Dialogue, Skill and Tacit Knowledge

Edited by
Bo Göranzon,
Maria Hammarén
and
Richard Ennals

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John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester,
West Sussex PO19 8SQ, England

Telephone (+44) 1243 779777

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List of Contributors

Göran Backlund is a manager and senior consultant at Combitech Systems, a knowledge based company specialised in embedded computer systems development, owned by the SAAB Group, Sweden. His assignments concern leadership and knowledge development for technical organisations. He is also a PhD student at the Royal Institute of Technology (KTH) in Stockholm, Department of Skill and Technology.

Karl Dunér is a director at the Royal Dramatic Theatre in Stockholm.

Lucas Ekeroth has a Master of Science at the Royal Institute of Technology in Stockholm.

Richard Ennals is Professor at the Centre for Working Life Research, Kingston University, and a Visiting Professor at the Swedish Royal Institute of Technology, the Norwegian University of Science and Technology, and Mykolas Romeris University in Lithuania.

Niclas Fock is Business Area Manager at Combitech Systems in Linköping. He is responsible for knowledge development at Combitech Systems and is also a PhD student at the Royal Institute of Technology in Stockholm, Department of Skill and Technology.

Bo Göranzon is Professor of Skill and Technology at the Royal Institute of Technology, Stockholm and artistic director of the Dialogue Seminar at the Royal Dramatic Theatre, Stockholm.

Maria Hammarén is a researcher at the Department of Skill and Technology at the Royal Institute of Technology, Stockholm. In her

doctoral dissertation, 'Clues in Transformation: On Creating a Reflective Practice' (1999) she outlines the Dialogue Seminar Method as developed in collaboration with the company Combitech Systems and co-researcher Bo Göranzon.

Mats Hanson is vice-rector at the Royal Institute of Technology, Stockholm.

Christer Hoberg is Chief Executive Officer of Saab Combitech Systems, and engaged in collaborative research with the Department of Skill and Technology at the Royal Institute of Technology.

Allan Janik is Professor at the Brenner Archiv, Innsbruck, and has long been engaged in research on aspects of Wittgenstein's philosophy.

Kjell S. Johannessen is Professor of Philosophy at the University of Bergen, Norway. Since the early 1970s he has been engaged in research on various aspects of Wittgenstein's philosophy.

Erland Josephson is a distinguished actor and a former artistic director at the Royal Dramatic Theatre in Stockholm.

Øyvind Pålshaugen is Research Director at the Work Research Institute in Oslo.

Adrian Ratkic is a researcher at the Department of Skill and Technology at the Royal Institute of Technology, Stockholm.

John Shotter is Emeritus Professor at the University of New Hampshire, USA.

Jan Sjunnesson is a manager and senior consultant at Combitech Systems. His assignments concern leadership and knowledge development for technical organisations. He is also a PhD student at the Royal Institute of Technology (KTH) in Stockholm, Department of Skill and Technology.

Peter Tillberg is a research student in the Department of Skill and Technology at the Royal Institute of Technology.

The Department of Skill and Techology is a part of the School of Engineering and Management, Royal Institute of Technology, Stockholm, Sweden.

Introduction

Richard Ennals

Practical Needs of Learning Organisations

It is common for companies to claim to be learning organisations, without explaining what this means in practice. Conclusions from practice are confounding academic orthodoxy, and opening the way for real sustainable benefits for participating organisations. Reflection on experience can be more effective than reliance on theories from social science. In all the rhetoric about 'knowledge society', there has been little discussion of what is meant by 'knowledge'. In this book, based on practical cases, we offer a way forward.

Problems of Knowledge

It has become increasingly evident that conventional approaches to business and technology have failed to come to terms with fundamental problems of knowledge. This presents practical difficulties, amid all the rhetoric about knowledge society and knowledge economy. It had been imagined by many that knowledge could be commodified, and made available for commercial exploitation, without dependence on the continued presence of the experts whose knowledge had been elicited for use in expert systems. How can companies address this challenge in practice?

As knowledge has been seen as increasingly important as a driver for economic development, research has exposed the limits of what can be achieved by conventional means. Since 1987, collaborative research led by Bo Göranzon, and involving Maria Hammarén and Richard Ennals, has been tackling Skill, Technology, Culture and Communication. Starting by demystifying the claims of artificial intelligence, and working closely with companies, a new foundation has been developed, based on practical philosophy, and with dialogue at the centre of activities. Learning is seen as arising from encounters with differences.

Preparatory Dialogue

The three editors have collaborated since 1987, in the context of a succession of projects in the research field 'Skill and Technology', and supported by the award-winning Dialogue Seminar, based at the Royal Dramatic Theatre in Stockholm. The core ideas were set out at the 1988 conference 'Culture, Language and Artificial Intelligence', and published in a series of six volumes, edited by Bo Göranzon, published by Springer Verlag, London 1988–95:

- *Knowledge, Skill and Artificial Intelligence*, eds Bo Göranzon and Ingela Josefson. 1988.
- *Artificial Intelligence, Culture and Language: On Education and Work*, eds Bo Göranzon and Magnus Florin. 1990.
- *Dialogue and Technology: Art and Knowledge*, eds Bo Göranzon and Magnus Florin. 1991.
- *Skill and Education: Reflection and Experience*, eds Bo Göranzon and Magnus Florin. 1992.
- *The Practical Intellect: Computers and Skills*, Bo Göranzon. 1992.
- *Skill, Technology and Enlightenment: On Practical Philosophy*, ed. Bo Göranzon. 1995.

In Stockholm, the collaboration involved the Royal Dramatic Theatre, the Swedish National Institute for Working Life, and the Swedish Royal Institute of Technology, providing an encounter between different perspectives in knowledge. A succession of seminars and conferences with international partners followed, including a seminar and conference series at Kingston University. Since 2000, the doctoral programme in 'Skill and Technology', which used the six volumes as a teaching resource, has enabled the dialogue to continue and mature, with philosophical insights used as tools to reflect on practice. A series of practical cases have been developed. The doctoral students are also practitioners, experienced senior managers. The expertise of the team has matured, as a second generation of leaders are now involved. There are courses with major companies such as Combitech Systems, Sony Ericsson, Volvo and Electrolux.

The present book builds on those foundations, and this long period of dialogue, but is almost entirely comprised of new case study material and reflections. It is intended to help companies and other organisations to address problems of knowledge, and to support the new doctoral programme 'Managing Reflective Practice', and related programmes which are now developing around the world, and in particular in Europe. Many

of the participants in these courses are also engaged in full-time professional practice, and the challenge is to facilitate reflection. Management is reinvented as the orchestration of reflection.

At the core of the book is a concern for epistemology. There has been a deep-seated concern among the contributors that major mistakes have been made in the treatment of knowledge, in many high profile programmes which have tended to emphasise the role of technology. As was argued at the 1988 conference, the attempt to represent the full richness of expert knowledge in explicit form was doomed to failure, and based on a misunderstanding of the nature of knowledge. Only a fraction of expert knowledge can be codified and expressed in explicit form, as facts and rules. Another layer of implicit knowledge is not usually represented, but may exist in the form of accepted procedures which can be elicited and formalised using available methods. This leaves the submerged iceberg of tacit knowledge, which is not reliably accessible by traditional analytical approaches, or 'drilling down'.

In this book we explore the significance of tacit knowledge, and consider accounts of how access has been gained, through analogical thinking. Principal among these is the 'Dialogue Seminar Method', which has been developed and applied by the first two editors. Case study accounts are provided, together with guidance for those wishing to use it. After so many years of collaborative endeavour, there is now a body of experience, and many documented cases of organisations whose cultures have been transformed by the 'Dialogue Seminar Method'.

Each chapter in the book stands alone, and is accompanied by specific references and notes. However, there are numerous links and cross-references between the chapters, for example as particular cases are considered from different perspectives. These connections are illuminated by the subject and name indexes.

Part 1. Dialogue and Skill

It is often assumed that a single model of knowledge will cover the range of different fields of study, and indeed such a view underpins positivist social science, suggesting consistency with the natural sciences. The use of computers has highlighted glaring deficiencies in this view, as is explored by Bo Göranzon, in 'The Practice of the Use of Computers: A Paradoxical Encounter between Different Traditions of Knowledge'.

For those who come from backgrounds in the natural sciences, it is possible to fall into the trap of seeing language, and writing, as used

only for descriptive purposes. Maria Hammarén, reflecting on her own long experience of practice as a journalist, opens up a broader perspective, in 'Writing as a Method of Reflection'.

Adrian Ratkic, of the Royal Institute of Technology, introduces the new programme which has resulted, in 'The Dialogue Seminar as a foundation for research on skill'. Bo Göranzon and Maria Hammarén offer guidelines to 'The Methodology of the Dialogue Seminar', to enable others to take the approach forward in practice.

Part 2. Theatre and Work

The theatre has provided an arena in which the ideas have been brought together, rehearsed and presented. We have developed the concept of 'performing knowledge', with the central image of the actor as a model for professional skill. The scene is set by the distinguished actor and director Erland Josephson, in 'A Dwelling Place for Past and Living Voices, Passions and Characters'.

The philosopher Allan Janik presents theatre as offering fundamental insights into knowledge, in 'Theatre and Knowledge'.

Part 3. Case Studies

Interesting case studies are not enough in themselves. What was required was sustained engagement with committed organisations, who through their practice and reflections demonstrate the transforming impact of dialogue on their culture. Niclas Fock presents the case of his company, in 'Dialogue Seminar as a tool: experiences from Combitech Systems'.

The Chief Executive Officer of the company has been a key research leader, and has championed the transformational process, as well as publishing a successful book in Swedish on the experience. Christer Hoberg explains his approach in 'Maximum Complexity'.

The collaboration between the Royal Institute of Technology and Combitech Systems has led to major changes in approaches to systems engineering, as is described by Göran Backlund and Jan Sjunnesson in 'Better Systems Engineering with Dialogue'.

The same philosophical perspective, and insights into skill, has applications across the range of sectors, as is demonstrated by Peter Tillberg,

with a military background, in his 'Some aspects of military practices and officers' professional skills'.

Meanwhile, at the Royal Institute of Technology, fresh approaches are being taken to multidisciplinary work, as expounded by Karl Dunér, Lucas Ekeroth and Mats Hanson, in 'Science and Art '.

Part 4. Dialogue Seminar as Reflective Practice

Bridging the gap between theory and practice has been a constant concern for Bo Göranzon, who links the philosophical perspectives on tacit knowledge with practical concerns for risk and decision making, in 'Tacit Knowledge and Risks'.

We emerge with new firm ground. With renewed philosophical vigour, Maria Hammarén returns to reflections on writing, in 'Skill, Story-telling and Language'.

It is not enough to be pleased about the success of a particular local favoured method. The Dialogue Seminar has been subjected to critical analysis by leading philosophers and researchers. Øyvind Pålshaugen revisits the work of Wittgenstein, solving what has been a mystery for many frustrated readers of the 'Tractatus Logico-Philosophicus', by revealing, in Wittgenstein's own words, that there had been two volumes, only one of which could be written. The chapter 'Reading and Writing as Performing Arts: at work' was first presented at a conference on 'Performing Knowledge', in Stockholm, which brought together the worlds of philosophical theory and the practice of working life.

These links are clarified in a chapter by Kjell S. Johannessen, 'Knowledge and Reflective Practice', which legitimates the epistemological underpinnings of the Dialogue Seminar method.

The argument is taken further by John Shotter, who has considerable experience of dialogue conferences and their applications in regional development as well as diverse social contexts, as he explains in 'Dialogue, Depth and Life Inside Responsive Orders'.

Part 5. Tacit Knowledge and Literature

Tacit knowledge has been a matter for academic debate for decades, but the challenge has of course been to make explicit the issues that have been so hard to understand. The Norwegian philosopher Kjell S. Johannessen

provides a lucid introduction to the field in 'Rule Following, Intransitive Understanding and Tacit Knowledge'.

After years of working in Scandinavian theatre, Allan Janik tackles the challenge of assessing the importance of Ibsen, in 'Henrik Ibsen: Why we need him more than ever.'

6. Conclusions

Richard Ennals broadens the context of discussion, and identifies new potential applications of the Dialogue Seminar Method to current practical case study work in action research, workplace innovation and regional development, in 'Theatre and Workplace Actors'.

In the final chapter, 'Training in Analogical Thinking: The Dialogue Seminar Method', Bo Göranzon, Maria Hammarén and Adrian Ratkic paint a broad picture, setting the scene for the next generation of cases.

This has been a long and demanding journey, during which we have crossed many borders, bridged many gaps, and encountered many outstanding performers of knowledge. We hope that our readers will wish to join us in the process of dialogue, and bring their own distinctive contributions.

Part 1

DIALOGUE AND SKILL

1 The Practice of the Use of Computers: A Paradoxical Encounter between Different Traditions of Knowledge

Bo Göranzon

Fundamental to the design of knowledge-based systems is the understanding of the nature of knowledge and the problems involved in computerising it. This chapter deals with these issues and draws a distinction between three different categories of knowledge: propositional knowledge, skill or practical knowledge and knowledge of familiarity. In the present debate on 'Information Society', there is a clear tendency to overemphasise the theoretical knowledge at the expense of practical knowledge thereby completely ignoring the knowledge of familiarity. It is argued that different forms of theoretical knowledge are required for the design of current computer technology and the study of the practice of computer usage. The concept of dialogue, and the concept of 'To Follow a Rule', are therefore fundamental to the understanding of the practice of computer usage.

Paradoxical Views of Knowledge in the Age of Enlightenment

In the modern sense, applied mathematics was the creation of René Descartes. In 1637, Descartes presented a study in which he showed how, by applying abstract algebraic concepts, it is possible to formulate

geometry's concrete points, lines, surfaces and volumes. He demonstrated a link between our three-dimensional world and a mathematical-logical way of thinking.

In Descartes' work *Discourse on Methods, Optics, Geometry and Meteorology* (Descartes, 1637) in which he presented his revolutionary mathematical theory, the word 'machine' is applied to the human body for the first time in history:

> And this will not seem strange to those, who knowing how many different automata or moving machines can be made by the industry of man without employing in so doing more than a very few parts in comparison with the great multitude of bones, muscles, nerves, arteries, veins, or other parts that are found in the body of each animal. From this aspect the body is regarded as a machine which, having been made by the hands of God, is incomparably better arranged, and possesses in itself movements which are much more admirable, than any of those which can be invented by man.

Descartes continues with an important argument:

> Here I specially stopped to show that if there had been such machines, possessing the organs and outward form of a monkey or some other animal without reason, we should not have had any means of ascertaining that they were not of the same nature as those animals. On the other hand, if there were machines which bore a resemblance to our body and imitated our actions as far as it was morally possible to do so, we should always have two very certain tests by which to recognise that, for all that, they were not real men. The first is, that they could never use speech or other signs as we do when placing our thoughts on record for the benefit of others. For we can easily understand a machine's being constituted so that it can utter words, and even emit some responses to action on it of a corporeal kind, which brings about a change in its organs; for instance if it is touched in a particular part it may ask what we wish to say to it; if in another part it may exclaim that it is being hurt, and so on. But it never happens that it arranges its speech in various ways, in order to reply appropriately to everything that may be said in its presence, as even the lowest type of man can do. And the second difference is, that although machines can perform certain things as well as or perhaps better than any of us can do, they infallibly fall short in others, by the which means we may discover that they did not act from knowledge, but only from the disposition of their organs. For while reason is the universal instrument which can serve for all contingencies, these organs have need of some special adaptation for every particular action.

The notion that '*animals are machines*' lies at the core of the Cartesian view. Descartes coined a phrase to express this opinion: Bete machine. There is a reference to this phrase in one of the earliest documents produced in the French Age of Enlightenment: Man a Machine, published in 1748 by Dr de La Mettrie. To La Mettrie, learning to understand a language, i.e. learning to use symbols, is to become a human being. Culture is what separates man from the animals. La Mettrie means that thinking should turn from general abstractions to consider the concrete, the details. It is the models to be found in the concrete examples we meet that nurture us in a culture. According to La Mettrie, a mind that has received poor guidance is as an actor who has been spoiled by provincial theatres; he goes on to say that the separate states of the soul are in constant interaction with the body. La Mettrie struck a chord that was to characterise the contradictory views of knowledge during the French Age of Enlightenment (Lindborg, 1984).

Denis Diderot, leader of the French Encyclopedia project in the Age of Enlightenment, attempted to track down the paradox inherent in the perception of the way knowledge and competence are developed and maintained. On the one hand there is the belief that everything can be systematised and formalised in a symbolic logical notation. On the other hand there is Minerva's owl which, although it first appears on the periphery of the project, when seen as a link with the current debate on technical change, becomes vitally important to develop further.

Denis Diderot says this: 'If I knew how to speak as I think! But as it is now, I have ideas in my head but I cannot find words for them' (Josephs, 1969).

To be at once within and standing apart from oneself. To observe and be the person who is observed. But thought is like the eye: it cannot see itself. How do we shape the rhythmic gestures of our thoughts? Here we can establish a link with Ludwig Wittgenstein's philosophy of language, which is currently becoming more prominent in the international debate on technical advance.

On Following Rules

Ludwig Wittgenstein's philosophy focusses attention on the particular concrete case or example. He wishes to remind us of the complex and many-faceted logic of the example:

> It is not only a question of the errors in thinking we make when we focus only on the universal. It is also a question of the values that are lost through this intellectual attitude (Kjell S. Johannesen, 1987).

The multiplicity of disparate activities or practices: following a rule in one's activities is what Wittgenstein refers to as a practice; it is the focal point of his interest.

Wittgenstein perceives a concept as a set of activities that follow a rule, in contrast to regarding the concept as a rule, a view that characterises the earlier scientific traditions to which we have referred. In this way, the concept becomes related to its usage. The use of the concept determines its content. It is our usage or practice that shows the way in which we understand something.

The rule is built into the action. The concept of practice brings out this fundamental relationship. To master and coordinate actions implies an ability to be part of a practice. '. . . But if a person has not yet got the concepts, I should teach him to use the words by means of examples and by practice . . .' (*Philosophical Investigations*: 201) '. . . If language is to be a rneans of communication there must be agreement not only in definitions but also (queer as this may sound) in judgements' (*Philosophical Investigations*: 242).

We are taught a practice through examples, through models. The ability to formulate examples is vitally important. There are good examples which lead our thoughts in the 'right' direction and which refresh our minds, and there are examples that make it impossible to understand the sense of a practice. This cannot be made explicit by means of a formal description. It requires the ability to put forward the essence of a practice through examples that are allowed by teaching, by practice. We acquire a deeper understanding of the concept 'tool' by using tools in different activities. Taking part in different practices, when, for example, using computers, can give different opinions about the way computer usage affects the activity, while people sharing in a common practice may have varying opinions about the use of computers in this practice.

What is a Computer?

At an international conference in Sigtuna, Sweden in June 1979 on the theme 'Is the computer a tool?', Allan Janik (Janik, 1980) the philosopher, discussed 'essentially contested concepts' and the part played by these concepts in our attempts to describe reality:

> Basically, the most vexed issues which humans face involve conflicts about how we are to describe the situation we confront . . . Our evidence may be the wrong sort of evidence and our tradition may lead us to ask the wrong questions. We must be at one and the same time guided by what we take to

> be the substance of the issues at hand and also prepared to reconsider precisely what the substance of the issue actually is. It is always necessary to bear in mind that the most serious issues we confront concern 'essentially contested concepts', i.e. disagreement over just what the substantive issues are. To prevail in the conflict is to be prepared to follow the discussion, even when it leads us into unfamiliar terrain.

The content of the concept 'tool' is not self-evident in the same way as understanding what a computer is. There is a profusion of metaphors and parallels about computers in analogies with steam engines, electricity, the motor car, typewriters, etc. In the same way there are numerous analogies of what a human being is in connection with the debate on technological development: man as a clockwork machine, an ant, a piano, etc. A usual starting point in the debate on computers is to compare the memory capacity of the brain to that of a computer. Here, the main function is information processing. A different starting point is the comparison between human language and the 'language of machines'. The point of this comment is to interpret Allan Janik's attention to 'essentially contested concepts', namely that our perception of the man-machine relationship plays a decisive part in controlling our questions on the use of computers.

A Boat Builder on the West Coast of Sweden

The conference on 'is the computer a tool?' was also attended by Thomas Tempte, a carpenter and craftsman who for his part could see no striking similarities between computers and what he in his own 'profession' was used to calling 'tools'.

Thomas Tempte (1981) described Gosta, a boat builder on Sweden's west coast:

> Gosta is a product of the old master-journeyman-apprentice training system in which sophisticated and complex knowledge was passed on without using words. This is not because of any aversion to transferring knowledge by means of the spoken word, but because no such tradition had been developed.
>
> Putting a question to Gosta elicits very precise information, often after a pause for thought. His knowledge is neither unconscious or unrefined, but he is not used to passing it on in words. He demonstrates by doing the job, supplementing his example with a few words of commentary. This often takes the form of a story about a craftsman who did not do the job in a certain way, which caused him to make a mistake. One gets the feeling that he has all the answers, and this allows him to disassociate himself from the

> ill-judged behaviour of the offending craftsman. All this is related in the form of an anecdote.

Here, Tempte gives an unusually penetrating description of his professional work. None-the-less, it contains an unacceptable assumption on the nature of knowledge and how it is transferred. Tempte expresses himself from within a tradition which more or less tacitly presupposes that it is possible to express everything in words. At the same time, he describes the master craftsman as 'demonstrating, with a few words of commentary'. This is as far as one can go, providing examples and stimulating practice.

One consequence of the essential operation of following a rule is that special emphasis is placed on practice/learning. Previous experience and problem-solving, so-called sediment, is turned into a process of following rules that form the basis of the practice that we are being taught: 'Is it that rule and empirical proposition merge into one another?' (*On Certainty*: §309) Wittgenstein asks, and goes on to say: 'If experience is the ground of our certainty, then naturally it is past experience and it isn't for example just my experience but other people's, that I get knowledge from.' (*On Certainty*: §275)

There are many ways of following a rule. In Wittgenstein's view, guessing is of central importance to a rule system and to all forms of learning. Applying a rule is a matter of knowing what to do at the next stage. Guessing is done on the basis of examples we have been presented with and continues until we have the talent to do it correctly.

As we grow more sure, i.e., have met a large number of examples through our experience, our competence increases, and we master a practice.

Judging Light in Photography

Peter Gullers (1984), a photographer, has reflected upon his professional work and made a penetrating description of the essential aspects of judging light in photography:

> The text of a recent advertisement for cameras said: 'Instructions for taking good pictures – just push the button'. Thanks to new technology we no longer need to know a lot about the technique of photography before we can take good pictures. The manufacturer had built a program into the camera, a program which made all the important decisions and all the assessments needed to produce a satisfactory result.
>
> New technology has made it easier to take photographs and photography has become very reliable and accurate in most normal conditions. When there

is not enough light, the exposure is blocked or a built-in flash is activated to ensure satisfactory results.

The program cannot be modified and no opinion can be passed on the results until later. The underlying principles are invisible – the process is soundless. Neither does the manufacturer describe how the program makes these assessments. In retrospect, when the picture has been developed, even the uninitiated judge can say that the picture is too dark, too light or blurred. On the other hand the cause of the fault is difficult to establish without a thorough knowledge of technology, or of the conditions under which the photograph was taken.

There are numerous problem areas and the causes of these problems tend to merge with each other.

Physiologists claim that the eye is a poor light-meter because the pupil automatically adapts to the intensity of light. This may be so. When faced with a concrete situation that I have to assess, I observe a number of different factors that affect the quality of the light and thus the results of my photography. Is it summer or winter, is it morning or evening? Is the sun breaking through a screen of cloud or am I in semi-shadow under a leafy tree? Are parts of the subject in deep shadow and the rest in strong sunlight? Then I have to strike a balance between light and darkness. If I am in a smithy or in a rolling mill shop, I note how the light coming through the sloping skylights contrasts with the sooty heat of the air in the brick building. The vibrations from hammers and mills make the floor and the camera tremble, which makes photography more difficult and affects the light-metering. The daylight is enhanced by the red glow of the steel billets.

In the same way I gather impressions from other situations and environments. In a new situation, I recall similar situations and environments that I have encountered earlier. They act as comparisons and as association material, and my previous perceptions, mistakes and experiences provide the basis for my judgement.

It is not only the memories of the actual process of photography that play a part. The hours spent in the darkroom developing the film, my curiosity about the results, the arduous work of re-creating reality and the graphic world of the picture are also among my memories. A faulty assessment of the strength of the light and the contrast of the subject, the vibrations and tremors become important experience to be called upon next time I face a similar situation. All of these earlier memories and experiences that are stored away over the years only partly penetrate my consciousness when I make a judgement on the light conditions. The thumb and index finger of my right hand turn the camera's exposure knob to a setting that 'feels right', while my left hand adjusts the filter ring. This process is almost automatic.

The problem with automatic computer-aided light-metering is that after a long period of use one tends to lose one's ability to judge light conditions.

Few people can manage without mechanical or electronic light-meters today.

But it is not simply the ability to judge the light value that is disappearing. Unless one regularly makes a manual judgement of light, one's sensitivity to shades of light tends to become blunted. Our pictorial memories of past experiences are not activated in the same way unless they have been connected with similar assessments. Unless one regularly performs the actual work of producing pictures, the ability to make the best use of composition and light-modifying techniques when printing will wither too.

The problem with the automatic meter is not only that its program does not consider whether it is day or night, or the nature of the subject, or the inexperience of the user. The most important point is that it denies me access to my memories and blunts my perceptions and my ability to discern shades of light. This intimate knowledge is not linked to what I do when I photograph, i.e. the operations 1 perform, but to actual memories and experiences when I take photographs and when I develop and print pictures.

Technology and Culture

Gullers' example contains a cultural-critical perspective. The type of change in professional competence that Gullers points to, 'the sensitivity to shades of light tending to become blunted, is a phenomenon that takes a long time to occur. It is one of the reasons for calling attention to links with the past. Without a link with the past through epistemology and the history of ideas, a debate on the future of technological development will lack any contact with reality. It will be devoid of content, and full of clichés and vague rhetoric such as 'placing the human being in the centre'.

The cultural-critical element is constantly present in Wittgenstein's thinking. Describing a practice involves adopting a standpoint on the description of a culture. 'A whole culture belongs to a language-game.' A practice is thus, at one and the same time, both fundamental and relative to the culture and the epoch.

In a study carried out by the International Labour Organization in Geneva comparing 13 industrial countries and their experiences of technical change in the 1970s, a common factor emerged, namely the attention given to changes in professional qualifications. When discussing solutions to the problem of changing professional qualifications, it becomes evident that individual cultural and national characteristics become involved. The problem is a common one, but culture and tradition become decisive factors in the way different solutions are debated. There are culture-specific characteristics that must be observed when making international

comparative studies. Why, for example, are 'isolation' and 'lack of identity' emphasised in West German studies of the use of computers? Has the computer any decisive significance in terms of the occurrence of these phenomena or are they culture-specific and can they be discussed separately from the issue of computers?

Routine Practice and Development Practice

We call an activity that can be described exhaustively in stated rules a routine practice. Here, the rules are closed; they can be described in a set of essential and sufficient conditions. There is an obvious relationship to a set of rules adapted for computer technology.

An activity that is characterised by open rules, meaning that their expression admits of a variety of meanings, we shall call a development practice. It is this kind of practice that we are primarily interested in. The rules that form a development practice cannot be entirely expressed in words. As we pointed out earlier, it is essential to have good examples and to learn a practice by training. It is the following of the rules rather than the rules themselves that is the prism in this perspective.

At the same time, it is important to emphasise the intersubjective aspects of following rules in a practice. It is logically impossible to be the only person following a rule. A single practice can therefore not be seen as a logical place for dialogue and shared action.

Error-location in a Computer Program

Per Svensson (1983), who is responsible for developing a computer system for forest valuation, makes the following remarks on error-location in a computer program:

> In the routines at the Agricultural Administration for valuing forests using EDP, error-location and the correction of input data is one of the most important jobs. Programs have been written that search through input data and report any errors, controlled by given rules that are part of the program. It is impossible to make programs to locate and make a perfectly clear report on every kind of error. The input data varies far too much for this to be a practical possibility. Instead, the users must learn this work through experience. After having worked with this application for a long time, the speed with which most experienced users now locate these errors is incomprehensible to new employees. When asked: 'How do you locate this error?', they answer: 'I see that it is an error'. One explanation of why

> experienced users recognize errors when inexperienced users do not discover them is that their experience contains memories from earlier, similar cases, even if one cannot with certainty report when they occurred. This is a form of knowledge that is extremely difficult to document, but which none-the-less exists and works in practice.
>
> Attempts have been made to document this particular work operation. The experience gained from these attempts is daunting. The result of the documentation was a very comprehensive catalogue of every imaginable error, how they were reported by the program and what action should be taken on them. For new users, this catalogue was both frightening and of little use, while experienced users worked quicker and more surely if they trusted their own experience and did not use the error-location catalogue. Experience cannot always be documented in a usable way.

This knowledge cannot be taught directly to others, but can be transferred to some people by using analogies and concrete examples. At the same time the individual must strive to win a deeper insight into a practice, and become proficient in its use. There are different practices for error-location, for example the skills mastered by flight mechanics, and in the medical care sector in professional groups such as physicians and nurses in order to make diagnoses. To be skilled in one of these practices does not mean that one can transfer this ability to another practice. Error-location on aeroplanes and error-location in a computer program for forest valuation are not interchangeable skills. At this level analogies and examples are not transferrable between different practices. Today, because these different activities use computer technology, there is growing interest in the possibility of moving from one activity to another if one has mastered the technology. It is this perspective that, for example, André Gorz expresses when he claims that less emphasis need be placed upon professional skills and that computer technology skills must be given pride of place. It is important to emphasise the activity-specific aspect of mastering a practice, and that analogies and examples must be taken from within a practice. Of course, there may be striking examples that can be used to illustrate a number of different activities. A special talent is needed to formulate and present these good examples. There is a continuity in the mastery of error-location in an activity that is accentuated in the conversion from old to new technology.

Three Categories of Knowledge

The exercise of error-location involves the application of what we may call practical knowledge, knowledge which contains experiences obtained