WHERE THE ACTION IS

DISTRIBUTED AGENCY BETWEEN HUMANS, MACHINES, AND PROGRAMS

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1. Distributed agency: A concept beyond human action and technical means

Usually, the action is where the humans are. Action means moving the body, making something, showing initiative, bringing about an alteration by force, and expressing oneself thereby. Action becomes particularly visible when there is unexpected reaction to something or resistance to somebody’s will. In the humanities and social sciences, action is closely associated with the anthropological concepts of man the artist and tool-maker or the speaker and symbol-communicator.[1] Human action – defined to be intentional and creative – is often sharply distinguished from animal behaviour, which is characterised as instinct-driven and only tool-using, and from machine operation that is described as a repetitive and pre-programmed activity. If we continue to define action by the demanding features of intentionality, rationality or reflexivity that are attributed to humans only, then – no wonder – all other uses of the term “action” in everyday life and actual technological developments would be only metaphors or even categorical mistakes. In this case we would miss and misunderstand the massive changes in intelligent machine design and interactive media use that open up Pandora’s box filled with thousands of agents. These software or hardware agents equipped with belief, desire and intention algorithms are able to take part in manifold actions and even to change their action programs by case-based learning. Certainly, they are different from human actors, but they are also different from classical machines and media. Both features, their particular capacities of being active and interactive and their growing population in everyday gadgets and in the worldwide web of the internet, justify the undertaking which has been made in the following, to develop a more symmetrical and sophisticated concept of agency.

What are people talking about when they use the word ‘action’ in everyday life? Do the youngsters still mean good old human action, when they are acting in videogames inducing an avatar to follow and fight other creatures only by button-pushing? It is evident that button-pushing in this case is not the one single and simple instrumental action of fighting with swords, but one activity under many others: It activates a cascade of programs which themselves activate characters that show contingent action in a virtual action environment.

The players surely know the fundamental difference between the other human actors and the artificial agents in the game; but they are more interested in the interactivity and the particular high level of agency that they

1 Leroi-Gourhan 1980

experience during their interaction with both kinds of partners or adversaries: the humans and the agents.

We learn something about the meaning of action when we listen to people talking about the genre of action films. They do not only mention the human actors who are in states of super-activity like running, jumping, or shooting and who are entangled in highly interactive situations like chasing one another or fighting with one another. Action includes more than human bodies in interaction. It is closely connected with the activities of high-speed vehicles, explosives and firing weapons as we know so well from James Bond films. Action of this special kind emerges from accelerated sequences of action of all kinds of acting units. The impression and fascination of action is finally produced by the many interactivities between the mixed agencies, not by the human interaction alone.

Actually, computer and media scientists use the vocabulary of human action when they describe the features of new technologies. Are software agents, for instance, really acting like human actors, when they ask the user for tasks, when they cooperate and compete with one another in the artificial society of agents, and when they assist persons in their daily actions of sorting out e-mails, searching for optimal traffic connections, looking for best prices, booking tickets and buying investment papers? Is it correct when interface designers speak about Human-Computer Interaction (HCI) and students of Distributed Artificial Intelligence call their programs 'agents' or 'multi-agent-systems' because they are constructed with the explicit intention to act like a person who is acting in the name of an other person? Action can be composed of different acts, and some can be delegated. Collective actions can be unified in a corporate actor like an organisation. They can be divided between principal and executive agents.[2] If the actions are distributed between human actors and nonhuman agents,[3] why should we not treat this 'hybrid constellation' as a particular kind of a collective actor?

Answering the main question 'where the action is' actually seems more complicated than before. The introductory considerations have alluded to four relevant changes in the sphere of human-technology relations that call for some conceptual revisions:

- The number of acting units and the kinds of action are increasing for the first time since modernity and enlightenment successfully diminished it by banning moving objects and talking trees, inviting nymphs and punishing gods, speaking oracles and helpful angels out of the sphere of action into the world of fetish and fiction.

2 Coleman 1990

3 Latour 1988

- Instrumental actions between active people and passive objects are turned more and more into relations of interactivity between two heterogeneous sources of activities. The analysis and design of these relations require a more balancing approach of interactive contingency than a hierarchical one of instrumental causality.
- Actions are fragmented in many pieces and delegated to myriads of pro-active and cooperative agents on the back stage where they perform parts of the action by mimicking human agency and interpersonal interaction.
- Actions emerge out of complicated constellations that are made of a hybrid mix of agencies like people, machines, and programs and that are embedded in coherent frames of action. The analysis of these hybrid constellations is better done with a gradual concept of distributed agency than with the dual concept of human action and machine's operation.

In this paper it is argued that the advanced technologies take part in the course and constellation of human action and that they do this with real effects, not only metaphorically. The first part starts with the search for a useful concept of agency that enables the researcher to describe and classify all activities that contribute to the performance of an action. The concept shall include different levels of human agency as well as different levels of technologies in action (2). The following chapter treats the consequences that these activations of technologies have for the human-technology relation. If technologies change their role from passive means into agents and mediators, then the narrow concept of instrumental action should be replaced by a broader concept of inter-agency (3). This part of the paper culminates in the presentation of a gradual model of agency that can be used to describe and distinguish between different levels and grades of action without any regard to the ontological status of the acting unit, be it human-like or machine-like (4).

In the second part of the paper the question 'What is the adequate unit of action?' is answered. It starts with a thought experiment about the question: Who is really flying the Airbus? We learn from both views, the humanist's and the technologist's one, that what is usually called action, such as flying 240 tourists to Tenerife airport, consists of many distributed actions that have to be coordinated by social organisation or technical configuration (5). The concept of distributed agency is spelled out in three steps: It presupposes many loci of agency, not one actor (5.1). It declares the hybrid constellations made of the mixed human and material agencies to be the adequate research unit, and not solely the homogeneous social organisations or the technical configurations (5.2). Finally, a third mode of integration called 'framed interactivity' is elaborated that may emerge between the hierarchical mode of master-slave-relation and the open mode of autonomous systems (5.3).

2. Technologies in action: From artifacts to agents

Human action and technological operation belong to two different worlds: the realm of freedom and the realm of forces. Following Kant's definition, human action is characterised by its moral autonomy from external forces and laws. Although humans are subjected to these forces, they have the capacity (free will) to give themselves the rules of action that may become the general maxims for others, too. Referring to Reuleaux's definition, machines follow the very idea of forced movements. Heteronomy is the characteristic of von Foerster's "trivial machines" that are completely determined systems.[4] The dichotomy of tool-maker and artifact is completed by the dichotomy of rule-making and rule-following.

This fundamental dichotomy may be helpful to divide between the ontological spheres of morality and causality. But it should not be applied to our questions of empirical changes and practical consequences. If we want to analyse the gradual changes of advanced technologies, the qualitative changes of the interaction between people and technologies, and even more, the re-configurations of the hybrid constellations from which action emerges, then we have to overcome this dual concept of action and operation. Thus we start with a symmetrical concept of agency that permits us to describe and classify what could be meant by the feature 'in action'. On this low level, we look for features of self-movement, activeness and self-acting.

How can we decide whether advanced technologies have changed and in which aspects? Let us take the five aspects that are often used in the engineering literature: technology as a motor/driver ("Motorik"), as an actuator ("Aktorik"), as a sensor system ("Sensorik"), as an information processor ("Informatik"), and as a communicator ("Telematik"). With respect to the aspect of motion, we can state that the gadgets and machines have gained higher degrees of self-movement: from one central stationary steam engine towards distributed systems of many engines powered by electric drive, from externally driven carts and coaches to self-driven vehicles, called automobiles. Under the aspect of acting and working, we make out a strong drift from crafted tools through mechanical machines to automatic systems.

The next three aspects seem to be of critical importance for the level of technologies which are subsumed under the label of "smart machines", "intelligent systems", "new electronic media", or "high technology".[5] Regarding the

4 von Foerster 1985

5 Rammert 1992

aspect of context-sensitivity, we actually realise a strong tendency away from systems that are completely blind to ones that are equipped with a feedback mechanism, all the way up to highly sensitive systems that are able to realise situations and to adapt their action to changing environments. The greatest steps in the direction of activating technical objects have been made with respect the aspect of information-processing: Looking backward, we reconstruct the movement as a loop from hard-wired tools and machines whose activity plans are incorporated in the design of the artifact, via flexible machines that are programmed by cards and records towards highly autonomous systems that strongly self-control their activities by nested systems of computer programs. Last, but not least, the aspect of communication between objects has emerged. Communication about the state of the machines' activity has been the task of people observing them at the work bench or in the office of the factory supervision. The direction is now inverted: The machines, the gadgets and even the products themselves observe the states, places and times of their actual activity and communicate them to people and also to one another via cable (Internet) or radio frequency (RFID).

ASPECTS	FROM	CHANGE	TOWARDS
Motor	stationary gadget	>>>	mobile agent
Actuator	passive instrument	>>>	pro-active agent
Sensor	blind machine	>>>	context-sensitive agent
Processor	hard-wired artifact	>>>	programmed agent
Communicator	single apparatus	>>>	cooperating agent

Fig. 1. Aspects of technological change

The current advanced technologies show signs of increased self-activity within each aspect. As they are human-made technologies, they remain artifacts. However, they loose their passive, blind, and dumb character and gain the capacities to be pro-active, context-sensitive and co-operative. Insofar as the technical artifacts have been put into action by these changes, it is justifiable to define them as agents.

What are 'agents'? From a technological view, agents are particular computer programs. They are written with the intention that software agents can execute actions like human agents. This means that actions are delegated to them. The agents divide and delegate the action among other agents. They cooperate with one another, thereby moving, taking the initiative and addressing others. They coordinate the cooperation themselves and communicate the result of their activities to the human user. In a seminal text on intelligent agents, the main characteristics are presented as relative "autonomy", a particular "reactivity" to the environment, "pro-activeness", and "sociability".[6] From a sociological view, agents are persons who act in the name of a principal, e.g. the owner of an enterprise or as an informant of a party in a strategic spy game.[7] The business and the secret service agent are bound to the general aims of the principal, but they are free to choose the adequate actions. Their actions are not blind executions of the principal's will. Agent-oriented programming and the design of architectures for multi-agent-systems follow this social concept of an agent and take over other mechanisms of society like cooperation, competition, trust or community in order to establish more flexible systems of distributed artificial intelligence. The up to now dominant design of a master-slave architecture is slowly being replaced by open systems of distributed and cooperating agents. The higher grade of activeness given to the software agents motivates the software engineers and the system designers to transfer those social and sociological concepts which have been proven as successful mechanisms of coordination.[8]

Technologies are changing on the level of technical systems, not only as concrete tools, machines, media, and sign processors. They show higher levels of complexity, they are more heterogeneously combined, and they are more complicatedly nested with one another. A review of the advanced technological and media systems reinforces the impression of a radical change in quality, not only in quantity and diffusion of technical objects. The Airbus is highly complex in a different way than a cathedral that is also made of millions of stones, glass pieces, and thousands of fixed relations between them, or than a Cadillac car in the fifties that is assembled out of thousands of exchangeable parts and has hundreds of variable relations between them. The cathedral and the Cadillac, however, combine heterogeneous materials and technologies, but the construction of an Airbus requires the integration of much more diverse technologies in an incomparable way. Especially, the embedding of so many different programmed physical and information systems in one plane produces the system's opacity that favours the interpretation of being confronted with an autonomous being. Stanley Kubrick clearly demonstrated this strange feeling in his "Odyssey in Space" when the computer system HAL, which was a part of the automated space ship, had to cope with contradictory rules in his program, then resisted human control and started to follow its own rules of action.

It is precisely to escape such fantasies of autonomous action on the one hand and the stubborn notion that technologies do not show any sign of agency on the other hand, that a more differentiated approach to the problem

6 Wooldridge/Jennings 1995

7 Goffman 1969

8 Schulz-Schaeffer 2002

of technology in action should be developed. A scale with five levels of agency is presented here which may be seen as a first step on this route. The principle of its construction refers to the performance of technical objects and systems, not to their function. It also refers to the above-mentioned aspects and their interrelatedness. Examples from different technological domains are given for reasons of understanding. This scale is designed to raise awareness about different levels of agency and can be used for descriptive and classificatory reasons.

LEVEL OF AGENCY	DESCRIPTION	EXAMPLES
Passive	Instruments completely moved from outside	Hammer; Punching card
Semi-active	Apparatus with one aspect of self-acting	Machine tool; Record-Player
Re-active:	Systems with feedback loops	Adaptive heating system
Pro-active:	Systems with self-activating programs	Car stabilisation; Help agent
Co-operative:	Distributed and self-coordinating systems	Mobile robots; Smart Home

Fig. 2. Levels of agency for technical objects

It is not so easy to give examples that are typical of the particular level. The position in the scale depends on the precise description of the equipment and the connectedness between its parts. A brake can be a simple tool that functions mechanically. It can also be activated by a little motor; then it changes to the level of a semi-active hydraulic machine. When the brake is connected with a feed-back measurement instrument, it then operates on the level of re-activeness. Actual brake systems in the ICE or TGV trains are to be allocated on higher levels: They are pro-active, because they start their action themselves after having monitored and computed critical dates of inner and outer states. When there is also communication between the brake systems at the different wheels, then we can speak of a distributed and co-operative system. What can be learnt from this example? New insights cannot be gained from talking about agency on the first two or even three levels. It is completely sufficient to use the mechanical vocabulary of operation and determined movements. When the parts of a technical system, however, can behave not only in one pre-fixed way, but more flexibly, when the interaction with other parts or the interaction with the environment changes the behaviour, and when some parts actively search for new information to select their behaviour and even more to change their pre-given frame of action, then and only then does it make sense to use the vocabulary of agency and interaction in the world of objects.

3. Types of Inter-Agency: From instrumentality to interactivity

What makes it happen that a move, a behaviour or any other activity is recognised as a significant gesture or a meaningful action? How do we know whether a winking eye is only a body reflex or an intended signal to be willing to flirt? How do we know whether a flashing sign on our screen of our PC is a mechanical mistake, a routine recommendation to continue writing at this point or the triggered sign of an unexpected spy software? If one follows the social theory of pragmatism, the answer would be: One has to observe the sequence of three acts and relate them with one another as a circle of interaction. It is only at the end of this threefold interaction process that one can attribute the label causal effect, instinctive behaviour or meaningful action to the initial move.

Act 1: Winking eye >>> *Act 2: Winking back* >>> *Act 3: Winking and laughing*
Act 1: Winking eye >>> *Act 2: Winking back* >>> *Act 3: Looking away*
Act 1: Winking eye >>> *Act 2: Looking away ashamed* >>> *Act 3: Also looking away*

These three sequences demonstrate that the meaning of the winkling eye in act 1 can only be ascertained after the next two acts: In the first line, the additional laughing completes the interaction circle and makes the first winking into a significant part of a social interaction called flirting. Act 3 in the second line constitutes the same meaning, but a different attitude to it, namely not being interested in flirting. The two consecutive acts of looking away in the third line seem to constitute a different meaning to the winking eye in act 1: It is an illness of nerves for which one does not want to stigmatise the person. What is important to note in the context of our argumentation, which is the central message of pragmatical interactionism is the following: The interactions observed and practised between the units of agency are what make critical differences and constitute the relevant meanings, not the individual act.

This approach is usually applied to interpersonal interactions between human actors only, as in the case above. However, one can find some hints in the literature that the approach can also be transferred to relations between people and objects.[9] For systematical reasons and for our particular purpose, three types of inter-agency should then be distinguished:

- *Interaction* between human actors,
- *Intra-activity* between technical agents, and
- *Interactivity* between people and objects.

Interpersonal interaction constitutes the social world of 'inter-subjectivity'. It is populated by human actors, expectancies and communications; it is structured by institutions, social systems and cultural meanings; it is the classical subject of the social sciences. Technical objects are principally excluded from this sphere of pure sociality; they figure either as neutral means for purposeful action, or as irritating objects from outside the society, or alternatively they are interpreted as mere carriers of meanings.

Intra-activity is quite an unusual term: In analogy to the relations between people it can be confined to the relations between objects, especially between technical agents. It constitutes the material world of 'inter-objectivity'.[10] In so far as the objects show low levels of agency – according to our scale – and in so far as they are strongly coupled in linear, sequential or otherwise aggregated ways, one does not need to open the black box to study the internal operations. If, however, they display higher levels of agency and show more loosely coupled relations between the units, as in the cases of complex and high-risk systems or in cases of distributed and multi-agent systems, one should also follow the activities of the objects and describe their intra-activities. Otherwise one could not understand the differences which come up when people get into use relations with these kinds of technical systems. For it makes a difference whether people encounter an encapsulated system or a cooperating ensemble of agents, a hierarchical fixed order or an open network with case-based learning.

Interactivity is the term that is reserved for the cross-relations between people and objects. It belongs to the hybrid world of "interfaces", "human-computer interaction" and "socio-technical systems". This boundary territory is widely occupied by the engineering sciences and their techno-morph approaches, such as the ergonomic models of the user as a body machine and a sensory mechanism, or the psychological models of "human factors" and "adaptive organism". It seems that the social sciences have given up this

9 McCarthy 1984

10 Latour 1996; Rammert 1998

terrain at the limits of the social sphere, supposedly because they fear the contagious contact with "objectuality"[11] and "materiality"[12]. Exceptions from this theoretical withdrawal can typically be discovered in the cultural media and science and technology studies. Bruno Latour has developed the most ambitious approach to re-present the things in the polity and to "re-assemble the social", including human and nonhumans.[13] In my view, his actor-network methodology succeeds very well in bringing the "missing masses"[14] into the collective play, but the semiotics of actants[15] cultivates a certain blindness towards observable actions and interactions and underrates processes of sense-making. Basing social theory in pragmatism may perhaps help to overcome such weaknesses.[16]

Pragmatism's social theory of interaction has been shown to be fruitful in explaining the production of social meaning by interpersonal interactions. This approach can also be used to analyse the relations of interactivity between people and physical objects. Georg Herbert Mead is famous for his comparative interaction analysis of two dogs fighting with one another and of two men boxing and faking against one another.[17] He has developed a not so well-known, but remarkable piece of theory about human interaction with physical objects: Children start to draw distinctions between different kinds of objects (own body, outside objects, moving, and living objects), after they have learnt the interpersonal role-model of social interaction.[18] They analyse the activities and attributes of physical objects by taking over the role of them, as they have learned it by playing mother's or sister's role. Being heavy, flexible, moving, having an outer surface and an inner kernel, making noises and behaving in an unanticipated way, all these features of objects are experienced in children's play with stationary, mobile and interactive objects. Socialisation encompasses both processes: the interpersonal interaction between people, but also the interactivity with physical and symbolic objects.

This integrated view on inter-agency has implications for our own enterprise here, namely the inquiry into the changing character of advanced technologies and its consequences for human–technology relations. As long as technologies, such as simple tools and machines, can be characterised as passive or semi-active means, they are used in an instrumental mode: People

11 Knorr Cetina 1998

12 Pickering 1995

13 Latour 1994; Latour 2005

14 Latour 1992

15 Akrich/Latour 1992

16 Rammert 2007

17 Mead 1963

18 Joas 1989; Mead 1932

take and handle them to attain their goals at work or in other everyday life situations. The effective action of a tool or a machine is incorporated in its design, like the hammer's long shaft and heavy weight at the end or the engine's encapsulated explosion and the spark generated by the turn of the key. Therefore, the user can integrate these objects as mere instruments into his action. One can immediately begin using this kind of technology, and one can rely on the fixed function and the repetitious operations. One neither has to choose options out of a menu of options, nor is one involved in a dialogue with the machine. The only resistance or unexpected re-action of the technology would appear if the machine is out of order or the user is completely incompetent. When sociologists speak of "instrumental action", then they refer to this kind of *unmediated instrumental relation* between a man or a woman and a machine or a tool.

Gadgets and machines with higher complexity must be instructed before they start their efficient and useful activities. Simple versions of instruction can be already found on the classical tool machines: The craftsman instructed the machine by turning wheels and tuning measurement instruments. What started as a slow specialisation of instructing machines by Jacquard cards, paper stripes or record play-back was revolutionised by the invention of computer control and software programming from the 1940s onwards. The instruction of the machines' activities became a separate domain. In the long run, the devices were miniaturised and integrated into nearly every machine and gadget. They were turned into programmable machines, interactive media or smart objects. The instrumental use was changed: It was the beginning of an *instructive-communicative relation* between people and objects.

The rise of a third kind of relation can be observed when the machine asks back: Can I help you? Do you really want to delete the document? Please, tell me what makes you so sad? What looks like a dialogue between a woman at the reception and a guest, an assistant and his boss or a doctor and a client was the beginning of a new kind of relation between people talking to the machine on the one hand, and software programs that took over the roles of communicators, coordinators and agents of all kinds on the other hand. Weizenbaum's ELIZA program showed only marginal changes on the program's side.[19] The program's reaction was restricted to take up some key words of the client's answer and to integrate them in a set of pre-given question sentences. Nowadays, the software agent technology has developed a much wider range of capacities to show higher levels of agency. The agents can deviate from the standard expectations. They can choose an activity out of a bundle of activities. They can assimilate their behaviour to the personal user. They can normalise their behaviour by drawing from statistics, and

19 Weizenbaum 1977

they can change their behaviour by case-based reasoning. These features of agency force the user to conceive the relation as if an intelligent agent or partner were acting on the other side. Under these conditions of contingency and interagency, *interactive-communicative relations* are emerging.

Human–technology relations change when technologies are turned into more active agents and agencies. The instrumental relation that is typical for using tools in craft work and using machines like a tool is fading or only stage-managed as an illusion. The push on the button, the foot on the brake, and the click with the mouse trigger the activities between several agencies that more or less guide the machine, delegate the information-finding to Google's search algorithms, or confront the user with unexpected offerings and assistance because the profiling programs have made the user into an object. The user of this type of advanced technologies is neither the master of the machine nor the slave of the technological system, neither the sovereign of his action nor the victim of media's manipulation. A different concept is needed to decide the question of mastery or manipulation, case by case. The wider concept of inter-agency replaces the narrow one of instrumental use and of the perversion of means and goals. The more precisely both activities, the agency of objects and the inter-agency between objects, can be observed, the more the human–technology relation shows features of complex and contingent interactivity. Then the instrumental relation is only one particular case of an interrelationship. Relations of instructive and communicative interactivity are the other cases. They will dominate in the future, because nearly all kinds of technical objects will be equipped with programmed agency and will be made able to communicate with their environment.[20]

4. A gradual model of agency: Analysing humans, machines, and programs in action

The level of human agency is not necessarily always higher than the agency of machines and programs. Now we will bring together the two lines of argumentation that have been presented before separately. When people are in action, their level of agency is not always the highest possible one. They may act routinely, like handing over five 100 Euro notes at the bank counter. Or they may even do something without any intention, because they follow a hidden curriculum of a repressed desire. Reflexive action takes place when problems arise or irritations emerge in the course of action. Then people can switch from subconscious or routine action over to the next higher level of agency, searching for alternative courses of action or reflecting on the moral meaning. If one were to count the activities of people, only five percent could

20 Adelmann/Floerkemeier/Langheinrich 2006

be classified as actions with reflected intentions. The rest follow practical reasons that could be mostly explained if asked for, or they follow everyday routines that often lack even practical reasons.[21]

When machines and programs are in action, their level of agency can be higher than usually perceived. Cash machines hand over the money like the human actor, at the same time examining the client's identity and credit line, varying the number of notes, signaling misuse, and stopping its activities. Even more, video surveillance cameras can be combined with pattern recognition software, interactive data-banks, and programs that process and mail notices of payment dues. They execute and coordinate actions a lot of police men on the street and employees in the offices would be needed for. Very simple dispositions are inscribed in this really existing London City law enforcement system. One can imagine multi-agent-systems to assist space flights or financial brokering whose software agents are equipped with even higher ranges of belief, desire and intention capacities in order to learn from reactions of other agents and from changing environments.

When the fundamental duality is to be be overcome of giving all of the action to the people and no parts of the action to the objects, then a concept of agency is required which also works with lower qualifications of the case of what an action is, on the one side. At the other side, it has to be more sophisticated about the question of what kind of action do we observe. Thus a gradual, three-level model of agency was developed, thereby referring to and distancing oneself from Giddens' three-level model of action and Latour's flattened concept of agency.[22] Giddens distinguishes three levels of an action: a first one where a difference of state is produced, a second one where a difference of options is possible, and a third one where actors can give an explanation for their action if asked.[23] We do not understand these levels as a necessary condition of action, but we interpret them as different levels of agency. We call these three levels "causality", "contingency", and "intentionality". Latour, however, pleads for a methodological and ontological symmetry and reduces all action to his flattened concept of agency.[24] We share his anti-dualistic methodology, but we insist on levels and degrees of agency.

On the first level of *causality*, we start with a weak term of action. Agency of this kind means an efficient behaviour, a behaviour that exerts influence or has effects, as in the Latin term "agere" or in Latour's term "actant" or Callon's term "translation"[25]. Under the performative aspect on this level, it doesn't make any difference whether humans, machines or programs execute

21 Kaufmann 2008

22 Rammert/Schulz-Schaeffer 2002

23 Giddens 1984

24 Latour 1988; Latour 2005

25 Callon 1986

the action. The money is handed over either by cash machines or by bank employees. The situation changes when greater irritations and more options come into play.

On the second level of *contingency*, the criterion of contingent action is required, which means the capacity to act in a different way and to choose between options. When the environment changes, the routine action program has to be changed and adapted to it, by people as well as by programs. Another possibility arises, when one's own action program is changed in such a way that its consequences are not immediately transparent and accountable for the others. When technologies reach this level of contingency, they cannot be used as immediate instruments any longer, and do not follow the paradigm of command and execution, as has been demonstrated in the previous chapter. Instrumentality is replaced by relations of interactivity. Dialogical inter-faces and internal user-modeling increase the action level. Interactive videogames create spaces of high virtual contingency[26] that simulate human user's action. These technologies function like a Turing test:[27] they make it nearly impossible to discriminate between human-enacted and computer-enacted characters in the play.

On the third level of *intentionality*, the species of reflexive and intentional action is allocated. As long as intentionality is by definition ascribed to conscious and knowledgeable human actors only, this level is the domain of meaningful action that is oriented to the supposed meaningful action of other actors. Chessplaying programs cannot literally have the intention to win a game, but they can be constructed as if they had an intentional structure – the philosopher Dennett calls this "from an intentional stance"[28]. Software agents cannot cooperate with others in a bodily manner and trust them under the explicit belief of augmenting their chances to reach a common goal. However, they can be equipped with an intentional vocabulary by which they really coordinate and communicate their activities as human actors do, with similar semantics. On this level, we plead against a substantial definition of action that excludes inquiries into agency. Instead we follow pragmatism, which means following all kinds of agencies and focussing on the observable practices in which cases the vocabulary of intentionality is used for the control or interpretation of activities of people as well as of technical objects.[29]

26 Esposito 1995
27 Turing 1950
28 Dennett 1987
29 Rammert/Schulz-Schaeffer 2002; Schulz-Schaeffer 2007

LEVELS	low >>> DEGREES >>> high
III.	>>> up to guidance by complex semantics
Intentionality:	>>> from ascription of simple dispositions
II.	>>> up to self-generation of actions
Contingency:	>>> from selection of pre-selected options
I.	>>> up to permanent re-structuring of action
Causality:	>>> from short-time irritation

Fig. 3. Levels and grades of agency [30]

This gradual and multi-level model of agency gives us the possibility to escape the dilemma of having to either reserve agency up to the humans or to flatten the concept of agency unnecessarily. Neither are we forced to claim that the activities of humans, machines and programs are substantially the same kind of behaviour. Nor do we have to stick to the conception that human action and technical operation are fundamentally different from one another. This gradual concept of agency opens up a wide range of possibilities to identify and to classify kinds and intensities of agency without regards to the substantial character of the unit that is in action. Thus the question of where the action is can be transformed into an empirical question.

5. Distributed agency: The very idea

The question of where the action is cannot be answered unless the answer to a second question has been clearly decided: What is the adequate unit of action? Conventionally, we suppose a single human actor to be the adequate unit of action: the philosopher who thinks and ergo knows that he exists, the employee who hands over the bank notes, the pilot who flies two hundred tourists to Tenerife airport, and so on. But let us look more precisely at the streams of actions from which an action arises. It arises as a distinct action, because it is sectioned off, retrospectively emphasised, and ascribed to a single unit, an actor or an author.

We would have never heard of Descartes' thought act if he had not written down his famous sentence with a pencil on paper. Even more, the working actions of dozens of printers were needed to distribute the phrase in hard-covered editions. Additionally, the teaching of hundreds of philosophy professors was necessary to diffuse the message under many thousands of

30 Rammert/Schulz-Schaeffer 2002

students. Perhaps this thought act never took place as a single action at one place. Descartes was connected with a lot of thinkers whose arguments he received and whose papers he read. Perhaps the foundational thought act that is ascribed to him could have been discovered at many loci in that time, as if it would be very much "in the air".[31] The act of writing interrupts this continuous chain of acts and turns it into the unique philosophical thought action that changed the world or at least the world view. The act of writing the sentence down by one single actor is emphasised, but both, the flux of thought acts before and the sequences of actions afterwards, such as printing, distributing, reading, teaching and learning, were put into brackets and neglected. It is an efficient strategy of teaching and tradition-building to attribute a thought act to one author because it reduces cognitive and social complexity. However, if we are doing research and inquire into the places, faces and activities where the action really is, we should follow all possible actors and agencies to the many loci of agency.[32]

5.1 Distributed agency I: From a single actor to many loci of agency

A thought experiment will be used to introduce the second part of the paper: Let us answer precisely the question: Who or what is acting in the case of flying the tourists to Tenerife?

PEOPLE	MACHINES	PROGRAMS
Pilot?	Jet engine?	Auto-pilot software?
Co-pilot?	Elevator, Rudder?	Navigation card and system?
Radio operator?	Radio equipment?	Radio signals and codes?
Flight-controller?	Radar unit?	Radar screening?
Tourist office?	Booking machine?	Reservation software?
Airline company?	Aviation technology?	Technological R&D plans?
Aviation industry?	Air traffic system?	Roadmaps for infrastructure?

Fig. 4. List of actors and agencies in the flight case

31 Merton 1957

32 Latour 1987; Rammert/Schubert 2006; Schubert 2007

Humanists and social scientists focus on the people's side in the list. Their first and most plausible answer will be that the human pilot is the acting unit that flies the tourists to Tenerife. He is conscious of the goal, the methods and instruments. He reflects on possible interventions into the path of the aircraft and deviations. Finally, he can be made responsible for the flight because he has the power of command and control. But a first uncertainty appears when one is confronted with the question: Doesn't the captain have at least one radio-operator at his side? We know from some cases of accidents that the communicative actions between pilot and co-pilot or between pilot and flight-controller have been critical for the flight action: the consequence can entail escaping a collision or not. So we learn that agency can be divided between several human actors. The acting unit, then, is either the team on board or the locally dispersed assembly of people on board and at several control centres on earth. A further question raises other doubts about the single heroic actor: Does the captain or this group of navigators and controller really plan the flight action? No, it was the air line which planned the route, the time and the final departure. It needs more than 200 paying passengers so that the action can take place. In comparison to this powerful principal agent the other actors fall back in the role of executing agents. The company is the so-called collective actor which plans, decides, and controls the flight action to Tenerife. In sum, four different units of action can be distinguished on the people's side: a single human actor, a social group or team, a dispersed association of people being in interaction by a division of work, and a collective actor that coordinates activities towards a goal. Certainly, human agency is multiplied, divided, distributed, and connected.

Encouraged by our gradual concept of agency, one may dare to insist on a more precise answer to the question of what actors and other agencies contribute to the flight action. Engineers and scientists probably would emphasise the role of machines and programs. Their first and most plausible answer would be: No pilot and no flight without up-currents or artificial drivers, like propellers or jet propulsion! Elevators and rudders give the air plane the direction, and the radio and radar equipment enables the plane to find its position and to correct its route. As we have discussed earlier, the agency on this low level of causality doesn't really add new explanatory power. But the situation changes completely when these machine technologies and communication media are in close intra-activity with the agencies that are enlisted on the programs' side. For the most time of the flight, the flight action and the many sub-actions are delegated to the auto-pilot. This is a combination of many different software programs that are continually measuring, monitoring, and computing, but also actively correcting the height, tempo and direction of the flight. The automatic landing system sometimes even restricts the human pilot from intervening into the action. In sum, the unit of technical agency is constantly changing and growing towards a highly combinatory and relatively autonomous technological system. It starts with wings and rudders. It develops into an aggregated technological system integrating many sub-units such as propulsion, navigation, and communication systems. A qualitative shift in the level of agency is achieved at the end, when advanced computer programs take over the planning, control and navigation activities, especially their intelligent coordination, and even more when the flying plane itself is turned into one agent in a more extended and self-regulating air traffic system.

In the end, we see that it is not so easy to define a human and, in particular, a social action. Philosophical and sociological textbooks may help to think about the criteria. The authors usually start with a concept of action that is isolated from the stream of other actions and that is idealised in a certain way. The "ego" is the unit that creates changes, and chooses and defines the situation, like God the creator. One can call this concept of action "agency ex nihilo" and contrast it with an alternative one, "agency in medias res"[33], that reconstructs action out of the many activities before and around the focused action. Flying 200 tourists to Tenerife is not the instrumental action of a pilot navigating the plane to Tenerife airport. It is one activity that is combined with other activities of controlling and communication. It is additionally integrated in the commercial activities of an airline company. Finally, it is also nested in the activities of a highly complex organised system within air traffic, the aviation sector and the tourist industry. Looking at the activities from this perspective, one discovers many loci of agency instead of one single actor. One can reconstruct the flight action as the commercial action of a collective actor or even a network of organisations[34] which hire people, invest in new planes, lobby for public support, advertise cheap charter flights, and organise the flight route.

Looking at the technical side of the list, the talk of gadgets and machines as simple means of action underrates both the complexity of aggregated technical systems and the self-activeness of programmed and nested systems. The collection of many devices and the compilation of different types of technologies cannot be handled like bigger tool-boxes with an increasing number of instruments in it. These interrelated parts build highly complex systems, with many planned intra-activities and some unforeseen interferences,[35] so that they lose the clear transparency of an instrument and require strategies of interactivity for their control. The combination of nearly all parts with computing and communication capacities converts them into pro-active

33 Fuller 1994

34 Teubner 2003

35 Perrow 1986

agents that often are connected in relatively autonomous systems on a higher level, like the automatic landing system or the internet-based reservation and booking system. As the advanced technologies mostly simulate human actions, the different tasks, roles and competencies and actually also the social mechanisms of coordination, it makes sense to describe these activities and intra-activities with the vocabulary of action and inter-agency. It is the adequate way to discover the many loci of technological agency.

5.2 Distributed agency II: From homogeneous agency to hybrid constellations

In the predominant dualist tradition of thought, the social and cultural world of human action, and the material and artificial world of technological operation are separated from one another. On the one hand, social scientists focus on the motives and expectations of people, such as pilots and flight ticket sellers, and on the kinds of social organisation. They reconstruct a homogeneous world of symbolic interaction and communication purified of physical objects. On the other hand, engineering scientists are preoccupied with questions of setting something going, such as air planes or software programs, and of improving the effectiveness or safety of technological configurations. They construct a homogenous world of forced movements and functioning technological systems purified from social interests and human users. Facing the growing interrelatedness of problems of nature and of society, such as man-made climate change or artificial stem cell growing, and facing the co-construction of socio-technical systems made of people, machines and programs, one may, however, ask whether a non-dualist conceptual approach could help to make these hybrid constellations a sound subject of research.

At the borders between the two academic cultures, we already observe regular border traffic and even conceptual bridge-building. From research in technology and organisations, approaches are being pushed forward that respond to the strong interdependency between the material and the social, such as the Tavistock approach of socio-technical systems,[36] the concept of large technical systems consisting of people, organisations, material and symbolic artifacts,[37] and comparative analysis of high risk systems screening them along aspects of complexity and interaction between human and non-human elements.[38] The most influential approaches took research in science and technology as their point of departure. Some researchers of this area

36 Trist 1981

37 Hughes 1987; Mayntz/Schneider 1988

38 Perrow 1984

argue against bridging and proposed a radical change of perspective,[39] such as particularly the adherents of the ANT approach, but also of the concepts of "objectuality"[40], "socio-technical agency"[41], and of "material agency"[42]. Research in media and culture is actually a growing third branch where hybrid constellations are the new subjects, like being a "cyborg", "technoscience" or living in "virtual life".[43] Bridge-building and trans-disciplinary concept-development can be also observed at the science side of the border. Particularly the engineering sciences cross the border and take up concepts of the humanities and the social sciences. Interface designers integrate psychological concepts of cognition and sociological concepts of routine-building and role specialisation. Designers of software agents apply philosophical concepts of mind, belief and intention. And the architectural designers of multi-agent systems use sociological concepts of trust, contractual, and market relations.

From the dualist point of view it makes sense to keep the two territories separated. A lot of arguments can be mobilised for this decision, such as the ontological differences between people and machines,[44] the epistemological differences between the disciplines, the institutional differences between social organisations and technical configurations and so on. But these differences lose their relevance under certain conditions: When human actions, machine operations and programmed activities are so closely knit together that they form a "seamless web"[45], then it makes sense to analyse this hybrid constellation as a heterogeneous network of activities and interactivities. When a human action such as flying an Airbus or searching for a certain piece of information in hundreds of libraries, millions of books, and trillions of files can only be executed with the assistance and intervention of hundreds of other agencies, then it is urgent to develop a concept of agency that acknowledges all these agencies, though they are heterogeneous in substance. And finally, when programmed machine operation is developed such that it should execute delegated actions under conditions of contingency, and when it is implemented in open systems that are constructed by the interactions between the software agents, then one should integrate these agencies into the framework of analysis. Therefore a concept of distributed agency is argued for here only under these conditions of advanced technologies and instituted hybrid constellations.

39 Callon/Latour 1992; Collins/Yearley 1992

40 Knorr Cetina 1998

41 Girard/Stark 2007; Preda 2006

42 Pickering 1993

43 Haraway 1991; Haraway 1997; Ihde/Seliger 2003; Turkle 1995

44 Collins/Kusch 1998

45 Hughes 1986

Coming back to our flight action example, the answer to the question of what the adequate unit of action is can now be given: It is the hybrid constellation of people, machines, and programs. It is the mode in which the agencies of the heterogeneous instances are distributed and connected with one another and the level of agency that is given to them in certain situations. It is neither the single or the collective human actor, nor the technical artifact alone, nor the combined technical system. It is the mixed ensemble made of all elements on both sides of the border. One can call it a *collective agency*, alluding to the term “collective actor”. This collective is constituted by the distributed activities of heterogeneous units in comparison to what is referred to by the other term, which is built out of the homogeneous stuff of human actions.

5.3 Distributed Agency III: From hierarchy to framed interactivity

Two modes can be distinguished in which actions can be divided and integrated: a hierarchical mode in which specialised activities are strongly integrated, and an interactive mode in which distributed modal units are weakly coupled. In the sociology of organising, they are often referred to when distinctions are made between bureaucratic and organic models or between strongly or weakly coupled systems.[46] Observing complex organisations, one learns very quickly that hierarchical integration is only the most effective mode for divisions with fixed inputs, routine processing and stable environment, like the mass-production of things. Units that are confronted with changing inputs, many variations in the process and dynamic environments require a more interactive, flexible and open mode of organising, like R&D departments or creative industries. Most of the modern organisations show a mix of both modes of integration, mechanising the routine parts and learning by interactivity with the environment.

It was taken for granted up to now that the hierarchical mode was the only and the best way to specialise and integrate technologies. It was the paradigm for the first machine made of the forced movements of people working based upon a division of labour to build the pyramids, and also for the ongoing process we call mechanisation.[47] Technologies are defined by their capacity to force different activities into a mechanical form that is reliable, accountable and usable as a mean to solve particular problems in an effective and expected way.[48] Tasks are divided between many specialised parts

46 Perrow 1986; Weick 1976

47 Giedion 1948

48 Rammert 2001

and integrated by linear chains of operations and hierarchical schemes of processing. However, this dominant mode and its supposed universality are now being challenged. Some technical configurations and socio-technical constellations can be observed that are integrated in a different mode that resembles the above mentioned interactive mode.

One can already observe small deviations from the strong mechanical mode when looking at the feed-back loops of cybernetic systems. The sandwich architecture of the computer also shows a loosening of point-to-point determination between its physical machine level and the logical level and the program language level.[49] A further milestone on the path of breaking the linearity was the concept of *"distributed computing"*[50]. It started with the simple problem of distributing computing time, but gained its momentum when a new generation of software programs were developed that used fuzzy logic, distributed artificial intelligence, agent-oriented programming, and models of socionics in order to admit distributed activities and parallel processes. Particularly in social computing[51] and in socionics[52], many modes of interactive integration were developed that were in opposition to the hierarchical mode.

Another milestone was the development of the concept of *"distributed cognition"*[53]. The psychologist Hutchins criticises the dominant model of individual problem-solving in the cognitive sciences that supplies the artificial intelligence community with a construction plan. It presupposes separated and functional specialised activities that can be easily aggregated. Also being an ethnographer, Hutchins observed the techniques of navigation "in the wild" and "in medias res": He studied precisely how the Polynesian long-distance sailors performed navigation in the wide Pacific ocean though they had no sophisticated nautical instruments, and how a navigation team on a warship maneuvered their long ship into the small harbor entrance of San Diego though its nautical system was damaged. In this way he discovered a mode of self-organised integration between distributed processes of cognitive activities. The cognitive action of positioning was organised as a distributed process that was performed by some people with different practices, natural objects and technical instruments. The critical point for our argumentation here is his observation that these distributed processes did not require any planning, functional specialisation or hierarchical integration. Their mode of integration was described as a natural process of loose coupling, overlapping

49 Winograd/Flores 1986

50 Rumelhart/McClelland 1986

51 Hewitt 1977; Star 1989

52 Malsch 2001; Meister et al. 2007; Rammert 1998

53 Hutchins 1996

activities, experimental adaptation, and a step-by-step stabilisation of a common frame for the interactions.[54]

The concept of *"distributed agency"* that is presented in this paper follows the lines that were started by those concepts of "distributed computing" and "distributed cognition". The first step towards constructing this concept of distributed agency has been to demonstrate that human action is distributed between many loci and instances that plan, control, and execute the activities. Distributed action means that someone searches for significant marks, someone else measures the angles, a third person plots by drawing a line, and others count, communicate and correct the data. All these interactions between them constitute an observable unit of action called navigation. This kind of distribution can also be transferred to computer operations. The action of sending a message to a certain person can be broken down into many activities at different places, such as encoding, packaging, addressing, transporting, and reading TCP/IP protocols at the PC, at the server, at the local area network, or at one of the knots of the worldwide web.

The second step has been to cross the Rubicon between the two homogenous spheres of human action and technological operation: distributed agency then refers to hybrid constellations made of heterogeneous units of agency. Moving objects such as the sun and the currents of water, measuring instruments, counting tables, and carved records participated in the action of navigation. As we have argued before, objects participate more actively and on a higher level of agency when the nautical pilot program and the automatic navigation system are in action and in close intra-activity with one another.

The third step now emphasises the two modes of integration. They differ in how the units are divided, how they are processed, and how they are connected with one another. The dominant hierarchical mode of integration prolongs the traditional line that allows us to treat even complex technologies and hybrid constellations as reliable means and robust mechanisms. The mode of framed interactivity is rarely implemented because it deviates from the well-known and trusted master-slave relation. The technological units are given more freedom of choice and higher levels of agency in order to enrich their capacity of assistance and to strengthen their role as relatively autonomous agents.

54 Hutchins 1998

MODES:	HIERARCHY	FRAMED INTERACTIVITY
Type of Differentiation	Division of work Functional specialisation	Distributed activities Fragmented units
Type of Organisation	Mechanical Bureaucratic	Organic Open System
Type of Connection	Linear sequences Strongly coupled Fixed and general rules Pre-Programmed	Parallel processes Loosely coupled Flexible, situated, and specific rules Framed Self-adaptation

Fig. 5. Two modes of integration

Though the mode of framed interactivity has rarely been implemented up to now, this mode may become a new paradigm for the design of future constellations. It is currently sought after in many different places: in laboratories of distributed intelligence, in research and development clusters on robotics, man-machine interfaces and new media design, as well as in the studios of interactive artists, in the media labs of the entertainment industry, and at the software benches of videogame developers. This mode of framed interactivity will get its chance to be diffused when the next generation of technologies is consciously designed and implemented from the perspective of distributed agency, when the frames of heterogeneous agencies are balanced and tuned to each other, and when a new generation of users is coming up that is used to the new experiences with interactivity.

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