Knowledge in the making: practitioner-driven systems development in a community

This work contributes to the field of information systems and examines how practitioner-driven systems development is shaped by long-term theories-in-use on practitioners' actual domain and community formation at grass-root level. The topic is approached as an in-situ infrastructuring process in a non-profit community where information technology (IT) is developed by non-IT-professionals. Such an approach to IT design is tentatively conceptualized as 'organic' infrastructuring, i.e. IT transformation done by practitioners whose work is conditioned by aspects of their domain, community and its raison d'être and realized in domain-specific IT developed continuously in everyday usage. The study shows how certain parts of infrastructures are difficult to approach by IT-driven design and demand the raison-d'être scope and practitioners' local expertise. Continuous systems development is particularly useful in communities of practitioners who seek new knowledge, work on open questions or with constantly changing topics.

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INTRODUCTION

Today practitioners have several possibilities to take part in and contribute to collective work settings: directly; indirectly; formally; informally; collectively; individually; voluntarily; and so on. Participation can be actual or perceived contribution [51] which may have varying intensity, motives and goals both temporally and materially. In spite of that, quite often IT systems are designed basically by starting from the viewpoint of design (design-drivenness) revealed by a number of design methods (e.g., participatory design, contextual design, user-centred design). Although these methods include 'users', they are also put into a role defined by IT design: they are 'users', who in many cases provide a contrast to IT-professionals. The gap widens further by too high abstraction levels used in systems requirements. From the viewpoint of actual work practices, practitioners' expertise and roles are usually defined via the raison d'être of their activities in relation to the domain, organization or work community where continuous reproduction of their meanings and knowledge in-the-making are aspects of everyday work. However, although the 'one standard fits all' ideology [45] and design first of all –thinking may be sensible from the viewpoint of IT-admin, management, and professional design, the more dynamic 'hybrid model' (ibid) and comprehensive domain-thinking often better suits the actual work practices.

Thus instead of emphasising the rather standardized conceptions of user-designer dichotomy based IT design (that is mostly studied in the field of information systems, too) and the commodity production as an ideal form [46] of IT design and use, in the context of organizational IT we should extend our research and design scope towards a more dynamic infrastructuring including in-situ design with domain-specific aspects and mutual learning. What this means is that in the practitioners' world there are many kinds of use activities, not only the one defined by IT use, usability and effectiveness measured as 'office work'. In addition we ought to define use also for the sake of developing knowledge of the practitioners' actual domain, communities and practices where diversity of theories and their practical applications are continuously creating new 'organic' offshoots of a social group [1, 21, 26].

Although we have diverse design methods, there are still challenges for dealing with practitioners' contribution to IT transformation and treating them as experts and developers of their core activity which is significant and inseparable from IT. Instead of the current design-driven methods and techniques for IT design, we should produce tools for integrating both professional designers and practitioners as 'infrastructurers' who share their object of work in 'infrastructuring' [45] activities. This sets challenges for practitioners, too. Their entry into IT production vitalizes the perspectives of design when systems under construction are meant to be used by them, in the context of their every-day work practices, and not by short-term interventionists, such as IT-professionals and researchers involved only temporarily in the systems development.

In this paper a practitioner-driven systems development is conceptualized by using an empirical case as a starting point for theoretical restructuring. This is done in order to increase understanding of aspects of such IT transformation which follows practitioners' knowledge-in-the-making processes in relation to their needs, goals and activities defined by them. Thus the topic here is to show what is the nature of theories-in-use, which direct domain-related practices in the long-term, and how they relate to systems development the significance of which is measured via the long-term success rate of knowledge-in-making processes in practitioners' raison d'être activities within their community, domain and field?

Based on the analyses of the case data, the topic can be categorized via three related lenses which overlap in a practitioner-driven systems development (PRAC): domain-specific, infrastructuring-specific, and community or practice-specific areas of expertise. Notions suggested by the data: theory-in-use (cf. [2]), infrastructuring [44, 45] and theory of practice [4, 5] as long-term phenomena are used to draw the complex change processes in a non-profit community where IT design is realized by practitioners. The following sections describe first the research settings and then the central features of the topic via the case description. After that the notions are framed for modelling the PRAC-activity by addressing how their overlapping aspects define such an area of systems development that needs an alternative approach to design, conceptualized tentatively as 'organic' infrastructuring via the role of IT in the unity of theory and practice.

RESEARCH SETTINGS

The work has been grounded on an empirical study of long-term knowledge-in-the-making and continuous systems development in a community of Karelian Bear Dog (KBDC) enthusiasts affiliated to the Finnish Spitz Club (FSC) which is a breeding organization of three indigenous Finnish hunting-dog breeds referred as "cultural heritage". These hunting dog enthusiasts interested in IT (non-IT-professionals) but even more in dogs, have developed a computerized IT system to use for their interest in breeding hunting dogs.

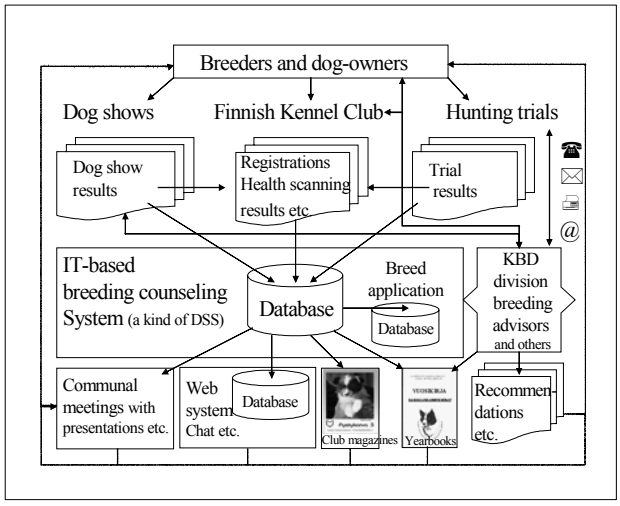

Figure 1: KBD community's interaction structures within FSC.

A basic interaction structure is outlined in Figure 1 and arrows show how practices are joined with information technologies and materials. In the paper, quotes identified by 'DB' stand for 'dog breeders', i.e., practitioners involved in this study as actual informants and/or their historical material. The focus is on both sociotechnical [43] and sociomaterial [46] working relations in IT and dog breeding practices with mutual learning seen through the dog-breeding lens. As an activity, KBD breeding is rooted in its own initially unstudied material origins and long-term practices inherited their theories-in-use from common breeding assumptions in the past and continuous work on open questions. For decades the knowledge-in-the-making of the practitioners' raison d'être issues within their actual domain and field has been the source of ideas capable of supporting the members' work on how to breed hunting dogs and its breeding infrastructure, while also shaping practices disciplined by the field of hunting dog enthusiasts.

The study unit following the ways of the activities in the field is approached as a microcosm community (McC) for analysis. It follows the temporal, spatial and material structures and is shaped via the selected informants by observing how members are positioned in the community's natural interaction structures. The McC has a scope outside the actual parent community and the organization and seeks to include objective and incorporated structures [5, vii, 31] in the field comprising of the historical construction of these structures [4] and the long-term scope demanded for the sake of natural processes studied. A set of historical material is thus needed to cover the historical context. Moreover, the McC covers also the body of knowledge for IT [24] transformation.

To be open interpretations of old organizational material [35] and the past world recalled by informants, the research data have been put into wider temporal contexts by following the central ideas of historical study methods, e.g. [16, 42] applied to information systems [34]. The "systematic approach" (a DB) adopted in the case community breeding activities is then constructed via the McC as a development of the significant historical activity system [12] within which the knowledge-in-the-making processes have evolved.

The author's membership (already before the study) of the FSC /KBDC (and in two other dog communities) allowed the ethnographic work [43] with McC members retrospectively and in real time. A significant part of the data has been gathered during field work in 2000–2004 by tape-recording thematic interviews and systems development/use practices and note-taking observations of domain related activities with McC members. All in all, two dozen persons were involved as actual informants in interviews, collaborative work events, and related field activities. The historical material has provided a long-term perspective of how the situation in the community has changed. The data contains several types of material from the past decades (books, club magazines, annuals, yearbooks) and the databases (cf. Figure 1) which contain data dated back to the turn of the 20th century. A stock of informal material (photos, letters, memos, emails, etc.) used in dog breeding activities has been collected from McC members.

The contents of the data have been analyzed as object-historical, information technology-historical and community-historical. The analyses have been supported collectively by qualitative data analysis sessions held at the University of Oulu 'in the company of trusting' [38, cf. also 20] participants and by protecting the informants' identity as agreed with them.

KNOWLEDGE-IN-THE-MAKING PROCESSES IN KBDC

The case community has evolved over time as the members have started to use, experiment with and transform IT alongside the ongoing development of the core activity: dog breeding. The members interact more or less regularly while participation is voluntary and based on personal engagement with dogs and the IT 'driven' by dogs. The unpaid work has been carried out for decades by the FSC's dog enthusiasts in the way of: "nothing has been done for the sake of IT or only on its terms". Thus, the 'core activity' is dog breeding: "dogs themselves have always set the requirements for development via the breeders" and the development and use of "information technologies (which) are just tools and secondary to the more important philosophy for which they are used." (Various DBs)

Through their self-developed IT, these practitioners have learnt to criticize their own conceptions of their theories-in-use in dog breeding by relating them to their practices and systems development. However, although the breeding system today "can produce much better dogs and much more rapidly and we also have got top-ranking 'super' litters in which every single dog has begun to bark at game", the trajectory line from common assumptions of dog breeding to KBD-specific breeding of a hunting dog has been quite a challenge. As suggested by the research data the work began to proceed in a more 'sure way' after the dog practitioners themselves took up the role of IT, too. It can even be said that the decades-long process of learning in and from practice and the self-made IT transformation has shaped the community to such an extent that the IT-system today is firmly intertwined in the dog breeding in the way of: "what would be left if the IT part of breeding was discontinued or separated into an isolated unit? … It plays such an important role and the practitioners' expectations are high." (Various DBs) The following phases can be identified from the systems development history.

Making of knowledge tools with unknown materials

The work with dogs started in Karelia (an area in Northern Europe, stretching from Western Russia to Eastern Finland) and the breed dates back at least to the 10th century and its early associations have been with hunting people. The dogs portrayed - "It fed the family, gave drink to the tribe, supported the forefathers" - were brought into "systematic breeding" by Finnish hunting dog enthusiasts. In the early 20th century the early phase of the breeding was: "Without knowledge of its background and without studying it, the KBD was accepted here as a dog that hunts big game… an elk-hunter" as other big game were sparse. The breed was officially recognized by the Finnish Kennel Club (FKC) in 1936, and the goal of "creating a sturdy dog that barks at big game" was set as a guideline. However, the work on the breeding standard took over eight years and more difficulties were met as the breed nearly was destroyed by a war, and another war ended with the loss of the part of Karelia to the Soviet Union which cut off access to the vital breeding stock. (Various DBs)

After the wars, the KBD community was created to keep up the indigenous breed of dogs. The first epoch-making turn can be identified when the hunting trial system was created as the breeding standard and dog shows could not guarantee the quality of dog material and guide the breeding activity appropriately. The first trial was held in 1945 and the results of these tests (and shows) have been saved in breeding databases. All this data are available via the web system, too, and in a similar way, today the community also collects information from bear hunting tests and from the health checks (since the 1990s) maintained by veterinarians and the Finnish Kennel Club which offer data for preventing inherited defects. Today most of the dogs are an essential part of their owners' families and free-time activities, such as hunting, dog shows and hunting trials, where the actual hunting event is imitated, enabling dogs to tests their skills in the wild.

In short, the historical and societal 'facts' have laid the ground both for the enthusiasm of KBDs and the sociomaterial long-lived inbreeding practice: the "best results can be achieved when the dogs are relatives" (the idea of how to produce pure bred animals is valid in 'dog worlds' at large [18]). Today: "there's no turning back to… inbreeding", the inbreeding method (theory-in-use) was earlier supported by 'collectively made facts' [30, 145]. Its mode called "line breeding" was the best known breeding method in those days; in spite of that it was the most disputed method "since the era of Aristotle" serious alternatives were sparse: "we knew of no better method at the time"; material resources were both unknown and limited; existing knowledge supported more breeding of dogs' visible than invisible qualities: "in the early years the results were more evident in the development of conformation than in hunting qualities". But, these inferences were not made until the 1990s as "the structural conditions of reflexivity" and "non-social structures" [29, 120] were developed with the mode of information used in KDB breeding. (Various DBs)

Making of feedback tools: IT for dogs and dog people

Up until the late 1980s there was only a manual system in use in KBDC and in the FSC (some breeders had individual files, too) but the FKC has a computer system. The number of registrations in the 1960s exceeded over a thousand new dogs per year, and a lot of data from trials and shows were accessible for breeding. It was however difficult to use because of different forms and formats and the "pen and paper" based system was found too ineffective to process all the data. So, a large part of the data remained untapped and quality analyses on success of the entire breeding work could not be made. In the early 1990s, after fifty years, the breeders were still unsatisfied: "top breeding dogs were scarce" as all potential dogs could not be identified from the big mass. (Various DBs)

An important step was taken when the FSC started to develop its new database in 1987 in order to facilitate annual publishing work (chiefly books on the results of hunting trials, dog shows, etc.) and give better tools to "people (who) can get more objective information about how things really are." The challenging goal of the database was set as only the best results, the top dogs, were better recognized by individual members and by FSC's public media. The KBDC introduced the new system in 1990. "The KBDs' system was at first only a reduced version of the 'red' dogs' (Finnish Spitzs) program" but it has been developed by new more KBD-specific functions and sub programs, e.g. "dozens of statistical functions" but "in my mind we don't have any useless statistics, rather there should be even more." (Various DBs)

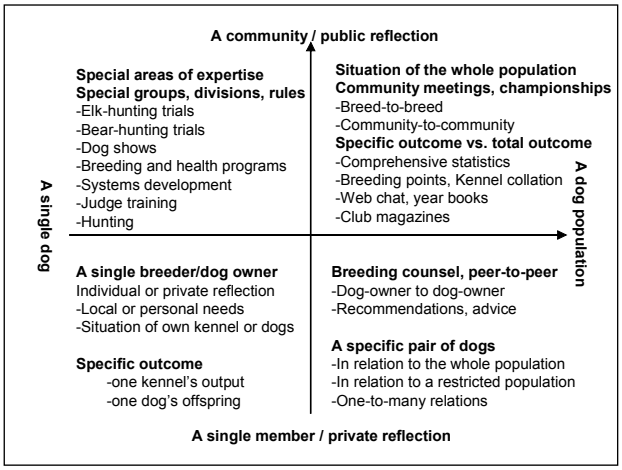

Figure 2: Scopes of materiality and reflective practices

Moreover, "we also have tools for those who are not so well informed about breeding matters" and "issues published in the club magazine, information given in FSC's meetings, the web system, and so on have a great significance also for those who do not contact the breeding counsel directly." As "work done with KBDs is in full view by the general public, too" it is available for browsing, discussion on the web chat, at face-to-face events, and to be used as asset in dog breeding (cf. Figure 2): "I can understand why people are interested in the Internet. There have always been people who want to know everything right from the very beginning, from 'the time of Adam'. Now they have the possibility and can make their inferences by themselves, too." (Various DBs) Today the system contains several tools and channels for the needs of individual members, breeding counsel and related responsible groups in FSC.

There is an eagerness to use the available knowledge resources and to learn from the practice: "I am an old man and never liked computers and IT. Well now I have bought a PC… because there is the Net system with pedigree programs and useful things." "You can see whose dogs bark and how good the results are (also) on the Internet… people do not need to act at random." But "we still need yearbooks… all of us do not have mobile phones or PCs… not all are Net users either." All this "has influenced the dog buyers' behavior. I have noticed that during the last couple of years." "Those who benefit most are the rank-and-filers and small-scale breeders" who "have learned how to play the game." "Now we are working for new dog buyers as they have to get good dogs, too." (Various DBs)

Also the IT practice itself is reflected and common sense criticized: "Geneticists of course do not acknowledge this kind of sense-making and take our ways of inferring the conclusions as nonsense… the hunting trial based method as unreliable. The fact is that all the features cannot be found in this way… the effects of the environmental factors have to be taken into account every time. We have tried to include them into computing… calculating the means, indexes and so… the practice shows that we have learnt to separate good and bad dogs for purposes of practical breeding work, accurately enough by processing the trial data… using samples wide enough… At least with this kind of system we can produce much better informed ideas than by the earlier system dependent on personal feelings" (a DB).

As a result, enabling tools are meant to support not only the technical or 'office work'-like activities but also the critical, intellectual activity that exists in 'everyone' [1, 22, 26] as was set in the goal. The current breeding system is trusted among members [47] in supporting KBD breeding towards the community's original goal. The transition of technology from individually held files to the integration of old and new technologies with shared archives and web tools has brought the system available to all members. It incorporates several social and technological structures in such a way that the system can account for both the entire community within the field and be locally adaptable for each breeder or dog owner. Through this dynamic reach from global to local practices, including the temporal scope, from history (an analysis base) to the future (design of new pairs of dogs) it embodies the performative nature of infrastructures [45] but in a particular KBD way as IT for KBDs and their breeders.

However, developing of community structures had to be involved simultaneously as they were tied up with the long history of usage of inbreeding. In this work members in charge of guiding the breeding needed "to have a sense of the history of the game" [5, 80] and both the new system and the experience on KBDC practices were involved. The following account describes the redirecting process in the community.

Shaping community structures via breeding methods

When KBD breeders started their work, "in the early years the results were more evident in the development of conformation than in hunting qualities. Close inbreeding was used… in lines". Later, interest toward the new breed meant that "breeders who did not much care about a hunting dog were continually joining the breed". Others, more 'knowledgeable' breeders were "long-line bear dog men", owners of "hidden knowledge", some "absolute true to the own dog-stock" and even "architectures of own fortune in dog breeding". There were also "breeders (who) were blowing their own trumpet about how good they were in breeding… by sending anonymous critical letters about others, also addressed to the Kennel Club". However "most men were less noisy and could have a good grasp of matters" and later many of them proved to be the driving force behind the change. (Various DBs)

Then "some hunters began making complaints which were accurate in so far as every individual dog was not necessarily suitable for hunting in the desired fashion". In some kennels decades-long work could come "to a complete standstill", "bear-dogs' game-bloods disappeared from own kennel" and even handsome dogs were returned back to breeders by hunters as totally game-free". Although "the emphasis in breeding was switched from one aim to the other", so, by using more dogs with 'known' hunting ability, the inbreeding method remained the same. After fifty years the results were still unsatisfactory: "the peak was a narrow one" and "public opinion was not so convinced that the KBD could be a good elk hunting dog on a larger scale". As practical experience seemed to have disappeared "in the heads of old men", the rest of the assets was "a sackful of papers" and "hidden knowledge of old-timers." (Various DBs)

After using and further developing the database by new statistical tools, members in charge of breeding guidance were able to conclude that: "line breeding was used for too long and eye disease came to the surface again." But "we couldn't see that then"; "we knew of no better method at that time"; also "top breeding dogs were scarce" and "we did not have a system… only pen and paper." (Various DBs) The change in the long-lived, habitual inbreeding practice got a new impetus after the new database was put into use. It revealed at least partly the practice's incorporated structures and quality of breeding results, as a whole, via dog pedigrees, trial and show reports inscribed in functions of the database. The epoch-making step was taken as the "Breed" (a program to calculate a coefficient of inbreeding (CoI) via the "path analysis" [50, 299] was integrated into the database (cf. Figure 3).

A breeding recommendation procedure for a female KBD (shortened) in the IS

```
define global "E", "S", "A" Number .        (global attributes)
assign global  E := data-entry eh-test      (elk-hunting trial results)
assign global  S := data-entry show .       (dog show results)
assign global  A := data-entry year .       (a limit for ages of males)
run procedure  "M-1" .                      (M-1,2,3 = male selection procedures)
run procedure "M-2" .
call program "C:\breed\Relation.bat /P:Relation.txt /B:110".
    (Relation.bat starts the Breed application, calculates CoIs (%) with male
    candidates and saves results in a temporal text file; 110 = a KBDs' race code)
import "RE-IN" .                            (results back to the procedure)
run procedure "M-3".
reorganize "Males".        → user activities, selecting 3-5 final candidates
for Males with H = data-entry Pevisa and Total <= data-entry eh- test and P = data-
entry show;                                 (H health, Pevisa = health check results)
list records Reg;                           (Reg. = dogs' identity no)
run data-entry Female.     → print out recommendations with quality criteria
```

Figure 3: A piece of breeding recommendation procedure

The restructuring of local breeding practices was quite a job as: "the most sceptical ones did not even believe that the Breed tool could be useful for bear dogs" as breeders trusted the line inbreeding as a means to produce good dogs. The slow transition in breeding practices was initiated by a thorough analysis of the dogs' CoIs and hunting trial results and statistics were presented at FSC meetings, repeated in one-to-one counselling events and published in the club magazine. Gradually this work focused on the too close inbreeding approach and reopened the health risk question and finally "opened up the eyes of many breeders". From then on, the community has given up inbreeding, and information technologies have been incrementally developed alongside the more extensive change process in the dogs and breeding practices. The system contains hundreds of functions, sub-procedures (etc.) joined together via 'partial translations' of IT to dog practices and vice versa, through learning maintained by the open code: "I always look at what others have done" and "by computing as participating in… meetings." (Various DBs)

The open code (partially translated into English cf. Figure 3) demonstrates how vast is the social system which produces a new KBD-litter for the needs of hunters in Finland. A person who is familiar with hunting dog breeding can quite easily find the names of the field's systems (eh-tests, shows, 'pevisa', etc.) and what happens between actors and what the breeders/owners of bitches get, and how these interaction 'loops' are involved and tested continually. The same structure is used to measure the progress of the whole population by statistics. It shows progress, about the dogs' CoIs, their revitalised abilities to hunt (an original feature of all kinds of dogs) and get "satisfaction… from the fulfilment of a possibility" [19, 52] as an original hunting dog.

Regarding the social transformation process the breeding method in use (also inscribed in functions of the database) is the social theory-in-use through the community members' collaboration. In complex ways it relates to the breeders' responsibility for their dogs' vitality in the gene exchange defined in the breeding process and via their owners' activities in the entire field, the society. Hence, "if we notice that we have made mistakes, whitewashing is not the solution. Instead we should study where the defects come from so that we can avoid further mistakes" (a DB) in planning of new dog pairs.

Materially, "preserving diversity is one of the most important methods in KBD breeding" and "now breeding is founded on knowledge… not based on guesswork anymore." Although "some breeders want only to go on with their own dog-lines, the same they have used forever… on the other hand, we let the boys try as it is interesting to see what results they get even though their dogs are not 'in' at this moment." As "if the dogs don't reach a good standard, few will want to buy their puppies." So, the "breeders have learned a lot in the course of the years" and "when the dog is healthy, has a good appearance and conformation and it barks at game for the full time - that is the breeding dog's quality standard". (Various DBs)

All these principles are also written in the KBDs' breeding program which identifies the breeding standard, the rules of hunting trials (etc). They have been derived from the reality of the hunters and dogs in their natural environment and actually contain relevant qualities of an ideal hunting dog, also in the sense of theory-in-use for KBD breeding.

Summary: the mainstays and development steps

The known features of dogs and the practice have been put into the database step by step: "we did what was needed in practice" and "it is just what we need" (two DBs). This dog-driven IT design enables the development of long-term theories-in-use both in 'technical' tools and in breeding practices and allows a continuous study of consequences of both systems. The important role of the members is acknowledged, not only as IT-user but also as dog buyers, breeders, participants in trials, shows, meetings and other related activities.

In changing the breeding practices, the members' relative positions [5, 5, 31] were affected by the dogs each one has bred or owned (cf. 'capital' 70, 107). Active participation in the field is valued: "There have to be people who are in touch with, who know about the dogs. One has to have a personal relationship with dogs… to be active, either to own a dog, to participate in dog shows and hunting trials, or to be a judge. Then one knows, in addition to the computer side, also the other side." Hence, they maintain that "we absolutely need persons under whose direction the whole system works… as mainstays of the community… who the field respects deeply… as they know the matters… who look after the things in the field… usually they do not need to push anything" (a DB). This 'social capital' [5, 70, 107] is needed as members in charge of breeding guidance have to balance tensions in relation to members, other communities and organizations in the field in order to further the 'shared' capital: "In my work I have aimed at furthering the common good for the Karelian Bear Dogs. Trials and everything else, like rules, generally they serve to make bear dogs even better than they are now." (Various DBs)

The above implies the raison d'être of the current breeding system of which an essential part is the dynamic relationship between objective and incorporated structures. Dog-practitioners' artful grasping on the members' dispositions, and their reflective practices supported by self-developed systems and tools have shaped the KBDC structures in a way that breeding work can evolve continuously but "we need IT and involved members to take care of the tools - otherwise the FSC cannot serve anybody" (a DB).

The following account illustrates how dog breeders have realized their role as 'organic' infrastructurers, as 'constructors, organizers and persuaders' within the field [1, 21, 26].

Theory and practice: By keeping in mind that for dog-practitioners dogs are 'the flesh and the soul' [18], they as enthusiasts of IT and of dog breeding have been able to create culturally possible feedback processes for the community. This has laid the foundations of the breeding practice which is today based on knowledge, responsibility, and sustainable care work [25] for the significant hunting companions. This new kind of bond of producers (work with materials) and the social organization of knowledge [26](including work with the 'bits') has been created by joining the past and the current systems together through structures following the real world's systems. Every dog registered and their participation in trials, dog shows, health checks, and so on reshapes and brings new structures which show how actors move in the field, with whom they act and so on. These structures allow then an indirect measurement of the changes in dog breeding practices which then help to guide the breeding process through the system also relating it to the common good. In the implementation of the long-term theories in use for sustainable breeding work, three essential steps can be identified in the KBDC's redirecting process:

First step: fixing of the foundations for KBD breeding. In the late 1980s the situation in KBDs was described: "the peak was a narrow one" and the breeders were still suffering from a lack of good breeding dogs. Given this situation the members reasoned: "if we want to have elk-hunting dogs, breeding dogs should bark at elks and their external appearance is less important". The KBDs' essential feature was fixed permanently and other factors became comparable to it without changing the emphasis: "The starting point is that a dog barks at game and is healthy but it is not a hunting dog without hunting ability", "for a hunting dog its 'game-blood' is the starting point… it has this quality and uses it at its own will is the core around which health, appearance, and other features are bred by serving it". (Various DBs)

Second step: a rational use of available resources. As the community could use only those dogs available in the field, some of the desired features were defined at first only marginally. Though the revealed quality of dogs as a whole "was not as good as expected", nothing has been rejected without a reason. As the members began to understand that the source of many problems was too high inbreeding: "Some very popular males could be found in the pedigrees of almost every dog", with the help of the Breed tool these "bottlenecks" have been reduced. Highly inbred dogs were bred with distantly related dogs when possible, but not without testing the hunting capacity: "we needed a… sure way…we've got to continue in a gradual manner". Later dog pairs were planned so that both males and females were tested in hunting trials. (Various DBs)

Third step: creation of measurable, bound, practice-specific indicators. New elements are included in the breeding system as soon as their qualities are well recognized and made measurable. These have been formed by relating specific output (cf. Figure 2) to the total output and by taking into account the nature of the domain, so: "to find out as early as possible the ability of the dogs to pass down their hunting qualities to offspring" and not in hindsight "after their breeding age has past" (a DB). The precondition for this is that the total output is measurable in relation to relevant features.

The strategy (cf. "the art of anticipating the future of the game" [5, 25] is developed by long-term and large-scale planning, the objective of which is to manage the breeding situation more comprehensively: "when I plan a new dog combination, I also try to think how this can help the future of the whole population" (a DB). Thus, if you are able to locate and know the entity through which you work, it makes it possible to make decisions in relation to the entity, to further its future and guide it towards the common goal.

The tactic ('what is to be done in a given situation' [5, 25]) is adopted for local and short-term action through which the strategy is put into practice. Plans and advice have to relate to 'the two-way relationship' between 'objective structures' and 'incorporated structures' (ibid, vii). This should be done within the culturally and historically shaped activity ('to have a sense of the history of the game' – 'which is inscribed in the present state of play', ibid 80, 25): "There always are all sorts of things between breeders… I have learnt their dispositions… you know what ideas they accept… how they react in suggesting breeding pairs… though we would have a suitable dog in some place another man might not accept it if something has happened between the men... the assumption for a successful breeding work is that you know the folks" (a DB). Kind of 'practical sense' makes the breeding process go in practice and according to the long-term strategy simultaneously.

The success of the strategy and the tactic is measured by statistical tools via the infrastructure. The tools allowed comparative analyses of the realized 'normal' quality in grass-roots activities and not only in relation to the top results: "It had to be irritating for those with poor results to be told this statistic" but after the breeders got used to the new tactic "many breeders were longing for feedback". As members got better results when applying 'the sure way', the success was received "with great enthusiasm. All the details were welcome. No matter what the topic is or what sort of statistic was presented, everyone wanted to know which dogs have succeeded and how well." Even the creators of statistics say, it is "a stern way" to guide members (cf. [1]) but they also reason that "the game is hard" in the field, and "today KBDs are on a level with other breeds." Gradually resistance against measures were removed and the 'critical' activity capable of evolving the breeding practice continuously provided a "systematic and goal oriented approach and continuity" as the "planning became more sustained and long-term." As "it is clear that people want KBD to be a successful breed", in the end it benefits the dog business, too. (Various DBs)

In short, the above account shows the unity of theories-in-use and the practice via the infrastructure, and these overlapping notions can be used to frame the activity as whole.

THE NOTION OF LONG TERM THEORY-IN-USE

In [52, 129]: "Although the labor of men and women to improve their world is rooted in the material conditions of their era, it is also affected by their capacity to learn from the past, to imagine and to plan the future", gives support to this work. The case study has revealed that long-term theory-in-use can be understood as forming a shared, integrated, and conceptual knowledge-base which is dynamically used and tested in everyday grass-roots practices. In supporting the actors' work', it is used in object-oriented activities in communities of practitioners [8, cf. also 29, 32] where access to resources and power relations also shape the community structures [9].

In terms of common sense, long-term theories-in-use are often considered as something 'not seen but known' as they are 'internalized' in processes of doing and knowing and through long series of developmental events [52, 132]. In several ways they are influenced by the social and material environment and form the mental [49] and practical foundation for everyday action as socially shared and rooted in the culturally available world. As adults have long personal histories, the stimuli which finally can change their understanding may differ from younger learners' practices, but are also tied up with "the tools of thinking available" [52. 126]. As the case shows, these tools should be linked with the practical raison d'être activities if the aim is to support sustainable development [cf. 1]. At the level of action we may see changes in participation [31] but the long-term success only in qualities of results of work that has practical value for actors' socio-material production processes. Reflection, care, relevant feedback and meaningful bounded knowledge indicators are involved in these processes [cf. 41].

In an analytical sense, the case confirms that 'there is nothing done without reason' [5, 85]. Usually people do not act randomly but the inside, shaped by relational positions and situated power relations, affects their work and theories in use: "every relation of hegemony is necessary an educational relationship" [1, 212]. However, as the case implies in communities of practitioners where sociomaterial production is the shared interest, power play per se is not the main intent but development of the raison d'être activity. It is the 'practical reason' [5] and includes the 'shared meanings' and the 'community knowledge' made possible by 'living in the same world' [29, 157]. All this is needed 'in order to reach agreement' [11, 254] in collaboration and to produce outputs needed and valued in the community.

In this sense, grasping the historically located aspects or purposefully hidden working relations or issues influencing new ones often require more intensive, longer-lasting, active participation in practices under study and may be out of reach by short-time 'interventionists' [2, 158]. Often work with a body of knowledge and knowledge artifacts [23] used by practitioners in their collaboration are needed to gain an understanding of which of them are considered relevant tools.

As we consider that a theory-in-use is a tool [13] put into use by adding knowing to knowledge [10], regarding the interrelation of tools, object of work and its goals, the case suggests that it is basically valid only so far as the qualities of both objects of work and of the mediating tools are recognized consciously. This in turn holds in so far as some new quality is recognized in such a way that it can challenge the prevailing situation. Only after conscious recognition qualities of the tools (conceptual or material) or the object of the work, tools can be further developed or changed; otherwise unrecognized qualities continue their search and cause problems. One way to reach beyond these 'invisibilities' is learning *in* and *from* the practice where continuous change, related activities, and dynamicity are the underlying features of the knowledge-in-the-making.

Hence, as self-developed tools with specific cultural-historical roots in practitioners' practical activities theories in use unfold through the certain sociomaterial production disciplined by the certain raison d'être of the collective activity around which practitioners are gathered on purpose. Through practitioners' work, long-term theories-in-use are exhaustive enough and 'public' [23] as they enable satisfactory collaboration. Their applications have usually longer-lasting consequences inscribed in practices via tools, systems and materials.

THE NOTION OF THEORY OF PRACTICE

By assuming that a concrete world with particularities exists, we should try to reach beyond the 'everything is relational' via local theories-in-use (particularities) and learn how practitioners shape their 'social network… with the aid of which' they have done their part of the work' (a DB). As human cognitive activity is "not limited to the use of tools or signs only" but includes also the capacity to externalise and share understandings of shared experiences with others in sociomaterial processes [52, 55, 132]. How people create their practices and the shared meanings, which as 'social' or 'symbolic' capital' [5, 70, 107] can relate the particular individual setting to the shared collective setting, result often via complex historical accumulations of working relations. As we only can trace those relations, which leave permanent 'signs', the practice may also come across as 'irrational' instead of that it has originally had 'practical reasons' [5] and sensible logic, affected by the economy of reward systems capable to maintain reproduction of practices.

Therefore instead of judging the historical actors through the length of networks [30, 259] viewed via the lens of current knowledge, we should be fair to them by placing their undertakings in the wider spatial and temporal scope. By relating their situation to the materialism and ideologies of the time, many aspects of 'irrationality' may turn to rationality of the historical era. In this way, the cultural-historical meditation of tools gets also practical, materially bound explanations, e.g., of how "capital finds its way to capital" [5, 17] and that people can create social capital and invest it into new collaboration, which can even up 'the game' also materially.

Theory of Practice [4] at grass-root level includes such key aspects as field, habitus, and capital. Field is "the global social space, that is, both as a field of forces, whose necessity is imposed on agents who are engaged in it, and as a field of struggle within which agents confront each other, with differentiated means and ends according to their position in the structure of the field of forces, thus contributing to conserving or transforming its structure" [5, 32]. In their social space participants have relative positions and dispositions which refer to how agents orient themselves in the field. An orientation instrument is a kind of practical sense, "an acquired system of preferences, of principles of vision and division… of schemes of action, which orient the perception of the situation and the appropriate response… what is to be done in a given situation – what is called in sport a 'feel' of the game… the art of anticipating the future of the game, which is inscribed in the present state of play" (ibid, 25). A participating individual can be seen acting like a strategic player in her or his social space and is simultaneously the collective actor whose subjectivity is socialized by habit [6, 126] and shared meanings.

Capital contains several forms from economic to symbolic ones but the divide between different types of capital is dynamic in the sense that each form can have varying meanings, roles, and values to such a degree that exchange from one form to another is possible. For instance, information capital [5] of which one dimension is cultural capital deals with such issues as concentration, treatment, and redistribution of information which is maintained by creating instruments (e.g. infrastructures, databases, mass media, libraries) for institutionalized accumulation of knowledge. Often this includes codification systems of results of action for processes of sort of unification. In this sense, culture is "unifying" (ibid, 45) of behaviour, language, communication, norms, recipes, rules, and so on (cf. also artifacts, conceptual or material, as fundamentals and constraints of culture [7, 181]).

Although 'unifying' today is multi-cultural as the current society is represented oftentimes, cultures still have their own 'inbreeding systems' with closed superstructures difficult to enter from outside. One such embodiment is professionally (i.e. culturally) [46] specialized expert systems (e.g., IT-designers vs. users) with 'knowledge workers' and the inherited patriarchal system of management (see also [21, 26, 29]). Conversely, when people live within some culture by adopting the fundamentals, shared meanings and collectively made facts, they do not start to question such principal issues straight away. Rather more commonly the fundamentals will be taken for granted until some important factor challenges them.

However, as the case addresses and gets support by [29, 120], many times such an awakening is influenced by the lack or existence of tools for reflective and critical function which in turn is joined with IT production structures. Only those who are well informed by and sufficiently familiar with IT production languages can more easily benefit IT structures and participate in their development, and the same hegemonies will be reproduced once and again. This is the case in IT use and design, too, and the domain expertise where logic is rooted in "the force of shared meanings and habits" [29, 166]. In this sense 'shared meanings' are not just positive forces but without certain consensus collaboration do not happen at all.

The way of how to change social practices is thereby connected to "the two-way relationship between objective structure (those of social fields) and incorporated structures (those of habitus)" [5, vii] which contain in complex ways also the construction of these structures [4]. However, the complex insiderness within these structures makes practices quite challenging to enter, and if they are only approached via their objective structures practice can be taken as 'irrational' or corrupted by 'espoused theories' [2, 11] ('espoused practices').

As the case addresses, recognizing the ensemble of social structures inside each other is challenging but also necessary for successful re-orchestration. Although some reason or relic beyond the activities may be difficult to see, they exist somewhere and often the only way to find out is to participate in the practice in one way or another. Sometimes such reasons may be difficult to fully comprehend even by the people themselves [40] and demand an outside view, as was done in the KBDC.

Thus, as the case illustrates the 'outside' factor can also be crated 'technically' by developing the IT systems 'from inside'. Moreover the 'insiderness' in systems development can be seen as the necessary condition for transforming the case community's social practices, in the first place for the reason that 'money was short' and secondly that it brought the trust and acceptance and new domain-expertise via the IT and increased 'social capital' [47] that were then invested in new dogs into the field. As this investment produced better results, it gave a new impetus to the practice-oriented design and vice versa. In this place the work gets support from the notion that understanding technology 'from inside' "both as a body of knowledge and as a social system" [33, 198] brings benefits in a business sense in a domain and is appropriate in IT, too.

THE NOTION OF INFRASTRUCTURING

The claim that the design of technical systems is a process of inscribing knowledge and activities into new material forms via 'partial translations' and 'artful integrations' [46], applies to IT design, too, and gives support to the case [25]. At the heart of integration is the sociomaterial relations of multiple, heterogeneous issues and the collective, situated interweaving of people, tools, and processes that make up the working relations needed for, and sustain the visible and invisible work required in, the design and use of technical systems.

Instead of a vision of a single technology that subsumes all others, there is an assumption about the continued existence of

hybrid systems as parts of infrastructures [44, 45] composed of heterogeneous media, material and practices; not hegemonies, but artful integrations. From this standpoint, change is a part of everyday practice, not licensed act of interventionists. The statement of continuity in turn challenges 'radical' technological change and asserts new forms emerging through juxtapositions and connections of existing forms. If technologies are to be made useful, practitioners must effectively take up the work of design [46] by appropriating [37] technologies into their environment and set of practices.

The above case denotes that the actual or perceived value of technology in use is measured basically as 'local', so, when some resource is put into use as a tool. When technology is working as expected and satisfying its real or perceived definitions, all this creates an effect that the technological infrastructure in use disappears [44]. It, in one way or another, becomes invisible until some unexpected (real or perceived) breakdown makes it "not accessible" to the local actors and for their needs. What finally awakens 'infrastructuring' is then such a lack of work infrastructure [17] that practitioners cannot continue actual work in a sensible way. As the case suggests, in complex ways there exists interplay between domain-specific knowledge-in-the-making processes and infrastructuring which overlap (cf. [3]) and causes these aspects of work to be inscribed in practices via tools, systems or materials at hand. In systems development domain-expertise is then needed if the aim is to somehow, at least 'partially', translate these into IT.

Thus, what finally 'makes' the technological infrastructure is not its existence per se but the use activity through which the available resources are put into practice in forms of tools, processes and related 'know-how' of when, how, with whom, for what purposes or why some technology is used. All this consequently illustrates that infrastructures in use have an ability to partially create the world they attend [45] but the case suggests that basically this is possible only when they are firmly intertwined with the practitioners' domain. Moreover, it is the raison d'être of the work community (within its actual field) which embodies the actual interest of practitioners to contribute to IT design. For this reason not only the infrastructure in use itself but also the infrastructuring gets the tentative, flexible and open character of which one essential part in-situ design is as it is capable to implement old and new relations of the work community into new material forms.

What can be seen in the case account is that these kinds of sociotechnical relations defined via the raison d'être of communities of practitioners are difficult to support by outside-driven design. In this sense the case also suggests that from the viewpoint of design and research the definition of the salient features of infrastructure [44] gets more structural and analytical power via the object of work defined in the way of practical activities. Hence, it is this continuous interplay between and within different sociomaterial, sociotechnical and organizational levels (including invisible layers of control and access) through which new tools, systems, and technologies are integrated into existing practices in communities, and via them into the domain and field in question. All this maintains the 'installed base' inherited from previous practices and systems in good and harm, for the sake of which continuity is occupied.

As a result, design, use and other forms of 'doing' intertwine with each other in infrastructuring. They form the actual, historically shaped work activity that is linked together via available technologies and resources into the wider domain-oriented raison d'être activity of the work community in question. In this sense, how infrastructuring happens in situ is heavily influenced by the aspects of localness, the infrastructural layers in which the need for change exists in the first place. These local particularities then "involve materials, tools, work processes, and products of which outside designers have no prior knowledge" but in which practitioners "working at the particular organization have received many years of training" [27, 221] and not only as users but as practitioners.

Participatory design approach may thus be a good starting point for in situ design as continuing its work toward the raison d'être of practitioners [14], collaborating via actual participative practices [39] and including aspects of community evolution cycles [36]. Activity-centred design [15] extended beyond the level of action and tool usage per se [28] demands both a temporal and spatial scope via the active mode of infrastructure [45], and the continuity and care work [25] maintained by the grass-root practitioners rooted in their community, domain and field in the overall culture and society.

The work described here is also in line with [30, 259] who claim that rather than by tackling science, technology and society as separated, they should be taken as interrelated, as "understanding what facts and machines are is the same task as understanding who the people are". What the case signifies especially is that this understanding of people should also reach beyond grass-root activities, and the idea clearly driving the systems development in the case community. The challenge then is: we also have to learn to understand the practitioners as practitioners, not only as users, in activities defined by them of which significant part the IT should be, not vice versa.

CONCLUSIONS

The work examines a practitioner-driven systems development which contains three base 'systems' developed in interrelated knowledge-in-the-making processes: a domain-oriented body of knowledge, a field-oriented social-system and an activity-oriented IT system. These together shape the change process that can be grasped as domain-specific, activity-structured and practitioner-driven IT transformation disciplined by the raison d'être activity of the community and continuous everyday knowledge-in-the-making. Through the case described here, the paper shows that the tentative, flexible and open-ended systems development acquires its 'organic' nature in the sense that the activity is profoundly disciplined by practitioners' theories-in-use on domain, community and its raison d'être and realized in grass-root practices. All this enables then the integration of new technologies (tools, activities, processes, and 'know-how') with existing people, materials and technologies in in-situ infrastructuring practices.

The work shows that practitioner-driven (PD) systems development (PRAC) (cf. Figure 4) can be described through three interrelated aspects, namely the development of domain knowledge, information technology design as in-situ infrastructuring and transformation of a community. These overlapping areas need an alternative approach to design than the technology/design-driven approach applied to many professionalized design methods. The approach here is conceptualized tentatively as 'organic' infrastructuring based on the role of IT unfolded in the unity of theory and practice.

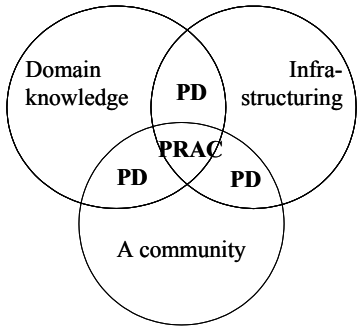

Figure 4: A practitioner-intensive systems development: PRAC

Secondly, the study shows that practitioners can contribute to IT transformation, not only as users but also as active competent developers, on their own terms. They can be called 'infrastructurers'. This work does not position professional design and practitioner-driven systems development against each other but regards them as counterparts who share the same objects of work and ultimately the same goals, also in the business sense. The paper thus seeks to puzzle out where practitioners' expertise is particular valuable but also that there is no single way to design IT or to infrastructure.

Thirdly, the study suggests that aspects of habitual practices, professionalized or non-professionalized, and their influence on learning, should be taken into consideration in the context of information systems development for knowledge intensive work including grass root activities. The case particularly shows that constant practitioner-driven systems development 'from the inside' is useful in communities of practitioners who seek new knowledge, work on open questions which have no a priori answers, or as constantly changing topics challenge the technological environment.

Finally, the study is based on a microcosm community which is proposed as a practical way of community studies.

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