Between Scylla and Charybdis – and Enjoying it? **Organisational Tensions and Research Work**

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In Greek mythology, Scylla and Charybdis were two immortal monsters that lived in the narrow waters traversed by the hero Odysseus. They are personifications of a whirlpool and a dangerous rock, but Scylla and Charybdis can also be seen as a poetic expression to the dangers that confronted Greek mariners when they ventured into uncharted waters. With increasing demands for external relevance, utility value or commercialisation of research results, as well as new forms of management, evaluation and accountability, many researchers probably feel they are venturing into uncharted waters too. For instance, in cross-sector research co-operation, careful manoeuvring may be necessary to avoid the projects from turning into traditional industrial R&D or private sponsorship of traditional academic research. Indeed, research work, with a fundamental demand for originality, is a constant venture into uncharted waters in itself.

However, the balance of opposing forces, be it whirlpools or rocks, is not a new phenomenon in scientific work. Kuhn (1963) claimed that scientists face "creative tensions" that can be "almost unbearable", and Pelz & Andrews (1976) found that research performance was highest under conditions that seemed antithetical, e.g. simultaneous high levels of autonomy and dependency upon others. In the general literature about organisations, issues like ambiguity, paradox and tension have become popular, not least following the emergence of themes such as learning and change management. A central claim in the literature is that tensions need to be balanced or maintained if the organisation is to change, be productive and/or to innovate (see Foss Hansen, 1995; Dougherty, 1996; Weick & Westley, 1996; Birkelund, 2000).

In this paper[1], I will take a closer look at tensions in research work and research units. My starting point is that many scientists reportedly have produced higher quality work in some re-

search units than they have in others – the social environment has somehow been conducive to the quality of the research products (e.g. Blau, 1973; Pelz & Andrews, 1976; Long & McGinnis, 1981; Thagaard, 1991). Even Nobel Prize winners have in interviews stated that they have done better work in some settings, termed "evocative environments", than they have done elsewhere (Zuckerman, 1977). I suggest that *tension* is a key word for characterising these environments, the way they influence research quality and how this "better work" can be described.

There are several previous investigations of the concept of research quality and how it can be elaborated further (e.g. Chase, 1970; Hemlin, 1991; Buchholz, 1995; Kaukonen, 1997; Andersen, 1997; Dirk, 1999). Focus has mainly been on more or less in-depth specifications of, or ranking of criteria for good research, but the question of why some individuals or organisations produce better research than others, has barely been touched upon in this literature. On the other hand, many investigations have looked at research units or organisations to discover "determinants of performance" (e.g. Pelz & Andrews, 1976; Andrews, 1979; Hare & Wyatt, 1988; Nagpaul & Gupta, 1989; Sing & Krishnaiah, 1989; Spangenberg, 1990a; 1990b; Harris & Kaine, 1994; Asmervik *et al.*, 1995 and 1997; Bennich-Björkman, 1997). However, with only a few exceptions, these studies have used more or less rough quantitative measures of performance and have not tried to go deeply into the constituents of good versus bad or high versus low performance. The present investigation aims to fill some of the gap between these two bodies of literature by exploring tensions in research work.

Earlier Investigations and Perspectives

Useful input into the present investigation can be found in the research quality literature, organisation theory and prior studies of research units.

Research Quality

The question of good research has naturally been studied as long as humans have carried out research. The philosophy of science has dealt particularly with the validity of (different forms of) scientific inquiry, and the sociology of science and other fields have also provided input to the discussion about quality, for instance by specifying an *ethos* for science (e.g. Merton, [1942] 1973). Recent empirical investigations of research quality (like Hemlin, 1991; Kaukonen, 1997) are rarely inspired by fundamental discussions about themes like objectivity, validity, truth, confirmation, simplicity and rationality, maybe because these concepts are often seen as controversial and ambiguous (cf. Tranøy, 1986; Toulmin, 1992, Fuchs, 1997).

It is obvious that nature and society do not provide us with clear specifications of research quality. Fundamentally, I see definitions of good and bad research as being constituted by the many judgments of quality that are carried out in evaluations (of proposals, manuscripts etc.) and not least in the daily work of scientists. I assume particularly senior scientists play a crucial role in determining good and bad research through citing or using others' research in their work and through the peer re-

view processes that they participate in.

Earlier investigations of research quality have almost exclusively focused on universities and university scientists. Explorations into the constituents of quality reveal a spectrum ranging from simple two-factor models to complex multidimensional conceptual frameworks. An example of the former is in Ravetz (1971). Here, research quality is decomposed into two criteria – adequacy and value, as well as four classes of quality, from "competent" to "immortal". When applied to particular cases, tacit judgments of adequacy and value are made that depend on one's intimate knowledge of the relevant field. The framework described in Hemlin & Montgomery (1990) is an example of a complex model. Quality in this framework is seen as a combination of certain attributes and aspects of the research. Aspects are problem, method, theory, results, analysis and writing style, while correctness, novelty/originality, stringency, intra-scientific effects, extra-scientific effects, breadth and general utility are examples of attributes. It is asserted that some combinations of aspects and attributes correspond more to good research than others.

Prior empirical studies of the quality concept are mainly based on quantitative data. These include a Swedish survey of 224 university researchers, based on the framework developed in Hemlin & Montgomery. Here the most frequently mentioned attributes of good research were novelty/originality, stringency and correctness (Hemlin, 1993). Extra-scientific relevance was mentioned before intra-scientific relevance in open questions, but not in closed questions. The most important combinations of aspects and attributes were stringent and correct methods, and original and stringent problems. In a Finnish study among 205 researchers at six university departments, originality, practical utility and methodical level (reliability and validity) were most often referred to in open questions (Kaukonen, 1997). In closed questions, verisimilitude (probability for truth) ranked highest followed by originality and intra-scientific utility.

Following this brief review of literature (see Gulbrandsen & Langfeldt, 1997, for a more thorough review), my first research proposition is that *research quality can be divided into several more or less incommensurable elements, and these elements together constitute major tensions in research work.*

The Organisation as Tension or Paradox

On the organisational side, numerous theories, concepts and organisational paradigms can be found in the literature, and the criteria for selecting a particular view are unclear and debated (cf. Clegg & Hardy, 1996; also Pfeffer, 1982; Scott, 1992). Many authors have argued that empirical investigations need to incorporate several frameworks or views in order to capture a more complete picture of organisations (e.g. Bolman & Deal, 1984; Morgan, 1988; Foss Hansen, 1991). Each perspective may give a logically coherent but still insufficient view of organisational elements and processes. Multiple frameworks are thus needed to capture ambiguous, inconsistent, paradoxical and dichotomous aspects.

Foss Hansen (1995) has taken this a step further and proposed a paradox

perspective in which the inconsistencies and paradoxes of organisations are defined as their central element. She argues that all organisations can be characterised by contradictory traits, e.g. concerning tasks, processes and structures. These contradictions are elaborated as *tensions* that "keep organisations breathing and alive" (p. 41) because they release energy and thus improve performance. It is claimed that organisational effectiveness in fact rests largely on the ability to maintain and manage the balance in relevant dichotomous dimensions. Hence, research evaluations should for instance look for the existence of paradoxes and the ability of the organisation to sustain them. Foss Hansen provides three examples of tensions in research organisations: norms of elitism versus norms of egalitarianism, international versus local integration and renewal versus the maintenance of current paradigms and problems. She underlines that the perspective seems fruitful both to get an improved understanding of organisations and to suggest methods for improving quality.

A matching framework is proposed by Dougherty (1996). Here, tension is the key word for understanding how innovation is organised. There are many similarities between research work and innovation (research can e.g. be seen as part of the innovation process). Dougherty distinguishes between four main types of tension: inside versus outside, old versus new, strategic determination (top-down) versus strategic emergence (bottom-up) and responsibility versus freedom. Innovation (or R&D) typically implies a focus on outside orientations, originality, emergent strategies, and freedom, while the rest of the organisation may be better served by an orientation towards the opposite. It is indicated that tensions stem from the activities themselves, but the theme is not elaborated much further. The dilemma of creative destruction and stability versus change is also well known from the general innovation literature (cf. Zaltman *et al.*, 1973; Abernathy & Clark, 1985).

Similar to Foss Hansen (1995), Dougherty (1996) underlines that tensions cannot be eliminated: "These tensions must be balanced throughout the organisation, because the activities of innovation extend beyond a project, and are inextricably bound up with the organisation as a whole." To balance or accommodate tension is seen as crucial to facilitate innovation. Weick (1979) suggests that even if the objective of the organising process is to reduce ambiguity, some ambiguous features have to remain to make the organisation able to survive the transition to a new and different future.

Tension can furthermore be linked with theory on organisational learning, because learning is seen as disorganising and increasing variety, while organising implies forgetting and reducing variety (Weick & Westley, 1996). It is claimed that these two opposites should be connected (i.e. maintaining the tension), and that a focus on informal organisational aspects is necessary to accomplish this. Tolerance of ambiguity and paradox, albeit difficult to achieve, is seen as a key factor behind organisational renewal (see Birkelund, 2000 for an elaboration). It has been found that eminent scientists frequently work simultaneously with alternative methodologies, competing hypotheses, conflict-

ing theories etc., compared to "run-of-the-mill scientists", thus maintaining a kind of tension at the individual level (e.g. Zuckerman & Cole, 1994).

An interesting parallel can be made to micro-level investigations of influences on motivation. Herzberg *et al.* (1993) claim that the motivation to work is affected by two types of factors – hygiene and motivation. The former factors may make the worker less demotivated or dissatisfied, but do not by themselves contribute in a positive way. Examples are salary, physical working conditions and the relationship to colleagues. Motivational factors, on the other hand, contribute directly and positively to motivation/satisfaction, and their influence will be greater if the necessary hygiene factors are present. Herzberg and his colleagues mention the work itself, recognition and responsibility as examples of motivational factors. The authors furthermore assert that these will be more important the higher the work/educational level of the personnel. Hence, such inner factors should be central in an R&D context. A central claim is that the two types of factors influencing motivation are independent of each other, and that any individual's motivation can be explained by "a paradox of two dynamics" (p. xvii).

Thus, organisations can be characterised by tension in various dimension, or connected with certain aspects. Some dimensions/aspects can be external versus internal orientation, freedom versus responsibility and egalitarianism versus elitism. The essence of a tension or paradox perspective is that one side cannot (and/or should not) be selected at the expense of the other, but that a balance between opposing characteristics can lead to innovation and learning. My second main research proposition is that *there are several organisational tensions in research units, and they reflect inherent tensions in the quality criteria.*

Although this is not a major point in much of the literature, a brief specification of terms like ambiguity and tension can be useful. Ambiguity may refer to objective phenomena subject to more than one interpretation (like the text of a policy document), a conscious or unconscious awareness of multiple interpretations (of an incident, text etc.), as well as confusion caused by ignorance or lack of information. Tension may be the case when two interpretations of a context are in opposition and/or are seen as mutually exclusive, and when both interpretations are accepted to be true simultaneously (see Birkelund, 2000 for a further elaboration).

Tension in Research Units

A tension perspective is consistent with earlier findings in empirical studies of research units – good research organisations seem to be characterised by many such ambiguous aspects. In the words of Kuhn (1963: 342), "The ability to support a tension that can occasionally become almost unbearable is one of the prime requisites for the very best sort of scientific research." This seems particularly directed towards originality in research work; Kuhn names the phenomenon creative tensions.

Pelz & Andrews (1976) adopt the expression and argue that factors of challenge and security together constitute creative tensions. They assert that all organisational aspects of research units may have a stabilising and destabilising

side, and that both have to be present in order to create an environment that makes the individuals perform their best. In their empirical study, performance was found highest under conditions that seemed antithetical, e.g. simultaneous high levels of autonomy and dependency upon others:

> It seemed reasonable to say that the scientists and engineers of our study were more effective when they experienced a 'creative tension' between sources of stability or security on the one hand and sources of disruption or challenge on the other (Pelz & Andrews, 1976: xv).

Some of the most distinct tensions were related to time use – the researchers' distribution of technical time (time spent on non-administrative tasks) across five different technical activities (basic and applied research, development, improvements and technical service) – and communication. Pelz & Andrews found that the highest performers in all types of settings devoted a relatively large share of their time to other activities than what could be described as the main goal of their laboratory or organisational unit. Effective scientists did not spend their time in basic science or in "the world of application" alone. For instance, "Even in laboratories devoted to pure research the best performers carried out four functions; they did not concentrate on research alone, but spent some time on development or service functions" (p. xviii). If Ph.D.'s or assistant scientists tried to do all five types of R&D activities, performance dropped, whereas engineers flourished under such conditions. Pelz & Andrews discuss seven broader tensions surrounding research units: science versus application, independence versus interaction, specialisation versus breadth, autonomy versus external demands, influence on others versus control by others, intellectual harmony versus intellectual conflict and young versus old (e.g. related to group age).

One implication of balancing security and challenge could be that university departments/research groups can be described as "nice places to work" without necessarily making high quality research products (Jacobsen, 1990). Having a good and friendly working climate contributes to a feeling of security among the researchers, but does not provide the challenge necessary to produce very good research. It has also been found that groups with high autonomy but little external pressure perform poorly, while groups with an equivalent level of autonomy and much pressure or with strong group-internal norms of innovation and change, perform well (Kim & Lee, 1995). It is perhaps typical that the literature that gives a more ideal picture of good research units focuses almost exclusively on challenge factors – e.g. Asmervik *et al.* (1995), who depict good research units as "dynamic, demanding and courageous".

Separating factors in this way may for instance explain why few studies fail to find a significant relationship between resources and performance (e.g. Pelz & Andrews, 1976; Stolte-Heiskanen, 1979; Jacobsen, 1990; Kyvik, 1991). A certain level of (economic/material) resources may be necessary to be able to do good work, but does not in itself contribute to high performance – this is a hygiene factor in the terminology of Herzberg *et al.* (1993). Thus, it can be asserted that a certain minimum of human, time-related and financial resources, as well as

possibilities of interaction with colleagues and other relevant actors, is necessary for creating good research. Time to carry out research, a friendly (or maybe at least non-hostile) working climate and the right equipment will not, however, automatically lead to research quality. Other factors influence how good the performance will be, e.g. a strong dedication to research, pleasure of carrying out the actual research work and interaction with challenging colleagues.

From the literature, it can be claimed that the institute sector has some particular challenges (Mathisen, 1989). Mathisen argues that institutes need to develop a third alternative through balancing forces that pull them in academic and in market directions. Focus on strategic research and new forms of recognition and dialogue (hybrid communities) are some of the arrangements that are suggested for balancing tension. My third main research proposition in this paper is that *new forms of knowledge production, in which criteria of academic excellence and user relevance are combined, may be a source of particular tensions, and many research institutes can probably constitute good examples.*

Methodology and Data

Following the exploratory purpose of the investigation, its theoretical starting point and its main research propositions, as well as the nature of my object of study, I selected a qualitative methodology with data collection based on focused interviews. A semi-structured interview guide was made that aimed to touch on central issues identified from the literature, but with room for flexibility and follow-up questions. A sample of senior researchers, mostly of a certain repute, was selected. The informants, 64 in total, represent universities, institutes and industry in ten different disciplines – basic biomedicine, biotechnology, chemistry, clinical medicine, economics, engineering cybernetics, French language, mathematics, philosophy and sociology (see Table 1).

Table 1. Sample distribution across sectors, disciplines and fields of learning.

	University	Institute	Industry	Totals	
Philosophy	3			3	} 6
French	3			3	
Mathematics	3	3	2	8	} 19
Chemistry	3	3	5	11	
Biotechnology	3	1		4	} 11
Cybernetics	3	3	1	7	
Sociology	3	3		6	} 15
Economics	3	3	3	9	
Biomedicine	3	3		6	} 13
Clinical medicine	3	3	1	7	
Total	30	22	12	**64**	

Three assumptions lie behind this choice of method. First, research quality is largely a tacit concept, and explicating the tacit dimension requires a less structured method of gathering data. Second, research quality is defined by central researchers in each discipline, for example through decision-making related to publications, projects and appointments. Third, organisational tensions may often be unrecognised and suppressed, thus requiring a careful and indirect collection of qualitative data.

Concerning the last assumption, several investigations have found that subjective indicators of e.g. a research unit's resources display stronger correlation with performance than more objective indicators (e.g. resource levels taken from budgets) (for instance Stolte-Heiskanen, 1979; Harris & Kaine, 1994; also Visart, 1979). The type of motivation and dedication of researchers may be a particularly central influence on whether the organisational environment is seen as evocative or as a barrier to performance. Thus, qualitative interviews are likely to yield useful information about research quality and relevant organisational characteristics.

The interview guide consisted of two parts. The first one, included open and closed questions about research quality. The informants were asked to describe and typify their professional activities, to define good and poor/bad research in their field, to comment on some of my suggestions for quality elements or criteria, to connect the criteria with individual and organisational aspects, and to describe judgments related to manuscripts, proposals and appointments. In the second part of the interviews, a number of open questions about organisational and individual aspects were asked about resources, leadership, size, autonomy, the composition of groups and departments, organisation of work, motivation, creativity and recruitment. There were no direct questions about tensions, but this was very frequently touched on in all parts of the interviews.

My analytical approach follows long traditions in the social sciences. I have looked for broad similarities and differences in the statements of researchers, who were asked to talk about research quality and research organisations. The similarities and differences are initially taken at face value, i.e. seen as a reflection of the motivations and actions of researchers. I have then constructed a more generalised version of research quality and its relationship with organisational factors. The NUDIST software package was applied in the data analysis.

Empirical Results

Tensions in the Quality Concept[2]

In general, the answers to open-ended and both highly specified and unspecified questions show that good research has *three* necessary overall criteria: (1) solidity, (2) originality and (3) scholarly relevance or some form of social or practical utility. These criteria may be described as minimum demands or ideal demands – based on the minimum characteristics which research must have in order to be perceived as good, or on the characteristics that we ideally think research should have. The minimum demands for good research are, in short, that it must reveal something that we did not know before, it must not be trivial

and it must be substantiated in some way. The *ideal demands*, on the other hand, are considerably higher. Ideally, we want research to say something new in a revolutionary sense with great effects for the discipline or praxis, and with solid evidence – contributions that yield definitive new understanding of central phenomena or problems (or solutions to problems) in an absolutely convincing and tenable way.

The informants underlined that most often the very best research works are judged favourably within all elements or they score particularly well on originality. Middle-range research may score well in one respect and poorly in some other respects, or may be judged moderately well on all criteria. From the interviews, I have the impression that solidity and to some extent originality frequently are assessed based on well-established disciplinary norms, while the two types of relevance are more dynamic criteria, changing faster and closely related to the larger scientific community or groups outside of the research units (mainly users).

The relations between the four elements of good research are not without problems. The elements partly overlap or depend on each other, but may also conflict with each other. Several interviewees were concerned about elaborating on such matters. An often-mentioned dilemma is experienced between solidity and originality. Systematic work and a thorough and long training contribute to solid results, but may hamper creativity, and thus reduce originality. Many also stated that some researchers are much more creative "by nature", while others are thorough and patient, and that people rarely combine these two features.

Originality and scholarly relevance may both presuppose each other and conflict with each other. Research which is scholarly relevant by discovering general principles, filling holes in the stock of knowledge or opening new areas, is by definition also original. However, scholarly relevance may also be judged in a narrower sense, based upon contemporary research trends. The research community does not always value the originality that implies breaking with prevailing traditions. The relation between originality and scholarly relevance thus depends on how scholarly relevance is defined.

The relation between originality and utility also has more than one side. On the one hand, several informants emphasised that the potential utility is proportional to the degree of originality. A mathematician with relations to both university and institute sectors thought, "Originality and utility most often are positively correlated, and the best researchers often are successful both in academia and industry." On the other hand, many informants claimed that unoriginal research can be far more useful than original research. For example, "yet another survey on living conditions" can be important and useful, but is not especially original (and perhaps not even regarded as research in the stricter German and Scandinavian sense of the word). The negative relation seems particularly connected with short-term utility. This was expressed in two different ways. Some emphasised that the less original research projects are, the less future utility may be expected. Others said that demands for short-term utility result in less original research.

In the same way, there was said to be an animosity between concrete utility and scholarly importance: utility will increase with the narrowness of the problems that are focused upon, while general results and overall perspectives will be more interesting to other researchers. Focus on extra-scientific utility may therefore reduce the scholarly value of the results, and vice versa. Another case of tension between utility and scholarly relevance was mentioned by two medical researchers. They gave examples of experiments that yielded small effects on a certain variable in the research subject (e.g. 5-10 percent). Effects of such a magnitude are most often written off as measurement errors, and scientists rarely bother to communicate the results explicitly to users or follow the experiments up with further investigations. However, many industries (both informants mentioned the food industry as an example) would be very interested in identifying substances that can produce small changes in the output of a product, because the companies' operating margins are often very tight.

On the other hand, the relation between solidity and utility seemed far less problematic. Several interviewees mentioned that in order for research to score on practical utility, it must be solid. For instance, scientists in industry stressed that solid research is a prerequisite for successful industrial implementation. Some informants problematised the relation between solidity and utility, though. A few social scientists asserted that some users of social science in public administration may find the results of non-solid research much more useful than the results of solid research, provided the non-solid research gave the conclusions they *wanted*. One medical scientist also thought that high demands for solidity may hinder utility. He claimed that competing firms might use unrealistic solidity requirements to prevent new competing drugs from reaching the market and thus be able to block any social utility of the new product.

The most central specifications (in *italics*) and tensions are summarised in Table 2.

The first main research proposition (research quality can be divided into four more or less incommensurable elements, and these elements together constitute major tensions in research work) is confirmed, but only partly. There is obviously tension between quality aspects, and a decomposition into four elements (less than e.g. Hemlin & Montgomery, 1990; more than e.g. Ravetz, 1971) worked quite well for a large majority of the informants. However, it is evident that all decompositions, also the one I have proposed and elaborated, lose a facet or an aspect of research quality. Even after long interviews with experienced researchers who were prepared to talk about quality, a tacit and largely personal factor remains that is not covered by originality or relevance. Good research is something that one feels or experiences as much as analyses, and many informants concluded long attempts at explications with the (often somewhat resigned) phrase "you know good research when you see it". Individual preferences were expressed, for instance, in sentences like "personally, I put much weight on originality", and "methodological contributions are most valued by me, but not necessarily by others". This tacit and highly subjective component should

Table 2. Specifications of research quality and quality tensions.

Quality elements	**Solidity**	**Originality**	**Scholarly relevance**	**Practical utility**
Solidity	*Well-founded claims/ conclusions; good documentation and data; consistency and coherence; factual interpretations; impartiality, stringency, clearness, avoiding fraud*	Systematic work vs. creativity; creative researchers vs. those that are more thorough or patient	No tensions sketched (unless the research work is extraordinarily original, it has to be solid to be relevant to others)	No tensions sketched (solidity is seen as a pre-condition of practical utility, with a few exceptions)
Originality		*Theoretical/ academic novelty or originality related to practical problems; incremental versus radical originality*	Following the major research trends vs. breaking with tradition (although original research often is relevant to others)	Short-term utility vs. more radical originality (which requires long-term focus)
Scholarly relevance			*Cumulativity (filling holes/ other contributions, opening new areas) and generality (e.g. general principles, research tools and methods)*	Focus on broad or general problems (scholarly relevant) vs. narrow or local problems (potentially useful)
Practical utility				*Long-term and short-term (immediate); specific users or more broadly defined social sectors (health, economy, environment)*

Note: Eleven informants stated that one of their own fundamental criteria of quality could not be included in these four sub-elements. Probably the most difficult aspect to incorporate is the research work's *mediation quality* (how well it is written, how and where it is published). This was particularly mentioned by scientists from soft fields.

probably be regarded as a legitimate and integrated part of research quality that nevertheless escapes decomposition and, to some extent, elaboration.

I have named these research quality tensions inherent, because they stem from criteria that scientists try to meet in every piece of research work. The tensions can be pictured as forces that pull the research in different directions. I see three important ways in which this can happen:

- *Attention* – a researcher or organisation that emphasises one of the aspects, may end up scoring poorly in another aspect (without necessarily intending to do so). For instance, strong norms of user relevance at an institute may make the organisation less attractive for collaboration with universities. A biotechnology researcher from a government institute said that his unit had experienced difficulties in co-operating with university professors in other countries after a string of highly applied and similar projects. "We need that co-operation to increase our competence, and we have paid this German professor to work with us. But we

definitely need more than money to offer in the long run."

- *Time* – the informants emphasised that both originality and solidity demand time and patience. Research projects often have a limited duration, and scientists need to allocate their time on different activities that may further only one of the quality elements, not all. A lot of time spent on idea generation and idea processing leaves less hours, weeks, months or years for the later phases of the research process.
- *Perspective* – following a trend or aiming to make one line of research and arguments ever more convincing and tenable, can over time lead to a decline in originality and more resistance towards new perspectives and paradigms. This may be seen both at the individual and organisational levels.

Organisational Tensions

Many organisational tensions were discussed during the interviews without asking any direct questions about them. For instance, a professor of clinical medicine stated (in a question about the working climate), "I think that people work best – and now I think mainly about doctoral students – in a unit where they get a suitable blend of challenge and support. You do get large challenges from the international research community that you encounter at conferences and when you write your articles. So we can be more on the support side, because I tend to see us as a base from which our young people go out into the world and present their stuff, write their articles and do their projects. And we're the home base to which they return to lick their wounds, and they get encouraged to go out there again. (…) The danger is of course that you get too kind and supportive, but since we have the ambition that everything should be published internationally, I feel that we've taken that into account." This quote shows that balance between opposing forces need not be considered internal to the research units. Almost all organisational aspects that were discussed during the interviews, carry with them some kind of strain, by themselves or together with other ones. In table 3, I have summarised what I see as the most central ones.

These organisational tensions can be tied to research quality in two different ways. First, some organisational aspects can promote one aspect of quality and restrain another. User control was for instance mainly seen as beneficial to utility value, while such control also was seen as an obstacle to creativity. Another example is that clearly defined responsibilities and formal training of scientists were seen as positive for solidity, but with possible negative effects on originality. Second, the organisation can be a source of creative tensions (see Kuhn, 1963; also Pelz & Andrews, 1976) – e.g. the eternal battle between unorganised chaos and the drive towards higher levels of organisation and efficiency may be a source of creativity (see Tardif & Sternberg, 1988; also Amabile, 1988).

The tensions I have described in Table 3 are effective at a meso level – they influence individuals and their dedication, motivation, understanding, creativity and more. At a macro level, hardly any tensions were sketched between the norms of the research units and their organisational host, i.e. the university,

Table 3. Organisational tensions in research units.

Organisational aspect	Tension
Individual	Ambitions of becoming eminent vs. desire to lead a normal life.
Mechanisms to release the potential in young people	Social support coupled with teamwork vs. critical professional feedback and autonomous tasks with little support. Projects giving a broad introduction to the field of work vs. projects that allow for more in-depth development of unique skills and competencies.
Rewards	Undifferentiated vs. differentiated pay to attract/reward competent scientists.
Promotion	Appointing the most ambitious (management-wise) people as leaders vs. making the best scientists leaders for research units (particularly in industry).
Leadership	Juniors need for support/rules vs. seniors expectations of non-interference. Strict focus on quality standards vs. inspiration and general social support.
Internal/external balance of work	Defining core competencies may be a tension in industry (deciding how much and which parts of research work should be done internally vs. outsourcing all or parts to others).
Formal organisation	Need for structure and responsibility vs. need for autonomy and flexibility. Autonomy vs. interaction/interdependence. Loose structure vs. attractiveness when it comes to doing contract research.
Size	Positive drive towards larger units (due to increased stability, access to funding, etc.) vs. disadvantages of being large (fission, reduced interaction, etc.)
Diversity of people	Diversity is in itself a form of tension; it is most often a greater challenge to interact with people a little different from yourself.
Diversity of tasks	Involvement in other activities can create pressure on the individuals time. Other activities can create strain by being highly intellectually challenging.
Organisational culture	Strong sense of unity vs. heterogeneity. Collaboration vs. competition.
Communication	Expectations of reciprocity/balance implies that communication can be a tension in itself. Contact with both users and universities (institutes; tension through affecting time use and perspectives). Ensuring intellectual property rights vs. open communication (industry).

institute or firm they are part of (see Hackett, 1990). The only ones who touched upon this were a few informants from applied units who discussed problems related to defining the "expected value" of research projects and the strain between the top management's focus on economic indicators and the researchers' wish for other criteria for high-risk project selection. In the universities, the informants did not describe tensions between their units and the institutional level, although some described the Research Council of Norway in slightly or highly negative terms. There is clearly a deep cultural conflict between the Research Council and at least part of the Norwegian scientific community. In addition, the differences in quality criteria and organisation of research work between institutional settings can be an obvious cause of tension across sectors. It can perhaps be argued that Norway's large institute sector between universities and industry, contributes to reducing such system-level strain (and possibly creates new ones).

A few additional comments can be made. First, some of the informants emphasised that good research units seek out tensions. They can for instance try to employ somewhat different people, focus on many professional tasks and combine norms and formal mechanisms of social support with strong demands or expectations of high ambitions and an orientation towards the research frontier.

Second, the dilemma or balance in industrial R&D units between doing the work internally and/or externally was not mentioned in the other sectors. Deciding "what we should *not* do" can be controversial, and several informants were of the opinion that particularly universities need to make more of these decisions. Especially some applied scientists expressed frustration that universities lacked the will or ability to build up good units in areas they saw as important to Norway. Such a decision is of course not necessarily a tension in itself, but the industrial scientists emphasised that the internal/external balance of work is a continuous issue, connected with most projects and strategy discussions.

Third, it must be emphasised that tension is not the same as personal conflict. Severe personal conflicts were unanimously seen as disastrous and destructive to the working climate of an otherwise possibly good unit. Scholarly disagreement is naturally not negative unless it escalates into a hard personal conflict. Fourth, there are tensions related to time that are not well reflected by the above table. Particularly applied scientists stressed that research units need to take on projects with different time horizons simultaneously, and they talked about the benefits of being targeted, flexible and broad at the same time. A few university professors talked about how a strong common organisational culture can lead to too much homogeneity over time. They saw planning for long-term diversity as central, even though this could conflict with short-term benefits from massively exploiting a line of research or taking on a lot of contract research and thereby gaining resources.

Can All Tensions Be Balanced?

The somewhat normative underpinnings in many specifications of tension

deserve to be commented. For instance, Foss Hansen (1995) argues that tensions and organisational paradoxes are good because they release energy and stimulate individuals. However, it is not necessarily certain that all types of scientific personnel feel comfortable in such organisations. Pelz (1967) found that high-performing researchers seek out units where the levels of both security and challenge are high. It could be claimed that some individuals and research units want less tension because they do not aim to become eminent or internationally leading. A clinical medicine researcher saw this as a particular challenge for the Norwegian research system: "Compared with other countries, it's clear that Norwegian research has a giant problem. We go home to wife and children relatively early, while in other places, they go to the pub *together with colleagues* and drink beer the rest of the evening. And for research, beer drinking would be better. But I don't think I would switch – it's a choice of values." The implication is perhaps that some researchers choose to work in units where there is more security than challenge or where the level of tension or ambiguity is lower.

Behind the claim that organisational tensions or paradoxes need to be balanced or maintained to ensure innovation and/or performance (Foss Hansen, 1995; Dougherty, 1996) lies the frequent assumption that there is a curvilinear relationship between performance and tension (as in Pelz & Andrews, 1976). This is also reflected in the many specifications that my informants offered throughout the interviews. I do not see statements like "not too large, not too small", "different people but not too different" and "a certain breadth combined with a certain depth" as naive expressions of moderation and a "golden mean", but rather as strong emphasis on balance between the various forces in research organisations.

Still, some tensions are obviously more difficult to balance than others, and in some cases, equilibrium may be impossible to obtain. The issue of differentiated pay can be an example. In most research units, it would be impossible to have individually-negotiated salaries for some, but not all, of the scientific personnel. Furthermore, some research units have a very strong egalitarian culture, making differentiated pay a possible source of envy, personal conflicts and deterioration of working climate. Challenges related to rewards can thus be seen more as dilemmas that need to be solved locally or centrally instead of tensions spurring creativity or other benefits. Nevertheless, a "middle road" could be to offer bonuses for particularly good work, such as international publication in prestigious journals. Informants from all sectors mentioned such bonuses. For instance, a philosophy professor said that his department offered to "buy you out" of teaching obligations based on your publication productivity (weighted towards the international community).

The list of tensions in Table 3 is an indication of how hard and complex the leader's task is. Very good professional and social skills, along with a willingness to work long hours, are probably necessary to maintain a balance between opposing forces. Perhaps the leader has an even more challenging role in this period of time characterised by increasing external control of research work, where it may be difficult to maintain a perception

of independence and autonomy among the scientific personnel.

Working life in an organisation focused on originality, with many forces pulling in opposite directions, is not necessarily easy. Previous investigators have found that eminent and ambitious scientists have a higher tolerance for ambiguity than others (Jackson & Rushton, 1987), and some of my informants have indicated likewise. For instance, some stated that good researchers have a high tolerance for work that is open, vague and unfinished, and many scientists do not feel comfortable when there are too many rules, too much order and too little chaos. If some individuals do not thrive in such an environment due to less tolerance for tension and ambiguity, that could be yet another process behind cumulative advantages. Very ambitious scientists may seek out the units where the tensions are most evident and the possibilities of becoming eminent are higher, while the not so ambitious end up in units with a more calm and clear-cut profile. It can be added that the strong emphasis on a good working climate in my interviews can be explained if good collegial relations are a precondition to tolerating tensions (as proposed by Weick & Westley, 1996).

At the heart of many organisational tensions is the issue of challenge versus support. To maintain motivation and to "release their potential", researchers need a certain degree of support and recognition for work done. Challenges, on the other hand, can stimulate creativity and help make the researchers productive and updated. Support and challenge go hand in hand in good research units, and in this respect, scientists most likely are no different from other professionals. What may be particular is the extremely open nature of many research organisations, hence, balancing challenge and security need not be seen as an internal task. Tensions furthermore often imply political processes. Tensions can stem from varying needs between junior and senior personnel, different interests between researchers and research managers. Balance in this framework may imply a successful compromise between opposing political forces.

My second main research proposition (that there are several organisational tensions in research units, and that they reflect inherent tensions in the quality criteria) can also be partly confirmed. Many organisational tensions have been elaborated, and these can be tied to research quality in two different ways. First, some organisational aspects can promote one component of quality and restrain another. For instance, user control is beneficial to utility value, but may restrain originality. To make a piece of research solid, original and relevant implies balancing forces that affect the researchers' time use, attention or perspectives. Second, tensions can be creative, i.e. a source of new ideas and approaches. Still, tensions can also be connected with maintaining motivation and dedication, and they may also reflect political conflicts in research units

Challenges for the Institute Sector

Because research institutes in Norway are often expected both to contribute to their discipline or area, and to the competitiveness, productivity, and health of their users, institutes that deal successfully with this challenge may constitute a model for university-industry relations

elsewhere. I have to point out that the institute sector in Norway is very diverse. Some of the institute researchers in this study work in a way that is very reminiscent of university scientists. Their main output is articles, reports and books, and they emphasise (theoretical) originality and scholarly relevance, as many university professors do. Particularly the social scientists, but also some of the medical scientists answered in this manner. On the other hand, some institute researchers' responses are very similar to those of industrial scientists. For them, utility value is the central criterion of quality, and personnel from the institute may take part in the whole innovation process, including, for instance, training of operators and advanced technical maintenance of the applications they have developed. There is often a strong identification with the contractors and users.

Still, a majority of the institute researchers can be grouped in a category between these two. Although scholarly relevance is not very often in focus in this group, many talked about cross-disciplinary relevance and a desire to disseminate to other researchers the essence of the work they do for external users. Intellectual property issues may make this difficult. Research quality (and prospective income) is not the only criteria of accepting a project in the institute sector. One example is where the institute has carried out a project for a contractor and then gets a request from a competing firm. This second prospective contractor might become a "free rider" because the first one paid for increasing competencies. Many of the institute researchers that I interviewed claimed that they never carried out similar projects for two competing firms in this manner, and that the institute had ethical guidelines to deal with cases like this. In practice, instead of turning down the second request, one often tries to build in a degree of originality into the project so that it does not turn out a copy of previous work.

However, interviews with representatives from industry indicate that this may be changing.[3] Usually, firms gain all the rights to the research results when they contract the work out to an institute. Industrial scientists and R&D managers state that they have noticed that institutes increasingly try to retain some of the rights, for instance by patenting applications or copyrighting software that has been developed. The institute's goal is to make money by licensing or selling products to others. For many firms who depend upon particular skills and competencies in the institute sector this could be a dramatic change, not least since institutes are struggling to become more internationally oriented and may thus have a greater chance of getting in touch with the competitors of the Norwegian firms. Some of the informants from industry claimed that this can lead to more free rider problems. The institute researchers argued that keeping at least some of the intellectual property rights actually ensures integrity and independence from a single contractor.

In addition to the conflicts between scholarly relevance and utility value and the problems related to intellectual property, informants from institutes sketched many other tensions, for instance between the institute's needs for income-generation and the researchers own wish for professional updating and development. As mentioned, some see

these tensions as fruitful and a source for creative solutions and formulations of projects. Others described such tensions as unfruitful – they lead to frustration and loss of motivation, and in the end perhaps neither utility value nor professional development. Why do some experience organisational tension and conflicting quality demands as fruitful, and others not?

One possible explanation could be to look at the environment of the institutes. The types of users, or user structure are probably particularly central framework conditions. Typically, the institute researchers who were frustrated and demotivated said that they have users who "do not return". When a project is carried out, you are finished with that user for a long time – you have installed the latest automation technology in the paper business or promoted a "quantum leap" in production technology among the makers of cured ham. This makes it difficult to build generality into projects. When contractors repeatedly come back, it is easier to get them to pay for development of skills and competencies. There is a complex dynamic process at work here. Many short-term or very applied projects with little originality value may make it difficult to create good links with universities, because professional exchange often carries with it expectations of reciprocity and balance. And without links to universities, recruitment and professional updating could be restrained. It can be added that Norway is a small country with few firms in each business, and this can explain why some institutes have invested much effort into gaining a foothold within the EU framework programmes. In this they see a possible larger and more sophisticated user base, as well as a better balance between international and local integration.

The internal organisation of the institute also seems to matter. Some institutes, but not all, have a formal policy of rotating personnel on more routine tasks, set aside time for publishing, courses and other forms of personal development, and maybe also give the researchers possibilities of testing out their own ideas (although many do this in the evenings and weekends). Some claimed that the main challenge is to create synergy or cumulation between projects – a sufficiently general content in projects that makes the individual or group able to learn something new in addition to producing something useful. Aiming for balance between different types of projects and tasks also implies that institutes may actually try to get some more short-term consultancy types of tasks in times with many long-term projects.

In many ways, successful research institutes have developed a hybrid culture (see also Mathisen, 1989). They move in a trajectory between the extreme values "academic nostalgia" and "commercial nihilism", specifying their own niche of strategic research, and rewarding good performance when recognition is absent from the academic community or the user community (as often seems to be the case). A fundamental prerequisite is to maintain close links with both users and universities. The hybrid culture with its balance between very different values does not *resolve* tensions related to research quality, on the contrary. It is by *balancing* the tensions, rather than "choosing a side" that institutes are able to perform well. In this manner, conflicting quality criteria are institutionalised.

Some also emphasised that the balance between basic research and user relevance is a unique source of creativity, inspiration and exciting projects. It can be added that the interviews indicate that most institute researchers have selected their workplace strongly based on their professional interests. "I'm not much into publishing and theory development that they do at the university, and I don't want to work in the hamster wheel of industry either," one of them said.

I see my third main research proposition (new forms of knowledge production, in which criteria of academic excellence and user relevance are combined, may be a source of particular tensions, and many research institutes can probably constitute good examples*)* as mainly confirmed. Research institutes in many ways need to contribute both to scholarly development and to social and technological innovations, and this is an obvious source of tension or strain. To deal with this, institutes need to maintain a number of ambiguous aspects in their organisation, e.g. connected with diversity (people, tasks, time-frames), rewards and communication patterns. It must nevertheless be added that similar tensions and conflicts were described (both in positive and negative terms) by university professors (particularly from engineering cybernetics in a positive manner) and industrial scientists. Later studies may want to include users in the empirical material. Although none of my informants said that users are able to judge the (total) quality of the research projects, they are fully able to (and in some researchers' opinion, the only ones that should) judge the utility value.

Discussion

I have found and specified many organisational paradoxes in research units (more than simply security versus challenge). The interview data indicate that the good units seek out tensions, for instance by instigating a recruitment policy leading to diversity (of backgrounds, age, sex and more), by striving for a project portfolio that includes both theoretical, practical, broad, narrow, short-term and long-term work, and by combining high levels of support and responsibility for scientists with equally high expectations of performance and top quality professional contributions. My data point to three main functions of these tensions.

First, they reflect conflicts inherent in the demands for good research (the functional role of tensions). For instance, if the work is required to be both practically useful and to contribute to the development and application of state-of-the art methods, the organisation will probably need to maintain good links with users and the international scientific community (or actors who function as gatekeepers to it). For the individuals in the organisation, this will constitute a tension. Not only can a time pressure arise out of the necessity of communicating with many external actors, but this communication will also expose the researchers to perspectives and demands that are likely to be perceived as difficult to combine. Thus, tension can be a key word for connecting the "research quality" and the "determinants of performance" literature. Research organisations need to maintain or develop tensions or paradoxes simply to reflect the inherent tensions in the

quality criteria they relate to. Related to this is that a certain level of diversity (in backgrounds of people, approaches etc.) may constitute a preparedness for different trajectories of knowledge production.

Second, and related to the first function of tensions, they can be connected with the centrality of originality in research work (see Kuhn, 1963). The fundamental demand of making a new contribution (e.g. to the international research frontier) that simultaneously is perceived by others as relevant and important is most likely a basic source of tension in research work (as it may be in other organisations where creativity and innovation are central aspects). My data support the earlier claim that not all people are able to support this kind of tension (Jackson & Rushton, 1987; also Kuhn, 1963). Thus, good researchers may have a higher tolerance for ambiguity and paradox, making them better suited for work in the "best" research units, assuming that these units also have the highest levels of tension.

Third, tensions can be linked with the maintenance of motivation and inspiration (the social-psychological role of tensions). The language of Pelz & Andrews (1976) seems well suited here – researchers need to be subject to a blend of security and challenge to remain motivated. My informants emphasised in particular this when they talked about doctoral students, i.e. the start of a potential scientific career. Social support and inclusion in scientific networks were mentioned, combined with friendly, yet critical feedback and transfer of quality criteria. This was seen as necessary to "get the doctoral students started" in a virtuous circle. Also seniors need this balance of security and challenge, but they may to a larger extent assume the responsibility for it (as well as be in a beneficial trajectory where it happens more automatically"). In addition, scientific communication is for many a positive tension in itself. Communication is a source of recognition, feedback and inspiration (factors of security), but it carries with it expectations of reciprocity and balance (that may constitute a challenge). My interviews furthermore indicate that motivation is particularly closely related to productivity. To become a good researcher, one needs to work long hours, think about work-related puzzles outside the office or laboratory, and spend time on the dissemination of results (the mediation quality). This may be very difficult if motivation is low. It should be noted that there is probably nothing special about researchers in this respect (cf. e.g. Herzberg *et al.*, 1993).

Still, not all conflicts and challenges in research organisations can be considered as productive tensions. Severe personal conflicts probably have no beneficial effects on quality and productivity. It is also evident that the needs of researchers vary, and that different ideals when it comes to leadership and resource allocation can give rise to political conflicts. My informants particularly noted junior scientists' need for supportive leadership and professional feedback, while seniors often expect non-interference from a research unit's leader.

There is a normative claim in much of the literature that tensions need to be balanced or maintained (e.g. Pelz & Andrews, 1976; Foss Hansen, 1995; Dougherty, 1996). Although I find gen-

eral support for this claim, I have also found that balance or equilibrium in some respects may be very difficult to achieve. One example is the question of differentiated pay and other rewards, which could be impossible to balance with the strong egalitarian culture of most research units, making the issue a possible source of envy, personal conflict and deterioration of working climates. Another example may be the abovementioned different needs of juniors and seniors. Balance in this respect could mean a successful compromise between different interest groups in the organisation (the possible political role of tensions).

This perspective can also be used to shed light on other theoretical discussions in the social studies of science literature. The long debate about norms in science may be a relevant example (see Merton, [1942] 1973; Mitroff, 1974; and Foss Hansen, 1988 for a review). Merton ([1942] 1973) asserts that science is governed by a single set of norms (an ethos), while Mitroff (1974) has argued that norms and counter-norms exist side by side in scientific disciplines, although the task uncertainty of problems and specialities will make one set of norms dominant. Later authors have for instance argued that modern science is undergoing a normative shift – a new cluster of norms is emerging that incorporates commercialisation of R&D knowledge (see Etzkowitz, 1998; Ziman, 1996). With my theoretical perspective and findings regarding informal organisational aspects, it can be claimed that good research organisations always can be characterised by opposing norms. Many of my informants, particularly from the institute sector, stated that their main challenge is to balance traditional academic values with the values of industrial utility and capitalisation of knowledge. Scientists working with fundamental research assert that they are inspired by, and sometimes actively try to encourage, the practical application of their results. Changes in the research system may thus represent a change in the balance between opposing forces, rather than the substitution of one set of norms with another. To capture the essence of a research organisation, one may have to look at how ambiguous values are balanced, rather than look for a single set of characteristics.

A basic challenge for future studies is the methodology for investigating tensions. A qualitative and indirect approach (based on an interpretative or critical paradigm) as in this investigation will probably still be useful, but maybe with a stronger focus on some of the dimensions that should be central in tensions (see Table 3), as well as on political aspects. In addition, I believe it is necessary to gather information from all members of research units, not only the seniors. An approach is needed that allows for recognition of the diversity of multiple and opposing meanings and values.

In the title and introduction of this paper, I referred to the story of Scylla and Charybdis, using it as a metaphor of tensions that researchers may experience in the work they are carrying out and in the organisations they are part of. When Odysseus faced the two monsters, he assessed the consequences of getting too close to each of them. Advised by Circe, he sought a safe passage between the dangers. Although his ship became the second in history to pass the monsters,

Odysseus could not avoid that six of his crew were eaten alive by Scylla (incidentally, a six-headed beast). Just like such a voyage into uncharted waters, working life in organisations characterised by various types of tension is not necessarily easy. Not all researchers may enjoy it, and all researchers may not enjoy it at all times. To maintain diversity of people and tasks, to work with several time perspectives in mind and to face not only colleagues but also critical users and others, is most likely a tremendous challenge to individuals who often may prefer stability, predictability and less ambiguity. My informants unanimously indicated that a good working climate is for most individuals the best way to cope with this.

Notes

1 This paper is based on Gulbrandsen (2000). An earlier version was presented at the 4S/EASST conference in Vienna, September 2000.

2 This section is partly based on Gulbrandsen & Langfeldt (1997), and partly on an unpublished paper on research quality by Gulbrandsen & Langfeldt.

3 These paragraphs are also based on interviews with industrial scientists and R&D managers in Gulbrandsen & Larsen (2000).

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