»PRACTICE MUST SPEAK FOR ITSELF«

Remarks on the concept of practice

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»Um eine Praxis festzulegen, genügen nicht Regeln,
sondern man braucht auch Beispiele.
Unsre Regeln lassen Hintertüren offen,
und die Praxis muß für sich selbst sprechen.«[1]

1. The concept of practice has become topical and has been so for several years now. In fact, it has acquired some of the characteristics of a bandwagon, as suggested by the term *The Practice Turn* which has gained some currency since it was launched about ten years ago.[2] However, on closer inspection the »practice turn« is not a unified movement by any standard. It is an umbrella for a wide range of intellectual efforts that are motivated by different concerns and move in different directions, and the very term »practice«, accordingly, seems to be used if widely different ways. However, the »turn« to »practice« is not pointless.

2. The modern concept of practice was developed over several centuries, from about 1400, for the purpose of expressing the *unity* of the activities of work.

2.1. When conceived of as a *practice*, work is not reduced to executive activities (i.e., mere activities), such as sequences of operations, but is taken to also encompass sundry conceptual activities such as envisioning outcome, devising methods and planning, identifying tasks, preparing and allocating tasks, as well as activities of evaluating, instructing, learning, etc.

2.2. The point of using the concept of »practice« in the context of CSCW, HCI, STS, Knowledge Management, Organization Theory, etc. is to overcome, or at least avoid, the notional separation of conceptual and executive activities that is part and parcel of the modern discourse about »work«.

2.3. The concept of »practice« is in an *internal relationship* to the concept of »theory« (»principles«, »procedures«, »rules«, »plans«); that is, the two concepts form a conceptual unit like the concepts of »ground« and »figure« or »structure« and »process«. They are conceptually inseparable; consider them apart, and one is talking nonsense.

3. It is noteworthy that the concept-pair »theory« / »practice« was formed as a way to express the absolute conceptual separation of the two concepts.

1 Wittgenstein, Über Gewissheit, §139. »To establish a practice, rules are not enough; one also needs examples.Our rules leave back doors open, and the practice must speak for itself.« (my translation)

2 Cf. Schatzki/Knorr-Cetina/Savigny: The Practice Turn in Contemporary Theory.

3.1. Aristotle (and Plato) understood »praxis« as mere activity, productive and yet performed without understanding of its rationale (the why questions), whereas »theory« was understood contemplatively.

> But yet we think that knowledge and understanding belong to art rather than to experience, and we suppose artists to be wiser than men of experience […]; and this because the former know the cause, but the latter do not. For men of experience know that the thing is so, but do not know why, while the others know the ›why‹ and the cause. Hence we think also that the master–workers in each craft are more honourable and know in a truer sense and are wiser than the manual workers, because they know the causes of the things that are done (we think the manual workers are like certain lifeless things which act indeed, but act without knowing what they do, as fire burns, – but while the lifeless things perform each of their functions by a natural tendency, the labourers perform them through habit); thus we view them as being wiser not in virtue of being able to act, but of having the theory for themselves and knowing the causes.[3]

Aristotle thus conceives of the manual worker as something akin to a disciplined natural force: the worker accomplishes things, sure, but so does a fire, the point of the analogy being that workers, like fire, »act without knowing what they do«. This is the crux of the aristocratic notion of »praxis« as conceived by Aristotle: »The slave is the minister of practice.«[4]

3.2. The Aristotelian notion of »practice« should be seen as an (apologetic) expression the extreme separation of ideative and executive work or »manual« and »mental« work that characterized ancient societies based on widespread slavery or other forms of forced labor.[5]

4. With the early developments of a capitalist economy based on craft work (»mechanical arts«) from about 1400 this notion was increasingly seen as problematic.

4.1. As the historian Paolo Rossi puts it in his *Philosophy, Technology, and the Arts in the Early Modern Era* (1962), between 1400 and 1700,

> A new view of labor, of the function of technical knowledge, and of the significance of artificial processes through which nature was altered and transformed clearly makes its way into the work of artists and experimentalists of the fifteenth century and into the treatises of engineers and technicians of the sixteenth century. […] It was now

3 Aristotle: Metaphysics, 981a-b.
4 Aristotle: Politics, 1254a.
5 Cf. Farrington: Greek Science; Redlow: Theoria.

> argued that some of the methods employed by technicians and artisans to modify and alter nature might also be useful for acquiring a real knowledge of natural reality. […] The men who toiled in the workshops, in the arsenals, and in the studios, or those who had dropped their disdain of practice, considered the operations conducted on these premises a form of cognition.[6]

> Thus, the literature of the 14th and 15th centuries is ›extraordinarily rich in treatises of a technical character, which at times were real manuals, and at times disconnected reflections on their own work or procedures employed in the various arts‹.[7]

4.2. In order to develop the emerging (eventually capitalist) economy, it became crucial for merchants, mechanists, and scholars to understand the actual role of practical reason and practical experience vis-a-vis the role of mathematics, physics, astronomy, etc. As Rossi puts it:

> The actual union between ›discourse‹ and ›practice‹, ›speculation‹ and ›manufacture‹, in reality presented serious problems.[8]

To exemplify this observation, Rossi quotes the Italian military engineer Bonaiuto Lorini who, in a treatise on fortifications (1596), addressed the problem of the relation between the work of the »purely speculative mathematician« and that of the »practical mechanic«:

> The demonstrations and proportions found by the mathematician ›between surface lines and imaginary bodies and separated from matter do not respond so perfectly when applied to material things‹, because the concepts with which the mathematician works ›are not subject to those impediments which by nature are always conjoined to the matter that is worked on by the mechanic‹. The mechanic's judgment and ability consists in knowing how to foresee the difficulties deriving from the diversity of the materials with which he must work, and this is all the more difficult in that no such rules can be offered for ›such accidental impediments‹[9]:

> Indeed, the material itself could present a very great impediment, as would be the case when material wheels have to be moved around their axes, which can be impeded by their own unequal weight, even

6 Rossi: Philosophy, Technology, and the Arts in the Early Modern Era, S. ixf.
7 Ibid.
8 Ibid., p. 61.
9 Ibid.

> more so when the wheels are sustained over such axes or poles that are not properly centered, all of which can tend to make motion difficult. The pure mathematician, however, imagines them as weightless and tied around invisible lines and points.[10]

4.3. In consequence of this entire development, Francis Bacon a couple of decades later called for a reversal of the relationship between »theory« and »practice«:

> Although the roads to human power and to human knowledge lie close together and are nearly the same, nevertheless, on account of the pernicious and inveterate habit of dwelling on abstractions it is safer to begin and raise the sciences from those foundations which have relation to practice, and to let the active part itself be as the seal which prints and determines the contemplative counterpart.[11]

4.4. The »practice turn« that was generated by generations of practitioners and students of the »mechanical arts« in the centuries from around 1400 and articulated by Bacon was spelled out in 1751 by Denis Diderot, in his article on »Art« in the first volume of *l'Encyclopédie*:

> Every art has its speculation and its practice: the speculation is nothing but the idle knowledge of the rules of the art, the practical aspect is the habitual and unreflective application of the same rules. It is difficult, if not impossible, to develop the practice without speculation, and, reciprocally, to have a solid grasp of the speculation without the practice. There are in every art with respect to the material, the instruments, and the operation a multitude of circumstances which can only be learned in practice [usage]. It is for practice to present difficulties and pose phenomena, while it is for speculation to explain the phenomena and dissolve the difficulties; from which follows that hardly any but an artisan who masters reasoning that can talk well about his art.[12]

Diderot went on to argue that, for instance, no levers exist »for which one could calculate all conditions«. Among these conditions are a large number that are very important in practice:

> From this follows that a man who knows only intellectual [academic] geometry is usually rather incompetent and that an artist who knows only experimental geometry is very limited as a worker. But, in my

10 Lorini: Delle fortificationi di Buonaiuto Lorini, Libro V.
11 Bacon: The New Organon, §II:iv.
12 Diderot: »Art«, p. 266, emphases deleted.

> opinion, experience shows us that it is easier for an artist to dispense with intellectual geometry than for any man to dispense with some experimental geometry. In spite of the calculus, the entire issue of friction has remained a matter for experimental and handicraft mathematics. […] How many awful machines are not proposed daily by men who have deluded themselves that levers, wheels, pulleys, and cables perform in a machine as they do on paper and who have never taken part in manual work, and thus who never have known the difference in effect of one and the same machine in reality and as a plan?[13]

4.5. Forty years later still, Immanuel Kant summarized this modern concept of »practice« with admirable precision:

> One calls a conceptualization of rules, even of practical rules, a theory when these rules, as principles, are thought of in a certain generality and thus have been abstracted from a multitude of conditions that nonetheless necessarily influence their application. On the other hand, one does not call just any operation a praxis; rather, only such a purposive endeavor is considered a praxis that is taken to be attained by following certain generally accepted principles of procedure.[14]

5. The concept of practice has to be seen in the context of the geography of our conceptual schemes in the general region of action:

5.1. A practice is something we *perform*. »Practice« is an *activity concept*. However, a practice is not simply an activity. When we talk about »a practice«, we are not merely talking about a particular activity, but of a category of activity (cf. the distinction between genotype and phenotype and phenotypic variation).

5.1.1. An activity has what Wittgenstein, in contrast to concepts such as »to understand« and »to know«, calls »genuine duration«[15]; *it starts and ends*. By contrast, like *knowing* something or *understanding* something, our practice of doing this or that does not cease to exist when we are inactive.

5.1.1.1. A *type* of activity does not cease when a particular *instance* of that type of activity ceases.

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13 Ibid., p.271.

14 Kant's original German reads: »Man nennt einen Inbegriff selbst von praktischen Regeln alsdann Theorie, wenn diese Regeln, als Prinzipien, in einer gewissen Allgemeinheit gedacht werden, und dabei von einer Menge Bedingungen abstrahiert wird, die doch auf ihre Ausübung notwendig Einfluß haben. Umgekehrt, heißt nicht jede Hantierung, sondern nur diejenige Bewirkung eines Zwecks Praxis, welche als Befolgung gewisser im allgemeinen vorgestellten Prinzipien des Verfahrens gedacht wird.« (Kant: »Über den Gemeinspruch«, p. 127.)

15 Wittgenstein: Zettel, §§ 71-83.

5.1.1.2. Note that the verb »to practice« signifies an activity, in contrast to the noun »a practice«. The relation is of course that one has to practice in order to master a practice.

5.1.1.3. The adverbial-noun phrase »in practice«, however, points to the internal relationship between »theory« and »practice«.

5.1.2. When we talk about »a practice«, we are categorizing a particular activity with respect to a criterion: a body of rules; we are talking about a *rule-governed activity*.

5.1.3. For an activity to be conceived of as an instance of a practice is predicated on its being a *regularly recurrent* activity. However, mere regularity is not a defining characteristic. The *criterion of identity* required for various activities to be considered regularly recurring (a type of activity) is that the activities in question are guided by the same body of rules.

5.1.4. On the other hand, when we talk about »a practice«, we are not merely talking about »a custom« or »a convention« or »a culture«. A practice is something one *masters* (or does not master). This makes »practice« different from related concepts like »culture«, »custom«, »convention«. One does not *master* a culture: one adopts a culture or is socialized into it. A practice is something one learns and thereby learns to master.

5.1.5. A practice is a conventional way of *doing* things.

6. The concept of »practice« is in an *internal relationship* to the concept of »theory« (»principles«, »procedures«, »rules«, »plans«).

6.1. Mere regularity in terms of patterns of behavior is not a sufficient criterion of a practices: what is required is normative conduct.

6.2. When we talk about »practice«, we are talking about activities categorized with respect to how they are normatively constituted: a rule-governed activity.

6.3. Identifying a practice in terms of a body of rules involves an abstraction from presumptively irrelevant circumstances. That is, not every action or operation in exercising a practice is rule-governed with respect to the practice in question. In chess, one may hold the pieces in any sort of way, just as one may close one's eyes when thinking about the next move, etc. But the rules define this practice vis-à-vis another practice, as the rules of, say, chess is what makes playing chess different from, say, playing checkers.

6.4. »Practice« and »rule« are internally related concepts. Rules presume competent action of the part of the practitioner, and the notion of mastery (competence) presumes rules as criteria of correct conduct.

6.5. The rules followed by practitioners are rigorously observable. People are instructed, trained, etc. Members may ask, »How do we do this?« Or they may say, »What are you doing? We don't do *that*!«, or »Sorry, my mistake!«.

7. The point of the concept of »practices« is to overcome or avoid the (received, ideological, institutionalized) notion of an absolute separation of conception and execution.

7.1. But the point is of course *not* to disregard the enormously ramified system of division of labor and specialization.

7.2. Practitioners are situated in the social division of labor and in so far as one focuses on a specific category of practitioners (e.g., defined by their having the same job or their belonging to the same profession), one can of course investigate the practices of workers thus situated. But the problem is that such a limitation is inherently problematic, in that one (invariably, perhaps) will tend to accept, implicitly, the scope of that »job« as determined by the »job description«, thus eliding »articulation work« activities of conceptualization, preparation, and evaluation that are not listed in the job description and perhaps not even routinely visible to members.

7.3. To look at work activities from a practice perspective requires that we take into account how their work activities are constituted: how are plans formed, how are plans agreed to, how are experiences accumulated, how are contingencies handled, etc.?

7.4. It is meaningless to conflate the concept of »practice« with the concept of a »job« or similar.

8. We talk about »practices« at different levels of aggregation or generality: A range of local practices may have commonalities that allow practitioners to move effortlessly from one setting to another and thus, by the same token, also allows observers to consider these practices as local variations of a general practice, or as members of a family of practices.

8.1. For an example, cf. the study of three oncology clinics by Schmidt, Wagner, and Tolar.[16]

9. The concept of »practice«, as a concept of competent activity constituted by »rules«, is inextricably tied up with the concept of »technique« in as much as the mastery of a practice, *in practice*, involves the mastery of a set of requisite techniques. One's mastery of the given practice is exhibited in the rational use of the techniques of the given art or trade.

9.1. There is no internal relationship between the concept of »practices« and that of »technique«. That relationship is rather a contingent one — and a very complex one.

9.2. Practices and techniques are categorially different. Techniques are applied, not performed.

16 Schmidt/Wagner/Tolar: »Permutations of cooperative work practices«.

9.3. Techniques are so to speak neutral with respect to the purposes for which they are applied.

9.4. By conflating technique and practice, much of the constructivist sociology and history of technology gets in trouble at this point:

> Computers as a materialisation of bureaucracy. Why did computers fit so well into the big managerial corporations and public government departments of the twentieth century? Because computers were made in their image. As a materialisation of bureaucracy and managerial capitalism, the universal machine was made like the world.[17]

9.5. Techniques are routinely appropriated for purposes different from the ones for which they were originally devised. These moves — I have used the term »lateral shifts«[18] are ubiquitous in the history of technology.

10. Practices develop over time, in response to experiences, changing conditions, etc.

10.1. The development of techniques (through invention, innovation, emulation, adoption, appropriation, etc.) is an integral aspect of practices (as is the development of plans, procedures, etc.).

10.2. Techniques and practices are inextricably intertwined. A new technique may make it possible to do something that previously was impossible or economically more or less unfeasible and may thus form the material basis for a novel practice or a transformed one.

10.3. A key issue in the relationship between work practice and technique is the issue of *cost* (»cost« here used in the sense of expenditure of human and material resources).

10.4. In *work*, in its ordinary sense as activities of the »realm of necessity«[19], cost is an overriding concern and, accordingly, the issue of cost is a ubiquitous aspect of the constitutive body of rule of work practices.

11. The term *technology* was originally coined to denote the science of techniques and associate studies of work practices.

11.1. As already noted, since about 1400, ordinary work practices have been subjected to systematic studies for the purpose of describing them for others to be able to emulate established practices as well for the purpose of understanding their rationale: why they work the way they do and, when relevant, to rationalize these practices or rather their repertoire of techniques.

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17 Agar: Turing and the Universal Machine.
18 Schmidt: Cooperative Work and Coordinative Practices, Chap. 11.
19 Cf. Marx: Das Kapital.

11.2. As stated in the preamble to the *Descriptions des arts et métiers* produced in the course of a century by the *Académie Royale des Sciences* in Paris, the aim was not merely to »examine and describe in turn all operations of the mechanical arts« but also and equally »to contribute to their progress«.

> The Academy expected that ›new degrees of perfection of the arts‹ would be achieved when scholars undertake the effort of investigating and developing the ›often ingenious operations performed by the artisan in his workshop; when they see by themselves the needs of the art, the boundaries at which it stops, the difficulties that prevent it from going further, the assistance that one could transfer from one art to another and which the worker is rarely expected to know‹. Subjecting work practices as they have slowly evolved from ›obscurity‹ to systematic study, rationalizing them, would show the competent worker a way to ›overcome the obstacles that they have been unable to cross‹, a way to ›invent new tools‹, etc.[20]

11.3. From »technique« to »technology«.

> Technology is the science of the transformation of materials or the knowledge of handicrafts. Instead of merely instructing workers to follow the master worker's prescriptions and habits in order to fabricate a product, technology provides systematically ordered fundamental directives; how one for exactly these ends can find the means on the basis of true principles and reliable experiences, and how one can explain and exploit the phenomena occurring in the process of fabrication.[21]

Technology, stated, provides ›complete, systematic, and perspicuous explanations of all works, their outcomes, and their grounds‹.[22]

11.4. »Technology«, in this sense, results from systematic studies of work practices with a view to identify and rationalize the techniques, and the techniques that originate from studies and rationalization of work practices.

11.5. The relationship between »theory« and »practice« becomes intricate in the development of science-based techniques, technologies.

11.5.1. It is tempting to say that what happens as a result of such studies is that the body of rules that constitute the practice expands. It would be better to say

20 Académie Royale des Sciences: L'art du meunier, du boulanger, du vermicellier, S. xvif.

21 Beckmann: Anleitung zur Technologie, oder zur Kenntniß der Handwerke, Fabriken und Manufacturen, p.19.

22 Ibid., S. 20

that the theory of the practice and of its procedures, tools, machines has been enriched: aspects of what was traditionally in the dark have been brought to light.

11.5.2. In consequence, procedures may be modified, tools may be ameliorated or replaced, new techniques may be introduced, etc.

11.5.3. Much (but certainly not all) of what has been conducted under labels such as »scientific management« from Babbage to Taylor to Toyota can be understood as examples of that.

11.5.4. Much (but certainly not all) of what has been conducted under labels such as ethnographic studies of work practices in CSCW and HCI can also be understood as examples of that.

11.5.5. But »theory«, however enriched, does not act: theory has to be put into practice.

12. We now *also* use the term »technology« as a label for *science-based techniques* that have their origin in scientific knowledge (e.g., semiconductor technology as developed on the basis of quantum mechanics as applied in solid-state physics).

12.1. Such techniques have may their origin in scientific knowledge but the techniques may or may not have been subjected to systematic investigation and rationalization.

12.2. Much of the work engendered by the development of computing technologies is strictly speaking craft work awaiting rationalization (e.g., software development).

13. Computing is a »protean technology« formed in practice.

13.1. Computing technologies did not come out a box, ready to »plug and play«. First of all, they did not originate from a particular body of mathematical theory; to be sure, their development has depended critically upon a host of mathematical theories (recursive function theory, Boolean algebra, Shannon's information theory, etc.), but their development was not the result of the application of any particular theory.

> As pointed out by the historian of computation Michael Mahoney, computer science has taken ›the form more of a family of loosely related research agendas than of a coherent general theory validated by empirical results. So far, no one mathematical model had proved adequate to the diversity of computing, and the different models were not related in any effective way. What mathematics one used depended on what questions one was asking, and for some questions no

> mathematics could account in theory for what computing was accomplishing in practice.[23]
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> That is, ›the computer‹ was not ›invented‹: ›whereas other technologies may be said to have a nature of their own and thus to exercise some agency in their design, the computer has no such nature. Or, rather, its nature is protean‹.[24]

13.2. It would be more accurate to conceive of this in terms of *costs* and thus say that computing technology is protean in that the costs of construction and modification of software machines are drastically reduced compared to those of previous machine technologies.

13.3. Anyway, according to Mahoney, for a very long period of time where the question »What is a computer, or what should it be«, »had no clear-cut answer«. The computer and computing thus only acquired »their modern shape« in the course of an open-ended process that has lasted decades.[25]

13.4. Computing technology is not a technology in the sense that it is a technique that has been put on a scientific basis or a rational footing. It is a complex of techniques, of which some are not well understood, while others have been rigorously proved (e.g., algorithms) or at least put on a solid engineering basis (e.g., performance calculations).

13.5. As a whole, computing technologies are the outcome of a series of innovative practice-oriented innovations: the construction of and experience with myriad practical applications, and a myriad of associated lateral shifts of techniques.

14. Interactive computing as fledged technologies.

14.1. Interactive computing was initially devised (in the development of Whirlwind and SAGE) as a digital version of the techniques of air defense practices. A US Air Force colonel at the time thus, justifiably, characterized the SAGE system as »a servomechanism spread over an area comparable to the American Continent«[26]. Techniques such as Graphical Interface and Direct Manipulation were developed so as to emulate the modus operandi of air defense operators.[27]

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23 Mahoney: »Computers and mathematics«, p. 361.
24 Mahoney: »The histories of computing(s)«, p. 122.
25 Mahoney: »Computers and mathematics«, p. 349.
26 Mindell, David A.: Between Human and Machine, p. 313.
27 E.g. Wieser: Cape Cod System and Demonstration (1953); Redmond/Smith: Project Whirlwind (1980); Wieser: »The Cape Cod System« (1985); Bell: »Toward a history of (personal) workstations« (1988); Ross: »A personal view of the personal work station« (1988); O'Neill: The Evolution of Interactive Computing (1992); Redmond/Smith: From Whirlwind to MITRE (2000).

14.2. The techniques of interactive computing were never derived from any preexisting theoretical knowledge. In fact, the techniques of interactive computing were later further developed and refined by computer technicians to satisfy requirements they themselves had formulated on the basis of principles and concepts known from their own daily work practices.

14.3. In sum, the techniques of interactive computing were initially developed in the course of a deliberate design effort (in the Whirlwind and Cape Cod projects), drawing upon the principles of »man-machine systems« based on experiences with servomechanisms. After that, the techniques of interactive computing were subjected to two decades of almost »arrested growth«. However, the technology of microprocessors, mass-produced CPUs provided a burgeoning platform of development on which the computer scientists at SRI, at Xerox PARC, at Apple, and elsewhere could extend, elaborate, and refine the principles of interactive computing on the basis of their own practical experiences.

14.4. Scientific rationalization (and yet further refinement) was developed *post festum*.[28]

14.5. Important paradigms of interactive computing applications were developed in the same way, as practical techniques, built by practitioners for their own use, and later generalized (but only partially rationalized). For example:

14.5.1. Computer-Aided Design (CAD) was primarily developed by engineers for their own use, especially in the automobile and aerospace industries industry and was later adopted by engineers in other industries and by architects.[29]

14.5.2. Spreadsheet: based on accountants' worksheet. (Visicalc on Apple II, 1979, etc.).[30]

14.5.3. Desktop publishing: The PageMaker design team involved a layouter in the key role.[31]

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28 E.g. Shneiderman: »The future of interactive systems and the emergence of direct manipulation«; Shneiderman: »Direct manipulation«.

29 E.g. Ross: »Oral history interview«, Interviewed by W. Aspray (1984); O'Connell: »CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing): Part I« (1987); O'Connell: »CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing): Part II« (1988); Ross: »A personal view of the personal work station« (1988), Ross: »Oral history interview«, Interviewed by J. E. O'Neill (1989); Ryan: »Oral history interview«, Interviewed by A. L. Norberg (1993); Machover: »Oral history interview«, Interviewed by P. Frana (2002).

30 E.g. Campbell-Kelly et al.: The History of Mathematical Tables; Grattan-Guinness: »The computation factory«, Norberg: »Table making in astronomy«; Swade: »The ›unerring certainty of mechanical agency‹«; Wilkins: »The making of astronomical tables in HM Nautical Almanac Office«.

31 E.g. Brainerd: »Oral History of Paul Brainerd«.

14.5.4. Layer order of plans and drawings (based on geometrical rules of projection) was presumably derived from draughtsmen's practice of transparent »tracing paper«.

14.5.5. The layer technique has later migrated to other types of computing applications such as drawing tools (Adobe Illustrator, Adobe Photoshop) and has been adopted by practitioners in professions that previously may not have used these techniques.

14.6. Again, important paradigms of collaborative computing applications were developed in the same way.

14.6.1. Communication techniques such as, e.g., file sharing, email, and instant messaging, were developed by engineers for their own use[32]. Although based on a science-based technique (semi-conductor technology, Turing's universal computer, time-sharing OS architectures, network theory, etc.), these techniques were developed in very much the same way as the techniques of the »mechanical arts« have been developed for centuries. And like traditional techniques, they were shifted laterally and appropriated for other kinds of practice.

14.6.2. The World Wide Web, developed in 1989 at CERN by Tim Berners-Lee and Robert Caillau, was initially also developed by engineers and scientists for their own use.[33]

15. Computational coordination techniques pose an entirely different issue. Existing paradigms (workflow management systems, scheduling systems, group calendar systems, etc.) are really (hugely complex) hacks and have so far eluded rationalization.

15.1. Computational coordination techniques pose a different issue because they cannot be developed in the »empirical« (incremental, trial-and-error) manner in which practitioners ordinarily develop and appropriate and have developed and appropriated techniques in the past.

15.2. In this respect, computer coordination techniques is similar to technologies like satellite navigation systems: techniques that are and can only be born as fully fledged technologies.

15.3. Only, computer coordination techniques still awaits the scientific work required to make these sorry techniques into technologies. That requires in-depth studies of actual coordinative practices in a large variety of settings, coupled with experimental development of systems, and is thus the task for CSCW.

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32 Cf. Abbate: From ARPANET to Internet; Abbate: Inventing the Internet.
33 Cf. Berners-Lee: Information management; Gillies/Cailliau: How the Web was Born.

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