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LEARNING WHAT IS NOT YET THERE: KNOWLEDGE MOBILIZATION IN A COMMUNAL ACTIVITY

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Abstract

Professionals at the cutting edge of their field are often faced with problems for which there is currently no solution. As learners, they are challenged to learn "what is not yet there" (Engeström, 1991, p. 270) and to pass this new knowledge on to others. This research into the work of a group of expert scientists investigated how one particular community of scientists generated, developed and implemented robust and reliable solutions for application in a demanding, high-profile context. The concepts of expansive learning, negotiative knotworking and the shared object of third generation activity theory, together with co-configuration assisted the identification and explication of the elements of the knowledge mobilisation process within this global community. The research also identified the key role in the complex task of knowledge creation for a trusted, shared private space that could be visited regularly by these scientists

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Introduction

Experts "work at the cutting edge of their profession … contribute new knowledge to their field, interact with other members of their profession, address problems which [their] profession faces and represent the shared views of the profession to those affected by its work including policy makers and society at large" (Kazlauskas & Crawford, 2004b, p. 63). As learners, experts are challenged to learn "what is not yet there" (Engeström, 1991, p. 270) and to pass this new knowledge on to others. Our research is focused on the work of the scientific directors of laboratories accredited by the World Anti-Doping Agency (WADA) to carry out analyses for sports doping control work. As experts working in a high profile, global and dynamic context, this research is well suited to developing a better understanding of the nature of expert

work and maintaining expertise in the early 21st century. Data about how anti-doping scientists generate and mobilise the knowledge they need to maintain their expertise and improve their ability to detect doping in sport was collected through the use of surveys and interviews of willing scientific directors of accredited anti-doping laboratories, observations of the Manfred Donike Cologne Workshops on Doping Analyses (2003 – 2005) and from publicly available peer-reviewed literature on anti-doping science. In this paper, we extend our previous publications about expert work and look more closely at the processes used by anti-doping scientists to generate and disseminate the knowledge needed to maintain and expand both individual and collective expertise in this constantly changing field.

The paper begins with consideration of the motivation for and the avenues through which knowledge sharing takes place in this context. Following this, an examination of an annual event and its role as the major venue for knowledge mobilization within this scientific expert community are presented. The processes employed for knowledge mobilization are then interpreted through the lens of activity theory.

The Imperative to Maintain Expertise

Anti-doping science is a small, complex area of forensic science. Doping in sport is an ancient practice with third century BC Greeks using mushrooms to enhance their performance (Houlihan, 2002). In contrast, anti-doping science is not yet 50 years old. In the late 1960s when doping-related deaths of athletes made it obvious that rules that banned the use drugs to enhance performance were being ignored and the scientific detection of the use of banned drugs through urinary analysis was adopted to control doping by athletes. Since then, the ongoing evolution of the use of prohibited drugs and other forms of cheating has continued to place pressure on anti-doping scientists to maintain their awareness of, and ability to detect, the new substances and techniques that athletes use to enhance their performances. The directors of accredited doping control laboratories acknowledge the need for scientists in accredited doping control laboratories to both generate and mobilise such new knowledge within the anti-doping community as a means for maintaining individual and collective expertise. One director spoke of a moral imperative on the part of anti-doping scientists to share new knowledge with their scientific colleagues: "*I think it would be wrong if one laboratory kept information to [itself] without telling it to the others when you are playing catch up*". It was "*not a field where you can work alone*". Our research explains how these experts maintain their expertise by examining how new knowledge is acquired and disseminated. As will be seen in the next section, individual directors described different ways of gaining new knowledge.

Avenues for Maintaining Expertise

Professionals have different ways of keeping abreast with changes in their field. When asked about the means by which they maintained their knowledge, the directors mentioned both solitary and social means. The majority of directors stated that they used more than one avenue to

maintain their expertise. These avenues and the number of respondents who mentioned them have been displayed in Table 1 and discussed below.

Table 1: Avenues for maintaining expertise

Avenues for maintaining expertise	Number of mentions Max. 13 (100%)
Scientific meetings including the Cologne Workshop	10 (76.9%)
Communication with colleagues in the field	9 (69.2%)
Individual or multiple laboratory research projects	8 (61.5%)
Literature	7 (53.8%)
Research that follows up routine work	5 (38.5%)
Communication with scientists working in related fields	3 (23.1%)
Committee Work	1 (7.7%)

Traditionally, the peer-reviewed literature has been regarded as the principal means through which experts maintain their expertise. However, only seven of the thirteen directors, just over half (53.8%), referred to this avenue as one through which they kept abreast of anti-doping science. The most frequently used avenues for maintaining expertise were social. Attendance at scientific meetings was the most common means and was mentioned by ten of the thirteen directors (76.9%). Seven of these ten respondents specifically mentioned the annual Cologne workshop as a means through which they maintained their knowledge of recent advances in anti-doping science. Nine (69.2%) directors maintained their expertise through conversations with colleagues in the field and eight referred to involvement in intra- or inter-laboratory research projects as a means of maintaining expertise. A high rate of attendance by the directors and/or accredited laboratories at the Cologne workshop confirmed the importance placed on this event by anti-doping scientists. One director described the role of the workshop thus:

> You have to keep up internationally or you'll fall behind. That is why we must attend the drug testing workshops in Cologne every year where you can get your new knowledge but also you meet the other persons that are interested in this field ... I think it's more worth talking with the persons and discussing your problems and their problems … that is how we are keeping up.

Importantly, research was seen as a major means through which a director and laboratory staff could not just maintain their knowledge, but also expand it. Routine work was seen as providing what one director described as "*a continuum of cases to challenge the established knowledge and foster new [research and development] work*". This research-based approach to generating new knowledge resonated with Victor and Boynton's (1998) reference to the accumulation of knowledge resulting from improving the various aspects of an organisation's

work as the source of renewal that directed the process of invention and led to expanded capabilities. Victor and Boynton also noted the role of frequent informal interactions between co-located trusted peers in the dissemination of ideas, concepts and information through an organisation. In the absence of a shared physical location for their work, knowledge generated by cutting-edge research undertaken by anti-doping scientists has been disseminated through other means or at the annual Cologne workshop, an occasion when many anti-doping scientists are co-located. Before the role of the Cologne workshop is examined, the channels chosen by anti-doping scientists to disseminate their research outcomes to their colleagues have been presented.

Avenues for Disseminating New Knowledge

To learn about anti-doping, scientists preferences for formal knowledge dissemination, the agendas for the 2003 and 2004 Cologne workshops and the associated proceedings, published 12 months after the workshop, were examined as well as peer-reviewed publications sourced using the publicly available PUBMED database (see http://www.ncbi.nlm.nih.gov/entrez/query.fcgi).

The peer-reviewed literature has long-been regarded as the principal means by which scholars in all disciplines have presented their research outcomes to their peers and established themselves as scholars in their particular field. One director believed that this was the best way to disseminate new knowledge in anti-doping science, stating that

> Although there are faults in the peer-review system nobody has found a better way. A repeated criticism of doping control is that it operates in the semi-secret and that many policies are not openly declared. Again the peer review system is the only way.

In the absence of a peer-reviewed scientific journal dedicated solely to anti-doping science, anti-doping scientists have published in a wide variety of peer-reviewed journals. Searches of the PUBMED database for papers related to anti-doping science AND authored or co-authored by the directors of the accredited laboratories, found that 37 papers were published in 2003 and 40 in 2004. An examination of the programme for and proceedings of the 2003 and 2004 Cologne workshops indicated that of the 55 presentations given at the 2003 workshop, 38 were written up and published. In 2004, 57 of the 64 contributions were published (see Table 2). Whereas the number of papers listed by PUBMED remained reasonably constant, there was a marked increase in the number of workshop presentations and associated publications.

Table 2: Knowledge dissemination channels used by anti-doping scientists in 2003 - 4

Medium	Workshop agenda '03		Workshop agenda '04		Cologne Workshop Peer-Reviewed Proceedings		PUBMED Listings	
	Talks	Posters	Talks	Posters	2003	2004	2003	2004
Number of items	33	22	34	30	38 (69%)	57 (89%)	37	40
Total contributions	55		64		95		77	

* Non-attendance at the 2006 workshop meant that the researcher did not receive a copy of the 2005 Workshop's Proceedings and so was unable to extend the comparison to 2005.)

As noted above and elsewhere (Kazlauskas, under examination; Kazlauskas & Crawford, 2004a, 2004b), interview, publication and observation data indicated the Cologne workshop has a particular role in this community. The workshop facilitates the formal and informal dissemination of both new and current knowledge about anti-doping practice amongst experienced and inexperienced anti-doping scientists. The role of the workshop in the evolution of individual and group expertise in the anti-doping scientific community is considered in greater depth in the following section.

The Cologne Workshop: a Trusted Context for the Communal Activity of " Keeping Up"

Since the early 1980s the Cologne workshop has played a major role in facilitating knowledge exchanges between anti-doping scientists. Representatives of 32 of the 33 then accredited laboratories (97.0%) attended the 2004 workshop. The wide-ranging, substantial scientific content of the workshops engaged and excited the participants and fostered ideas for further research in anti-doping science. The formal and informal discussions that permeated the week-long Cologne workshop stood out as a major means of knowledge mobilisation within the community of anti-doping scientists. During these week-long workshops, anti-doping scientists demonstrated or developed their knowledge of and capacity to discuss with colleagues the stories, problems, frameworks and perceptions of their work in anti-doping science. They expanded their ability to talk meaningfully about their field of endeavour, and they discussed the "social configurations in which (their) enterprises are defined as worth pursuing and (their) participation is recognizable as competence" (Wenger, 1998, p. 5). Over time, the reciprocal exchanges within the environment of the workshop had led to the development of mutual trust amongst members of this community. Referring to successful cooperation, Maxwell (2005, p. 416) stated that trust was the "medium within which exchange [took] place, the key ingredient of social capital" and that

the group within which knowledge was exchanged had "to be small enough that knowledge [could] be shared. Trust [was] harder to achieve in large groups".

Observations made by the researchers of the Cologne Workshops in 2003 - 2005 indicated that this event provided a trusted environment for scientific directors and other anti-doping scientists to build and expand their individual and collective identities and knowledge as they maintained their expertise in a constantly changing field. Clearly, the workshop provided the directors of accredited doping control laboratories and other anti-doping scientists with a regular opportunity to consider communally the issues that related to their work and to consider a large number of presentations about recent scientific research in their field. The workshop also offered newcomers to the field both access to experienced practitioners and the time in which they could engage in discussions about the day-to-day mechanics of doing anti-doping science. Through the lens of activity theory, the activity system associated with the annual Cologne workshop comprised subjects with diverse cultural histories, tools for gaining and exchanging knowledge such as the formal presentations and informal discussions, rules relating to attendance, participation and scientific norms, the community of attendees and stakeholders, the division of labour between organisers and attendees and the shared multi-faceted object of "keeping up" with the field of anti-doping scientific practice. This system has been represented in Figure 1.

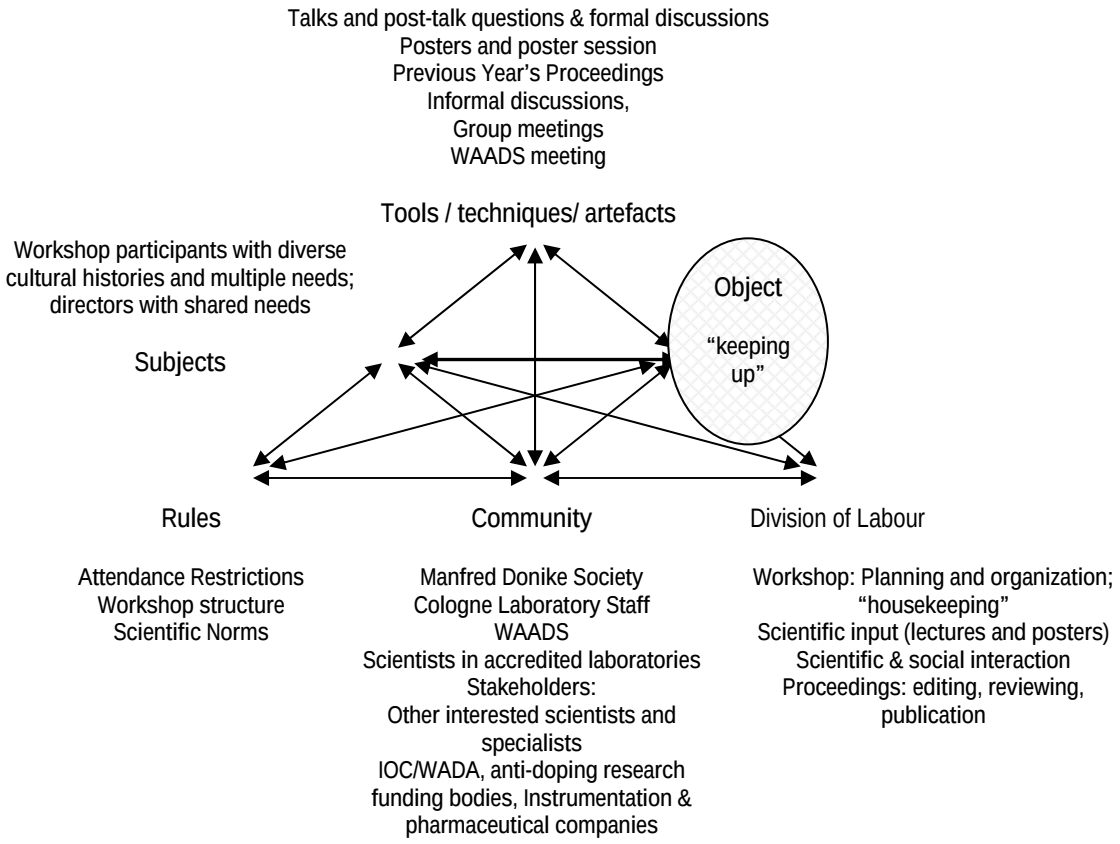


Figure 8: The Cologne Workshop on Dope Analysis as the activity of "keeping up"

Tensions existed in this as in all activity systems and contributed to the evolution of workshop activity. The tensions related to the need to accommodate the increasing size of the anti-doping scientific community, would-be anti-doping scientists and interested stakeholders. Another tension related to the need for university based anti-doping scientists to publish in the academic literature and the need for other anti-doping scientists to access new knowledge before it became public. The resolution of these tensions has been described elsewhere (Kazlauskas, under examination). The subsequent evolution of this comfortable provision of scientific demonstrations, formal talks, poster sessions, and frequent opportunities for casual conversation and relationship development all contributed to achieving the individual and collective object of "keeping up": of disseminating anti-doping scientific knowledge and other aspects of the professional practice of anti-doping science amongst both novice and experienced anti-doping practitioners and of facilitating the ongoing development of new concepts for application to this field.

Hasan and Crawford (2003) coined the term 'knowledge mobilisation' to capture active notions of creativity and innovation rather than the management of something that was "owned and traded by competitive individuals" (p. 2). From an activity theory perspective, the generation and incorporation of new knowledge into our activities expanded the nature of those activities. The next section of this paper considers knowledge mobilisation more closely through an

examination of the activity of the formation of the new scientific concepts that lead to the generation of new developments in anti-doping science. The interactive processes involved in concept formation in this community were those at the heart of the expansive learning that occurs as a result of knotworking and co-configuration work (Engeström, 2004; Engeström, Engeström, & Vahaaho, 1999; Helle & Engeström, 2005a, 2005b; Victor & Boynton, 1998.

Concept Formation in Anti-doping Science

Third generation activity theory provided insights into the time and effort involved in the formation of new concepts by multiple activity systems. In third generation activity theory, the interactions between multiple activity systems focused on creating a new shared object and consequent generation of new forms of their own activity. The ongoing refinement of this shared object involved 'knotworking', a process that Engeström and others (Engeström, 2000b, 2004; Engeström et al., 2003; Engeström et al., 1999; Hasu & Engeström, 2000; Toiviainen, 2003) regarded as a necessary part of the transfer of an innovation. In this context, a knot was described as a "rapidly pulsating, distributed and partially improvised orchestration of collaborative performance between otherwise loosely connected actors and activity systems", (Engeström, 2000a, p. 972). Knotworking was "a longitudinal process in which knots … formed, dissolved, and re-formed as the object [was] co-configured time and time again, typically with no clear deadline or fixed end point" (p. 973). Such "rapid negotiation and improvisation with constantly changing configurations of partners" (p. 973) challenged work communities. The horizontal learning processes involved in knotworking occurred when hybrid solutions arose from negotiating and combining ingredients from the familiar, multiple parallel contexts within which workers found themselves. Figure 2 is a diagrammatic representation of knotworking.

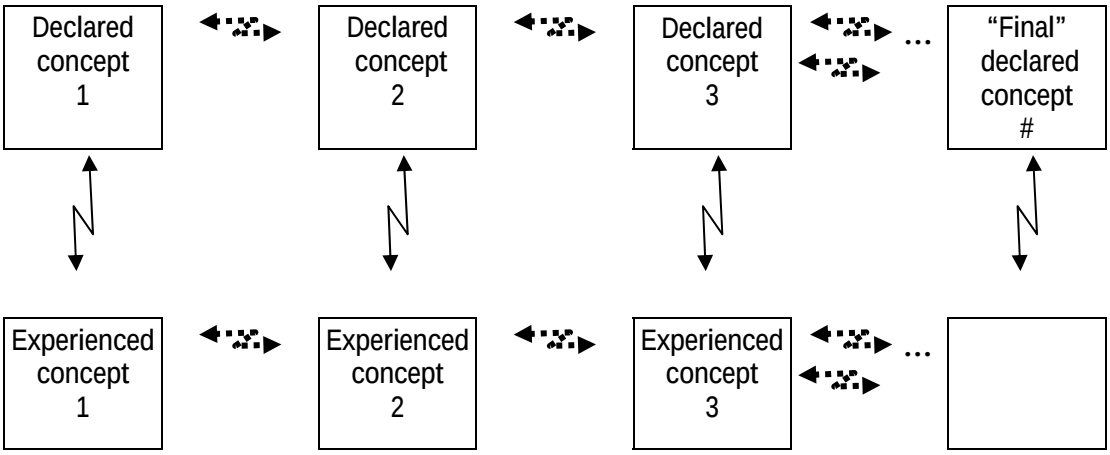


Figure 9: Knotworking - the horizontal and vertical movements in concept formation and learning

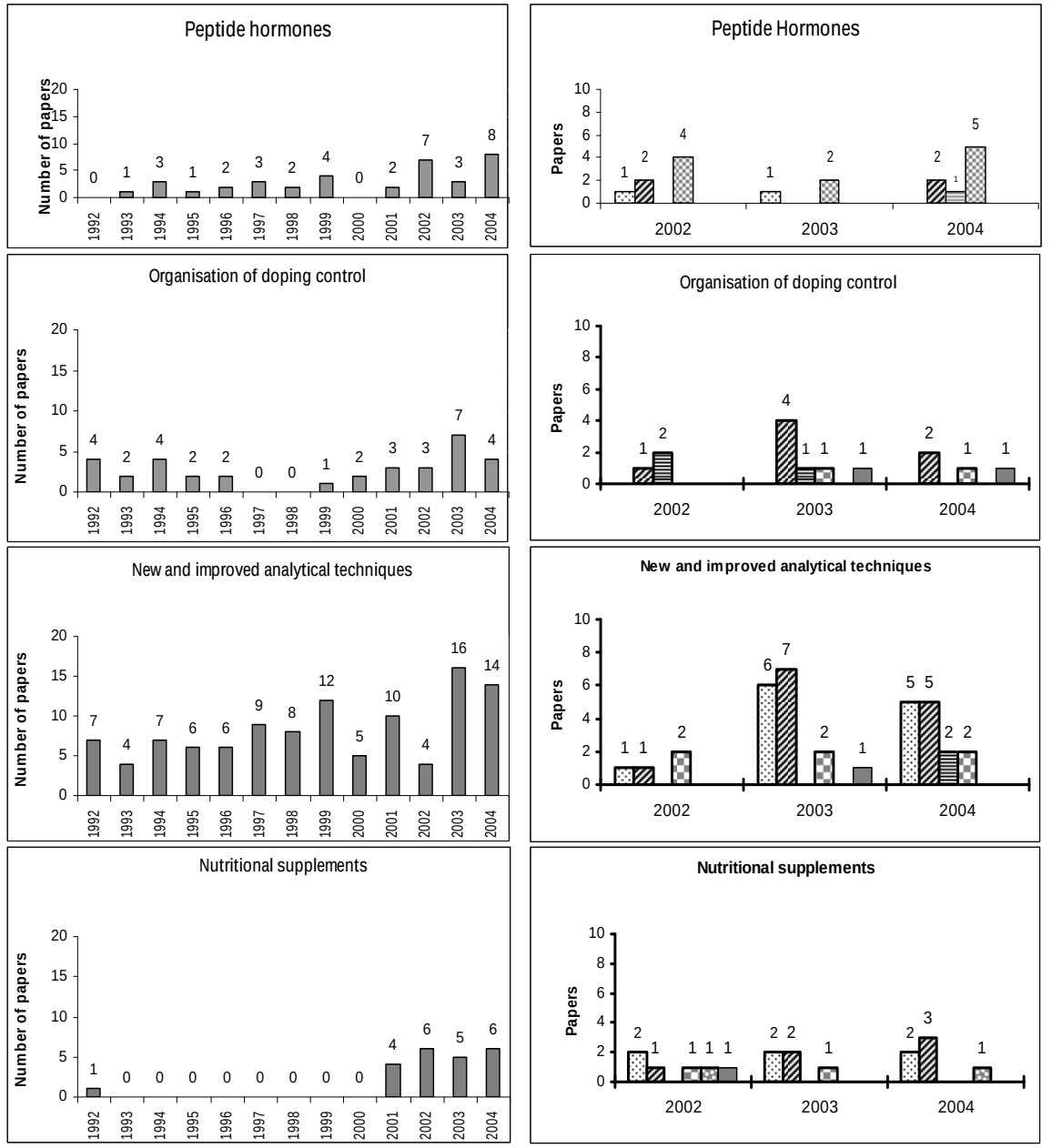
Engeström (2004) and others (Helle & Engeström, 2005b; Leadbetter, Daniels, Soares, & NacNab, 2005; Warmington, Daniels, Edwards, Brown et al., 2004; Warmington, Daniels, Edwards, Leadbetter et al., 2004) noted the relevance of knotworking for Victor and Boynton's (1998) concept of co-configuration work where producer and client jointly configured a new product. Engeström (2000a) regarded knotworking as the "emerging interactional core of co-configuration" (p. 973). Victor and Boynton, and Engeström et al. (2003), stressed the role of discourse in the co-configuration and knotworking processes required to cross the zones of proximal development associated with ensuring flexible, adaptive responses to changing workplaces. The discourse at the heart of knotworking was evident in the interactions between the Cologne Workshop participants as representatives of various anti-doping research groups.

Between annual workshops, anti-doping scientists worked independently in their laboratories, i.e. in their separate activity systems. Each laboratory conducted its practice in a manner that met the requirements of the field and the particular context in which the laboratory is situated. Throughout the year each laboratory operated as a separate activity system carrying out routine practice and research in selected aspects of anti-doping science. When the representatives of the various laboratories went to present the results of their research at the Cologne workshop and to hear about the research that others had done, they took on the roles of knowledge giver and /or receiver, or of producer and/or client as determined by the nature of the exchange. In this way, the Cologne workshops acted as "microcosms in which collective zones of proximal development [were] articulated and enacted as practitioners [looked] back on the history of their activity and [engaged] in future-oriented framing experiments" (Engeström et al., 2003, p. 288) related to the concept formation that is integral to the creation of knowledge in their field. As a regular event, the workshop encouraged scientists individually and collectively to analyse existing solutions and relevant knowledge in order to frame or model new solutions through expansive learning .The ongoing examination and implementation of these new concepts as model solutions, reflection on them followed by further refinement eventually led to a reliable and robust testing practice as demonstrated in the next section.

Evidence of Vertical and Horizontal Movements in Anti-doping Science Research

As noted above, observation of the workshops 2003-5 and their agendas indicated that anti-doping scientists used the trusted shared space of this community event to engage in the discourse associated with knotworking and co-configuring advances in anti-doping science through concept formation. Evidence of the longitudinal processes associated with knotworking was evident in the proceedings of the workshops from 1992 – 2004 while the multi-voiced, horizontal nature of the process of knotworking became clear following analysis of the authorship of papers in the workshop proceedings.

In Figure 3, the ongoing nature of the discourse as demonstrated by papers relating to peptide hormones, new and improved analytical techniques, organisation of doping control and nutritional supplements has been represented graphically. The graphs on the left side of Figure 3 demonstrate that contributions to the development of knowledge in each category occurred longitudinally (1992 – 2004). The patterned columns in the graphs on the right side highlight the fact that anti-doping scientific knowledge has been created and disseminated by various researchers from within and without the accredited laboratory system.



Contributor Legend for graphs on right hand side

Cologne Laboratory	Another accredited laboratory	Joint accredited laboratory research	Joint accredited laboratory & external	Non-accreduted doping control	External researchers'

Figure 10: Longitudinal and multi-voiced nature of anti-doping research

An Example of Knotworking to Form New Concepts

Drawing on Engeström's (2000a, p. 972) two dimensional representation of the vertical and horizontal nature of movements in concept formation (see Figure 2), Figure 4 portrays the vertical and horizontal nature of the knotworking associated with research into the peptide hormone erythropoietin (EPO) presented at the Cologne workshop over the years 2002-2004. This diagram highlights the "relatively open-ended long-term" (Engeström et al., 2003, p. 306) nature of the object of these experts' research work as they continue to improve their scientific capability through declaring, experiencing and refining concepts related to the development of robust and reliable methods of detecting athletes' use of EPO. The continuing research effort in this area was confirmed recently at the 2006 IAAF Anti-Doping Symposium in a talk by Dr. Francoise Lasne from the accredited laboratory in Paris.

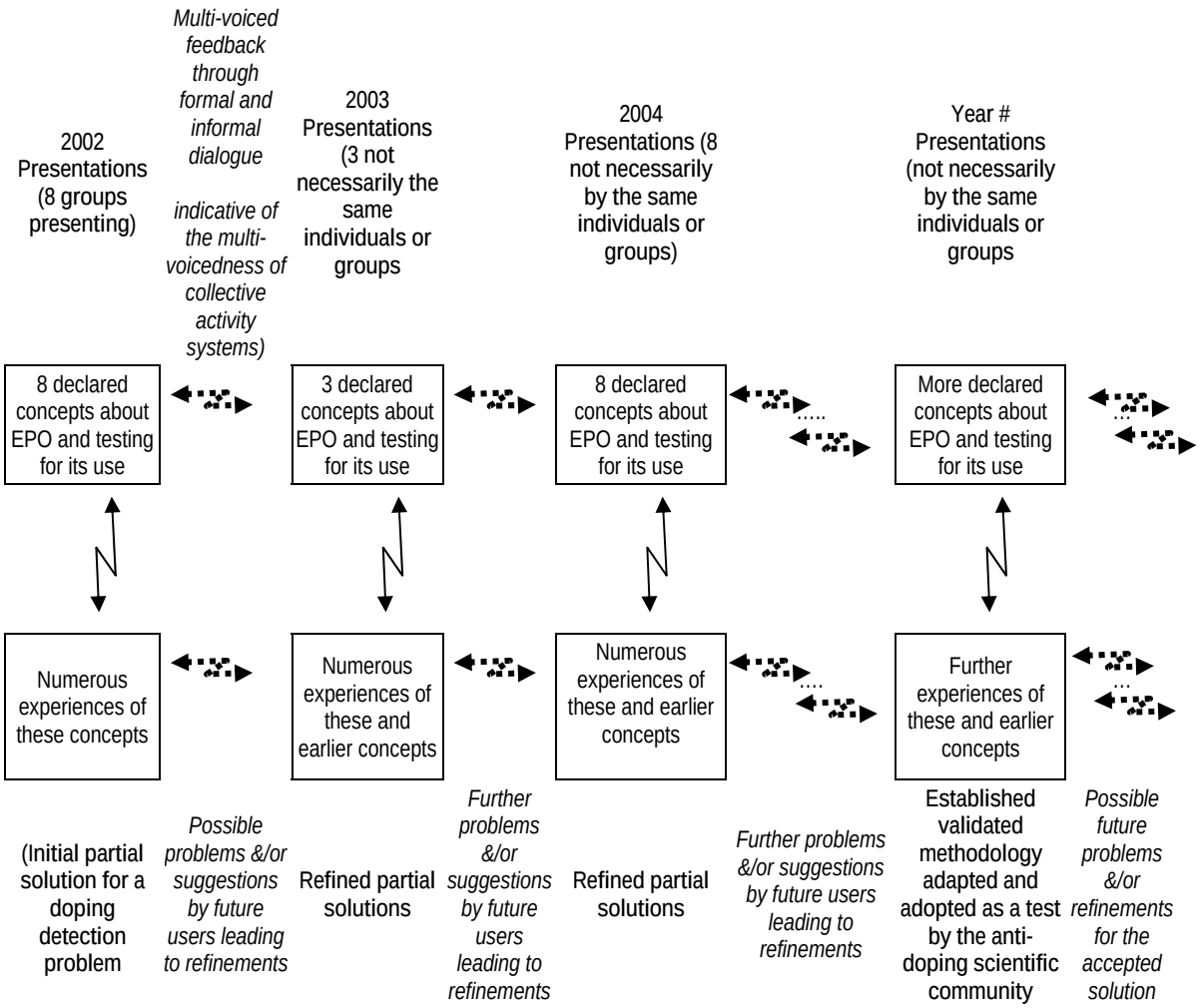


Figure 11: Vertical and horizontal movement in concept formation and learning surrounding EPO through presentations at the annual Cologne workshop

In Figure 4, each of the temporally distributed concept articulations in the upper boxes of the knotworking process represented a new, joint starting point for future research work, a base from which future expansions occurred. The experiences of these concepts, the lower boxes, triggered zones of proximal development for anti-doping scientists whose crossing expanded anti-doping scientists' understandings of the indicators for the detection of the presence of banned performance enhancing substances in urine. Over time, this ongoing discourse of knotworking supported the co-configuration of processes associated with the implementation of robust, defensible analytical methods customised to suit each laboratory's particular environment – an agreed shared object of activity. Rather than "glorified small talk" (Engeström et al., 2003, p. 287) the workshop discourse, formalised within the publications of the workshop proceedings, exemplified the means by which plans, scenarios and findings were gradually translated into practice by the anti-doping scientific community. The vertical and horizontal movements within the knotworking process also indicated that anti-doping scientists are both the users / producers of

new and innovative ideas as well as the critics / critiqued of those ideas. In taking on these roles, scientists drew deeply on the tacit, articulated, practical and architectural knowledge gained from the craft, mass production, process enhancement and mass customisation work associated with laboratory-based anti-doping analytical work. Through their participation in the negotiative knotworking of co-configuration work, the representatives of the various research teams built the interactive relationships that ensured that the knowledge to improve anti-doping laboratory practice was continuously customized to meet their own and their scientific colleagues' needs. In this way, the annual Cologne workshop also provided an opportunity for the study of what Engeström, Engeström and Kerusuo (2003) described as a collective artefact-mediated activity in response to an increasingly socio-spatially and temporally distributed form of professional work.

Engeström, Engeström and Kerusuo (2003) stated that the pressure of long-term open-endedness drove organizations toward "strategic alliances and other forms of partnerships and interactive networks" (p. 306) where members contributed interdependently to the achievement of their mutual evolving object. The interactions around knotworking and co-configuring a shared object by separate activity systems have more recently been described as interagency working (Daniels, 2004; Warmington, Daniels, Edwards, Brown et al., 2004; Warmington et al., 2005). In the context of the generation of new concepts and the creation of anti-doping scientific knowledge, an expansion of the standard representation two interacting activity systems of third generation activity theory was necessary. This network of activity systems has been shown in Figure 5.

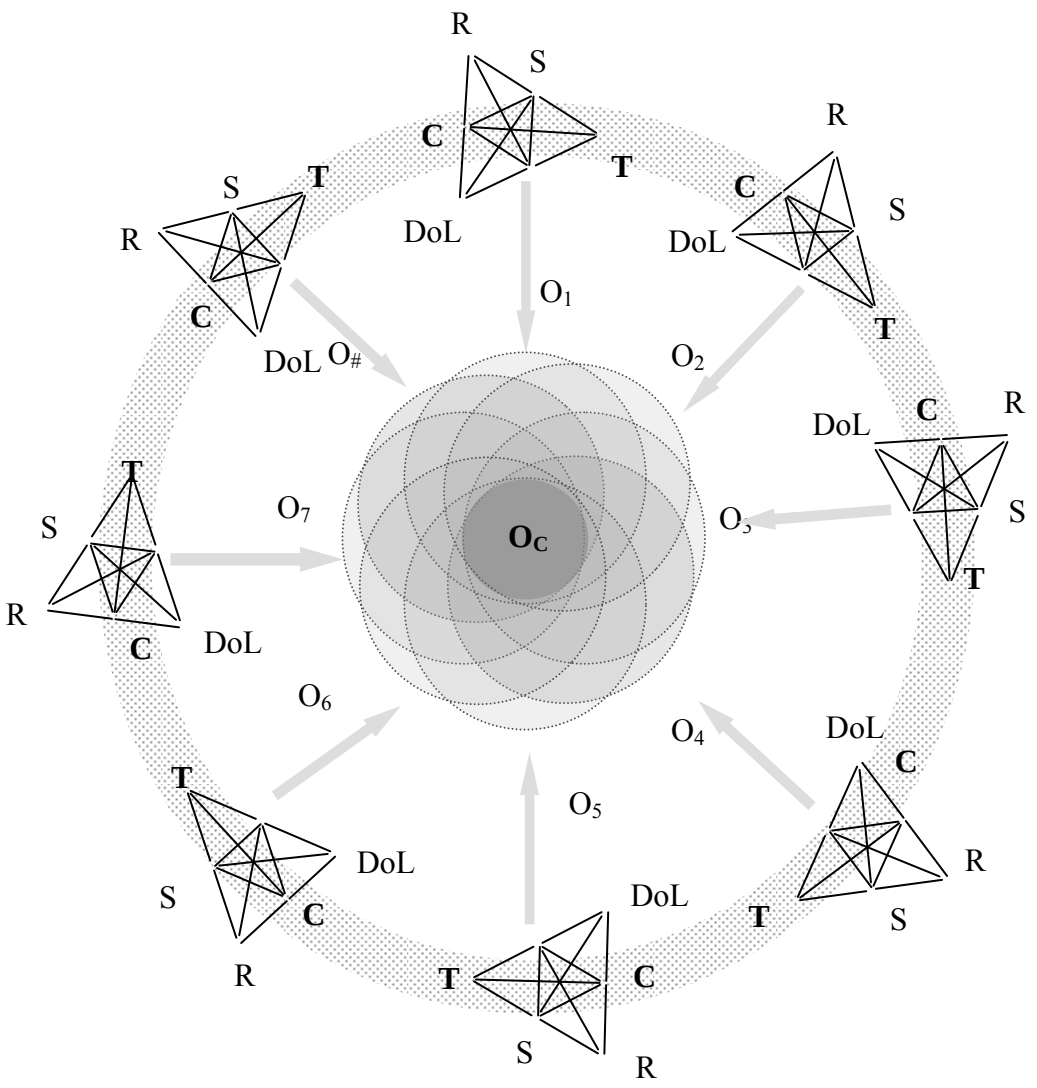


Figure 12: Knotworking as shared object formation by interacting activity systems

(In the figure S: subject, T: tools, R: Rules, C: community and DoL: Division of Labour)

In Figure 5, the initial research has been represented as having been directed towards an initial object, O_1, such as the identification of one step of an analysis for a particular banned substance by one particular laboratory. When other scientists draw on their individual experience of anti-doping activity to give formal and informal feedback in the light of their own activity, they effectively refine the object for the current activity, rendering it transitory. Discussion within community to which the initial presenter and critic belong, result in the proposal of a second collectively meaningful approach to the analysis: O_2. This jointly constructed object, perhaps the achievement of a modified step in the analysis, may then be further discussed, refined and extended by other members of the community, subsequently giving rise to numerous other jointly constructed transitory objects in the process: O_3, O_4, O_5, and so on. Over time, the interacting

activity systems of the researchers construct a collective object (O_C) which is accepted and shared by the various activity systems and adapted for implementation by each laboratory as a robust, reliable and defensible doping test. In Figure 5, the darkest area at the centre of the "knot" represents the current state of the evolving, collectively meaningful object (O_C), the result of the transformation of many preceding transitory objects ($O_{\#}$).

Conclusion

Making sense of the complexity of anti-doping science has proved a long-term undertaking for the small group of specialist scientists who participated in this research. As suggested by the *Cynefin* framework for sense-making (Kurtz & Snowden, 2003; Snowden, 1999), this research confirmed that much of the work of unravelling the complexity of a problematic situation takes place in a private space where thorough analysis of what does and what does not work can be carried out with confidence. For anti-doping scientists, this private trusted space is provided by the annual Cologne workshop on dope analyses. The use of activity theory to study this space has yielded numerous insights into knowledge mobilisation in this community. Collectively the scientific directors and other anti-doping scientists at the Cologne workshop engage in the expansive learning associated with the activity of "keeping up". To do this they not only share their existing knowledge about this field, but, as representatives of separate research groups they engage in expanding the knowledge on which their practice is based. To this end, scientists present the outcomes of recent research and engage in the knotworking associated with the configuration and reconfiguration of the different shared objects of research projects focused on the development of anti-doping scientific methods as the products/services to be mobilised within this community. Without external scrutiny, the workshop is a place to relax, to enjoy and to playfully explore as well as devise experiments to test new ideas. It is here that anti-doping scientists engage in the activity of sharing their knowledge of what does and does not work as an integral part of their learning what is not yet there in their field.

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resulting from a google search for knotworking expansive learning

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