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Distributed Agency and Advanced Technology
Or: How to Analyse Constellations of Collective Inter-Agency[1]

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[1] This contribution is based on the lecture "The illusion of autonomous action and the reality of distributed agency" held in German at the Einstein Forum in Potsdam. Especially in its later parts it follows the line of reasoning presented in the article "Where the action is: Distributed agency between humans, machines, and programs", which was published in the book "Paradoxes of interactivity" (2008). Stephan Elkins (SocioTrans) helped improve the text by correcting my poor English.

1. The illusions of autonomous action and the reality of distributed agency

There are two grand illusions that have accompanied Western societies since the Enlightenment and the rise of modernity: the idea of autonomous human action and the project of autonomous technology. Even though they are the offspring of the same parents, they not only conflict with but even exclude one another.

The idea of human agency implies that only human beings have the capacity to create and control their behaviour consciously and give it their own rules and intended direction. This human freedom is seen as the basis of moral behaviour. Machines and other mechanisms show only material behaviour. Conscious choices and intentionality are missing. That is why we perceive only humans as acting whereas machines just function.

The project of autonomous technology takes place down on earth, but it also influences the higher spheres of philosophical debates about the ideas of agency and autonomy. It started with self-operating machines, automata and robots and has lead to the autonomous systems that have taken over the command and control of increasing parts of our production, traffic, and communication infrastructures. The architecture of these multi-agent systems and the programmed actor qualities of its software agents disclose the hidden plan of this project of autonomous technology: It aims to mimic human behaviour and simulate social intelligence to a degree of perfection that raises questions of material agency and artificial societies.

From the classical and canonical view of philosophy and social action theory, we must speak of a conflation of concepts when attributing categories of action to mechanical behaviour and cybernetic feed-back processes, even if they show features of high complexity, contingency and self-regulation. From the constructive view of engineers and the reconstructive view of philosophical and sociological pragmatism, however, it is the produced and observed *performance* of an entity in relation to other entities that is of critical importance. In this paper, concepts of agency are therefore scrutinized with an eye to their ability of coming to grips with concrete problems, for instance, in analysing and attributing agency, fault, and responsibility to any element in a mixed high-tech constellation or designing smart interfaces and common spaces for human and material agency. In the end, the conceptual distinctions, like all tools, are judged in terms of their usefulness for both scientific analysis and engineering synthesis.[2]

The conceptual duality of human action and mechanical procedures makes us blind for the material and mechanical aspects of human action. This fundamental distinction also hinders us in understanding the agential aspects and the interactive features of material devices. Therefore, the time has come for a pragmatic turn[3]: I suggest abandoning the ontological duality of human action and technical means in favour of a *multiple reality of distributed agency*.[4]

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[2] This argument follows the maxim of pragmatism: "Consider what effects that might *conceivably* have practical bearings you *conceive* the objects of your *conceptions* to have. Then, your *conception* of those effects is the whole of your *conception* of the object." (Peirce 1905: 481).

[3] The "pragmatic turn" in this paper is mainly influenced by a re-reading of the classical theorists of pragmatism, particularly John Dewey's anti-dualist concepts of inquiry and experience and George H. Mead's concepts of interaction with people and physical objects. It is partly informed by the philosophical discussion of a re-invention of pragmatism (Margolis 2002; Egginton/Sandbothe 2004; Bernstein 2010) and more closely connected with the representatives of the "practice turn" (Giddens 1984; Pickering 1992; Schatzki/Knorr Cetina/von Savigny 2001).

[4] This concept of "distributed agency" refers to the many levels and parallel processes of " distributed computing" (Winograd/Flores 1986; Rumelhart/McClelland 1986), to the self-organized adaptation processes of "distributed cognition" (Hutchins 1996; 1998), and to the dialectics of material and social agency of the "mangle of practice" (Pickering 1993; 1995).

A brief look at some examples shall give a first impression as to what extent human beings can actually maintain their ascribed status as autonomous actors and to what degree technological agency actually transcends the restricted role of passive and fixed instruments. Driving a car equipped with some smart assistance systems no longer means that the person is always more powerful than the built-in technical processes or even that he or she can control all of the interdependent agencies: The driver's mistakes are smoothly corrected by the computed communication between sensors, activators and processors. When we look at the control centres of nuclear power plants, traffic, surveillance or communication systems, a similar constellation of mixed and mutually interrelated human and material agencies can be identified. There is nearly no human action without the help of our little technical 'friends': Open heart surgery relies on a heart-lung machine, anaesthetic injection, control systems and other agents (see Schubert 2007 and in this volume). Searching, advertising, selling, buying, communicating or playing via computer interface and Internet are all activities assisted by an array of software agents. Most of them are hidden from the users' view because they operate on the backstage (Rammert 1998). Some communicative agents, however, do their job on the frontstage (Maes 1994), asking questions, articulating emotions or even visualizing the users' actions or the systems' reactions through avatars on a screen.

This short list of ongoing changes illustrates perfectly well what is meant by *the multiple*, *mediated* and *distributed* nature of agency: Actions are composed of many elements, and performing those actions is a process distributed across several acts and actors. In this light, we can call the idea of an individual and autonomous actor an illusion when all agency is attributed to only one human actor. Actions are composed of heterogeneous elements. The performance of actions is not restricted to human bodies but also involves material mechanisms and symbolic media. Even if nearly all elementary acts are performed by advanced technologies as agents showing features of intelligent, situated and self-regulated action, the projects of autonomous technical action can be defined as illusions as well when they disregard the multi-mediated character of technical action and neglect the imaginative, interactive and intentional part of human agency[5]. In the end, we have to avoid both the fallacy of overrating the individual human part in social action and of underestimating the agential capacity of advanced technologies.

In the next chapter (2), I will deconstruct the illusion of autonomous human action step by step and develop a pragmatic concept of agency that reconstructs it from the processes of inter-agency with other persons, things and signs. I will argue that agency emerges from these interactions and is not the product of a thoughtful ego or a sensible subject only. Chapter 3 goes on to describe the observable reality and autonomy of technologies in action in order to recognize and classify different types and degrees of agency. A symmetrical and gradual concept of agency is developed that can be used to analyse and evaluate the activities of each agent, be it a machine, an animal or a human being. The following chapter (4) outlines the consequences when the agency of objects enters the spheres of inter-agency. Our view of technology then shifts from the fiction of being a smoothly functioning instrument for the predefined purposes incorporated into its design to a fiction of technology as an interactive mediator and flexible partner. The reality of distributed and mediated agency (5) is finally demonstrated referring to the case of an intelligent air traffic system. It shows that agency can be observed on different levels and enacted by heterogeneous mediators. It is an open and empirical question whether the distributed agency observed is then attributed to a single hu-

[5] For these criteria of "human agency", see Taylor 1985, Wolfe 1991and Emirbayer/Mische 1998: 962.

man actor or to a collective of human actors, such as companies or states, or to some mixed constellation of inter-agency that is made up of human and material agencies.

2. The problem of human agency and the illusion of its autonomy

Human beings are not the single and autonomous actors as they have come to see themselves ever since Descartes' discovery of the rational, self-reflecting ego and Kant's definition of human autonomy. From the perspective of pragmatism and social theories of practice, agency in general and autonomy in particular arise from performing in specific ways, for instance, when objects, devices or opponents show some form of unexpected resistance, deviant behaviour, or wilful re-activity in the course of interaction. Agency and autonomy as well as the specific features attributed to them may change in scale, over time and from one situation to another. Therefore we cannot consider them to be the timeless and ubiquitous qualities of the human species as it is often argued from a philosophical and principled point of view.

We may distinguish two conceptions of agency: "agency ex nihilo" begins with a body moved by a mind, as in the case of a real person with an inner tendency, whereas "agency in medias res begins with a point of friction in an already constituted social space that resists any easy assimilation to the categories of existing laws and structures" (Fuller 1994: 746). According to the second concept of mediated and situated agency, agency arises in the context of interaction and can only be observed under conditions of interdependency. On the one extreme, we speak of causal mechanisms and determined behaviour – and not of agency – when such interaction involves no hesitation, no contingency and no creative deviation from the set course. On the other end, we call it pure chance, coincidence and ritualistic conformity – and again not agency – when we cannot identify any patterns of interaction, resistance, and coordination based on expectations. Agency, then, is located in the middle between perfect determinism und pure chance.

Consequently, autonomy cannot be reasonably defined as full freedom from being determined by external forces of any kind. Autonomy has to be derived from practical experiences of resisting, gaining distance or emancipating oneself from external interventions or influences in order to establish an agential centre in relation to the outer world. In the process, a relational, not a radical act of will emerges from those interactions with the world. According to Dewey's view of the decentred subject, the human organism arises as the "center of experience and activity" in continuous transactions with environing circumstances (Colapietro 1990: 651). Different kinds and degrees of autonomy can therefore be found in relation to different areas of interdependency with the world.

Three areas of interdependency seem to be of importance for the discussion of human agency: the *relations to natural forces*, the relations to other people, and the relations to artificial objects. The fundamental concept of human agency has been challenged several times by scientific concepts that view natural forces as a source of action. They argue that natural forces restrict the space for deliberate action or even reject the idea of acts of free will; for instance, instinctive reactions undermine the idea of rational action. Unconscious drives reveal talk of deliberate decision-making as an illusion. Genetic dispositions and neuronal brain activity are said to demonstrate the illusionary nature of human agency and autonomy. Yet we must not throw out the baby with the bath water. It is the capacity, no matter how small it may be, to resist, by-pass or outwit these forces that has the far-reaching consequence of allowing for agency against the power of natural forces. Even Kant defined human autonomy as the ca-

pacity to choose between different determining forces and not in an absolute sense as the capacity to govern the self by laws of its own making – as it is often misinterpreted.

The *relations to other people* are both sources and limits of human agency and autonomy. They are sources because human agency emerges and can be observed only in the interaction between people, like in play, games, or any other site of social encounter (Mead 1963). Such areas of interaction include the social relations between mother and child, pupil and peer group, master and slave, sovereign and subject, empire and colony. Resisting the will of another, deviating from conventional expectations, or creating new ways of doing things are all activities constituting agency. By contrast, we can hardly speak of agency or, at most, of a low grade of agency when people blindly follow a leader or the masses, when they conform to habits and values in a taken-for-granted manner, or when their behaviour takes on the character of routine or rituals. Agency occurs and becomes visible mainly in situations of immediate interaction and interpersonal encounters (Goffman 1983) but also in the mediated relations of tele-presence via TV, mobile phones, or Internet services (Horton/Strauss 1957; Knorr Cetina 2009).

The *relations to artificial objects* constitute another area of interdependency. Artificial objects are neither just nature nor social community but bind both together to constitute artificial worlds of their own. Technologies of medicine and drugs are developed and designed to restore or to empower human agency; at the same time, however, they improve the agential power of natural substances, microbes or other transformed entities. Tools and more complex technical systems of transformation are conceived as mere means of fulfilling human goals. Yet, sometimes they turn into "unruly technology" (Wynne 1988), showing unanticipated deviations from routine operations, which raise questions of human and machine agency. Art and media technologies, which turn objects into signs and produce illusions of experience and agency, open up a parallel area of interdependency. Art and media help overcome and transcend the restricted realm of human agency by creating new artificial realities. In the process, these media technologies are more and more endowed with a capacity for agency of their own, not one that mimics human agency or merely produces an illusion of it (for art objects see Gell 1998)[6]. "Iconic acts" may captivate the viewer (Bredekamp 2011).

In the face of these challenges to human agency and autonomy, most philosophers and social and cultural studies scholars stick to the traditional ontological and anthropological distinction claiming that only human beings have the capacity for agency, whereas things like microbes or machines behave or operate according to a fixed and functional programme.

In a historical perspective, defining agency 'ex nihilo' has had great advantages even though the definition is tautological and sometimes empirically wrong. The first advantage was the civilizing effect of drawing a distinction between animals and the human species. A second one was the moralizing effect of attributing responsibility and guilt to an individual: human agency and autonomy are necessary illusions for the juridical construction of a subject. A third advantage was the economically rationalizing effect on individuals by motivating them to creativity and entrepreneurship. With regard to these benefits, we are justified in speaking of useful illusions. On the other hand, the list of unanticipated adverse effects is not much shorter: A first drawback has been the overemphasis on control, both in terms of one's own control of agency in all situations and the overall control of other entities, from microbes up to large technological systems. A second risk is the loss of sensitivity to differences within one

[6] Nicholas Thomas writes in his foreword to Gell's book "…once appreciated as indexes of agency, iconic objects in particular can occupy positions in the network of human social agency that are almost equivalent to the positions of humans themselves." (Gell 1998: X)

ontological world and to the potential for interference between different worlds: human agency may be greater or lesser in different socio-technical constellations. Or agency may be attributed even though we may be unable to observe any signs indicating agency in the basic sense of our understanding of what defines a human being, e.g. in the case a foetus or a coma patient (Casper 1994; Lindemann 2002). Or, conversely, agency may be withheld from human beings although, for instance, slaves clearly displayed features of agency when engaging in creative craft work or revolting against their inhuman living conditions. Finally, there remains the risk that the illusion of human autonomy tilts in the opposite direction toward the equally illusionary notion of human beings having lost all autonomy and autonomous technology having taken over all aspects of agency (Winner 1977).

If one seeks to avoid fundamental positions that refuse to admit any differences in degrees of agency and any combinations between agencies of a different kind, one has to start with a concept of 'agency in medias res' and in 'medias mixtas'. That means we need to analyse a mixed field of interdependencies and distinguish between different kinds of media[7], such as the human bodies, physical objects and symbols involved in performing an entire action sequence. Then we must evaluate different degrees of agency in and inter-agency between these kinds of media. This results in describing the multiple reality of distributed agency. *The collective constellation can then be reconstructed as a configuration that is composed of more or less active mediators made of different stuff and that is shaped by different forms of inter-agency between them.*

3. The practical fiction of technologies in action

It seems fair to say that the humanities and social sciences, for the most part, do not have a very favourable view of technology. They often speak of "technology" in the abstract, thereby producing a simplified image of a single kind of technology. Technology, in its totality, is seen either as a tool in the service of humankind or as an autonomous system out of control. Students of the humanities and social sciences show little interest in looking into the many faces of technology; they generally do not follow technologies into the fields of action and application. Failing to do so keeps them from discovering the fine differences in the forms, features, and kinds of performance. They often put technology in opposition to life, culture, politics or sociality while failing to recognise that technologies are an integral part and a particular element of the human condition, cultural expression, institutional rules and situated action.[8]

Engineers seem to be the better guides to open our eyes to the fine differences in the characteristics and operational features of technologies. That is why we will join them for a while and explore their perspective in our search for relevant dimensions that may be useful in characterizing the changes observed in the shift towards *advanced technologies*. Engineers describe these real technologies in terms that we are familiar with from the humanities and social sciences: They are said to behave in highly 'intelligent' ways, to 'act' and 'interact' like human agents, or even to 'communicate' with human users and show features of 'autonomy'. In turn, the engineers are accused of using this humanist vocabulary in an improper and illegitimate way. This criticism of conflating categories, however, prolongs the blindness for relevant changes and solidifies the myth of a single technology separate from society.

[7] For an elaborate version of a relational and media/form-oriented theory of technology, see Rammert 1999.
[8] For a critique from a post-phenomenological view, see Ihde 1990 and Verbeek 2005.

Students of science, technology and society seem to be predestined to mediate between the two cultures. Social constructivists like Trevor Pinch and Wiebe Bijker (1987) earn highest recognition for their innovative approach. It paved the way for hundreds of detailed case studies of new technologies opening up the black boxes. Yet, they have missed the point of materiality and have reduced the world of technology to a mere social construction. The sociologist H.W. Collins and the philosopher Martin Kusch have dared to shift the boundary between human and technical agency a bit more into the technological realm. But ultimately, they have drawn an absolute and dogmatic demarcation line between "polymorphic" and "mimeomorphic action" (Collins/Kusch 1998) while taking sides in favour of the philosophical tradition of arguing "what computers still can't do" (Dreyfus 1992).

Bruno Latour, a former student of theology and a true lover of technologies (Latour 1996a), a historian and practitioner of science and technology studies (cf. Latour/Woolgar 1979; Latour 1984) and recently a confessing new sociologist (Latour 2005), was the first to cross over the Rubicon and to move criss-cross between the two cultures, smuggling agency into the world of things and bringing back things to the world of people (Latour 1988, 1992).[9] In the beginning, he followed the scientists and engineers into the laboratories and fields of experience on the other side (Latour 1987) and observed how human and nonhuman entities, mediators and intermediaries crystallised into heterogeneously composed collectives that were called actor-networks. Upon returning to the banks of the humanist side of the river, he did not hesitate to deconstruct and radically revise the categories of sociality, agency and subjectivity (Latour 1994; 1996b). Looking on from a creator-like observation point called "ontological symmetry", all entities were declared equal. His attempt at mediating between the two worlds, however, is based on a semiotic vocabulary that allows making microbes, microscopes and door closers the common subject of a sentence only (Akrich/Latour 1992) but does not grasp the pragmatic dimension of agency. It can easily be blamed of being a theoretical fiction or a rhetorical trick that does not lead to new insights (cf. Collins/Yearley 1992).

In the following considerations, I will argue *that agency is really built into technologies as it is embodied in people*. We can therefore observe agency. It emerges in real situations and not in written sentences. It is a practical fiction that has real consequences, not only theoretical ones. Pragmatism has taught us that all distinctions are the product of interactions, no matter what the distinction: me and others, body and mind, subject and object, or means and ends (Dewey 1916; Mead 1938). Andrew Pickering has nicely illustrated how human agency and material agency develop in a relation of interdependency – when materials or technological designs resist human expectations or even show us new and unexpected paths to follow – and how human actors are moved to change their goals. He calls this stepwise shift from ends-in-view to adaptations the "mangle of praxis" (Pickering 1995). I prefer to call it "experimental interactivity" (Rammert 2007: 71), thereby referring to John Dewey's concept of experimental inquiry and to Georg H. Mead's philosophy of acts and theory of social interaction. The notion of experimental interactivity opens a perspective on a social theory of agency based on a de-centred position of human reflexion that distinguishes between different degrees of agency and allows analysing mixed constellations of distributed agency.

Our point of departure is the observation of real changes in the types of technology under the aspect of agency and autonomy. We will enter the world of the engineers and adopt their analytical schemes and vocabulary to describe the qualitative changes from simple and complex

[9] This narrative overemphasizes the individual actor and underrates collective agency: Latour was strongly encouraged by Michel Serres's method of crossing (Serres 1994) and supported by Michel Callon (Callon/Latour 1981) and John Law (1987).

machines to smart and advanced technologies in action. An often used scheme in handbooks of engineering defines five dimensions of technical activities:
(1) motor and drive system,
(2) actuator and transformative system,
(3) sensor and adaptation system,
(4) information processing and control system, and
(5) communication system.
At lower levels of motion and operation, devices and machines have evolved toward higher degrees of self-propulsion: from a central, stationary steam engine to a system of many engines powered by electricity, from externally horse-driven coaches to self-propelled vehicles like the locomotive or the automobile. Under the aspect of action and transformative work, an evolution can be observed from crafted tools through mechanical machines to self-operating automatic systems.

The technical changes in the other three dimensions, however, are critical for the type of advanced technology showing higher levels of agency. In terms of context-sensitivity, completely blind machines have been replaced by ones equipped with feed-back mechanisms and embedded, highly sensitive systems that are able to adapt their operations to a changing environment. Considering information-processing, three kinds of loops can be reconstructed, from hard-wired tools and machines, whose operating programmes were incorporated into the design of the artefact, via flexible machines programmed by some type of information carrier, such as cards, magnetic tapes etc., to highly autonomous systems that control their own activities by nested systems of computer programmes (Noble 1984). Concerning the aspect of communication, mute machines requiring humans to monitor and communicate the state of operations were replaced by signal displaying devices and now by an "Internet of things" where machines, devices or even the products themselves are able to observe their own states, places and times of operation and communicate them to people or also to one another via cable or radio frequency (Adelmann/Floerkemeier/Langheinrich 2006; Herzog/Schildhauer 2009). We can summarize that current advanced technologies show signs of increased self-activity in all five dimensions. They lose their stationary, blind, fixed and mute nature as their capacities increase in the dimensions of mobility, context-sensitivity, programmability and communication. *They can actually be observed as pro-active 'agents' in the world of things and not just called 'actants' in the world of words.*

Before leaving the engineering sector and returning to the humanist riverside, I shall present an alternative way of thinking about the agency of technical systems. To do so, I will distinguish five different levels of agency by technical mode of operation.

Level 1 signifies a *"passive"* mode of operation: instruments are entirely moved from the outside, like a hammer, a mechanical brake or a punching card.
Level 2 indicates a *"semi-active"* mode of operation: any kind of apparatus falls in this category that shows some aspect of self-operating capacity, such as a machine-tool, a record-player or a hydraulic brake.
Level 3 refers to a *"re-active"* mode of operation: systems with feedback loops operate on this level of agency, like adaptive heating systems, an automatic door opener, or an anti-locking brake system.
Level 4 relates to a *"pro-active"* mode of operation: systems with self-activating programmes belong to this category, such as systems for car stabilization or brake systems in cars and high speed trains designed to monitor and compute critical internal and external data and initiate operations as determined.

Level 5 is called a *"co-operative"* mode of operation: systems with distributed agents and some form of self-coordination perform on this high level of agency, such as mobile robots playing football or multi-agent systems that control complex systems by communicating between different parts.

Simple and complex technologies showing low levels of performance can be described employing the usual vocabulary of mechanical operations and predetermined movements. *However, when the parts of a technical system are designed to react more flexibly, not only in a predefined manner, when the interaction with other components inside the system and with its environment may lead to changes in its performance, and when system components actively search for new information to select behaviour or to modify the pre-given script of operation, then it makes sense to use the vocabulary of agency and inter-agency in order to describe the activities that go on in this world of artificial things.*

Agency is a concept that is used on both sides of the river Rubicon: the engineers, especially the software engineers and distributed artificial intelligence people, have imported this term from the humanist side in order to describe more adequately this world of artificial things that they have constructed. On the one side, agents may be human actors who act in the name of a principal, e.g. an attorney on behalf of his client, a manager on behalf of the owner of an enterprise, or an informant of the secret service in the strategic game of espionage (Goffman 1969). They are bound to the general goals of the principal, but they have the freedom to choose the adequate path of getting there.

On the other side, agents may be computer programmes that are written with the intention of endowing them with the capacity to execute actions in the name of another, for instance a human agent. Tasks are delegated to such agents, but, here too, they are free as to how they get the task done. So these agents may divide and delegate tasks among other agents. They may cooperate with one another and, in the process, take the initiative, address others and make certain moves. They coordinate the process of cooperation on their own and communicate the results of their activities to the human user. The software engineers equip the individual agents with a belief-desire-intention system that gives them the features of "autonomy", "reactivity", "pro-activeness" and "sociality" (Wooldridge/Jennings 1995). They design an architecture for multi-agent systems that borrows concepts and coordination mechanisms from social theory and human society, like cooperation, competition, trust or community (see Hewitt 1977; Star 1989; Malsch 2001).

Our point of destination is a bridging concept that mediates between the engineering and the social scientific cultures of conceptualisation. The river forming the border has been crossed in both directions. This intercultural journey has demonstrated that people in action do not necessarily and always show the characteristics of autonomous agency. They give way to instincts and repressed desires; they fall back into habitual and ritualistic behaviour, and they blindly follow everyday routines and rules of a hidden curriculum. Rational or intentional action emerges in those rare moments when frictions of interdependency occur or problems of interaction and interpretation arise. On the other side, we learnt that technologies in action show a more differentiated spectrum of features than usually supposed. Particularly the advanced technologies perform tasks on the higher levels of situated reactions, pro-activeness and cooperation by communication. This type of agency is built into the objects by the engineers. The acts of performance are observable, and they have consequences that are similar to human agency. The agency of these elaborate things is a practical fiction that allows building, describing and understanding them adequately. It is not just an illusion, a metaphorical talk or a semiotic trick.

We live in a world where people in action and technologies in action are more or less strongly coupled. They do not dwell on separate sides of the river. Surely, they are made of a different stuff; but they both are passive and active parts of a common collective constellation; they are the resources and more or less active intermediaries that society is built of. Both can show higher or lower degrees of agency, and both can congeal into a technical form.

Two concepts have been developed to overcome the fundamental duality between human and material agency. The first one, a pragmatic concept of technology, has been designed to bring technology back into the social realm. It conceives of technology as a process of "technicization" and a particular "form"[10] of relating to the world in contrast to concepts centring on the concrete materiality of a technology. The technological form schematizes, combines and determines relations between people, objects and symbols in a way that a useful effect can be regularly expected and intentionally controlled. It is constituted by all kinds of relations: the causal ones between objects, the hermeneutical ones between people and objects, and the evaluative ones between people. Additionally, the stuff technology is made of or the media the technological form is incorporated in makes a difference: the same form of "technicization" can be embodied in human movements ("habitualization"), can be materialized in physical things ("mechanization") or can be fixed in systems of signs ("algorithmization") (Rammert 1999). Finally, the processes of practical experimentation and projects of technological mediation produce the many historical faces and cultural facets of a technological form.

The second one, a gradual model of agency, was conceived to open the eyes for agency in the material realm. It is not sufficient to only open up the black box of technology; it is also necessary and more informative to observe the different dimensions and levels of its performance. The model distinguishes three levels of agency and degrees of more or less autonomous agency. The levels of agency are inspired by Anthony Giddens' stratification model of action, which makes distinctions between a level of subconscious motives, a level of practical consciousness involving routine action, and a level of discursive consciousness involving reflexive action (Giddens 1984).

	DEGREES		
LEVELS	**low**		**high**
III. Intentionality	from attribution of simple dispositions	→	to guidance by complex semantics
II. Contingency	from choosing pre-selected options	→	to self-generated actions
I. Causality	from short-time irritation	→	to permanent re-structuring of action

Figure 1. Levels and degrees of agency (Rammert 2008: 77; Rammert/Schulz-Schaeffer 2002)

[10] The term "technicization" refers to Husserl's und Blumenberg's term of "*Technisierung*". The term "form" refers to Cassirer's typology of "symbolic forms" (myth, logos, art, technology). For further references and a detailed discussion, see Rammert 1999.

On the first level, called *"causality"*, we are dealing with a weak notion of action. Agency on this level means effective behaviour, a behaviour that exerts influence or has effects on something or someone. It corresponds with the Latin term "agere", Latour's term "actant" or Callon's term "translation" (Callon 1986), but it differs from Latour's semiotic approach inasmuch as the performative aspect is emphasized. Under this aspect it makes no difference whether humans, machines or programmes execute the action – the only difference is the media involved. Money can be handed out by cash machines or by bank employees. The situation changes when greater irritations and more options come into play.

On the second level, called *"contingency"*, the capacity to react in one way or the other and to choose between several options is required. Changing environments or unexpectable consequences of actions can be the cause of contingency and can trigger breaks in routine programmes and initiate a search for new reactions and adaptations. The paradigm of command and execution is replaced by the paradigm of flexible response; relations of immediate instrumentality are turned into ones of directed interactivity. Dialogical interfaces and internal user-modelling push the performance of technologies up to this level. Milestones on this way were the Turing test (Turing 1950), Weizenbaum's ELIZA program (Weizenbaum 1976) and interactive video games. The level of contingent reactions makes it nearly impossible to discriminate between human-enacted and computer-enacted characters in the interactive situation on a screen.

On the third level, characterized as *"intentionality"*, we encounter rational and reflexive action. Usually it is restricted to human agency by definition because intentionality is ascribed to actors with consciousness and interpretative capacity only. When different degrees of self-awareness and of intentional directedness can be observed, then we may argue that some technologies even show low degrees of intentionality: for instance, chess-playing software with a built-in disposition for winning or software agents equipped with an intentional vocabulary by which they coordinate and communicate their actions as human beings do while also using similar semantics. The essence of this kind of intentionality is not the same, but from the viewpoint of pragmatism, which observes acts of performance and their consequences in terms of further reactions, we may claim that the vocabulary of intentionality is indeed also properly applied in cases where developers have equipped advanced software technologies with the capacity to interact as if the software agents had beliefs, desires and intentions or have designed the whole architecture of a multi-agent system as if intentional actors had to be coordinated by a social mechanism of cooperation and communication. The users of these systems, too, have to apply the social role-taking perspective towards the materialized and visualized agency if they want to engage with this kind of technology with any success. We may call this type 'as-if intentionality' alluding to Dennett's "intentional stance" (1987).

This gradual and multi-level model of agency is evidently not a theory capable of deciding the unproductive debate on what humans can and machines cannot do. But it is a practical tool to help the observer, the designer and the user of human-technology relations to identify, construct and classify different kinds and intensities of agency. They must neither subscribe to the metaphysical notion of fundamental human autonomy, nor follow actor-network ontology into the flatlands where all things are endowed with the equal power of agency. *Since agency emerges from empirical interdependencies between entities, each of which may show different levels and degrees of agency, agency can only be studied in collective constellations of inter-agency.*

4. Inter-agency: From the fiction of a fixed instrumental relation to the fiction of a flexible partnership

It is an appealing but naïve assumption that human agency, conceived as meaningful action or reflected decision, could be the starting point for explaining human society. Where does meaning come from? Where does the autonomous subject of reflection come from? Neither hermeneutic theories of tradition and conventions nor individualistic theories of rational choices and social contracts know a plausible answer to these questions. When neither the creative spirit of God nor the evolutionary state of the individual brain can be accepted as being the sources, then mind, self, and meaningfulness must emerge from the earthbound and experimental areas of inter-agency as such. The observable interactions between the units of agency are the processes that constitute meaning by making and experiencing critical differences between me and others, mind and body, subject and object, or means and ends.

Usually, this approach is restricted to the area of inter-agency between human actors. Interpersonal interactions constitute the social world of *'inter-subjectivity'*. Mead's theory of pragmatism and symbolic interaction demonstrates how meaning can be derived from a triad of action, reaction and ascertained interaction. Mead (1963) describes and compares the interaction of two dogs fighting and two men boxing. The aggressive gesture of the first dog, the reactive gesture of subjugation of the second one, and the accepting response of the first constitute something like a "meaning", which is instinctively incorporated into the play of gestures. The moves and counter-moves of the two human boxers show the same pattern of interaction; but they differ in that the gestures are turned into significant actions as the triad unfolds. This is so because these human fighters can imagine which consequence their move would have on themselves and thereby expect the expectations of the other. This capacity to take the perspective of the other allows them to strategically fake an attacking move. The contingency of reactions is given in both examples; the supposed intentionality and double contingency, however, can only be ascribed to the interaction between the human actors.

The inter-agency between things is not seen as a serious subject of social analysis. It has been denounced as fetishism or accused of conflating the vocabularies of causality and agency. But when technical objects are developed that are capable of higher levels of agency, as in the case of the Internet of things or multi-agent systems, then we are well-advised to observe the technical objects within areas of interdependency and describe their activities and interactivities. These interrelations between objects constitute the material world of *'inter-objectivity'* as it can be observed and experienced by people.[11] For it makes a difference whether people encounter a single object or a collective of cooperating agents, whether they are confronted with encapsulated and closed or with open systems, and whether the relations between the entities are fixed and strongly coupled or flexible and weakly coupled (see Weick 1976; Perrow 1984). *The more objects that are included, the more aspects of objects that are activated, and the greater the heterogeneity of the objects and of the interrelations that come into play, the greater the need to use a vocabulary of agency and inter-agency in describing the performances of the single objects and the whole system.*

The inter-agency between people and objects is the strategic bridging concept between the two sides of human and material agency. These cross-relations of *'interactivity'* constitute the

[11] Latour (1996b) has independently developed the similar term of "interobjectivity", but with a different intention: his caustic critique of some principles of symbolic interactionism has led him to replace "intersubjectivity" entirely by this new term. Consequently, his approach neglects the interactions and narrows the view on the links, alliances, and annexes between all kinds of objects. In my approach of "distributed agency", however, "inter-objectivity" is one particular type of inter-agency, which altogether form the collective constellation.

hybrid world of interfaces, human-computer interaction or socio-technical systems. This borderland is widely occupied by the engineering sciences and their technomorphous approaches, such as ergonomic models that conceive of the user as a body machine or a sensory mechanism, or the psychological concept of 'human factors' instead of human actors. Humanists and social scientists seem to have given up this terrain on the boundaries of the social sphere, perhaps because they fear the contagious contact with "objectuality" (Knorr Cetina 1997), "materiality" (Pickering 1993) or "hybridity" (Latour 1994; 2005). In the meantime, students of anthropology, cultural studies, media studies and particularly of science and technology studies have started infiltrating and occupying the abandoned territory (see e.g. Suchman 2007; Michael 2000; Pinch/Swedberg 2008; MacKenzie 2009).

Pragmatism and interaction theory, however, have already laid the foundations for the analysis of interactivity. Dewey's concept of inquiry (Dewey 1940) can be seen as a mode of cultivating relations of interactivity with objects. In this view, technology is not a separate object that is used as an effective instrument of human will but as a set of "active productive skills" (Hickman 1990: 18). Such skills grow out of the experimental and experienced inter-agencies between intervening human actors and observed consequences in the behaviour of the objects. Even more important and less known is Mead's contribution to our understanding of this type of inter-agency between human bodies and physical objects (McCarthy 1984). Children learn to draw distinctions between different kinds of objects, like their own body, outside objects, moving or living objects, through interaction only. They analyse the activities and attributes of physical objects by adopting the perspective of the other, as they first learnt to do in interaction and role play with parents and peers (Mead 1932; Joas 1985). Being heavy, flexible, or moving, having an outer surface and an inner kernel, making noises and behaving in an unanticipated way are all features of objects that are experienced when children play with stationary, mobile and interactive objects. *Sense-making and socialization include both people and things and take place in processes of interaction between people as well as in the interactivity between people and things. It is a kind of dual and distributed inter-agency.*

This integrated view on inter-agencies opens up a frame for the analysis of how the relations between human beings and advanced technologies may change. Technologies that are adequately characterized in terms of passive or semi-active agency can be used in an instrumental mode; that means we can easily employ them as a means for fixed ends. We can neglect the small spaces of agency that have to be filled when users learn to adapt to the tools' particular features, e.g. properly balancing the hammer according to its weight and the length of its handle. Once we have adapted, we usually need no longer reckon with any kind of resistance or contingent reactions. The repetitive and habitual use produces the practical fiction of handling a smoothly functioning instrument or an acquiescent technology. This *unmediated instrumental relation* between a tool or machine and the person using it is called an 'instrumental action' in social theory. Of course, it is a simplification of a more complex inter-agency. Yet it can be justified as an effective and useful fiction because, after a period of habituation, the remaining small spaces of agency have no practical significance. It becomes commonplace to attribute all agency to human beings and none to the instruments.

Once our tools take the form of programmable machines or smart objects, we have reached the level of contingent agency. Consequently, the relations between these more advanced technologies and the human users change, even if the users themselves and the scientific mainstream continue to maintain the practical fiction of frictionless instrumental use. Despite this fiction, the contingency of the actions generated by single programmes or nested systems of programmes confronts the human user with a more complicated thing than a simple tool or an effective instrument. Even the new small, but smart key for my room at the university

causes irritation when I try to put it to instrumental use. Its fairly simple design, consisting of a software programme, a sensor, and a memory, intervenes into my attempt to unlock my door; it demands that I wait for two seconds and forces me to do so while I count the seconds. The fiction of the instrumental use of these programmable devices has to be replaced by the more adequate fiction of a *directive communicative relation*: here, the agency is distributed between people and programmes, on the one hand, and programmes and machines, on the other.

When these programmes, machines and media are equipped and designed to perform at a higher level of agency, this may take the form of questions and answers in a dialogue being weakly coupled, activities being initiated towards the human user, or the machine presenting itself as a partner in seeking information, fulfilling tasks or solving problems, or software may even assume the part of an unpredictable opponent in video games. In such cases the man-machine relation again changes. We quickly drop the illusion of being able to control every possible move that the programme makes and attempt to anticipate its operations by understanding its codes or reading its instructions. We have to adopt the 'intentional stance' if we want to use such a system effectively or play against it successfully. This new level of inter-agency produces the fiction of an *interactive communicative relation* where technologies are enhanced to play the role of visible partners or invisible agents. Under conditions marked by widespread use of such technologies, agency is much more distributed between people, machines, and programmes than ever before.

5. The reality of distributed agency: How to analyse constellations of agency

From the fiction of individual agency to the reality of collective agency

If we are interested in analysing agency as it emerges from inter-agency, the analysis must choose a constellation where all elements, all kinds of relations, and a particular distribution of agency are present. Flying two hundred tourists to Tenerife can be considered a realistic example of such a constellation. The precise question would be: Who or what acts in the case of flying tourists to Tenerife?

Complexity:	**PEOPLE**	**MACHINES**	**PROGRAMMES**
low	pilot? co-pilot? radio operator?	jet engine? elevator, rudder? radio equipment?	autopilot software? navigation card and system? radio signals and codes?
medium	flight controller? travel agency?	radar unit? booking units?	radar processing software? reservation software?
high	airline company? aviation industry?	aviation technology? air traffic system?	technology R&D schemes? roadmaps for infrastructure development?

Figure 2: List of agencies in the air traffic case

People are the only actors. That is why humanists and social scientists focus on the people column in the list. Their first and most plausible answer to our question would probably be

that the human pilot is the unit acting since he or she flies the tourists to Tenerife. The pilot is conscious of the goal, knows the methods and controls the instruments. He or she reflects on possible interventions and deviations. Finally, the pilot is the one who can be made responsible for the act of flying because of having the power of command and control.

First doubts arise when we are confronted with the question whether the captain is the only actor involved in this operation. Does he not at least have a radio-operator at his side? We know from accidents that communicative interaction between pilot and co-pilot or between pilot and flight controller is crucial for what goes on during the act of flying. For instance, the consequence may be to avoid a collision or not. So we can easily see that agency is often divided between several human actors. The acting unit then is either the team on board or a locally dispersed assembly of people on board and at several control centres on the ground.

A further question raises even more doubts about a single heroic actor: Does the captain or this group of navigators and controllers really plan the flight? The answer is of course no. It was the airline that planned the route, the time and the final destination. Furthermore, nearly two hundred paying passengers are required for the operation to take place. The airline company coordinates the individual wills of its employees and its customers. In comparison to this powerful "principal agent", the other actors are relegated to the role of executing agents (Coleman 1990). The company is the collective actor that plans, decides and controls the flight to Tenerife. In sum, four different units of action can be distinguished on the people side: a single human actor, a social group or team, a dispersed association of people interacting in a division of labour, and a collective actor that coordinates activities toward a common goal. *Without a doubt, human agency is multiplied, divided and connected.*

Encouraged by our gradual concept of agency, we may dare to insist on a more precise answer to the question as to which actors and other agencies contribute to the act of flying. Engineers and scientists probably would emphasize the role of machines and software programmes. Their first and most plausible answer would most likely be: No pilot and no flight without upcurrents and drive systems, like propeller or jet propulsion engines! Elevators and rudders give the airplane the direction, and radio and radar equipment enable the plane to find its position and correct its route. However, as discussed earlier, agency at this low level of causality does not really add new explanatory power.

Yet, the situation changes entirely when these machine technologies enter inter-objectual relations with the agencies listed in the programme column. For the most time of the flight, the task of flying and the many single actions involved are delegated to the autopilot. In essence, an autopilot is a compilation of many different software programmes that continually measure, monitor and compute, but also pro-actively correct the height, tempo and direction of the flight. The automatic landing system sometimes even restricts the human pilot from intervening into ongoing operations. *In sum, the unit of technical agency constantly changes and flows together to create a highly combinatory and relatively autonomous technological system.* It starts with wings and rudders and develops into an aggregate technological system integrating many sub-units like propulsion, navigation and communication systems. Finally, we observe a qualitative shift in the level of agency when advanced computer programmes take over the planning, control and navigation activities, especially their intelligent coordination, and even more so when the airplane itself turns into a single agent in a more extensive, self-regulating air traffic system.

We can now see that it is much easier to define what a human and, particularly, what a social action is with the help of classical texts than to analyse it in concrete constellations. Philo-

sophical and sociological textbooks may help us reflect on the criteria. Many authors usually start with a concept of action isolated from the stream of other actions that is idealized in a certain way. Then, the "ego" is identified as the unit causing changes, making choices, and defining the situation. In contrast to this individualistic concept, the act of flying has to be reconstructed based on the many activities before and around the action at the focus of attention. Flying two hundred tourists to Tenerife is not sufficiently explained in terms of a pilot engaging in the instrumental act of navigating the plane to Tenerife airport. The pilot's performance is only one among many other activities of controlling and communication. And those activities, too, are only a part of the wider commercial activities of an airline. Finally, we can see that all these activities are also nested in the activities of a highly complex organized system of air traffic, the aviation sector and the tourism industry. Looking at the act of flying a plane to Tenerife from the perspective of distributed and connected agency, one discovers many loci of agency instead of one single actor. The act of flying can be reconstructed as the commercial action of a collective actor or even a network of organizations (cf. Teubner 2003), which hire people, invest in new planes, lobby for public support, advertise cheap charter flights and organize the flight route.

Looking at the technology column of our list, we now notice that describing devices and machines as simple means of action underrates both the complexity of aggregate technical systems and the self-regulated activity of programmed and nested systems. The large assemblage of devices and the compilation of different types of technologies cannot be treated as if they were no more than bigger toolboxes containing a larger number of instruments. The interrelated parts form highly complex systems involving numerous planned inter-activities along with some unforeseen interferences (cf. Perrow 1986). As such they lose the clear transparency of a simple instrument and require strategies of interactivity in order to control them. Linking nearly all parts to computing and communication systems converts the assemblage of technical components into pro-active agents that are again often connected to relatively autonomous systems on a higher level, such as an automatic landing or an Internet-based reservation and booking system. Since advanced technologies usually simulate human action and the social mechanisms of coordination, it makes sense to describe these activities and interactivities using the vocabulary of action and inter-agency. Employing the perspective of agency "in medias res" is also the appropriate path toward discovering and understanding the different levels and the many loci of material agency.

From the fiction of homogeneous agency to the reality of hybrid constellations of inter-agency

In the predominant dualist tradition of thought, the social and cultural world of human action and the material and artificial world of technological operations are separated from one another. On the one side of this divide, social scientists focus on the motives and expectations of people, such as pilots and airline ticket agents, and on the modes of social organization. They reconstruct a homogeneous world of symbolic interaction and social communication void of physical objects. On the other side, engineering people are preoccupied with questions of putting things into operation, like airplanes or software programmes, and of improving the effectiveness or safety of technological configurations. They construct a different kind of homogenous world consisting of predetermined operations and the functioning of technological systems, which is void of social interests and human users. In the light of the increasing interrelatedness of environmental and social problems and the hybrid nature of socio-technical systems made up of people, machines and programmes, we must, however, ask whether a non-dualist conceptual approach might be a more promising path toward gaining a better understanding of these hybrid constellations and establishing more sound foundations for research.

From the dualist point of view, it makes sense to keep the two territories separated. A host of arguments have been mobilized to substantiate the divide, like the ontological differences between people and machines (cf. Collins and Kusch 1998), the epistemological differences between the disciplines, the institutional differences between social organizations and technical configurations, and so on. But all these differences lose their relevance under certain conditions: When human actions, machine operations and programmed activities are so closely knit that they form a "seamless web" (cf. Hughes 1986), then it makes good sense to analyse this hybrid constellation as a heterogeneous network of activities and interactivities. When human action, as the task of flying an Airbus or searching for a certain piece of information in hundreds of libraries, millions of books, and trillions of files, cannot be performed without the assistance and intervention of hundreds of other agencies, then it is high time to develop a concept of agency that acknowledges all these agencies even though they are made of different stuff. And finally, when programmed machine operations are designed to execute actions on behalf of other agents under conditions of contingency, and when these software agents leave the private zones of personal computers and firewall-protected firm networks and encounter other agents in the worldwide web, thus forming open and undetermined modes of association in the context of platforms, portals and auctions, then one should integrate these agencies into the framework of analysis. This leads me to argue that a concept of distributed agency is the adequate intellectual tool for analysing the constellations of inter-agency in the world of advanced technologies.[12]

Returning to the act of flying, we can now answer the question as to the appropriate unit of action: *it is the collective of people, machines, and programmes – in particular, the mode by which the agencies of the various elements are distributed and connected with one another in constellations of inter-agency.* It is neither the individual nor the collective human actor, neither the technical artefact alone nor the combined technical system as such. It is the mixed constellation composed of the elements on both sides of the divide. We may call it *collective agency* in comparison to the narrower term collective actor. This collective agency is constituted by the distributed activities of the heterogeneous units as opposed to the traditional notion of human agency, which is composed of the homogeneous stuff of human actions.

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[12] A simulation-based experiment – in the tradition of the Turing test and drawing on Latour and Rammert/Schulz-Schaeffer – has recently confirmed these assumptions about distributed agency. It also showed that the human actors involved reshaped their self-conception: In the course of the experiment, they voluntarily surrendered part of their agency and responsibility to the software programme and concentrated on particular activities instead. The distribution of roles was reconfigured (Fink/Weyer 2011: 108 f.).

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