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Intractable Mobiles. Patents and Algorithms between Discovery and Invention

1 Separation of concerns

It is an open secret that the scientific justification of a novel finding typically does not correspond well with the path that led to it. It remains difficult to integrate systematic and historical truths. Wherever the conditions of a science are brought into focus, whether in the form of its social, technological or cognitive situation, its subject matter comes into question at the very same instant. As science studies have long been able to exemplify, the gap between intervention and observation is a site for ever-new negotiation of distinctions between nature and artefact. The agency of mediators, such as boundary objects or epistemic things,[1] may be thought to embody precisely this ambiguity.

It is therefore necessary to situate a theory of such mediators, which might be called a 'media theory of science', from the outset within an indistinction between that which is found and that which is constructed. This distinction may appear anywhere within the space of mediation. Renaissance astronomy, for instance, when confronted with the phenomenon of sunspots, gave rise to conflicting views – did these effects result from the impurity of the telescope, or from the impurity of the sun (Biagioli 2006a)? The impurity drifts amidst different agencies – natural, technical, cognitive. There are other cases where it is not so much impurity that disturbs, but rather purity, as in the "uncanny usefulness of mathematical concepts", which gives rise to the impression that "it is not at all natural that 'laws of nature' exist, much less that man is able to discover them" (Wigner 1960). It seems that a lack of resistance may bring about doubt just as easily as an irrupting error. Perhaps it is the nagging feeling that something important has been left out; at any rate, it is disturbing not to

1 Star and Griesemer (1989) introduced the notion of boundary objects as things that allow for multiple interpretations simultaneously; in a sense they result in the stabilisation of multiple objectivities. Epistemic things (Rheinberger 1997b), by contrast, could be considered as their temporal equivalents in that they are the known unknowns, entangled within experimental systems, allowing for a transition of knowledge.

know whether to attribute the seamlessness to technical perfection or to natural law.

It has been emphasised that there is no clear line dividing pure and applied sciences (Bowker 1994; Carrier 2006); purification has come into view as perpetual labour; yet one of the most obvious developments in recent decades has been the integration of formal algorithmic methods into scientific practice at all levels. Computation has replaced many instruments and has more than ever enmeshed scientists' practice with the domain of mathematics. Instead of assuming that algorithms remain a strictly separate apparatus, indifferent to ontology, we should now perhaps rather expect distinctions between intervention and observation within them. Like sunspots, the notion of algorithms may shift; purity and impurity may surprisingly swap places and give rise to controversy. As Antoine Hennion concludes,

> [t]he problem is not to deny the theoretician the right to theory, but to concede it also to other actors. The great epistemological ruptures between the theoretical concept of the observer and the raw categories of the reality observed are repeated in a scarcely mediated separation between the causes of the theoretician and those of the actors.[2]

If we wish to grant the right to theories also to the reality observed, it should be worth revisiting some moments of entanglement and indistinction between theory and practice. One such site appears, surprisingly for me at first, within the interstice of algorithms and patent law.

1.1 Patenting

The present chapter considers algorithms from the perspective of a disagreement over the question: "Are algorithms patentable?" Patent disputes are instructive for the history of science because they reflect the relation between different ways of finding the same result, between openness and secrecy, between historical development and natural law.[3] As far as patents are con-

2 "Le problème n'est pas d'ôter au théoricien le droit à la théorie, mais de l'accorder aussi aux acteurs. Les grandes fractures épistémologiques entre le concept théorique de l'observateur et les categories brutes de la réalité observée répetènt une division bien peu médiée, entre les causes du théoricien et celles des acteurs" (Hennion 2007: 65).

3 Seymour Chapin argues that, despite their unimportance, patent interferences make up an interesting topic for research in the history of technology (Chapin 1971: 446). "As with many 'anticipations' in the realm of science, these patents are

cerned, the separation between invention and discovery is particularly essential, simply because natural laws or basic principles are commonly held to be unpatentable.

Before we focus on the patentability of algorithms, let us consider patent law in relation to our basic issue at hand. As we shall see in the course of this investigation, the notion of a patent is by no means trivial, especially when it comes down to specific disputes. Since in many cases – such as precedence cases – law refers to its own history, this history is controversial in itself.[4] In the Anglo-American system especially, jurisdiction is obliged constantly to integrate statutory law (which can be thought as declarative) and case law (which can be thought of as accumulating over time). Also, historically the notion of a patent has not always been so clearly connected with technical novelty as it is now. Because the difference is particularly clear in the British case, we shall follow the shift in the term 'invention' within the history of British patent law, before going on to ask more specific questions about patentability, this time with a focus on U.S. jurisdiction.

In British law, patents originally represented the transfer of royal privileges to their bearer; they were 'open letters' (*litterae patentes*) (McMullin 1985), unsealed and to be examined by any subject, conferring territorial trading privileges, much like a passport or a 'green card'. In this sense, they are a kind of prototypical *immutable mobile* – standardised media that function as guarantee of transfer and translation between a centre and its periphery (Latour 1986). Apart from some exceptions, patents began to be widely used as manufacturing monopolies only from the sixteenth century on. In his historical overview, Mossoff (2001) argues for an intimate connection between the natural rights revolution in English law and the shift of patents from being royal grants to legal contracts between inventors and society. I think it is by no means irrelevant that the initial use of the term 'invention' was not meant, as the later understanding suggests, as "action or operation of finding out something new;

interesting. They are not, however, very important, since, as Giorgio de Santillana so aptly put it, it is the 'assumption of responsibility' which makes for revolutions, intellectual as well as political. It is, therefore, the action upon concepts rather than the concepts themselves in which the historian of technology should interest himself. The patent interference is rather good evidence that such action is being taken. It provides, to employ a scientific simile, an inferometer with which one can at least indicate, if not measure, the cresting of a technological wave" (Chapin 1971: 445). For a discussion of the role of the patent office in inspiring scientific development, see for instance Galison (2004).

4 Geoffrey Bowker (1992: 54) draws an analogy between "the process of defending a patent in the courtroom and that of defending a position within the discipline of history."

the contrivance of that which did not before exist" (Webster 1830). To *invent* rather meant to import something into the kingdom to establish a new industry (Mossoff 2001: 1264). Understood in this sense, to invent is essentially to borrow from 'someone else'.

According to Mosoff, the first hints of the concept of innovation in this context appeared in certain defeats of patent applications on the grounds that the petitioners themselves had not introduced the technique in question – that is, the petitioners were not the rightful bearers of the privilege because their novelty was already in use. Thus, in the course of negotiation of conflicts over privilege, the concept of innovation shifted from association with geographical movement to association with individual origination. Two Baroque-era patents are notable here: a patent for bleaching and curling hair was challenged in 1673, and one for "the manufacture of imitation marble" in 1689 (Mossoff 2001: 1280).[5] The conflict between natural law and social privilege became relevant around the same time, not in the context of 'invention' but in that of 'translation' from and to colonised territory – notably in the case of the trade monopoly of the East India Company. A central argument that Mossoff makes is that in such early cases, patents were for the first time considered by natural rights philosophers such as Grotius and Pufendorf to "violate the natural law and the natural liberty of those subjugated to the monopolist's whims" (Mossoff 2001: 1283).

Influenced by Locke's concept of the social contract, patent law subsequently shifted away from the transfer of royal privileges to the King's subjects and rather concerned the subject's privilege over an innovative achievement, in exchange for its disclosure. Thereafter, the universality of natural laws and that of individual liberty acted together as juridical boundary conditions to what could be owned in the abstract, as a rule, or technique.

Against this background, it is also comprehensible how patent law came to occupy the same intermediate status as technology. The reasons why patent law and technology share such a status are not self-evident, as we will see. While patent protection is mostly defended in modern discourse by the claim of rewarding ingenuity and promoting disclosure,[6] patent law does not apply directly to scientific discovery. Neither does it apply to ideas themselves. Rather, it is generally restricted to cases where natural laws or principles are

5 Ideas of intellectual property and originality, which form the background of this shift, had been around already in the European Renaissance (McMullin 1985: 17-19).

6 "The abolishing of the patent system would most assuredly bring about a revival of the infamous cheatery in the sale of pretended *secrets*" (Dircks 1867: 14). See, for example, Biagioli (2006b: 1131), Chisum (1986: 1010, fn. 180).

made useful by integrating and delegating them to technical or otherwise functional processes or things. By consequence,

> He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end. (Gottschalk v. Benson, 409 U.S. 63, 1972)

Thereby it is not enough to make use of a newly discovered principle or practice. It has to be applied (or 'hardened') in a technical form, which is then patented.[7] How to define technology remains a disputed issue, though. As we will see, in U.S. statutory law, 'technical character' is not even an explicit requirement, only innovation is. This is understandable from the fact that patents confer the right to exclude everybody else from using the patented matter – after all, one could not reasonably stop anyone from making use of a universal principle or natural law. Only a mediator may fall under patent law. However, it is not sufficient to define the patentable as that part of nature that is governed by social means and ends, or as human aspirations mediated by nature. Be it technology or novelty, the decision remains grounded in the dichotomy between *invention* on the one hand, and *discovery* on the other. While an invention, to be patentable, requires natural forces to be involved, it excludes the actual discovery of these forces. By consequence, the separation of the scientific and the social bears directly on legal issues, just as much as law takes part in shaping this distinction.

1.2 Hybridisation

It comes as no surprise that where chemistry and biology are concerned, the line of demarcation between the natural and the social is especially disputed. Where it is possible to isolate subsets of organisms that may be employed for some application, hybrids come to the fore.

Why has the patenting of organisms or their metabolisms been held to be conceivable at all? Of course, living beings have always been made an integral part of all kinds of technology. But no law would grant the inventor of a new yoke a privilege over all oxen. One way to understand such an appropriation is that, at some level, a living being always consists of parts that can be claimed to be 'technical', in the sense that living beings in themselves already delegate

7 "Patentability has traditionally been judged by the nature of the primary instantiation anticipated by the procedure" (Samuelson 1990: 1112).

to processes other than their own. A living being is a collective of organs, of cells and, one may continue, of molecules and atomic particles. It lives across different categories simultaneously: organic, chemical, physical.[8] Not surprisingly, perhaps, it was just this principle that was at work in 1873 when Louis Pasteur received U.S. Patent 141,072, which successfully claimed "[y]east, free from organic germs of disease, as an article of manufacture." Here, it was claimed that the purified ferment was not natural, but rather man-made.[9] The legitimacy of a patent decides whether the claimed property is specific to the organism or to the new arrangement in which it is brought. If the new ensemble is taken as novel (in respect of this property), then its agency can be attributed to the inventor. Otherwise it falls back to the organism. One can also say that Pasteur's ferment, just as it had gained the status of a living organism, had to be immediately recharacterised as a "thing", to lose the status of being a "product of nature" (Madison 2005: 416).[10] Or more generally, only what can be 'enabled', what can be construed as an artefact of construction, may be claimed.

8 The fact that some parts of a living being are always alien to its nature, is a reason for Alain Badiou to use it as an example that the set theoretical axiom of foundation is valid in nature: "There is a certain term (perhaps the cell, in fact) which belongs to the set of living beings, but none of whose elements belong to the set of living beings, because those elements all involve only 'inert' physico-chemical materiality. Of this term, which belongs to the set but none of whose elements belong to it, we can say that it grounds the set [...]" (Badiou 2008: 71).

9 The Pasteur patent decision later served as an argument for patentability of genes, which also occur in nature, but not in purified form. "Like other chemical compounds, DNA molecules are eligible for patents when isolated from their natural state and purified or when synthesized in a laboratory from chemical starting materials. A patent on a gene covers the isolated and purified gene but does not cover the gene as it occurs in nature." (United States Patent and Trademark Office 2001: 1093). In the famous case *Diamond v. Chakrabarty*, 447 U.S. 303 (1980), the court concluded "that the fact that micro-organisms are alive is without legal significance for purposes of the patent law." Drawing the decision to a general conclusion, "anything under the sun that is made by man" (United States Patent and Trademark Office 2001: 1093) is eligible for patenting. Under what conditions would the parliament of things grant a patent to healthy yeast alone, as an article of its own manufacture and ingenuity?

10 It is obvious that the appropriation of organisms and the subsequent establishment of exclusive access implies serious ethical issues. Are plants patentable, because those who used them did not make a certain use of them? The rampant cases of biopiracy flag out an area where ethno-theory is brought into direct conflict with a certain type of observer-theory. This lends itself to an unfortunate projection onto a conflict between 'science' and 'local knowledges.'

For a contemporary theory of science to promote a hybridisation between natural and social means not only accepting the scientific discovery to be a heterogenous collective of agents, but also exposing it to possible restrictions under patent law. But then, the juridical self-limiting of the claimable territory to the fields of technology, invention, or mediation, does not solve anything. Rather, it sets the stage for an intractable problem: in some way, every formalisation or scientific observation can be framed as a process of derivation, be it a measurement or even a mathematical proof. If every extraction of a *part* of nature is an invention, then both scientific observation methods and their results are technical, and do not concern nature at all. Under this condition, everything found is a construction, and the only possible discovery would be nature as a whole (which arguably doesn't exist.)[11]

Evidently, the attempt to recognise fundamental technical aspects of science creates a slippery slope for its metatheoretical analysis. Of course one can hold that juridical practice is necessarily all about negotiation, and that this in no way excludes ontological questions. But the more law relies on constructivist notions, the less it can justify the impartiality and general validity of its decisions (Madison 2005: 417-419). Accordingly, one can find clear restrictions, expansive disputes, and ontological commitments in patent law. Novelty and ontology interdepend.

A closer investigation of tensions within patent legislation should help in understanding this dependency. To begin with, contemporary U.S. and European patent laws differ fundamentally in their design.[12] In regard to what counts as patentable, the much younger European law has followed a subtractive strategy: it tries to bypass the more difficult issues by directly naming exclusions. Article 52 of the European Patent Convention lists: discoveries, scientific theories and mathematical methods, aesthetic creations; schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers; and presentations of information.

Concerning foundational problems, however, the U.S. law system is more revealing – instead of excluding problematic cases, it provides a list of four positive categories: processes, machines, manufactures, and compositions of matter. The definition is remarkably recursive, since processes are, in turn, defined as "including any 'process, art, or method' and any 'new use of a known process, machine, manufacture, composition of matter or material.'"[13]

11 For an elaboration of the theme of nonexistence of nature as a whole, see Badiou (2007).

12 See McJohn (2008) and Khan (2005) for such differences in the historical context.

13 "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain

This infinite regress, pivoting around the concept of "process", is not entirely meaningless. It rather articulates a very inclusive idea of practical principles of productive action – in fact, it was as late as 1952 that the term 'art' was explicated and replaced by the combination of process, art, and method in the U.S. (Chisum 1986: 967, fn. 28). However, the permissiveness of statutory U.S. law created considerable difficulties, and accordingly forced the courts to exclude certain domains very early on. In particular, it was established that one should not be able to:

> patent a newly-discovered 'principle' or 'law of nature' *in the abstract*, but that, on the other hand, one could patent *the application* of such principle to create a new product or method. (Chisum 1986: 967)

I think it is significant that this decision (Le Roy v. Tatham 1852) attempts to establish the patentable as concrete and applied, while separating it from the abstract. Notably, it maintains abstraction to be a predicate of original causation: law cannot conceivably preempt nature. Neither should it preempt thought. "A principle, in the abstract, is a fundamental truth; an original cause; a motive; these cannot be patented, as no one can claim in either of them an exclusive right." In other words, the abovementioned historical boundary conditions of patent law – natural law and natural right – are now brought in correspondence with an abstract domain.

Over time, the rise of computer technology in the 20th century became a major obstacle to ontological clarity in U.S. patent law.[14] In certain respects, the concept of an 'algorithm' proved especially intractable. This is the trace that we will try to follow in the subsequent sections, to clarify the conditions under which the distinction between discovery and invention becomes necessary.

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a patent thereof, subject to the conditions and requirements of this title" (35 U.S.C. §101, 1988). "The term 'process' means process, art or method, and includes new use of a known process, machine, manufacture, composition of matter, or material" (35 U.S.C. §100(b), 1988).

14 "The subject matter courts have found to be outside of, or exceptions to, the four statutory categories of invention is limited to abstract ideas, laws of nature and natural phenomena. While this is easily stated, determining whether an applicant is seeking to patent an abstract idea, a law of nature or a natural phenomenon has proven to be challenging" (United States Patent and Trademark Office 2005b).

2 Are algorithms patentable?

2.1 Newell v. Chisum

Two 1986 articles on the patentability of algorithms – the first by the law professor and consultant Donald Chisum, and the second by the computer scientist and cognitive psychologist Allen Newell – provide an appropriate point of departure for a closer investigation. Entirely uninformed about the details of patent law, I stumbled upon Newell's text while in search of different definitions of the notion of 'algorithm'. I was struck by how this piece ("Response: The Models are Broken, the Models are Broken!", 1986) unfolded the ramifications of the initial question: "Is an algorithm patentable?" But what is an algorithm in the first place? On that point, Newell notes:

> Interestingly, the one thing that does not present conceptual difficulties is the notion of an algorithm itself. A standard definition is: An algorithm is an unambiguous specification of a conditional sequence of steps or operations for solving a class of problems. This definition is perfectly reasonable, it is not arcane, and I believe we can all live with it. The confusion, then, is not in the nature of algorithms. It is all the things around it that get confused. (Newell 1986: 1024)

Newell's article is a response; by invitation, he is reacting to 'The patentability of algorithms', an article by Donald Chisum that was published in the same issue of the journal. Now a widely quoted text, 'The patentability of algorithms' suggested a reconsideration of older cases and urged the law to count algorithms as patentable subject matter, despite their formal generality. In the following sections we shall try to follow Chisum's argument for making algorithms patentable, and then discuss Newell's reply as he tries to dismantle the notions underlying Chisum's enterprise.

In the United States, the publication of these articles coincided with a turning point in a broader juridical attitude towards computer programs and organisms, which in the early eighties had just begun to be considered a territory of possible patenting. This turning point was marked by two decisions of the U.S. Supreme Court, decisions that would later serve as precedents. The first concerned a genetically engineered bacterium capable of breaking down crude oil. This bacterium was first deemed unpatentable on the grounds that it was alive, yet in 1980 the Court granted the patent, because the organism could not be found anywhere in nature, and therefore was considered to be an invention (Diamond v. Chakrabarty, 447 U.S. 303, 1980). One year later, algorithmic timing control in the treatment of rubber was successfully claimed (Diamond v. Diehr, 450 U.S. 175, 1981), despite the fact that the innovation was located in the synchronisation algorithm alone, and not in the material process. Not only that, but an established scientific formula was central to the claim. It was granted nevertheless.

In 1972, almost ten years before this major shift, the term 'algorithm' had been used for the first time in juridical argument, referring to an efficient translation of one numerical code to another.[15] In this case (Gottschalk v. Benson), the Supreme Court had excluded algorithms from patentable subject matter, being "merely a series of mathematical calculations or mental steps, and [...] not constitut[ing] a patentable 'process' [...]" (Gottschalk v. Benson, 409 U.S. 63, 1972). In one way or another, this decision, often referred as the 'Benson decision', became a precedent for all subsequent cases involving the algorithmic.

According to Chisum, it is the explicit exclusion of the algorithm from the realm of the patentable that is to be blamed for the complicated juridical development thereafter, which "follows a path of confusion and arbitrary distinctions" (Chisum 1986: 1000, 992). "The continuing confusion over the patentability of computer programming ideas can be laid on the doorstep of a single Supreme Court decision, *Gottschalk v. Benson* [...]" (Chisum 1986: 1019-1020). Going through a history of patent cases on which it was grounded and which it also influenced, Chisum tries to demonstrate that overriding the Benson decision would help to establish clarity once again. He makes it clear that he does not intend to show that every algorithm deserves a patent, but rather that a patent claim should rest on novelty, usefulness and nonobviousness only, and that nothing should be regarded as unpatentable only because it is algorithmic. Breaking down distinctions that had been in effect earlier, Chisum follows the very broad and recursively defined statutory

15 Pamela Samuelson emphasises the Benson case as a pivot point: "The case law before Benson is silent on the patentability of algorithms; after Benson it is focused almost exclusively on algorithms" (Samuelson 1990: 1059). The Benson application itself reads as follows: "The patent sought is on a method of programming a general purpose digital computer to convert signals from binary-coded decimal form into pure binary form. A procedure for solving a given type of mathematical problem is known as an 'algorithm.' The procedures set forth in the present claims are of that kind; that is to say, they are a generalized formulation for programs to solve mathematical problems of converting one form of numerical representation to another. From the generic formulation, programs may be developed as specific applications" (Gottschalk v. Benson, 409 U.S. 63, 1972).

law, which, as we have seen, includes processes, compositions of matter, manufactures, etc.

Chisum is nevertheless forced to separate out those fields that are difficult to account for in the scope of patent law. Thus he finds fault with the established association of the concept of algorithm with the mind, liberal arts, and theoretical science. In one case, for instance, he notes:

> In a style unfortunately reminiscent of *Benson*, the court correlated 'mathematical algorithm' with 'scientific principles and laws of nature' and 'mental processes' lumped together 'mathematical algorithms and formulae'. (Chisum 1986: 1008-1009)

While Newell agrees as far as the general difficulty is concerned, his reply does not share Chisum's optimism. To him, it is not that the court decision is confused, but that it only brings to the surface much more fundamental confusions that "arise from the basic conceptual models that we use to think about algorithms and their use" (Newell 1986: 1023). These 'broken models' are not a problem within computer science, but they become a problem when applied in law:

> That the models are good for computer science does not automatically make them good for dealing with computers and the law. [...] I think fixing the models is an important intellectual task. It will be difficult. The concepts that are jumbled together—methods, processes, mental steps, abstraction, algorithms, procedures, determinism—ramify throughout the social and economic fabric. (Newell 1986: 1035)

Had the Benson decision been decided differently, the path might have been different, but the confusion would have remained the same. In other words, while Chisum locates the error in court opinion, Newell attributes it to the subject matter itself.

Following the protagonists in their attempt to distil the essence of the problem may give a clue as to some basic questions regarding the ontology that permits of a patent claim in the first place. According to the historical arguments, only what can be transferred can be claimed, and thus attract a privilege. Such a claim has been shown to be dependent on the difference between discovery and invention, and between the abstract and the applied, so that we can expect to learn more about how these two distinctions affect each other.

2.2 Means

From the beginning, Chisum (1986: 960) leaves no doubt that he intends to set up a normative argument: "new and useful algorithms, including mathematical algorithms, should constitute subject matter eligible for patent protection." However, because algorithmic methods link formal thought and scientific investigation, the term *algorithm* tends to resist the justification of such an argument, unless it is fundamentally reframed.

Before *algorithm* was first used in court and immediately advanced as the mark of unpatentable matter, there had been many unsuccessful attempts to establish claims in somewhat similar fields. These had led to a common exclusion of three categories that became closely related to the algorithmic in the Benson decision.

The first category comprises processes called *business systems*. Such techniques, generalised means to achieve some explicit type of goal, had been rejected early on. For instance, in 1913, the technique to give Ohio tram passengers a time-limited ticket in order to prevent free rides was not deemed patentable (Cincinnati Traction v. Pope, 210 F. 443, 6th Cir. 1913).[16] In order to frame his later argument related to algorithms, Chisum shows that by superposing the two terms *means* and *processes* one can easily establish the conceptual weakness of their distinction, and thus reveal the terminological inconsistency of the argument against business systems. Their exclusion

> can be reduced to a very narrow scope if 'means' for carrying out a business system is liberally interpreted as including a 'process' in the sense of a defined series of operational steps. With such an interpretation of 'means', almost any new business system can be 'connected' to means for carrying it out and subject to patent protection on that 'means'.

Algorithms, as "unambiguous specifications of a conditional sequence of steps or operations for solving a class of problems", resemble these business systems very much in some ways, especially in that they are characteristically not confined to any particular business. Their generality accords very well with the tendency of patent claims to be as broad as possible.

In the Benson case, which is the centre of Chisum's critique, a "dataprocessing method" was claimed as something completely independent of a specific implementation. The invention consisted of an efficient way of con-

16 After listing two other inventions that were to prevent appropriation or fraud, Chisum (1986: 964) notes: "One is caused to wonder about the morals of our immediate forbearers."

verting one number system to another[17] – an algorithm that could be followed by a patient human, or serve just as well as a specification for computers.

One of the arguments that led to the Supreme Court's rejection of the patent claim in 1972 was the assertion that it attempted to claim a form of mathematical thinking, and not a mechanical application. By the court's exclusion of phenomena of nature, mental processes, and abstract concepts from patentability, the algorithm was excluded too. Even if it was not easy to assign the algorithmic to one of these three domains, it was assumed that it would belong to them nevertheless.

2.3 Patentability beyond matter

In his attempts to work against this exclusion, Chisum is required to dissociate phenomena of nature, mental processes and abstract concepts from the algorithm, and thus he tries to support the idea that the algorithm is simply a kind of applied technology. To understand his train of thought, we have to keep in mind that the computer is generally assumed to be a kind of machine. What happens within the computer, for him, is thereby automatically related to technology. The fact that computerised accounting systems had sometimes succeeded in obtaining a business systems patent, even though they were generally denied one, served as a clue for the possibility that the delegation of practices to programs changed their ontological status (Chisum 1986: 965).[18]

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17 On the way from decimal numbers to binary numbers, the Binary Coded Decimal (BCD) may serve as intermediary. It treats every decimal digit as a separate number and encodes this cipher (0... 9) in binary format (taking four bits, so that 9 is encoded as 1001). In a second step, these cipher data are combined to the resulting binary number. The Benson claim concerned an efficient algorithm specifying this second step.

18 Delegation to hardware has sometimes been used to dress up business methods as implements: "Moreover, those applications that sought patent protection for business methods tried to disguise the true nature of their claims as being other than business methods. For instance, in one case examining such a patent, the patentee disguised the fact that it was claiming a business method by casting its claims 'in terms of apparatus, that is, 'means for' performing certain tasks or steps, rather than in terms of the method steps themselves'" (Grusd 1999). More recently, the case *In re* Beauregard 53 F.3d 1583 (Fed. Cir. 1995) served as a precedent for claims on instructions to a computer by means of their embodiment on some machine readable form, such as a CD or floppy disk.

While the exclusion of *business systems* was related to a limit on what can count as a 'process',[19] the exclusion of the other two categories depended on an alliance between thought and its means of reflection: *mental steps* and *printed matter*. In order to be able to proceed successfully in dismantling the status of algorithms as unpatentable subject matter, Chisum needed to reframe the entanglement between literature and its inscription medium, which links printed text to the realm of copyright. After all, in computer science books algorithms are often found simply as printed matter. Furthermore, he had to systematically disentangle scientific reasoning from its mental steps.

More generally, in order to succeed, such an argument must draw the line between formalised thought and mental processes. As we will see in the following, these two separations are established by showing that a computer may implement such abstract processes; a computer can be controlled by printed matter, and it can execute steps that could also be completed by a human being, say with a pencil and paper.

Just as the exclusion of business systems establishes a separation between a technique and its use, the juridical exclusion of printed matter holds that:

> an invention consisting of the arrangement of information on a substrate [...], could not constitute patentable subject matter unless the invention called for a new relationship between information and substrate. (*In re* Russell, 48 F.2d 668 – C.C.P.A. 1931)

In a quite similar way, courts attempted to limit the boundless proliferation of process claims by stating that "transformation and reduction of an article 'to a different state or thing' is the clue to the patentability of a process claim that does not include particular machines."[20] Quoting this passage, Chisum (1986: 987) asks: "What is 'the clue'? Is transformation a part of the definition of a patentable process, or is it not?"

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19 Keeping in mind that until 1952, 'process' was termed 'art' in U.S. statutory patent law.

20 "That a process may be patentable, irrespective of the particular form of the instrumentalities used, [...] cannot be disputed. If one of the steps of a process be that a certain substance is to be reduced to a powder, it may not be at all material what instrument or machinery is used to effect that object, whether a hammer, a pestle and mortar, or a mill. Either may be pointed out; but if the patent is not confined to that particular tool or machine, the use of the others would be an infringement, the general process being the same. A process is a mode of treatment of certain materials to produce a given result. It is an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing" (Gottschalk v. Benson, 409 U.S. at 70).

Weakening distinctions between material and immaterial as well as between information and its expression on a substrate, Chisum (1986: 965-966) demonstrates that "software" (for instance, a printed pattern on a rotating disc) is an essentially inseparable component of the "hardware" (an analog-to-digital converter, which is controlled by the pattern on the disk). Thus, he argues that a technical innovation may be "solely in the pattern or informational content", and quotes the court opinion, according to which printing "is not intended to convey intelligence to a reader [...]. The user of the disc is not supposed to contemplate it as he would a mathematical table, weighing scale chart, or the like in order to derive some information."[21] The fact that mechanisms and structures converge in printing anyway makes it easy to eradicate the distinction between form and matter by generalising the machine readability of text and setting apart the requirements of practical use from any remnants of physical material.

The computer, under its entirely symbolic aspect, thereby becomes a model for patentability of algorithms in general, which in turn are made to represent all types of formalisable procedures. Apparently, by their ambiguity between specifying processes and instigating processes, algorithms come to serve as mediators of patentability itself.

2.4 Hybrid patentables

It turns out, though, that to permit immateriality and to rely on utility alone is not sufficient to vindicate algorithm patents. As we have seen, in order to be patentable, general methods are required to differ from purely observational or theoretical methods, irrespective of being novel or useful in themselves. In other words, a procedure should neither be an 'abstract' logical or otherwise formal sequence (and therefore not sufficiently 'applied'), nor the result of the observation of a natural phenomenon (and therefore not sufficiently 'new').[22]

21 Here, Chisum (1986: 966) is quoting 373 F.2d at 1013.

22 The classic example of excluded matter is electromagnetism. Morse's famous rejected claim on electromagnetism reads as follows: "Eighth. I do not propose to limit myself to the specific machinery, or parts of machinery, described in the foregoing specifications and claims; the essence of my invention being the use of the motive power of the electric or galvanic current, which I call electro-magnetism, however developed, for making or printing intelligible characters, letters, or signs, at any distances, being a new application of that power, of which I claim to be the first inventor or discoverer" (O'Reilly v. Morse, 56 U.S. 15 How. 62 62, 1853). For a discussion see also Bessen/Meurer 2008, Chapter 9. Still today, signals themselves are not deemed patentable subject matter in the American *Interim Guidelines for Examination of Patent Applications*. The guidelines specifically

Patent disputes both before and after the introduction to juridical discourse of the term ‘algorithm’ in 1972 have struggled with the status of scientific practices. Geological and medical methods in particular have been candidates for a recontextualisation beyond scientific investigation,[23] arguably because they were often developed in an industrial or commercial environment. The question at issue here is whether scientific methods that formally relate data derived from measurements become patentable once they are delegated to computer programs. Often, the U.S. courts have rejected such claims when their subject matter is algorithmic, referring to the fact that such algorithms are simply the embodiments of scientific thought or natural law. In other words: in themselves, algorithms do not apply principles directly, but only implement the reasoning process about those principles in a computer.

Similarly, attempts to claim processes that incorporate an analysis stage in their functioning have often failed in court. Here, the algorithmic has several times become a bone of contention – for due to its connection to mathematical and scientific reasoning, it has been used as an indicator for the distinction between abstract and concrete, as well as between invention and observation. A crucial issue is whether it counts as an innovation to combine algorithms with patentable subject matter – for instance, when the interpretation of seismic measurement is claimed in the form of a computer program that processes empirical data.[24] Essentially, what is at stake in such cases is how far the use of a technical implement (possibly accompanied by reasoning) becomes an integral and autonomous part of the process as a whole. Separated, the parts cannot be claimed. Only the combination distinguishes them from the state of the art.

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exclude: “Claims that recite nothing but the physical characteristics of a form of energy, such as a frequency, voltage, or the strength of a magnetic field, define energy or magnetism, per se, and as such are nonstatutory natural phenomena (O’Reilly, 56 U.S., 15 How. at 112-14). Moreover, it does not appear that a claim reciting a signal encoded with functional descriptive material falls within any of the categories of patentable subject matter set forth in § 101. [...] A modern definition of machine would no doubt include electronic devices which perform functions. Indeed, devices such as flip-flops and computers are referred to in computer science as sequential machines. A claimed signal has no physical structure, does not itself perform any useful, concrete and tangible result and, thus, does not fit within the definition of a machine” (United States Patent and Trademark Office 2005b).

23 For a detailed analysis of a patent dispute in oil prospecting, see Bowker (1994).

24 Prompted by such problems, over the years, the courts have devised (and subsequently rejected) ever-new testing procedures, which attempt to separate out the unpatentable (United States Patent and Trademark Office 2005b). I confine myself here to Chisum’s argument, which raises enough issues for now.

The Supreme Court decision regarding *Parker v. Flook* (1978) and the already mentioned *Diamond v. Diehr* (1981) both involved such a combination and included a computer program as a novel feature in their claim. In Flook, a recursive averaging formula was used to continually calculate an 'alarm limit' from given variables (measured temperature) in a chemical reaction of hydrocarbons. The claim was exclusively for the calculation of the internal state that was required for the recursion. The Court considered the physical application of process control to be trivial, and located the innovation in the algorithm itself. The algorithm per se, being mathematical, was not patentable, though. Also, within mathematics, the formula was obvious, and after Benson its application in computer programming not patentable subject matter.

Taking issue with this decision, Chisum (1986: 994) argues that it is the *whole* claimed method that should be considered an algorithm:

> It took a number input, performed a number output. [...] The issue in *Flook* focused on a single step in the method because of *Benson*'s loose equation of an 'algorithm' with a 'mathematical formula.' One step of the method claimed in *Flook* was a mathematical formula (more precisely an equation). But that equation was just one step in an algorithm [...].

While, for the court, the application field of the algorithm was its realisation within information processing, Chisum counts the whole process as one. The court emphasised that the inventors claimed the computation of an internal state of the calculation (a variable), whereas, according to Chisum, the variable represents a measurement of a computer-controlled chemical process. Preventing such hybridisation, the court had argued that:

> [t]he notion that post-solution activity, no matter how conventional or obvious in itself, can transform an unpatentable principle into a patentable process exalts form over substance. A competent draftsman could attach some form of post-solution activity to almost any mathematical formula; the Pythagorean theorem would not have been patentable, or partially patentable, because a patent application contained a final step indicating that the formula, when solved, could be usefully applied to existing surveying techniques. (Parker v. Flook, 437 U.S. 584, 1978)

An algorithm is mathematical precisely in so far as it is general; nobody can claim to know all future applications: again and again, mathematics surprisingly "works" (Wigner 1960). Thus in order to justify the above hybrid procedure as an essentially *new entity* – as opposed to being merely a novel application of a well-known formula, Chisum has to weaken the ties between mathematics and its abstract effectiveness. He has to affirm the application of an equation ("post-solution activity") as internal to the algorithm, but nevertheless external to mathematics.

Chisum frames his argument by evoking the similarities of the other case, *Diamond v. Diehr*, in which the patent was granted in 1981. While the applicants used a well-known formula for the calculation of reaction speed,[25] their claim consisted of a procedure that intercalated numerous steps of measurement, calculation and control. Chisum (1986: 997) argues that in this case the "[i]ncorporation of computer use to improve the process did not make the process as a whole unpatentable" and thus tries to show how the novelty is distributed over the entire combination of physical and computational steps. While in the case of computer algorithms themselves he is forced to argue for the patentability of the immaterial and purely structural, in this case he has to present formalised processes as being moored in material transformation (classical domains of technology, industry and commerce), though without making the claim itself depend on materiality. Circumventing thought, the algorithm is rendered 'real' by interleaving it with natural phenomena.

2.5 Preempting the abstract

After following Chisum's argument so far, it seems to be not only the algorithm, but more generally formalisation that is at issue here. Generally speaking, by axiomatising a system, all those statements are made explicit that are valid independent of anything internal to the system. Given that it turns out to be consistent, it can be followed blindly without making it dysfunctional. It is *formally* consistent precisely as far as it is thoughtless. But it is also 'mechanical': in Chisum's words, "no 'thinking' or judgement is required other than the concentration on carefully following the instructions for the discrete operations prescribed by the algorithm" (Chisum 1986: 073-974).[26] So far, the difficulty of the argument has been to separate a description of a general law of nature from its link to observation and to incorporate it into something that can count as a patentable algorithm. The doubts regarding the patentability of such general patterns remain, though, simply because algorithms are established as an integral part of formal reasoning. By consequence, for many

25 The *Arrhenius equation* was established within chemistry in the 1890s.

26 Of course, the assumption that the mechanical implies an absence of thought is not necessarily self-evident: Leibniz's conception of 'blind thoughts' (*cogitationes caecae*) is perhaps one counter-example.

lawyers, any claim to patent such operational schemata is identical with claiming cognitive processes, and is thus excluded: "It is self-evident that thought is not patentable."[27] As we have seen, Chisum uses the argument of mechanised thought[28] and the absence of 'contemplation' in algorithms as an argument for the applied or technical character of form. Essentially, he tries to demonstrate that once thought is implemented in the form of a movement (be it in matter or purely structural), its expression becomes indistinguishable from technology. In such a way, any enactment sufficiently proves that an algorithm is not thought.

It remains an issue, though, that while statutory law is not very selective about what is patentable or not, abstract principles can nevertheless not be claimed. As we have seen, this is simply because such principles are agreed upon as having general validity: they are discovered rather than invented. Effectively, they cannot be preempted. But if algorithms are essentially mathematical entities, they are commonly considered to embody precisely such principles. It is interesting to observe how the consequence in Chisum's argument evolves: to make algorithms patentable, mathematics must be limited. Its subject matter is separated fundamentally from natural and technical processes. And in the course of maintaining a separation between abstract and applied, mathematics is reduced to a static, representational language.

This shift is perhaps most obvious when Chisum discusses a 1982 application by Meyer, who tried to claim a medical algorithm – a method for a neurological memory aid. The problem for Chisum in this case is to distinguish between thought and a formalised diagnostic procedure. The application concerned a method for systematically identifying locations of probable malfunctions in a complex system (*in re* Meyer, 688 F.2d 789 – C.C.P.A. 1982): (a) selecting a plurality of elements of the system; (b) initialising a factor associated with each element; (c) testing the system for a response; (d) determining whether the response was at least partially effective or ineffective; (e) modifying the factor associated with the element in accordance with the effectiveness of the response; and (f) repeating the above steps. It was indeed a very broad claim, which without doubt replaces "in part, the thinking processes of a neurologist" (688 F.2d at 795.), and arguably the thinking process of anyone else who, for instance, happens to have lost something that is hard to find.

27 188 F.2d 165 (C.C.P.A. 1951), quoted after Chisum (1986: 968).

28 "With the coming of the computer age, processes involving 'mental steps' no longer would necessarily be performed by the human brain but rather could be performed by the marvellous new computing machines" (Chisum 1986: 969).

In order to show that formal reasoning without "mathematical content" falls outside the scope of abstract principles, Chisum asserts that mathematics may well *represent* a computational process, but the representation is not applied within mathematics, but within other fields such as diagnostic procedures or computer technology.[29] He thus reinforces the distinction between "algorithm" and "mathematical formula", claiming that "a 'formula' is generally used to denote a description of structure or ingredients [...], not a prescription of action (as in an algorithm)."

Finally, perhaps the clearest example of this line of separation that Chisum is forced to draw is found in his discussion of the rejected claim on a compiler algorithm (*In re* Pardo, 1982). In Pardo, a patent had been requested for a method of recursively reducing formal statements until a solution was found. The request was rejected on the grounds that its problem was essentially mathematical in nature.[30] In his attempt to rid himself of the inconsistency such generic claims, Chisum argues in two steps. First, he states that the method "for controlling the internal operations of a computer to govern the manner in which the programs are executed" (*in re* Pardo, 684 F.2d 912 – C.C.P.A. 1982) does not "constitute a *mathematical* algorithm" (Chisum 1986: 1006). For justification, he quotes the application text, which holds that: "a computer controlled according to the invention is capable of handling mathematics is irrelevant to the question of whether a mathematical algorithm is recited by the claims" (Chisum 1986: 1007). In a second step, he shows that the domain covered by mathematics is minute compared to other applications. To that effect, he identifies the compiler algorithm as useful to mathematics, but not mathematical by itself: following Pardo's definition, according to which the domain of mathematics is essentially numerical, Chisum grants the

29 Regarding the Benson case, he writes: "It is true that algorithms are often devised to solve problems of a mathematical nature. But algorithms may also be devised to solve all sorts of nonmathematical problems. [...] It would seem that the conversion of decimal numbers to binary numbers is a 'mathematical' problem only in a very loose sense. [...] The algorithm involves some arithmetical steps (such as adding in binary form), but the problem solved is not a mathematical one (such as finding the greatest common divisor of two numbers or a trigonometric function)" (Chisum 1986: 977).

30 Of course, the C.C.P.A. could have rejected the patent simply because there existed prior art: the interpreter for the programming language Lisp (realised 1962 by Tim Hart and Mike Levin at MIT) was already well known by then, and it comes a bit as a surprise that as late as 1982 someone tried to claim such an algorithm. But the rejection was due to its unpatentable subject matter in the first place.

solution of the equations to mathematics, but the process of solving them remains a technical issue.[31]

Not without difficulty, Chisum manages to force mathematics away from the role of a boundary object, a mediator simultaneously part of different domains. In his eyes, mathematics makes up a representational tool that has nothing fundamentally in common with processes and algorithms. While he maintains the unity of immaterial and material functioning, he requires formal language and its mathematical character to be separated.

Here the ontology of the mathematical domain, as it has been discussed in the philosophy of science, is immediately touched by the justification of patentability. In what way and to what degree does mathematics refer to being, and how far may it be limited to its own field? The exclusion of the abstract from patentability bears directly on such foundational discourses, because the scientific status of abstract domains is at stake. But instead of bringing in issues of mathematical ontology directly at this point, we may take the opposite approach: we may ask if it is possible, from the internal consistency of patent logic, to limit the abstract to a narrow 'theoretical' field, from where it only becomes effective when mediated by 'practical' means.

So far we may retain that, by denying its own generic agency, Chisum silences the abstract character of the algorithmic within technology. In other words, if to invent is essentially to borrow from 'someone else', the origin must be rendered as exotic as possible. It seems that even he himself is not entirely happy with this solution. Reaffirming his initial stipulation, Chisum concludes that the Benson decision was at fault in the first place for making it necessary to maintain such distinctions at all. After all, he writes, "Benson held that 'something' is per se unpatentable but failed to provide reasoning that could be applied to determine the scope of the per se rule" (Chisum 1986: 1007).

3 Intractable mobiles

After having followed Chisum's train of thought extensively, it is clear that only a perilous distillation process is able to separate the unpatentable properties and justify the patentability of algorithms. It is not at all clear why

31 "There was no indication that the 'data' would be other than numeric. The problem to which the algorithm was directed was mathematical in nature – how to assure that solution of a group of formulae with defined and undefined variables would yield the same result, regardless of the order in which the formulae were entered into the program"(Chisum 1986: 1007).

one should consider the outcome satisfactory. Allen Newell, in his response to Donald Chisum's view, acknowledges the fact that in a world where industrial processes are becoming increasingly intertwined with computation, the patentability of algorithms is an important topic (Newell 1986: 1030-1031). While he confesses to being undecided whether to argue for or against patents on algorithms, he states that he "gradually perceived difficulty after difficulty with the underlying conceptual groundwork on which he was necessarily forced to build" (Newell 1986: 1024).

Why is this issue so intractable? While Chisum regards the problem to be only one of a juridical misconception, for Newell, the troublemaker is the algorithmic itself.

As we have seen, a patent is a privilege that may be granted only to the originator of an invention, "the true and original inventor" (O'Reilly v. Morse, 56 U.S. 15 How. 62, 1853). From a historical point of view, this phrase can imply either an innovator or a person who is the first to import something. Before we discuss Newell's argument, let us therefore step to one side in order to reconsider the issue from the point of view of agency and causation.

According to the logic of patent law, the right to use an invention cannot be granted, but only the right to exclude others from using it.[32] From this "exclusive nature of the right", it follows that something which is without place or already given falls outside of any such claim: it can't be withdrawn from everybody else in order to guarantee the exclusive privilege. Evidently, questions of agency are pertinent to the question of why certain areas (nature, thought, the abstract) must be excluded from patentability. By considering the agency of the patentable first, we may then ask about the agency of the algorithmic within this field excluded by patent law.

The argument may be laid out as follows. To grant a privilege, one must first be able to attribute the primary cause of the patentable to an individual (or juridical) person. This excludes, as we have seen, natural laws, since they are

32 This "exclusive nature of the right" applies to American as well as to European patent law. For concreteness, the United States Patent and Trademark Office (2005a) specifies: "The patent does not grant the right to make, use, offer for sale or sell or import the invention but only grants the exclusive nature of the right. Any person is ordinarily free to make, use, offer for sale or sell or import anything he/she pleases, and a grant from the Government is not necessary. The patent only grants the right to exclude others from making, using, offering for sale or selling or importing the invention." It can be argued that because most cases are never actually litigated to trial today, patents should not be considered a right to exclude others, but a right to try to exclude others (Lemley/Shapiro 2005).

"original causes" in themselves.[33] Instead, the inventor must be a true originator, a pukka agent.[34] Similarly, copyright grants exclusive rights over inventions or descriptions to their originators, under the assumption that such primary agency exists. But while copyright covers every form of reproduction, a patent includes all realisations of a productive method rather than an 'ideal' product itself.[35] It is a claim on a means of production, not on a product.

This wider scope, together with its "exclusive nature", is linked to the complementary aspect of patentability: Because the originator is granted a privilege to exclude everyone else for some time, it is not enough to state that the invention is not a discovery. In order to be able to enforce the privilege, it must be possible in principle to know that there has been an infringement in the first place. No legislator can confer to anyone a privilege over others' mental processes, as long as they are taken to be inaccessible and inalienable. One cannot patent thought, because (despite more or less successful attempts to control it) the mental resists access. This is why the invention must not only be sufficiently 'human' (as derived from an inventive step), but must also be sufficiently 'nonhuman' (as implemented in a transparent and functional form).

33 "A principle, in the abstract, is a fundamental truth; an original cause" (Le Roy v. Tatham 1852). An invention implies by definition that culture has been added to nature. The ingenuity of the inventor is held to change the character of an entity; intellectual activity confers property in it, as does the application of skill or labour which gives people (the possibility of) property in products" (Strathern 1996: 524).

34 The social anthropologist Alfred Gell refers to such "primary agents" in regard to intention as a different kind of causality: "Frazer's mistake was to impose a pseudo-scientific notion of physical cause and effect (encompassing the entire universe) on practices which depend on intentionality and purpose, which is precisely what is missing from scientific determinism. "Magic is possible because intentions cause events to happen in the vicinity of agents, but this is a different species of causation from the kind of causation involved in the rising and setting of the sun" (Gell 1998: 100-101).

35 Dircks writes in 1867: "Again, if an engine, or machine, is invented, its employments are often very numerous; [...] But in literature and in art every work stands by itself; reliant on its intrinsic merit [...]. But invention as understood in reference to mechanical and chemical subjects is widely different [...]. What is legitimate in literature, that is, imitating without borrowing, would in the case of mechanical inventions be evasions, or infringements. [...] supposing the invention confined to the steam engine, and that the first inventor employed a vertical cylinder, admitting the steam below; a second one admitting the steam from above, or reversing the cylinder; and a third fixing the cylinder horizontally, we should not here have three inventions; but only one invention, and two infringements" (Dircks 1867: 134-136). For a historical example of abstractness in copyright, see Kawohl/Kretschmer (1989).

Following the broadest version of this juridical logic, we can say that for something to be patentable, it must be a mediator simultaneously in two ways. Firstly, the patentable must grant access to an inventive step; it must be a clear index of the originator's agency. In other words, it mediates mental acts and natural forces in such a way that its origination is attributed only to the former, and not to the latter – there can be no invention without an inventor. This may be regarded as the requirement of novelty, originality, nonobviousness etc., implying the idea of some authentic originator, some great mind. At the same time, as we have seen, the patentable subject matter is required to be independent of the mental, in that it must be possible to disclose and completely delegate it. Because it is considered impossible to directly access thought, the patent system depends on the assumption that theory can be separated from practice, and that the agency of the inventor can be naturalised.

Secondly, it follows from the above that the patentable binds this originating agency such that it becomes a mobile implement effective in an unbounded number of contexts, irrespective of the particular application.[36] It must be useful, tangible, concrete, etc. – the patented entity must be able to de-scribe (Akrich 1992) the delegation of 'natural forces' in a way that they lose their generality in the multiplicity of their application. For instance, it was argued recently that "[a] method that does not operate on matter or some form of energy in the physical universe is not 'useful' to mankind in the technological sense of the Constitution's 'useful arts'" (*ex parte* Lundgren, Appeal No. 2003-2088, 2004). This functionality notwithstanding, the patented matter is required to be disinterested and abstract enough to be applicable and commodified. Retaining its identity across different functions, it embodies a separating reference between all those applications and the essential function that enables it. In other words, it delimits a class of applications, while avoiding falling under its own class itself. The patent is granted in the abstract, but not to the abstract.

3.1 Mind the gap

To become distinct from thought as well as from the abstract, the algorithmic is identified with processes and practices. Being treated as an inherent principle of application, it is thus also separated from nature. In this respect, Chisum's

36 "Patentees should take care to include in their patent specifications as many embodiments and permutations of their claimed processes as possible, and do so with language that describes the claimed process with some specificity without reading too narrowly" (Smith 2002: 209).

implicit philosophy of science overlaps with externalist or constructivist positions. Whether an algorithm is patentable or not depends exclusively on the domain of its application; the algorithm itself is outside the mathematical domain. Or, regarding the above considerations of agency, the algorithm is a mediator in two ways: it is a (possibly new) realisation of a general type of process, and it is applicable to numerous fields. To be patentable, an algorithm must be an invention whose abstractness is nothing but a closure of its multifunctionality.

In his reply, Newell shows that the separations required to render algorithms patentable bring the whole conceptual system into difficulties. His opposing perspective thereby transforms Chisum's discontinuity into a continuity. Let us see how far Newell's anamnesis of the symptoms of 'broken models' can help us clarify some basic issues of actor media theory.

3.1.1 Cognitivism

Regarding the relation of algorithm and mind, Newell argues from his own background as a cognitive psychologist, and as a cognitivist in particular. He notes that, according to a large part of psychology, the mind is functionally algorithmic, and human behaviour is computational. Thought itself is already a delegating activity comprised of algorithmic mental steps:

> We model what is going on inside the thinking human brain, as carrying out of computational steps. Therefore, humans think by means of algorithms. Sequences of mental steps and algorithms are the same thing. (Newell 1986: 1025)[37]

This reasoning may raise an eyebrow. It leaves aside any substantial difference between a model and the reality that it is supposed to represent – just because we model thought computationally, it does not have to be itself computational.

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37 This is a paraphrase of a much earlier statement by Newell, still in the era of optimism within cognitivism: "[...] we can write a program that constitutes a theory of the computer's behavior in literally the same sense that the equations of Newtonian dynamics constitute a theory of the motion of the solar system. The genuinely new analytic instrument available for explaining human behavior is the program. Thinking is to be explained by writing a program for a thinking process" (Newell/Simon 1959: 4-5). It was for Newell an important tool to avoid "dark corners [...] in which vitalism, or mysticism can lurk – nor even the vagueness of 'mediational' hypotheses" (Newell/Simon 1959: 5) that algorithms are independent of their form of realisation (in mental processes or in computer programs). Effectively, this is a variant of the Church-Turing Hypothesis.

Yet if the system of knowledge within cognitive psychology is formalised in terms of algorithms, it is not easy to prove otherwise without going beyond the algorithmic. As we have seen already in the discussion of organisms, a purely constructivist account has no means to make the necessary distinctions within the debate of patentability. But Newell rather argues from a sort of social epistemology here:

> There can be controversy about whether such an approach is the correct one for psychology. What is important is that such a view is a major one in the study of the human mind – that many psychologists see the mind this way and that thousands of technical papers are written from within this view, covering large expanses of psychological phenomena. Any attempt to build a patent system for algorithms that tries to distinguish algorithms as one sort of thing and mental steps on the other, will ultimately end up in a quagmire.

This legal "quagmire" results from a claim that cannot be grounded, one whose law cannot be enforced. Newell argues that the difficulty with algorithm patents would be to keep people from thinking certain thoughts:

> We are talking of people who engage in those patented thoughts daily and hourly – even every few seconds – in the pursuit of their business and who make their money and livelihood by so doing. (Newell 1986: 1025)

According to this argument, the patentability of algorithms is an intractable problem because thought is isolated but computational at the same time. Of course, although Newell does not mention it, such issues concern just as much the scientific praxis of the cognitive psychologists whose algorithms are implemented on exactly the same computers that for Chisum belong to the domain of useful, and therefore patentable, arts. The cognitivist knowledge is not so easily counted as 'useful' in the sense of patent law, yet according to Chisum's argument, it could not easily be excluded either. How to distinguish the 'applied use' of algorithms from their formal background? I think Newell's conflation of the model with its domain can be read as a symptom caused by a basic property of formalisation. It will become more evident as we continue to investigate the algorithmic.

3.1.2 Operation Chains

However static it may be as a symbolic system, the domain of an algorithm is made up of steps of operations in time, or, to use a term from cultural anthropology, *operation chains*.[38] They can be thought of as enchainments of possible events, as principles underlying processes, which can be inferred from artefacts as stone tools are. Such artefacts make sense as mediators in a transaction. Operation chains may thus be thought of as agency *behind* processes and their outcome, in that they shape the whole ensemble and the distribution of techniques. They resemble algorithms in that they make up general principles shared and enacted by different programs. They are thought of as an abstract structural cause behind a process. Consequently, an invention is a change of such an operation chain (Schüttpelz 2008: 239), which entails the change of many practices that are affected by it. If algorithms are patentable, it is precisely this agency in or behind the change that makes them so.

It should be noted however that operation chains have both a prescriptive and a situational aspect – they are followed like a plan that realises itself, and they are modified, just like a plan that is changed (Bleed 2001). While each link only plays its role in a larger game of translations, each link also has its own valence, which may transform the entire game. Therefore it is important to recognise how the chain is exposed to its own modification.

Here, programs are specific, because they are formalised descriptions of processes. Because algorithms may recursively operate on these very descriptions, they do not in general allow these two aspects of situation and prescription to be separated. But at the same time, in each context, the separation prevails: while it follows from formalisation that operations can swap roles with operands, the fundamental difference between these roles does not disappear. In general, a plan is never completely transparent (Rohrhuber 2008b; Suchman 1987).

Thus, algorithms mediate between two quite different operation chains, without thereby rendering them identical. The first chain implies the operational steps of the algorithm in a given context. This process is usually considered to be the task that it completes. Because it is formalised, a machine can follow its steps mechanically – for instance, a compiler might be given an algorithm written in a suitable programming language and translate the structural representation into a process. The second type of chain is orthogonal to the former: a rule can be rewritten. There is a chain that

38 Coming from Marcel Mauss, Leroi-Gourhan (1993) introduces *chaînes opératoires*, which Bleed (2001) discusses, in an international context, as *sequence models*. For the relation between algorithms and operation chains, see also Rohrhuber (2008a). We shall discuss Bruno Latour's adaption of this concept further below.

traverses possible reformulations of the algorithm. Because the algorithmic steps are determined within the space of a formalised syntax, possible alternatives can be deduced mechanically from it. In other words, an algorithm may be read syntagmatically or paradigmatically, in terms of the action it specifies, or in terms of the modifications it implies.

The mediation of these two levels repeats itself in another kind of duality, namely its double readability: a program can be read by a human as well as by a machine (or another program). This means that formalised statements imply algorithmic processes and structures, as well as a general knowledge about the same. It is in this respect that algorithms are certainly both mental and mechanical.

Conventionally, one relates the first type of operation chain to the blind runtime process of a computer, and the second to the reflexive mental practice of programming. Nevertheless, this does not have to be so: programs can rearrange programs (this is, for instance, what a compiler does), and humans may follow algorithms (e.g. in a board game or a dance). In a sense, the aim of a programmer is always to make her program replace her labour. Still – to understand a program means doing the obverse.

This duality entails the possibility of unsolvable decision problems in formal systems (Turing 1936). Practically, the causal relation between the two levels becomes intractable in the sense that it cannot be followed or described consistently within a given situation.[39] Once a system is closed, the ambiguity usually seems somewhat tamed. In its full algorithmic form, however, causality (and competence) remains distributed within all parts of the situation. Note that it is also for the same double mediality that Chisum is able to give all those examples where the algorithmic includes hybrid processes, which connect transformations of matter, human decisions, measurements, calculations and translations without losing their character. Accordingly, in the case of the analog-to-digital converter (*in re* Jones, 373 F.2d 1007 – C.C.P.A. 1967), a functional part of an automaton may well be a printed pattern, or an even more 'immaterial' structure.

The duality of algorithms is also evident in the ambiguous role that the terms 'algorithm' and 'program' commonly play. It shows symptoms of a conflation of function and specification: by 'program', sometimes the abstract

39 The notion of intractability within computational complexity theory is related but not strictly identical. Problems are called computationally intractable when they are neither solvable in a feasible amount of time/space, nor completely undecidable. There are different uses of this term regarding formalisms, however. I am indebted to Liesbeth de Mol for drawing my attention to this interesting notion in the first place.

mathematical reference of a description is meant, sometimes the description itself, and even the process that results from it. Sometimes the program text is called 'program', and sometimes the runtime application. Differentiating terms such as 'application' and 'program code' do not help much to reduce this ambiguity.[40]

In particular, the form of algorithms, or their medium of representation, does not necessarily give a clue as to what is data and what is program; what is data in one moment can turn out to be code in another. A program does not operate only on passive symbols, but these symbols typically represent processes, so that a program usually operates on operations. But this also means that the difference between a specification of how to do something and the specification of what is done is essentially ambiguous in this field. It is not generally possible to tell a description from its function, or, in the terminology of patent law, to tell the difference between claim and enablement.

It has been noted that the consequence of trying to claim patents for algorithms is the proliferation of unspecified "means" to achieve "technical effects" – which entails "that problems and not solutions are claimed" (FFII 2004). Clearly, such conceptual difficulties are not due to a lack of understanding of what an algorithm is. They effectively result from the fact that the algorithmic is indeed distributed among description and process, reflection and application. Because algorithms are operation chains that refer to and operate on other operation chains, their abstractness is by no means ineffective.

3.1.3 Gaps

In his article 'Circulating Reference: Sampling the Soil in the Amazon Forest', Bruno Latour (1999: 24-79) is concerned with the question of reference. How does the relation between scientific knowledge, as it is familiar from scholarly articles, tables and calculations, and its physical domain, such as the more or

40 The difference between a program and an algorithm is gradual, if it exists at all. Algorithms need not even have a procedural form. To speak in Newell's terms, the only thing that counts for computer science is that an algorithm (or program) is a specification that "*determines* the behavior of the system. [...] Consequently, the form of specification need no longer be procedural. Sequences of steps must march out after interpretation, but sequences of steps need not march into the interpreter" (Newell 1986: 1032). In this respect, he emphasises the fundamental relativity of abstractness. Hence, "any attempt, for the purposes of locating creativity and invention, to distinguish between the algorithm and any particular embodiment of it turns out to be extremely difficult" (Newell 1986: 1029).

less sandy soil of the forest, come into being? Latour addresses this issue in a variation of his conception of the immutable mobile (Latour 1986). The initial question should be understood in the context of an assumed traditional, or Cartesian, view, according to which a large gap, or rather an abyss, separates world and thought. This precondition leads to the foundational uncertainty of how to justify the objectivity of scientific knowledge.

Latour's intervention in this affair is to suggest a different distribution of oppositions. He does not intend to deny the existence of such gaps. But instead of a large gap, he proposes an extended series of "operators" in which the extremes of form and matter locally shade into each other, in turn binding a chain of such operators. This chain is orthogonal to the mediation between form and matter in each link. Between these operators, a large number of minute gaps persists. Accordingly, Latour observes an iterative and bidirectional transformation between soil, territory and forest to tables, maps and descriptions – a long chain of translation techniques. Each of these mediating steps is a means of transforming one kind of relation between form and matter into another. Accordingly, the gap should not be searched for in the extremes between symbols and things (which coexist in each operator), but between one operator and the next. The operators modify translations by connecting them to other translations.[41]

Is this translation of the same type as that which is assumed between an unpatentable phenomenon, such as a natural law or mathematical principle, and its patentable application? As we have seen, algorithms were hard to track down because they operated by crossing from one domain to another – be it between material properties and mathematical calculations, or between different representations of numbers, or between mental steps and transformations of data.

It turns out that a similar gap features also in Newell's argument; the justification of the patent system is based on the assumption of a separation between general principles and their practical applications:

> One model underlying the patent system posits the existence of a gap between general scientific discovery and its application to matters of social and economic value. The discovery of a natural law or

41 In mathematics and physics, the term *operator* usually stands for a higher order function that translates between functions, not between numbers. For instance, to the function $f = x^2$ can be added a constant value: $f' = f + 1 = (x^2) + 1$, independent of what specific values x happens to have. Applying the operator results in a new function f' (see, for instance, Margenau 1950: 331ff.). Note that in some programming languages, this distinction is not made at all, while in mathematical set theory, the issue is stated differently.

> mathematical truth does not wear its practical application on its sleeve, so to speak. Additional discoveries and inventions must occur. However, no great intrinsic motivation exists for making such practical inventions. [...] Thus economic rewards must be proffered to encourage jumping this gap with the additional inventions. The patent system is designed to provide such rewards. (Newell 1986: 1026)

He states that to judge their patentability one needs to decide:

> if algorithms are to be considered either natural laws or mathematical truths, hence not to be encouraged by patents; or whether they are inventions that jump the gap from such laws and truths to application, hence to be encouraged by patents. (Newell 1986: 1026)

Obviously, here this gap is precisely what distinguishes discovery from invention. It refers to a difference in the distribution of causality: natural laws do not need further encouragement, but inventions do, since they are considered acts of volition.[42]

It should be noted as well that according to this view, the gap itself is bridged by invention, not by discovery. Be this as it may, Newell maintains that the algorithmic is a rather theoretical, abstract part of this subject. Yet, because of the equivalence of virtual machine program and process specification, he argues that a direct "transfer of creativity" eradicates any fundamental difference between specifying the behaviour of a virtual machine and that of a physical "operations-machine" (Newell 1986: 1029). Precisely because computer science deals with methods, structures and natural laws or mathematical truths in the abstract, algorithms remain invariably related to use.

> With rare exceptions, scientific knowledge in computer science is in the form of means-ends relationships – what to do with something to perform a task. But algorithms, far from being an applied part of

42 For illustration, an example from a nineteenth century journal: "[...] the raw material of the world is of little value in its natural condition; and the sweat of the brain is of more importance than the sweat of the brow in turning it to useful account. A notion long prevailed that, though hand labour was obviously useful, and ought to be paid for, brain labour was a process analogous to laying eggs, and not dependent on volition; and therefore, it was not in the interest of the public to pay for the special cultivation of spontaneous faculties. The logicians who reasoned thus forgot that the act of laying eggs does not necessarily induce chickens, but that the process of hatching is also essential, and this latter is not spontaneous, but an act of volition; and hens will frequently abandon the hatching process when their eggs are too unscrupulously meddled with"(Anonymous 1863).

> computer science, are at the center of its basic theoretical structure. [...] So where is the gap? (Newell 1986: 1026)

This argument suggests not only that the difference between thought and technology becomes disputable where algorithms are concerned, but also that they do away with any difference between natural laws or mathematical truths and their practical application. By implication, the algorithmic presents us with a domain where the gap between invention and discovery does not exist.

As much as it may be attractive, this conflation turns out to be misleading. It tacitly assumes that the means-ends relationship is a transparent and unified field of knowledge within computer science, while in fact formalisation is a continuing dialectical process involving expectations, prescriptions, process analysis and interventions. In changing the means, we change the end (Latour 2002: 252). We have seen from the above consideration of operation chains that instead of *unifying* description and function, formalisation keeps their relation in suspense.

We are indeed mistaken if we imagine algorithms as being given first as abstract formulas and then 'becoming' applied; because algorithms are already descriptions of operations, 'appliedness' is itself the domain of computer science. The multiplicity of yet unknown uses (besides being a typical feature of computer science in general) is one of the main sources of its abstractness and its (over-)generosity.[43] Any argument in favour of a boundless continuum provided by a hybrid that unifies oppositions such as natural and social, or abstract and applied, fails to account for this problematic.

It is notable that this effective conflation of a gap between description and process is consistent with Newell's earlier argument, in which he identifies the algorithmic model of cognition with cognition itself. Here, description is taken to coincide with the process it specifies; there, thought was taken to coincide with what algorithms make it possible to bring about. Instead of embarking upon a discussion of the problematics of cognitivism, for our present problem it is perhaps sufficient to retain the underlying common motive: in response to having to recognise that observation and observed are entangled, one jumps to the conclusion that they are one and the same thing. Trying to describe algorithms from an operationalist perspective, the domain of knowledge is taken to be identical with the means of describing it – identifying measurement with the measured.[44] Here, Newell's and Chisum's arguments are not so

43 The notion of the 'generosity of artificial languages' was the theme of a meeting organised by Frits Staal in 2006.

44 For a critical discussion of operationalism and cognitivism, see Bickhard (2001) and Searle (1990), respectively.

different, after all: in his discussion of business methods, Chisum shows the weakness of any distinction between means and process. That the attempt to define technology as an 'efficient action on matter' (Latour 2002: 248) consistently fails, may support either of the two positions and makes up their common universe of discourse.

It is clear that we do have to doubt a clear and easy separation between the formal on the one side and the empirical on the other, and we should expect complicated boundaries here that may be difficult to trace out. Yet intractability implies neither nonexistence nor equivalence. While Chisum apparently refuses to notice the aporetic knot that they form, Newell draws the conclusion that trying to render algorithms patentable leads to inconsistency – the abstract quality of algorithms cannot be negated just because they are effective.

The notion of the algorithmic is intractable because algorithms systematically ambiguate causation. In treating them as an index of a primary agent such as an inventor, one is therefore drawn into inconsistency. These difficulties cannot be reduced to an underlying continuity between means and ends and between cognitive science and physics – this would mean that it is simply a matter of convention where discovery ends and invention begins. They are a symptom of the fact that a gap between discovery and invention continues to be effective *within* the algorithmic.

3.2 Prior art and the abstract

The algorithmic indeed poses a fundamental problem for intellectual property, simply because formalisation is not purely theoretical; its agency cannot be clearly delimited. A privilege on any formal procedure is always a privilege on an open class of problems. In a certain sense, one could consider that what has led both Chisum and Newell into the quagmire is the tacit assumption that *the applied* need not be defined and can be identified by rather vague notions of usefulness or concreteness.

Here, a broader social conflict becomes discernible, a conflict that is played out between commercial and scientific institutions, and in which the distinction between pure and applied science turns out to be entangled in questions of ownership. In terms of Marilyn Strathern's analysis, the assignment of ownership such as in patenting can be regarded as a stoppage in long networks of interdependence and obligation, such as is typical of a scientific community:

> Any one invention is only made possible by the field of knowledge which defines a scientific community. The social networks here are long; patenting truncates them. So it matters very much over *which* segment or fragment of a network rights of ownership can be exercised. (Strathem 1996: 524).

The very possibility of observing a delimitation between discovery (something has been found) and invention (something has been produced) is a function of these long networks; in this sense, science and law axiomatically need to accept the heterogeneous, should they be able to reflect on its internal contradictions. Accepting the existence of irreducible, but also unstable, gaps provisionally occludes claims of ownership and enables the shifts in agency that are characteristic of reflection and experiment in the first place (Rheinberger 1997a). 'Centers of capitalisation' and 'centers of calculation' (Latour 1988: 15) do not stabilise the same type of network.

To establish a relation of trust within this insecure field, principles of public access and free reapplication are foundational, and obscurity is at least discouraged. By contrast, in the industrial sciences, secrecy is just as much justified as obfuscation, so that it is here that patent law attempts to intervene and add a motivation toward publication (Bowker 1994: 843). In principle, such an intervention makes no sense for public research, which would need to be privatised first to then be opened again. That both Chisum and Newell, as academics, do not account for this whole context might be a consequence of the fact that, while the difference between pure and applied science is maintained, U.S. universities often improve their financial situation by patent licences, and therefore are encouraged to commodify scientific knowledge. Certainly, the efforts within the last decades to further such a conception internationally at the expense of a public research system that bars such ties, fosters the type of difficulties we have been dealing with here. Even worse, because scientific knowledge is increasingly amalgamated with software and often even exists in no other than algorithmic form, these issues hardly remain limited to specific areas of computer science.

While it may be impossible to decide what to consider applied and what theoretical, this really becomes a problem only where one enters a field of intellectual property like patent law. The distinctions that became so hard to maintain when algorithms were at issue are primarily important where usefulness is equated with market value, which depends on ownership. It may well be that most conflicts between theoretical and applied are a mere consequence of the contradiction between the visions behind commercial success and those behind public domain. While one may agree that the academic sphere is not separable from political and economic questions, it is more than obvious that the patent system is at least a very untrustworthy ally for the sciences.[45] But, as I will try to sketch out briefly as a point of conclusion, this is not only an issue for academic freedom; the very same doubt infects the internal consistency of intellectual property law.[46]

So far, the discussion has centred around the general patentability of algorithms, and less so around the prerequisites for being an invention: novelty and non-obviousness. Assuming that algorithms were patentable, would it be possible to tell whether a given algorithm was novel? As we have seen, abstract principles can be thought of as falling outside patentability because they are considered too general to be owned. Without necessarily being at all abstract, natural laws and thought also cannot be preempted: a natural law is valid everywhere, and thought by itself is inaccessible. In other words, the natural is discovered, and thought is intransitive. In the present context, though, the abstract quality of algorithms appears rather as a consequence of an unclear distribution of agency: it is difficult if not impossible to tell a description of process from the process of construction. This intractability has a direct impact on the question of how to draw the line between the invented and the discovered – after all, what is discovered falls under descriptions, while what is invented is the product of a construction. The novelty of the abstract is an oblique concept.

To know whether a given algorithm is indeed novel, one must at least be able formally to discern an infringement. Therefore, law must be able to decide whether something is prior art; if we want to tell whether a schema is invented,

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45 In molecular biology, this fact has become increasingly apparent (see, for instance Yun-hyoung Lee 2005), as it has for some parts of computer science and mathematics. For various reasons, though, the full scale of the predicament remains latent.

46 Bowker (1994: 846-847) noted that within the history of industrial science, the patent becomes so important that it is often the main product of the laboratories. It is therefore not surprising that process claims can sometimes even befall the field of law itself. A major company has, for example, attempted to register a patent on a process for patenting itself. In 2008, Halliburton Energy Services Inc. claimed a method for "Patent Acquisition and Assertion by a (Non-Inventor) First Party Against a Second Party," which discloses a method to use trade secrets in patent claims by a non-inventor against the latter. The method includes every action to be taken, including the filing of the claim with a patent office. In this case it is even hard to decide whether this was meant seriously or not. (United States Patent Application 20080270152, October 30, 2008. Thanks to T. Bovermann and R. Tuennermann).

we have to be able to correctly compare it with older schemata.[47] Or in other words, we have to know when two algorithms are the same.

Let us assume for a moment that an algorithm is the constructive idea behind a number of different programs. This is what is sometimes called multiple realisability. Why then is it so that two programs (perhaps in two different languages) may realise the same algorithm, while others that compute the same function are agreed upon as representing different algorithms (Buss et al. 2002: 175)? Addition, for instance, can be implemented in many equivalent ways – the strictness of formalisation does not preclude alternative ways to reach the same result. But are they one algorithm or many?

On closer investigation, it can be demonstrated that even deterministic, small-step, non-interactive algorithms do not admit of an answer to this question (Blass et al. 2008). We may focus on the form of its description, or on the behaviour over time. Even more, we may consider only the result, for each input, after the task is completed. It can be shown that in none of the examples is there a formally consistent way to decide which aspect should account for an equivalence, and one may even doubt that an intuitive judgement will be able to solve the issue.[48] In particular, the combination of two algorithms into a new compound proves to be predictable neither from their form alone, nor from their function. Either form or function may turn out to constitute the new quality of the ensemble (Blass et al. 2008: 13ff.).

From a more general point of view, the duality of algorithms discussed above can be recognised here: out of the two operation chains that the algorithm draws together, one relates to the steps describing the process, and the other to the description and its alternatives. Together, they form an *intractable mobile*, in which an entanglement of these two levels pertains to an entanglement of temporality: the future, as prescribed by the plan, is enmeshed with the accumulating past steps of its realisation. It seems that novelty is not only a controversial subject, but novelty as such is formally undecidable.

We are now in a position to recognise a similar problem for patent law, and we may ask: when are two patents the same? Are they only the same if their claim is formulated in the same way, or if both claims refer to the same schema? As we have seen, patent claims on compositions of matter, such as

47 For a different example in the history of technology, see Bowker (1994: 849-850) on the development of motors.

48 "Will two competent computer scientists (or mathematicians or programmers) always agree whether two algorithms are the same? [...] There are situations where disagreement is almost guaranteed. Suppose X has invented an algorithm and Y later invents a somewhat modified version of it. X will be more likely than Y to say that the algorithms are really the same" (Blass et al. 2008: 10).

Pasteur's artificial ferment, are difficult to justify because any mediation may be interpreted as productive or technological. Similarly, claims on processes are difficult to delimit, because means and ends are typically intertwined. Therefore such patents resemble algorithms in a critical aspect: to be justifiable, they require a gap between the patent itself, be it as mechanical as it may, and the process that it discloses, be it as abstract as it may. Including algorithms in patentable subject matter makes this gap disappear, conflating the patent with the patentable. After all, this is why claiming the patentability of algorithms means to render the abstract silent: in regard to algorithms, law is indistinguishable from mathematics. Algorithms are intractable (within law) because they become indistinguishable from (patent) law itself.

4 Summary

We have followed a rather long chain of operators, so let's briefly recollect the issue. Applying the juridical problem of the patentability of algorithms to science, we are confronted with a contradictory situation: algorithms are formalised and mobile patterns of action, and thereby part of the technical or methodological apparatus. At the same time they are inseparable from scientific theory and make up an indispensable part of its domain. The attempt, for the sake of patentability, to separate the algorithmic from pure science and mathematics results in a radical reduction of the scientific field. Recognising the inconsistency of this distinction, one may also try to find rescue in 'the applied', effectively constructing a seamless continuum between thought and algorithm, between know-how and know-what, and between invention and discovery. Both arguments, each in their own way, fail to take into account that it is a basic characteristic of formalisation to ambiguate causation between action and description.

Just because something can be rigorously stated, it does not mean that it becomes an unquestionable intermediary. Rather the opposite: formalisation permits and even necessitates multiple interpretations and uncertainty. Algorithms are intractable mobiles in that they keep in suspense the distinction between invention and discovery, while at the same time balking their unification. This makes them function as boundary objects between contexts of discovery and contexts of justification: amongst a wide variety of possible formalisations, they perhaps mark the point of greatest equality between systematic and historical unfolding.

It is therefore significant after all that it was the question of ownership which brought about contradictions within the definition of the algorithmic. The properties equally necessary for ownership and formalisation – mobility, immutability, and combinability – are in themselves not sufficient for maintaining the gaps of abstraction which enable us to understand and justify the formation of networks. In order to maintain two levels at each point, and concede the right to theory not only to observers but also to the observed, we need to permit intractability – an agency of a mediator that cannot be grounded in an inventor-subject, but remains vacillating between that which necessarily must have been present already, and the recognition of possible intervention.

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