuals, say, three, *a*, *b*, and *c*, we are faced with a choice between two assumptions:

1. The influence of *a* on *c* is due only to *a*'s own identity, not to any identity elements *a* has acquired as a result of its interaction with *b*.

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2. The influence of *a* on *c* is due to all the identity elements in *a* that are not in the identity of *c*.

In the first case, and with the simplifications made in the previous subsection, the equations are:

For $j = 2$ to n, and $j \neq i$: $\frac{d}{dt}W_{i,j} = \mu_2^+ W_{j,j}$; (3.5)

for $i = 2$ to n: $\frac{d}{dt}W_{i,1} = \mu_1^+ W_{1,1}$; (3.6)

for $i = 2$ to n: $\frac{d}{dt}W_{i,i} = -\mu_2^- \sum_{r=2,\neq i}^{n} W_{r,r} - \mu_1^- W_{1,1} - \mu_2^+ W_{i,i}$; (3.7)

and $\frac{d}{dt}W_{1,1} = -\mu_2^- \sum_{r=2}^{n} W_{r,r} - \mu_1^+ W_{1,1}$. (3.8)

In addition to these equations, we need to account for the fact that the reduction in the *individual* identity, $W_{i,i}$, through sharing identity elements with the rest of society, as expressed by the last term in Eqs. 3.7 and 3.8, is effectively an increase in the common part of an individual's identity, and can be expressed as an increase in the *core* identity, Z_i, by the following equations,

i = 2, …, *n*: $\frac{d}{dt}Z_i = \mu_2^+ W_{i,i}$; (3.9)

$\frac{d}{dt}Z_1 = \mu_1^+ W_{1,1}$. (3.10)

The macroscopic, or "thermodynamic", variable we want to calculate is the homogeneity, ζ, which for a society is now expressed as the average of the binary acceptance,

$$\zeta = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j \neq i} \beta_{i,j} = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j \neq i} \frac{Z + W_{j,i}}{Z + W_{j,i} + W_{j,j}} , \quad (3.11)$$

where $Z = Z_0 + Z_i$.

In addition, we can also calculate the size of the common part of each individual's identity, what we defined as the core identity, Z, in sec. 3.1. The results of a number of runs of the calculation are shown in Figs. 3.6 and 3.7 below, and they can be interpreted as follows: For $t \rightarrow \infty$, the society settles down to its equilibrium state, in which the homogeneity takes on the value 1. That is, the members have exchanged all the elements of their identities, and there is complete agreement about all the things that matter. If, as in Fig. 3.6, the interaction consist solely of persuading the other individual to accept elements of one's own identity, the equilibrium size of the core identity is a multiple of each individual's identity prior to interactions taking place, i.e. at $t = 0$. This multiple does not depend on the strength of the interaction, but on both the initial value of the core identity, $Z(t = 0) = Z_0$, and on the number of members of the society, *n*, in accordance with the relationship

$$Z(t \rightarrow \infty) = (n-1)(1 - Z_0) + 1 . \quad (3.12)$$

For small groups, i.e. small values of *n*, this may be reasonable, but there must clearly be a limit to this, determined somehow by the human capacity for keeping important matters immediately present.

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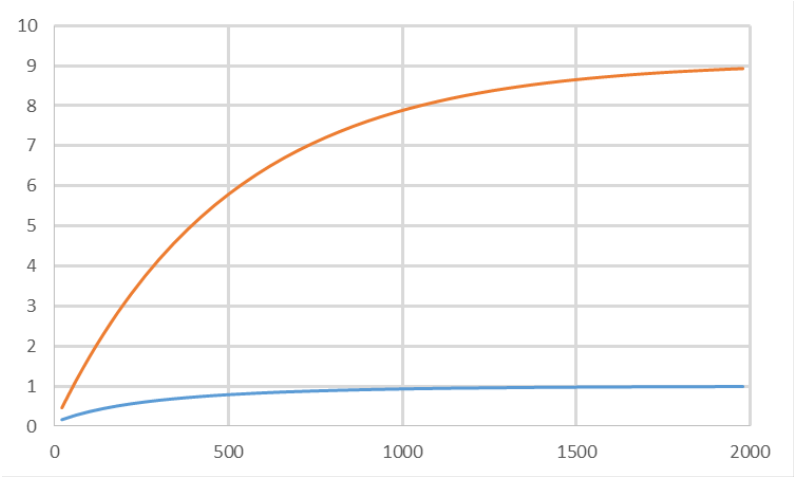

Figure 3.6 The homogeneity, ζ (lower curve) and the core identity, Z (upper curve) as functions of time for a society of 10 identical individuals, with $\mu^+ = 0.2$, $\mu^- = 0$, and $Z(t = 0) = 0.1$. The time axis is labelled in integration steps, and the step size is 0.01 units of time.

The significance of the result displayed in Fig. 3.6 is mainly that it provides a link between observed behaviour and the interaction parameter, μ^+, as defined by our model. As a purely hypothetical example, assume that the group of, in this case ten, individuals has been formed to consider an issue that is of importance to them all, but on which they have differing views and opinions. Each member of the group meets with each of the other members for one hour each month, and after twelve meetings - a period of about 7800 hours – they have reached a significant degree of consensus on the issue; say, corresponding to the point at 1000 time steps in Fig. 3.6, or 10 units of time. So, a unit of time corresponds to 780 hours. The initial slope of the Z(t) curve which, from Eqs. 3.5 to 3.10 is equal to $\mu^+ = 0.2$, is 2.16 per unit time, so that the unit of interaction strength is approximately 0.014 per hour. Of course, data from actual experiments would give a more well-founded value, as there are obviously many variables that have not been accounted for here, such as the background of the individuals, their interpersonal skills, the extent to which they refrain from persuading the partner to renounce his or her existing beliefs (which we shall consider below), etc. But if we put that aside for a moment, we might identify the duration of the interaction, D, (in this case 12 hours) and its intensity, I, (in this case 1/780 = 0.00128) as two significant parameters in determining the interaction strength, and if we, for simplicity, assume that there is a region of these parameters where the interaction strength is proportional to their product, then we have $\mu^+ = 13 \cdot D \cdot I$.

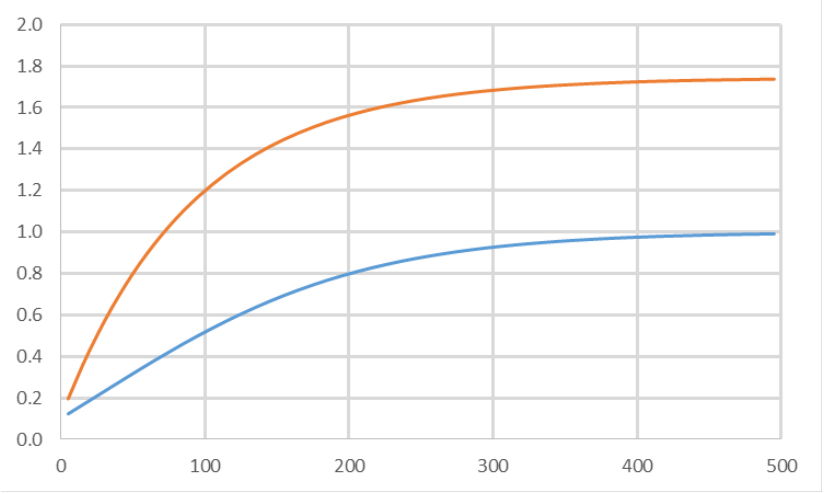

Figure 3.7 As for Fig. 3.6, except that $\mu^- = 0.1$. Note the changed time scale.

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Comparing Fig. 3.7 with Fig. 3.6 shows that allowing both the positive and the negative component of the interaction between individuals increases the rate of change, but reduces the equilibrium size of the core identity. In the case shown, $\mu^- = 0.5\mu^+$, the rate of change is increased by a factor of about 5, and the equilibrium size of the core identity is reduced correspondingly. This result demonstrates the importance of the "negative" part of the interaction – removing non-conforming identity elements – a result well appreciated by any totalitarian regime and applied in the form of brain washing. Further calculations show that the equilibrium size of the core identity equals 1 when $\mu^- = \mu^+$, irrespective of the value of *n*.

In the above calculations, all pairwise interactions took place in every time step. It might be more realistic to assume that the interactions take place in a random fashion, and so the calculation was run with each particular instance of the interaction given a probability of occurrence of 0.5. That is, each pairwise interaction was equally likely to take place or not. The result, for the same parameter values as in Fig. 3.6, is shown in Fig. 3.8, and it shows that, besides reducing the interaction intensity by a factor of 2, as we would expect, it has very little effect. This is, in part, due to the statistical manner in which our model operates; these "inherent" fluctuations within a single time step average out, and do not allow any one identity to become dominant, but this is more likely to be true of a society with a greater core identity than of a society with a small core identity.

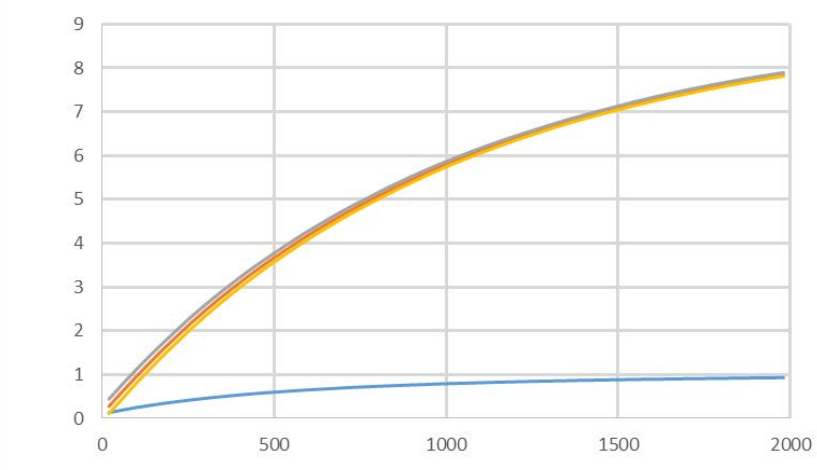

Figure 3.8 The same case as in Fig. 3.6, but with the pairwise interactions taking place or not at random. Of the three curves associated with the identity, the middle curve is the size of the identity averaged over all individuals, the upper curve is the maximum value of any identity, and the lower curve the minimum value of any identity.

If we now adopt the second assumption about the identity elements involved in the interaction between individuals, we find that Eqs. 3.5 and 3.6 each acquire an additional term and a factor α:

For $j = 2$ to n, and $j \neq i$: $$\frac{d}{dt}W_{i,j} = \alpha_i(\mu_2^+ W_{j,j} + \mu_2^+ \textstyle\sum_{r=2}^{n} W_{r,j}) \; ; \tag{3.13}$$

for $i = 2$ to n: $$\frac{d}{dt}W_{i,1} = \alpha_i(\mu_1^+ W_{1,1} + \mu_2^+ \textstyle\sum_{r=2}^{n} W_{r,1}); \tag{3.14}$$

where

$$\alpha_i = 1 - Z_0 - \textstyle\sum_{j=1,\neq i}^{n} W_{i,j} \tag{3.15}$$

The reason for the factor, α, is that the model resulting from the second assumption contains a feed-back mechanism that would otherwise drive the size of the individual identities to infinity. As already discussed, it is reasonable that the identity increases as a result of interactions with

other society members, but it cannot be unlimited. In the above equations, the increase is limited to the size of the initial individual identity, i.e. $1 - Z_0$, and it approaches this limit in an asymptotic fashion. This is an arbitrary limit, but it is one that is linked to a characteristic of the individual; one could make it a multiple of that quantity, if that were considered more realistic.

The equations 3.13 and 3.14 implicitly reflect the assumption that receiving the same identity element more than once within a time step is simply additive. That is, the reinforcing value of hearing a belief stated repeatedly remains constant.

The behaviour of this model is illustrated in Figs. 3.9 and 3.10, and shows how the equilibrium size of the identity is limited and how this limiting factor kicks on to provide a "kink" in the curve. The equilibrium value is given by the expression $2 - Z_0$, but only if $\mu^- = 0$; increasing μ^- decreases the equilibrium value, as each individual's own identity is decreased. These results show the expected increase in the dynamic behaviour of the society; a significantly faster response. They also show the same effect as in the previous model on this response time of introducing the "negative" component of the interaction; an increase of roughly a factor of 5. But the effect on the equilibrium value of Z is much less; this is because the feed-back process already accounts for most of the reduction.

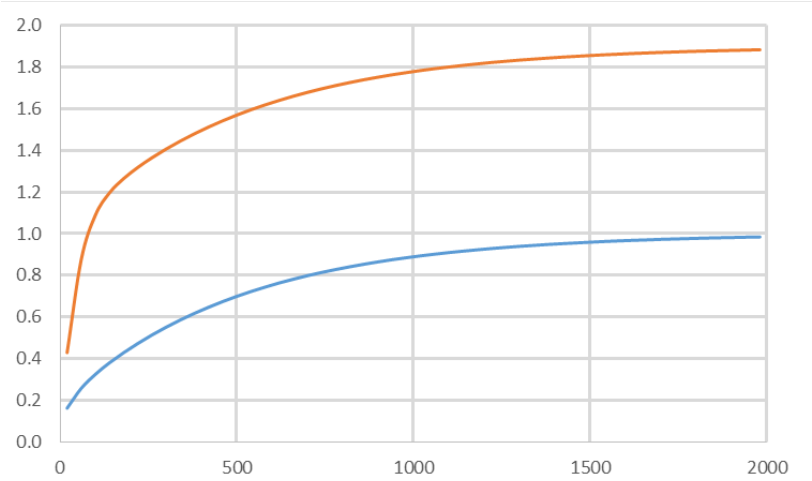

Figure 3.9 The same parameter values as in Fig. 3.6, but for the case of using the second assumption about the identity elements involved in the interactions.

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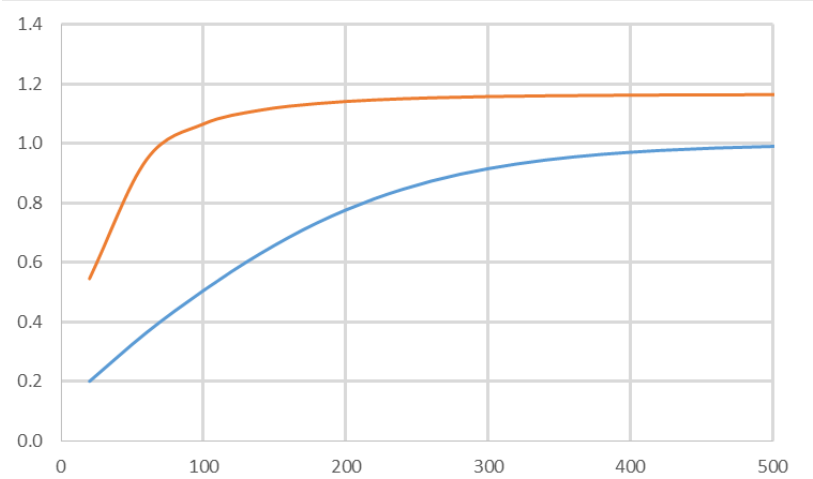

Figure 3.10 The same parameter values as in Fig. 3.7, but for the case of using the second assumption about the identity elements involved in the interactions. Note again the change of time scale, as compared with Fig. 3.9.

3.5 Non-Equal Society Dynamics

In the previous subsection we assumed that all the individuals in the society were equal, in the sense that their interaction strengths were equal. Now we shall examine the case where a single individual, say, individual number 1, is more convincing than the other individuals, which we express by assigning a greater interaction strength to this individual than to the other individuals of the society. That is, we have two sets (+ and -) of interaction parameters, $\mu_1 > \mu_{i>1} = \mu_2$. The effect of this is that the identity of individual 1 becomes dominant, and we express this in terms of a parameter, the *dominance*, ℵ, and to understand how this is defined, we need to revisit the concept of the identity. At time $t = 0$, the identity of every individual was the same, and had a size which we had normalised to 1. Of this identity, a portion, Z_0, was common to all the individuals, which is what we called the core identity. Now, at a later time, $t > 0$, and for any individual except number 1, we have the following picture of the identity:

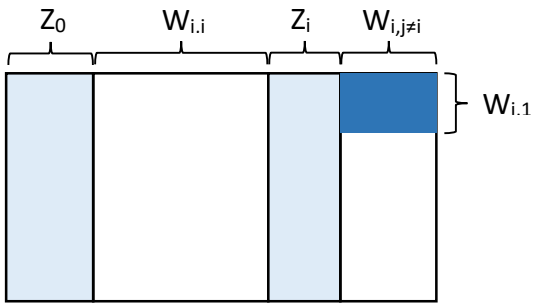

Figure 3.11 The identity of individual number i, with $i \neq 1$, at $t > 0$. The dominance of element number 1, ℵ, is the ratio of $W_{i,1}$ to the whole identity.

The *dominance* of individual number 1, which we will denote by ℵ; shall be defined by

$$\aleph = \frac{W_{i,1}}{Z_0 + Z_i + \sum_{j=1}^{n} W_{i,j}} \text{, for any } i \neq 1. \tag{3.16}$$

Again, as in the previous subsection, we start with the first assumption. Figure 3.12 shows the result for the same situation as in Fig. 3.6, but with the value of μ^+ for individual number 1 being 10 times that for the same parameter for the rest of the individuals. The result is that while the identity of individual number 1 will dominate for an initial period, its influence decays with time, and in the end it is no more important than that of any of the other individuals. However, if individual number 1 is also able to persuade the other individuals to give up elements of their identities, i.e. $\mu_1^- > 0$, then the identity of 1 gains a permanent advantage, as illustrated in Fig. 3.13.

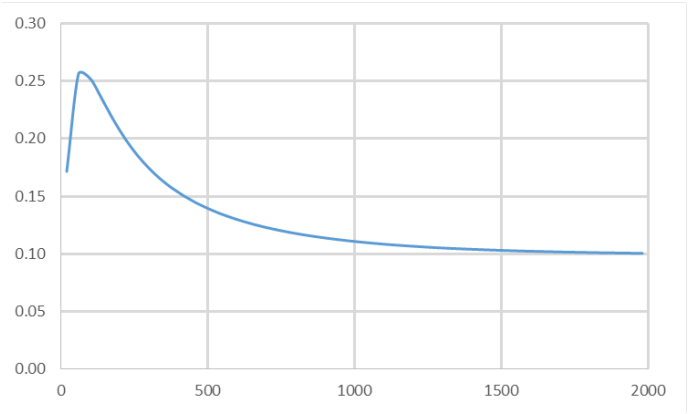

Figure 3.12 The fraction of the identity of an individual (but not individual 1) that originated with individual 1, ℵ, for the case where $\mu_1^+ = 2$, $\mu^+ = 0.2$, $\mu_1^- = \mu^- = 0$, $n = 10$, $Z_0 = 0.1$, and the time step = 0.01. In equilibrium ($t \to \infty$), there is no dominance; the fraction is just $1/n$.

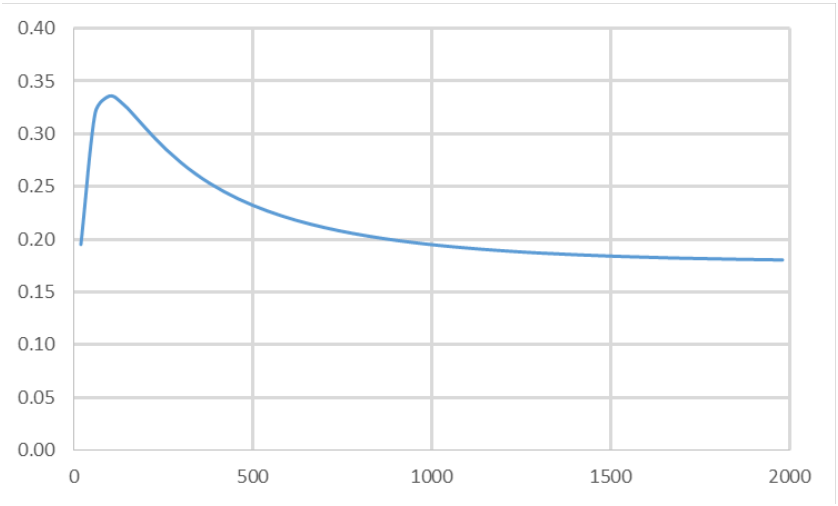

Figure 3.13 The same case as in Fig. 3.9, except that $\mu_1^- = 1$.

Turning to the model incorporating the second assumption, we find that the behaviour is considerably different. For the same parameters as in Fig. 3.12, Fig. 3.14 shows that the value of the dominance of 1 rises very rapidly due to the feed-back mechanism, but then saturates and remains at that value. Because of the saturation of the identity size, the identities of the other individuals have no opportunity to proliferate and reduce the dominance of 1. Running the model repeatedly shows how the dominance increases with both μ_1^+ and μ_1^-, as will be discussed further in Section 5. However, for the special case of $\mu_1^+ = \mu_2^+$, and $\mu_1^- = \mu_2^- = 0$, we have the simple result

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$$\aleph = \frac{1-Z_0}{(n-1)(2-Z_0)}\,, \tag{3.17}$$

which can be used to check the numerical calculation.

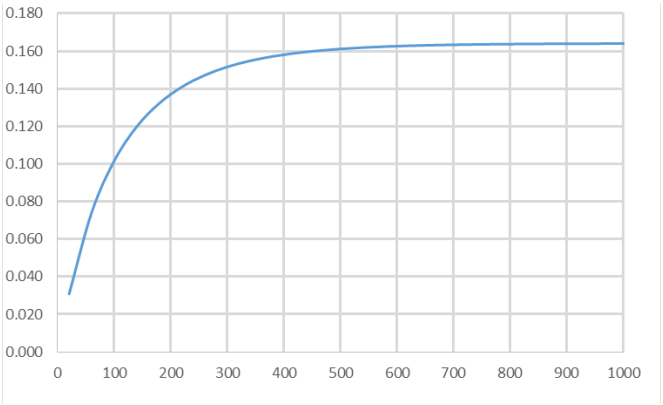

Figure 3.14 The dominance of one identity (i.e. that originating with individual 1) for the same parameter values as in Fig. 3. 11, except that the time step is now 0.001. Due to the feed-back mechanism the rise is very rapid, and saturation prevents the other individuals from subsequently reducing the dominance.

3.6 A Different Model

The previous model was the simplest extension of the binary interaction to a society of more than two individuals, and it had a couple of unrealistic features. Firstly, the initial conditions; switching the interactions on at t = 0. While this was suitable for investigating the dynamic response, it is a very special and in practice unusual case, and it has the peculiar feature that the fluctuation, in the form of the dominance of individual no. 1, develops simultaneously with the rest of the society. A more realistic and interesting case is that the society is initially in an equilibrium state, and then, at a particular time, say, t = 0, one individual suddenly transforms itself into a more forceful figure (the prophet arises, so to speak). The second feature is that, dominance or not, the society develops into an equilibrium state where nothing more can happen; there is full consensus and no scope for change, which does not correspond to any real society. It is therefore of interest to look at a slightly more complex model that does not have these features; the added complexity being that we ascribe to each individual a capacity for generating new identity elements through observation and the process described in sec. 2.3, as well as a capacity for rationalisation by eliminating identity elements through contemplation. The details of this model are as follows:

As before, the model considers the identity of individual *i* to consist of *n* subsets of identity elements, $W_{i,j}$, with the second index, *j*, indicating which individual created the elements in this subset. The size of each subset is a function of time, subject to the individual's interaction with its environment through observation and associated mental activity, as well as to the interactions with the other individuals in the society. The capacity of the identity is assumed to be limited, and its size is normalised to 1. Consequently, at any point in time, the part of the identity available for new elements is given by the expression

$$\alpha_i = 1 - \sum_j^n W_{i,j}\,. \tag{3.18}$$

Also as before, the interactions are characterised by pairs of parameters:

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μ_1^+ and μ_1^-	The strengths of an individual's interaction with the environment (observation) and intellectual activity (rationalisation)
μ_2^+ and μ_2^-	The strengths of the individual's interaction with other individuals.
μ_3^+ and μ_3^-	The strengths of individual no. 1's interaction with other individuals.

The rate of change of the sizes of the subsets is determined by a number of factors, as follows:

a. The rate of change of the subset $W_{i,i}$ is determined by three factors:

   i. The elements acquired through interaction with the environment (observation), which is proportional to the free capacity of the identity,

   $$\alpha_i \mu_1^+ \ ;$$

   ii. the elements lost through action by the other elements, except no. 1,

   $$\mu_2^- W_{i,i} \sum_{r=2,\neq i}^{n} \sum_{j\neq i}^{n} W_{r,j} = \mu_2^- W_{i,i} F_i \ ; \text{ and}$$

   iii. for $i \neq 1$, the elements lost through action by individual no. 1,

   $$\mu_3^- W_{i,i} \sum_{j\neq i}^{n} W_{1,j} = \mu_3^- W_{i,i} G_i \ .$$

b. The rate of change of the subset $W_{i,j}$, $j = 2,\ldots,n$, and $\neq i$, is determined by two factors:

   i. The elements lost through internal intellectual effort (rationalisation),

   $$\mu_1^- W_{i,j} \ ; \text{ and}$$

   ii. the elements added through action by the other elements, except no. 1,

   $$\alpha_i \mu_2^+ \sum_{r=1}^{n} W_{j,r} = \alpha_i \mu_2^+ E_j \ .$$

c. The rate of change of the subset $W_{i,1}$, i = 2,…, *n*, is determined by two factors:

   i. The elements lost through internal intellectual effort (rationalisation),

   $$\mu_1^- W_{i,1} \ ; \text{ and}$$

   ii. the elements added through action by element no. 1,

   $$\alpha_i \mu_3^+ \sum_{r=1}^{n} W_{1,r} = \alpha_i \mu_3^+ E_1 \ .$$

The quantities E,F, and G are quantities used in the numerical version of the model.

For any individual, except no. 1, the dominance of element *j* is now defined as follows:

$$\aleph_i = \frac{W_{i,j}}{1-\alpha_i} \ ; \ i \neq 1. \tag{3.19}$$

The temporal evolution of the society takes place in two stages: In the first stage, there is no difference between the elements; i.e. $\mu_3^+ = \mu_2^+$, and $\mu_3^- = \mu_2^-$, and the society evolves to an

equilibrium state, in which each identity still has room for further development, as expressed by the quantity α. The quantity α is a function of the four strength parameters, increasing with μ_1^- and μ_2^-, and decreasing with μ_1^+ and μ_2^+. In the second stage, which starts at t = 0, the values of μ_3^+ and μ_3^- are increased, expressing the dominant character of individual no. 1. The society again evolves to an equilibrium value, with α < 1, and a particular case is shown in Fig. 3.15. As there now are six parameters, it is not practical to discuss the influence of each parameter as a function of the other five in this paper; however, the significant influence of the rationalisation effort is illustrated by Fig. 3.16. This reinforces our belief that a vigorous and questioning personal intellectual life is the best defence against propaganda and misinformation.

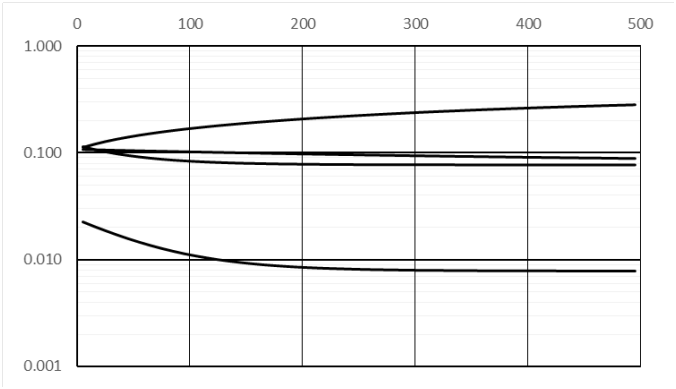

Figure 3.15 From the top, the curves are: dominance of element no. 1, dominance of a non-diagonal element (not no. 1), the free identity capacity α, and the dominance of the diagonal element, all for any individual except no. 1. The parameter values are $\mu_1^+ = \mu_1^- = \mu_2^+ = \mu_2^- = 0.2$, $\mu_3^+ = \mu_3^- = 1$, $n = 10$, and the time step is 0.01.

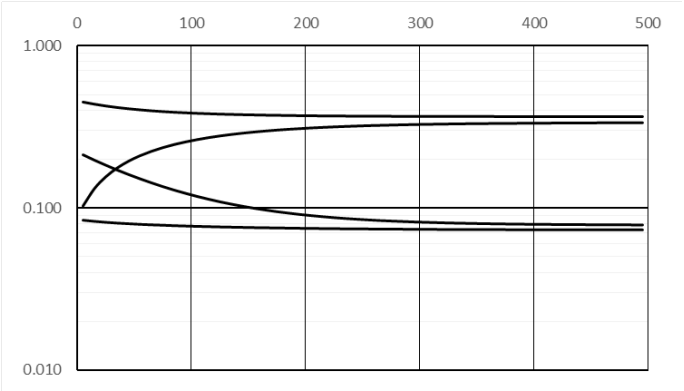

Figure 3.16 The same parameter values as in Fig. 3.15, except that $\mu_1^- = 1$. The curves are now, from the top: the free identity capacity α, the dominance of element no. 1, the dominance of the diagonal element, and the dominance of any non-diagonal element (not no. 1).

4 Fluctuations and Survival

4.1 The Causes of Fluctuations

In any society, the interactions between individuals take place in a largely stochastic manner. Both the frequency and intensity of interaction will fluctuate, and the intensity function $s_a(r_b)$ should be a stochastic function. In our view of society as a system we are neglecting these inherent fluctuations; our interest is in fluctuations of a different nature – fluctuations with a significant duration and arising from an identifiable source.

As we know, the progress of mankind, measured for example in terms of a rich and fulfilling life for the average person, has not been a smoothly increasing function. The proposition put forward here is that these fluctuations are, in the final analysis, due to failures of the evaluation and action process described above. The nature of the failures can be characterised in terms of three groups of what we consider to be secondary causes (the primary cause, which in the current context is the development and application of technology, will be addressed in the subsection after next):

a) Interference with the flow of information as input to the evaluation, either through limiting the information, falsifying it, or by obscuring it in a mass of irrelevant data.
b) Limiting the opportunities for taking adaptive action, either through direct repression, or by promoting a structure of society that isolates the individual from its environment.
c) Restricting the size of the society, and thereby the averaging process, through such strategies as nationalism, sectarianism, and an unwarranted focus on local issues.

Addressing each of these three groups of causes separately, we begin with a). When we are awake, we are continuously receiving information. One major part of it relates to our surroundings, and are not the subject of any conscious processing. Another major part relates to the control of what we might call automatic actions, such as eating, drinking, crossing the street, and saying “hello” to people we meet. A third major part consists of those inputs that result in a conscious assessment, and the outcome of which is that some are relevant to the things that matter to us, i.e. to our identity, and the rest are not. This latter group contains those inputs carrying information that is considered irrelevant to the individual, such as most of the advertising we are exposed to; it contains most of the inputs to our work and to our other activities, such as sport, hobbies, and cultural activities. Many of these inputs would, at some earlier stage of our lives have been assessed in relation to our identity and contributed to forming that identity, but they now fit into what we might call *a framework of accepted inputs*.

The inputs of relevance to the current subject matter are those that do not fit into this framework, and which therefore lead either to a change in our identity or to an adaptive action, or both. And with respect to these inputs, the current state of our society displays a couple of significant characteristics. Firstly, the amount of input presented to us on a daily basis, through a number of media, is so great that it is becoming impossible to assess and classify it properly, and as a result relevant information is lost or obscured. Secondly, it is becoming increasingly difficult to determine the veracity and accuracy of the information. Rather than being a direct result of interaction with the source of information, more and more of the information is being processed by the media delivering it, resulting in a view representing the interests and opinions of the media owners. These characteristics of the flow of information in modern society were very well described by Herbert I. Schiller (Schiller 1981, 1982), Nicholas Garnham (Garnham 1987, 2001), and Noam Chomsky (Chomsky 1988), just to mention three prominent critics, and do not need to be further detailed here. The point to be made here is simply that these characteristics of the information industry, which are reflections of the capitalist economic system, are drivers of the fluctuations on the evolution of society.

The causes within group b) are those that prevent adaptive actions, or that limit the range of possible actions. The motivation for adaptive action results from either of two outcomes of the

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process of evaluating an input. One is that the input is found to be so completely at variance with the identity that it represents a threat, and the adaptive action would have the purpose of countering this threat. The other is that part of the input resonates with the identity to the extent that the individual accepts the remaining part as a change to its identity and is motivated to display this change of identity through an adaptive action. However, in order for the individual to be able to realise a desire for action, there needs to be established means of doing so. These may take the form of voting in elections or referendums, posting a comment on public media, participating in the activities of an organisation or action group, or even starting a new group, and so on. Some or all of these means can be suppressed by a dictatorship, by a legal organisation, such as a church, or by an illegal organisation, such as the Mafia or a terrorist group. But these means can also simply be rendered ineffective by structuring society so that it is not affected by them; real power rests in entities not visible or accessible to the general public.

The third group of causes that can lead to failure of the evaluation and action process, group c), are those arising from not recognising, or taking account of, the changed environment in which the society finds itself. In particular, in not recognising that both the structure and the boundary of the society, e.g. as we defined them in Fig. 3.2 by means of the core identity, has become artificial, and that the society is holding on to an image of itself and its uniqueness that is no longer valid. Information is manipulated to fit this image. In today's dynamic world, the significant relationships are between groups of people, defined by shared beliefs and interests, and the nation should be seen primarily as a framework for managing relations between groups of people, both internally and externally. As the beliefs and interests change (not least due to increased level of education and economic development), the framework should adapt in order to manage the new relations. This is true for both international as well international relationships, and with regard to the latter (and of particular relevance to the Australian author), we are reminded of the words of George Washington:

> Nothing is more essential than that permanent, inveterate antipathies against particular nations, and passionate attachments for others, should be excluded; and that, in place of them, just and amicable feelings towards all should be cultivated. The nation which indulges towards another a habitual hatred or a habitual fondness is in some degree a slave. It is a slave to its animosity or to its affection, either of which is sufficient to lead it astray from its duty and its interest. Antipathy in one nation against another disposes each more readily to offer insult and injury, to lay hold of slight causes of umbrage, and to be haughty and intractable, when accidental or trifling occasions of dispute occur. Hence, frequent collisions, obstinate, envenomed, and bloody contests. The nation, prompted by ill-will and resentment, sometimes impels to war the government, contrary to the best calculations of policy. The government sometimes participates in the national propensity, and adopts through passion what reason would reject; at other times it makes the animosity of the nation subservient to projects of hostility instigated by pride, ambition, and other sinister and pernicious motives. The peace often, sometimes perhaps the liberty, of nations, has been the victim.
>
> So likewise, a passionate attachment of one nation for another produces a variety of evils. Sympathy for the favorite nation, facilitating the illusion of an imaginary common interest in cases where no real common interest exists, and infusing into one the enmities of the other, betrays the former into a participation in the quarrels and wars of the latter without adequate inducement or justification. It leads also to concessions to the favorite nation of privileges denied to others which is apt doubly to injure the nation making the concessions; by unnecessarily parting with what ought to have been retained, and by exciting jealousy, ill-will, and a disposition to retaliate, in the parties from whom equal privileges are withheld. And it gives to ambitious, corrupted, or deluded citizens (who devote themselves to the favorite nation), facility to betray or sacrifice the interests of their own country, without odium, sometimes even with popularity; gilding, with the appearances of a virtuous sense of obligation, a commendable deference for public opinion, or a laudable zeal for public good, the base or foolish compliances of ambition, corruption, or infatuation.
>
> As avenues to foreign influence in innumerable ways, such attachments are particularly alarming to the truly enlightened and independent patriot. How many opportunities do they afford to tamper with domestic factions, to practice the arts of seduction, to mislead public opinion, to influence or

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awe the public councils. Such an attachment of a small or weak towards a great and powerful nation dooms the former to be the satellite of the latter (Washington 1796).

4.2 The Structure and Propagation of Fluctuations

The interaction models we developed in secs. 3.3 to 3.6 are really only applicable to a small, homogeneous, and closed society, such as a small secret society centred on a guru-like personality. On the scale of, say, a nation, the structure of society is complex and multi-dimensional. There is a government structure (federal, state, council), a political structure (parties, branches), and industry structure (sectors, companies), a professional structure (unions, institutes, academies), and so on. A fluctuation has to propagate in this inhomogeneous environment, experiencing not only different conditions within each structural component, but also the effects of the transitions from one component to another. To make a start on developing and understanding of this, we propose the following, highly simplified model of the propagation from one structural component into another, as illustrated in Fig. 4.1. In this illustration and in the numerical calculations to follow, the inner component and each of the outer components all have the same number of members; but in general our model allows for the inner and outer component components to have different number of members.

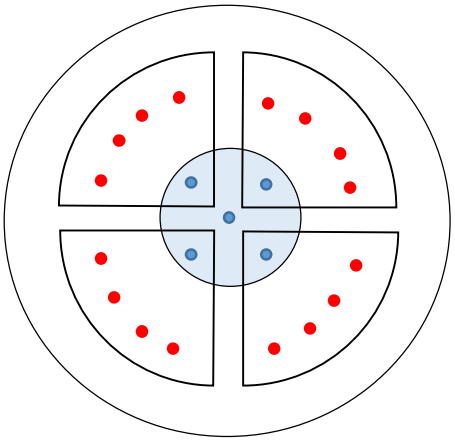

Figure 4.1 A simple model of the propagation of a fluctuation from one structural component of society into another. The fluctuation is initiated by the central member of the inner component, propagates to the other members of this component, and then each of these members becomes the carrier of the fluctuation into a sector of the outer component.

The propagation of the fluctuation from the central member of the inner component, who we shall call the *prophet*, to the other members of this component is described by modelling each of the two components by the model described in sec. 3.6, but making one of the individuals take on a dual role. Individual no. 2 of the inner component is also individual no. 1 of the outer component and, for reasons of simplicity, the behaviour of this individual, who we shall call the *acolyte*, is determined solely by its membership of the inner component. The individuals of these two components are identical, and so they are initially in the same state of equilibrium for $t < 0$, and governed by the same two parameter pairs, μ_1 and μ_2. At time $t = 0$, individual no. 1 of the inner component suddenly becomes dominant (i.e. becomes the prophet), as defined by the parameter pair μ_3, and the evolutions of the two components start to diverge. As the behaviour of these two components for $t > 0$ depends on the six parameters μ_1, μ_2, and μ_3, a detailed display of this behaviour would take up too much space in this paper, so we just illustrate a single feature of the behaviour.

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In Fig. 4.2 we show the evolution for a particular case of parameter values, assuming that, as far as the interaction with the other individuals in the outer component, the acolyte remains a normal member of society (i.e. $\mu_3 = \mu_2$ in the outer component). As we see, the effect is very small; the dominance of element no. 1 goes from about 0.75 to 0.95.

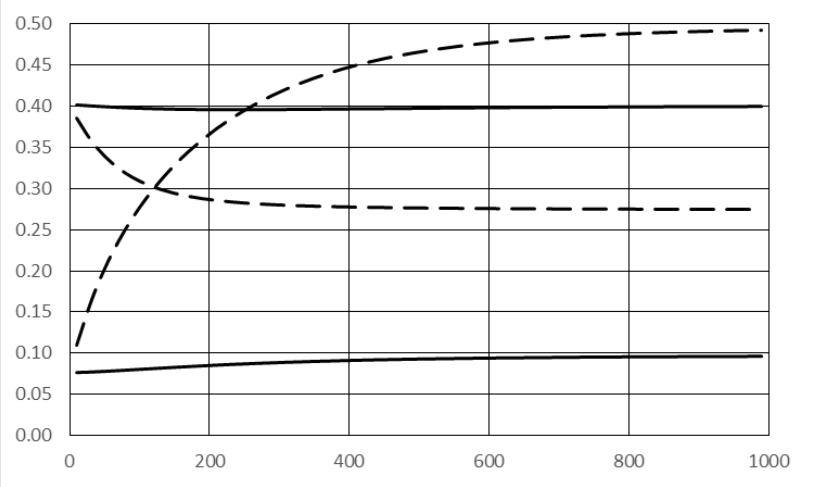

Figure 4.2 The two dashed curves belong to the inner component, with the upper curve being the dominance of identity element no. 1, and the lower one being the unoccupied part of the identity of individuals in the inner component. The two solid curves belong to the outer component, with the lower curve being the dominance of identity element no. 1, and the upper curve being the unoccupied part of the identity of individuals in that component. The parameter values are $\mu_1^+ = 0.2$, $\mu_1^- = 1$, $\mu_2^+ = \mu_2^- = 0.2$, $\mu_3^+ = 2$, $\mu_3^- = 1$, $n = 10$, and the time step is equal to 0.005. However, in the outer component $\mu_3^+ = \mu_2^+$ and $\mu_3^- = \mu_2^-$.

But we could also assume that, in addition to being indoctrinated and having its identity changed, the acolyte also becomes more influential in the outer component, e.g. by training and/or better means of communication, and we express this by setting μ_3 in the outer component equal to a new, time-dependent strength parameter, μ_4, defined as follows:

$$\frac{d}{dt}\mu_4 = x(\mu_2 + y(\mu_3 - \mu_2) - \mu_4)\big(W_{2,1} - U_{2,1}\big)\,; \qquad (4.1)$$

with $\mu_4(t=0) = \mu_2$. Here x expresses the speed with which the acolyte learns the technique of persuasion from the prophet, and y expresses the degree to which the acolyte manages to emulate the prophet, with $0 \le y \le 1$. The result in Fig. 4.2 is that of $x = 0$, in which case the value of y is irrelevant.

In Fig. 4.3 we show what is basically the same case as in Fig. 4.2, except that we have introduced the new variable strength of Eq. 4.1. We see that, as we would expect, the rate with which the acolyte manages to emulate the persuasion technique of the prophet, there is a time delay in the propagation of the dominance from the master to the individuals in the outer component, but the equilibrium dominance is the same in both components. Figure 4.4 is again basically the same case, but now with $y = 0.5$, and the result is that the equilibrium value of the dominance is less in the outer component than in the inner. The equilibrium value of the dominance, which does not depend on the value of x, is shown as a function of y in Fig. 4.5.

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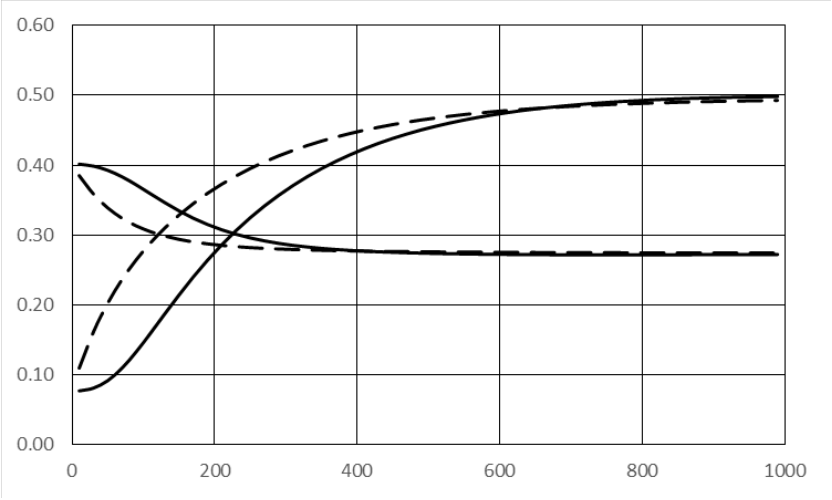

Figure 4.3 The same basic case as in Fig. 4.2, but with the learning speed, *x*, equal to 0.1, and the attainment, *y*, equal to 1. The learning speed determines the delay in the propagation from the inner to the outer component.

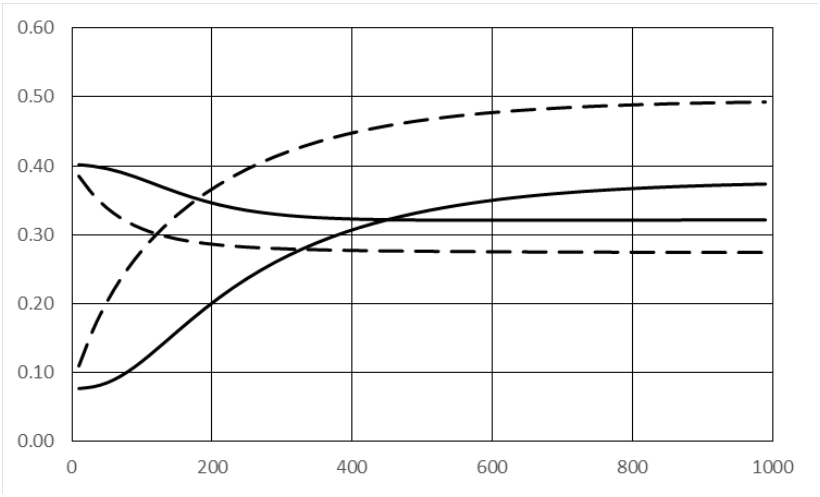

Figure 4.4 As in Fig. 4.3, except that the attainment, *y*, is equal to 0.5.

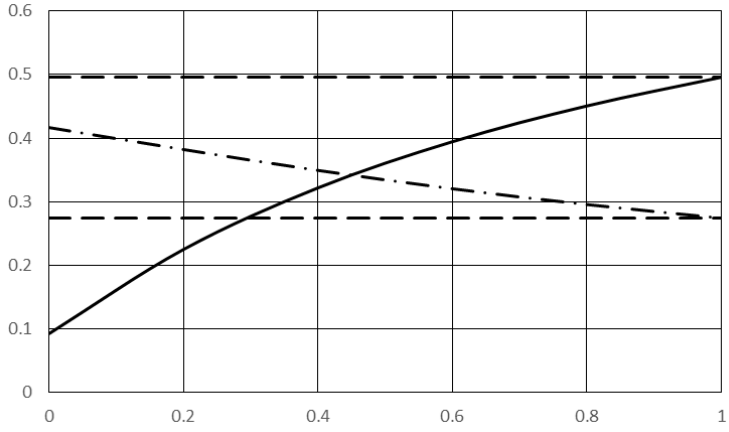

Figure 4.5 The dominance (full curve) and free part of the identity (dot-dash curve) as a function of the attainment parameter, y. The two dashed lines are the equilibrium values in the inner component, shown for reference only.

In this model, the propagation from the inner to the outer component is by means of a person, the acolyte (or disciple). However, as mentioned in sec. 3.2 in connection with the concept of distance as a parameter determining the interaction strength, there is the possibility of propagation across component boundaries by means of what we might call "broadcasting", where the central, or dominant figure interacts directly, mainly through electronic media, with the individuals in remote components. That type of propagation, in which applications of technology feature prominently, involves some further considerations and corresponding changes to the model, and it is intended to pursue that in a future paper.

4.3 The Role of Technology

We all intuitively realise that technology and its applications provide an essential support for the lifestyle we enjoy in a developed society, but we have become so used to having this support that we rarely think about the nature of this support; how it has determined some of the basic characteristics of society. A number of authors have certainly given considerable thought to these issues, but for the average citizen they are mostly peripheral. Let us look at two of these that are particularly relevant to the current investigation; the first one being our relationship to the physical components of our daily lives. Before the rapid rise of technology during the Industrial Revolution, it was a more direct relationship. We might grow some or all of our food, raise animals for food, men would build dwellings, women would make clothes, and so on, and we would have a first-hand understanding of what went into creating these things. They had a value as things in themselves. Today, technology has turned us into consumers; we see these things strictly as commodities through a suitable interface, such as a supermarket or a computer screen (for online shopping), with price and ease of access and use as the main parameters. From time to time concerns are raised about the ethics of the production process or its effect on the environment, but in the scheme of things they have a relatively minor impact on our attitude as consumers.

The second characteristic is capital; developing and applying technology requires investment. And with investment comes the need to generate a return on this investment, and the associated ownership and control; the hallmarks of the capitalist system. "He who pays the piper gets to call the tune." In principle there is nothing wrong about this, the need to generate a return leads to a quest for efficiency and a reduction of waste, as does the competition in an open market. However, the system also carries within it the seeds of instability and exploitation; in particular, because the interface between supplier and consumer, expressed in the consumer's acceptance of the product, is based not only on a rational, demonstrable value of the product, but on the consumer's perceived value of the product. This introduces the concept of advertising and, again, while much of advertising serves the useful purpose of making the consumer aware of what is available, it can also be employed to manipulate our judgement, belief, and value systems.

Both of these characteristics take on an enhanced importance if we focus our attention on information as the product and, as we discussed in sec. 2.2, in particular on the information that relates to our identity, to the things that matter, and that causes us to modify our behaviour through adaptive action. Regarding the first characteristic, nowhere has the change in our relationship with our environment been more significant than in our relationship to information. Not only is technology allowing us to generate an enormous amount of information every day through an array of measuring devices, recording equipment, and processing systems, but information technology is bringing it to us through various channels, such as print media, radio, TV, and the Internet, and presenting it through interfaces ranging from billboards to mobile phones. We are being inundated with information, and as a result we view it as a commodity, something without any value in itself, valued only for its immediate usefulness. We are no longer able to process this information, to consider its truthfulness and its implications; we accept it uncritically as something to be used as is, not as an input to, and to be transformed by, our own processing

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capability. In the more remote past, the small amount of information available led to a large amount of thought and speculation. We might often be tempted to ignore it as nonsense (which, in terms of our current knowledge it often is), but we should not overlook what it represents in human intellectual effort.

In considering the role of technology in shaping the nature of the information being presented to us and in influencing our relationship to this information, we need to keep in mind that technology itself does nothing; it is only the applications of technology that have an effect. When we speak of what technology "does", it is as an enabler; the responsibility for its applications rests with us.

One of the features of the information presented to us is its geographic scope. As a result of the ubiquitousness of recording devices, in the form of digital cameras and mobile phones, and the availability of high-bandwidth telecommunications channels in most locations, often via satellite, an increasing proportion of the information concerns issues and conditions to which we have no direct relationship. We cannot take any action, nor does the information seem to have any immediate consequences for us; we are simply spectators, and technology is conditioning us for that role. A related feature is the selection of the information that is presented to us. The amount of information generated every day is orders of magnitude greater than what can be presented through the main public media, such as newspapers, radio, and TV, so a selection is made on a set of criteria. Information technology allows this selection to be carried out in part automatically and to be based on an increasingly sophisticated set of criteria. In addition to such straight-forward ones as offensive language, gruesome images, and legal limitations, these criteria can also include ones relating to commercial and political objectives, something that can be observed daily in the public news media.

In addition to the public, or mass, media, technology is enabling a much more targeted delivery of information. On many applications, such as Google, email, Facebook, LinkedIn, and ResearchGate, just to mention a few of the more general ones, we are known as individuals, and by analysing our use of such applications, profiles of our identities can be built up. Recalling the mention of "cognitive advantage" in sec. 3.2, the effectiveness of information in initiating an adaptive response depends very much on the overlap of the information with elements of the identity and on being able to target those elements that need to be removed. A current example of this is the success achieved in radicalising Muslim youths, but many organisations practice the same approach. Information processing technology is increasing this ability at a great pace, driven both by security concerns and by the desire to influence people's judgement and spending choices.

Now, while the first characteristic of the relationship between technology and information was what we might consider a direct one, in the sense that applications of technology directly influenced the creation and delivery of information, the second characteristic – the relationship between information and capital resulting from the applications of information technology – is indirect. It is difficult to put an exact value on the technological infrastructure that supports the information industry, in the sense that we are considering it here (providing information to the society at large), but it is certainly in the many trillions of dollars, and this investment needs to produce a return. If this return were to be provided by the subscribers to the information content alone, the whole industry would collapse; the return is provided mainly by advertising. There is no in principle problem with this, as long as the advertising conforms to the applicable legislation (e.g. "truth in advertising") and industry guidelines; in practice the effect may be to drown out the information. The problem lies in the fact that the symbiotic combination of investors and advertisers is the power driving the information industry, and it is a power that has little interest in the quality of the information. It sees the industry as any other business; the product is only a means of obtaining the best return on the investment. The result is a potent tool for influencing the development of society that is rapidly increasing in reach and sophistication through the application of technology, and it is effectively available to the highest bidder.

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5 Discussion and Conclusion

In developing some comments on the above investigation and the results obtained, and attempting to draw some conclusions, a problem of terminology tends to appear repeatedly, and so it seems advisable to try to eliminate this at the outset. Basically, it is the use and meaning of the two words "capital" and "capitalism". As alluded to earlier, *capital* is a characteristic of technology, and it is as intrinsic to technology as is the conservation of energy. Any application of technology requires capital to be made available and attached to the application as an investment. The increasing development and application of technology results in an inevitable shift in the relative importance of capital and labour, as was discussed in some detail in (Aslaksen 2015a), and this brings with it a shift in the distribution of power within society. But just as technology is neither good nor bad, neither is capital; only the application can be judged in these terms. Under this perspective, technology can be seen as a value-neutral productivity multiplier; what we decide to use that productivity for is a different matter.

Capitalism, on the other hand, is not an inherent feature of the application of technology; it is a political ideology concerned with the *control* of the production process arising out of the application of technology. The nature of this control is often presented as a balance between opposing forces or ideologies, such as in the relative economic importance of capital and labour, or as between private and state ownership, or as between small government (minimal restriction on the production process and its proceeds) and big government (significant involvement through labour laws, taxation, etc.), or, finally, in a very simplistic form, as a balance between the two ideologies of capitalism and socialism. The latter characterisation is simplistic in the sense that both ideologies span a wide spectrum of economic, political, and social features. At present, the trend in the developed (western) world seems to show a shift in the balance toward capitalism, but while the generation of capital is inevitable, there is nothing inevitable about the shift toward capitalism.

While both of these ideologies, and everything in between, are promoted on their benefits to society, relatively little is published regarding their effect on the stability of society, and what is published, is often concerned with economic or social measures (e.g. education or public health). An article that discusses the synergy and contrast of the approaches of Emile Durkheim (sociology) and Friedrich Hayek (economics) is the one by (Birner and Ege 1999); other well-known contributions are various works by Edward Goldsmith (Goldsmith) and, of course, the apocalyptic prophesy by Oswald Spengler in *The Decline of the West*, of which a relevant condensation can be found in (Spengler 1931). What we are concerned with in this paper is a sudden change in the core identity of a society, starting as a local fluctuation caused by a single person and spreading so rapidly that it sweeps all opposition before it until it reaches a catastrophic climax. This has happened before, and we suggest it could happen again.

The probability of such an event and its consequences are both dependent on technology, but before we look at that, we need to be clear about the nature of such a change of core identity, and an important insight into this was provided by Hannah Arendt in her report on, and analysis of, the Eichmann trial (Arendt 1963). At the time, some people, particularly in the Jewish community, accused her of trivialising the Holocaust, but nothing could be further from the truth. Her conclusion, that the problem with moral truths is that they can be exchanged for other value systems, exposed the Holocaust as an example of an extremely dangerous feature of any society; there is nothing trivial about it at all. A society, or a sufficiently large proportion of a society, can be made to modify the basis on which its members evaluate information. The identity is not a fixed set of precepts and beliefs; it is constantly being modified by the information it processes, as already introduced in sec. 2.3. The results of that process is not only adaptive actions; depending on the individual and the situation it finds itself in, the results may be mainly modifications to the identity, without any externally observable change. The change only becomes externally observable when information is received that, when evaluated by the state of the identity at that time, calls for adaptive action.

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Throughout this paper, we have treated the interaction between individuals in a society in terms of a pair of interactions strengths, μ^+ and μ^-, and their very simplified actions on the identity: adding and removing identity elements. Looking below this high-level treatment, the interaction between individuals, either in a one-one-one setting or in a group setting, is a very complex issue, and one on which there exists a large body of knowledge. Without venturing into this issue in any detail, as it is one for which engineering provides very littles theoretical or experimental background (but lots of practical experience), it is beneficial to look briefly at an article by Cass R. Sunstein (Sunstein 1999) that provides a number of insights relevant to our purpose, as well as a large number of references for further study. In it, Sunstein develops the concept of group polarisation, the phenomenon that, when a group of people come together to deliberate on a particular issue, such as gun control, affirmative action, and gender issues, the members move toward a more extreme point in whatever direction is indicated by the members' predeliberation tendency. He discusses a number of processes that contribute to this phenomenon, and also links it to other well-known phenomena, such as social cascades. Two statements are particularly relevant; the first relating to our comments on Arendt above: "The problem with group polarization is not that people subject to it suffer from some cognitive or motivational defect. The Problem is instead that people may be shifted, as a result of entirely rational processes, in the direction of factual, legal, or moral mistakes." (p.20). At the end of the article, and in view of group polarisation, he raises some doubt about the efficacy of deliberation, but then qualifies that by the statement "Perhaps group polarization could be reduced or even eliminated if we emphasized that good deliberation has full information as a precondition; but that requirement is extremely stringent, and if there already is full information, the point of deliberation is greatly reduced. Not eliminated; there remains the question of what to do, given a certain understanding of the facts." (p. 27). This resonates strongly with the author's current work on the importance of information and, in a world that relies increasingly on applications of technology, on the role of engineers, as the creators of that technology, to provide the information (Aslaksen 2015b). Group polarisation should be seen as one of several mechanisms that exacerbate the effects of manipulated or incorrect information.

The models presented earlier illustrated the dynamics associated with a change in the core identity of a society (or a component of society), but did not provide any indication as to how great such a change had to be before it would become irreversible and lead to a catastrophic event. That is, what is modelled is the change in core identity that would allow an irreversible "flipping" of the core values of the society. This issue was discussed for two different situations in two earlier papers (Aslaksen 2003, 2004), where it was shown that random fluctuations in the structure of a system will eventually lead to instability. These are the fluctuations that we neglected or, more correctly, averaged out through our method of calculation. An interesting project would be to combine that random mechanism with the growth of dominance modelled above; it should show what every revolutionary has known, that to effect a significant and permanent change an existing system, you first have to create chaos (the random fluctuations) and then present the new system as a solution, not only to the problems with the old system, but also as an end to the chaos.

The change in the core identity of a significant part of the German people in the period between the two world wars might at first seem an extreme example that is unlikely to be repeated, but this is mainly because of the extent of the resultant catastrophe. If we consider the humiliating position Germany found itself in after the first world war, and then the crash of 1929, it was not so unlikely that someone like Hitler could rise to power by creating a narrative (Jews and Slavs as "untermenschen", the superiority of the Aryan race, etc.) that played on powerful elements of the core identity at the time (sense of betrayal at the loss of the war, punitive peace conditions, etc.). And even in a democracy it is not necessary to have a majority of the population on side; Hitler's party gained only 33 % of the votes cast in the 1932 election, but with the opposition in disarray, it was the largest party, and so Hitler became Chancellor in 1933. And the more recent times offer other examples of how a significant part of a population can be led to accept information based not on fact, but on conformance with a successively established set of beliefs.

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One such example is the beliefs nurtured in the Anglo-Saxon world about the Middle East, which allowed a significant part of the population of the US, Britain, and Australia to accept some blurry photos of a few trucks driving around in the desert as proof of a world-threatening WMD capability, and as justification for slaughtering more than 100,000 innocent Iraqis and turning the region into an ongoing nightmare. We should recognise that we are playing with fire and that we cannot afford to be complacent, and that the distance from "from my cold, dead hands" to a cold, dead world may not be as great as we think.

Returning now to the central theme of this paper – the influence of technology on the stability of society – it may be formulated in the form of two questions, the first of which is "How will the rapid advance of technology increase the probability of a catastrophic instability?". An attempt to provide an answer is presented in the form of a number of arguments:

1a *The ability to change the core identity*. The prerequisite for a fluctuation to grow a point where it may have catastrophic consequences is that the core identity, or belief system, of the society has been changed so as to make the information content of the fluctuation acceptable. This requires presenting a version of events that is consistent with the desired change and, as we saw in Sec. 3, disparaging any conflicting version. In other words, immersing the individual in an information environment that promotes the changed beliefs, and this is what information technology is increasingly able to do. It provides the means of, more or less subtly, modifying or editing the content and meaning of any verbal, written, or visual message or report, as well as the means of delivering the content to all of society.

1b *The ability to target individuals*. In a further development of the previous argument, it is becoming increasingly possible to present individuals with information that is tailored to their current identities for maximum effectiveness. A related, if simpler technique has been applied in online marketing for some time, where it is known as personalised retargeting; it simply uses a person's activity on an internet site, such as Facebook, to deduce what the person is interested in and then present ads accordingly. More advanced schemes build up a profile of a person based on information from various sources, and at least one company now offers this information for targeting voters leading up to elections (www.wpp.com/wpp/).

1b *The speed of change of the core identity*. As a corollary to the previous argument, information technology is providing information with an increasing intensity, above all through mobile media. As a result, the time it takes for a change to become effective has changed from many generations (e.g. Christianity) to one generation (e.g. Reformation) to a few years (e.g. Nazism) and now, possibly, only months. This greatly reduces the likelihood of debate and rational considerations.

1c *The complexity introduced by technology*. The increasing application and complexity of technology in all aspects of life makes it increasingly difficult for the average citizen to make an independent judgement in many areas of information, ranging from economics (big data, statistics) to nuclear technology (enrichment, reprocessing, weapons technology), which makes it easier to get selective or modified information accepted.

1d *The sophistication and extent of weapons technology*. The means of conducting an armed conflict are developing rapidly. As non-experts, we tend to think in terms of what we know from recent conflicts, which is mainly based on pictures of guns, aircraft, tanks, naval vessels, etc, all items that take many years to develop. But the real smarts lie increasingly in the information technology, much of it space-based, that determines how these assets are deployed, as well as in the intelligent and partly autonomous munitions they deliver. For these items, the development time is much shorter, and so the probability of making an incorrect assessment of a potential adversary's capability is increased.

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The second question is “How does technology increase the consequences of a fluctuation?”, and again, an attempt to provide an answer is contained in the following arguments:

2a *Rapid escalation*. Once the potential for armed response to a conflict is established, the time needed to ramp up to a major aggressive capability is very short. With the relative importance of technology vs. manpower swinging rapidly towards technology, there is no need for conscription and lengthy training; the standing, professional military force is adequate for any level of response. What starts out as a relatively minor incident could, in a sequence of tit-for-tat responses, escalate so rapidly that it might be very difficult to contain it by diplomatic or any other non-military means.

2b *Powerful weapons*. The build-up of military forces in all parts of the world, together with the sophistication and power of their weapons, increases the scale of destruction and loss of life. - Nuclear weapons were until now considered to serve the role of a deterrent, via the doctrine of “assured mutual destruction”, but with the ongoing development of tactical nuclear munitions, and the proliferation of nuclear weapons technology, the distinction between tactical and strategic may become blurred.

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