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Abstract

The management of a research project is full of uncertainty and complexity. Research has substantial elements of creativity and innovation and predicting the outcome of research in full is therefore very difficult. In addition, the relationship between the research project manager and the project participants is characterised by an asymmetric distribution of knowledge where individual researchers know a lot more about the potential – negative and positive – of their research contributions than the project manager does. Furthermore, researchers in a project may have many competing demands on their time and they may find themselves competing against each other for individual scientific priority or the right to patent a research result. Given these and other inherent difficulties of managing a research project this paper addresses two questions in particular: 1) What kind of guidance may a research project manager get from existing project management literature? 2) What kinds of changes or additions are needed to build a project management model for research? In dealing with these questions the paper gives an outline of some of the basic tools and assumptions of existing project management theory and compares these to conditions in research. Based on this, the paper discusses the task of the research project manager and the interpersonal dynamics of a research team with a view to giving some pointers to what a research project manager can do to create the best possible conditions for a successful research project.

1. Managing research projects

A research project manager is responsible for supporting creative thinking in small subject-oriented units. But he or she is not only responsible for supporting thinking but also for making sure that the thinking results in some kind of concrete output in the form of new knowledge codified into e.g. scientific papers, reports, journal articles etc. or concrete technologies or technological processes. What is more, this output should preferably be on time and according to budget. There is at least one common denominator for these different research project outputs and the process towards them; their high degree of knowledge intensity. Managing a research project is both about managing knowledge workers and about managing the generation of new knowledge and the sharing and dissemination of existing knowledge within the concrete setting of a joint project. Thus if research management as a general concept is primarily about managing the

context of research (Ernø-Kjølhede 1999) then, on the face of it, research *project* management would seem to be much more directly involved in the management of the content of the research.

As a starting point the research project manager thus has the task of managing both the complexities stemming from the culture(s) of researchers/research work *and* the uncertainties associated with generating research results. This makes research project management a balancing act entailing inter alia the balancing of such seeming paradoxes as:

- researchers' desire for a large degree of autonomy in their work and democracy in decision making versus the need for strict project control (*adherence to budget and time limits*)
- the fact that researchers both co-operate and compete with each other in the project *(competition for credit in the form of publications/competition for positions, grants etc. which may lead to conflict between the joint goals of the co-operation and individual goals of researchers)*
- the need for predictability of project output (*output with certain qualities "on time" and "on budget"*) versus the unpredictability of research outcome and new research opportunities arising in the course of the project (*quality of output may improve if deviations from plan are allowed or it may turn out that a very different output than the one originally expected would be qualitatively better or more useful for the project's intended purpose*)
- the lack of management information/difficulty of interpreting management information and uncertainty of end product and process (*exactly what are we looking for and which is the best way to get there?*) versus the need to act as if there is certainty and make management decisions continuously
- the knowledge asymmetry between the project manager and the individual researcher (*the latter is often in a better position to make decisions regarding his or her research)*
- the need to take risks to be innovative[1] vs. the need to reduce risks to ensure the delivery of the desired result on time and budget

It may be argued that not all of these apparent paradoxes are special to research projects. But the strength with which they may impact on the project is what sets research projects apart from most other projects. Furthermore, for international research projects such as those funded by the EU, which cross national, institutional and often also disciplinary borders the manager is faced with the challenge of coping not only with different national languages and cultures but - perhaps more importantly - also different professional and institutional languages and cultures. Under such circumstances the manager becomes a kind of "knowledge translator" with the responsibility of facilitating processes that make it possible for project participants to discuss and communicate about research created outside their own academic and institutional fields.

[1] To be innovative Jain & Triandis e.g. argue that R&D managers should make the following statement to their subordinates: "If you do not have several failures, you are not doing a good job" (1997:41). The reasoning behind this statement is of course that research that tries to play safe is likely to lead to conservative and expected results. To make groundbreaking results risk-taking should be encouraged with the possibility of creating failures. This, so to speak, represents a systems approach to research – a systemic advocacy for risk-taking. For the individual researcher however, it is to be expected that he or she will seek to avoid failure. In the vast majority of research projects the purpose of project management is also to avoid such failures. As we shall see later in the paper, the CPM and PERT methods even try to operationalise and calculate (PERT) risk and uncertainty. Obviously, failures are of course not something to strive for in research. To create an innovative research project the almost schizophrenic balance to be struck is then on the one hand to create an atmosphere that facilitates the creativity and innovation associated with risk-taking and on the other hand at the same time working hard to avoid failures stemming from such risk taking in the project.

Faced with these paradoxes and complexities, what kind of guidance may a prospective research project manager get from existing literature in the field? There is as yet only very little literature specifically addressing the management of research projects. On the other hand, there is a well-developed stock of general project management literature on the basis of which attempts can be made to work out a *modus operandi* for the management of research projects. This paper uses general project management literature as a point of departure and discusses it in the light of the special demands posed by the nature of the research process. This means that the paper alternates between description and discussion with a view to pinpointing issues and problems special to research project management and possible methods of dealing with these issues and problems. The paper is structured in accordance with the observation that project management basically consists of two elements/activities:

1. creating a *technical structure* for the project (the "hard" or technical side of project management; e.g. scheduling, financing, planning, controlling)
2. managing the *human processes* in the project (the "soft" side of project management; co-operation, communication and project culture).

Both elements/activities are thus addressed here but the prime concern of the paper is the latter. In other words, human processes are devoted most space as it is the position taken here that the real challenges of project management in most cases are not concerned with technical structure but have to do with the human processes (see e.g. Verma 1997). Included in these challenges we will find such concepts as teambuilding, communication, competition, conflicts, motivation, mutual trust, learning and leadership. These human processes are specifically dealt with in sections 2 and 4. But the technical structure of a project is also an integral part of project management. Therefore planning and scheduling a research project is dealt with in between the two sections focusing on the human processes, i.e. in section 3. Section 5 is the concluding section in which differences between the rationales of general project management and basic conditions in research are highlighted and pointers for research project management summarised from the discussion in the paper.

However, to provide the basis for the discussions in sections 2 – 5 the next two subsections address such fundamental issues of project management theory[2] as the status and foundations of project management theory (subsection 1.1) and the nature and life cycle of projects (subsection 1.2).

1.1 Project management theory from the industrial era to the knowledge society

Although there, as mentioned, is only a limited amount of theory to draw upon for *the research manager* there is certainly lots of literature on project management to which the research *project manager* may turn

[2] There is not sufficient room for a detailed discussion here of whether what is habitually referred to as "project management theory" is in fact a "theory" in the scientific sense of the word; i.e. for instance capable of giving a general account of a field or explaining an area of empirical phenomena. Nevertheless it is worth contemplating the extent to which project management theory in its existing form lives up to these theory characteristics and the extent to which what is generally referred to as theory may instead more aptly be described as a collection of techniques, normative statements and overviews of best practices. There are many indications that the latter seems to be the case. See e.g. Lundin & Söderholm 1994, and Packendorff, 1994 for a thorough discussion of this topic.

for support and guidance[3]. The amount of books available on project management is vast and the literature is full of its own vivid acronyms and concepts such as PERT, CPM, SMPT, PLC, PRINCE[4] etc. In addition to studying the large selection of books on project management, the project manager may also choose to expand her knowledge by becoming a member of her national or perhaps an international project management association[5]. Or the project manager may choose to invest in project management software - a.k.a. PMIS (Project Management Information Systems) of which there is plenty on the market. Another option to stay abreast of the developments within project management is of course to subscribe to one of the project management journals[6].

Project management is thus big business not just for publishers and software firms but also for consulting firms prospering in the light of the widespread belief that project and teamwork is the way of the future[7]. The idea that empowered work teams hold the key to future prosperity thus has many advocates and would-be mothers and fathers. One of the early and well known is Alvin Toffler who published his influential book "The Third Wave" in 1980. In this book Toffler, inter alia, argues that the third wave (post-industrialism) will necessitate new forms of flexible, adaptive organisations and drastic changes in the work environment. A corollary of this is that the individuality and personal competencies of employees come into focus. That message is also emphasised in the recent wave of publications on knowledge management. This focus on empowerment, individuality, flexibility and competencies corresponds very well to observations on the essentials of research management (Ernø-Kjølhede, 1999). Can research management theory thus perhaps make valuable contributions to the developments in more general organisation and management theory? This is discussed in subsection 4.1 below. A question to be addressed in this subsection is the one, which was posed above; what kind of guidance can a prospective research project manager get from existing literature? A tentative first answer would be to say, well, some guidance may be got, but much of the basic textbook literature is only partially useful for the research project manager. Put a bit roughly, we may say that a good deal of the general textbook project management literature can be sorted into 2 groups:

1. Broad how-to-do-it literature which generally focuses on manufacturing or construction projects or the like and covers all technical and controlling aspects of the project (planning, financing, scheduling, resource consumption etc.) from start to finish. Such books often devote little attention to the human and behavioural aspects of project management - or only treat such aspects in a relatively superficial way.

2. Specialised, technical literature focusing on certain aspects of project management in particular scheduling techniques such as PERT and CPM. This literature is often narrow in scope and sometimes very mathematical tending to treat project work as something, which can be dealt with by bureaucratic organisation and controlling.

[3] In September 1999 the internet bookstore Amazon.co.uk e.g. stocked 707 books on project management.
[4] Programme Evaluation and Review Technique, Critical Path Method, Self-Motivated Project Team, Project Life Cycle and Projects In Controlled Environments.
[5] The best known of these are probably the US Project Management Institute (PMI) and the UK-based International Project Management Association (IPMA). IPMA was until 1994 named INTERNET. Project management literature sometimes mistakenly still refers to it by that name. The Danish national association for project management is called "Foreningen for Dansk Projektledelse" and is a member of IPMA.
[6] E.g. The *International Journal of Project Management, The Project Management Journal, PM Network* and others. The Danish association on project management publishes the journal "Dansk Projektledelse".
[7] See e.g. Drucker 1998, Verma 1997, Bennis and Biederman 1997, Townsend et al. 1998, Katzenbach and Smith, 1993 and Fisher and Fisher 1998. But these are just a selection, numerous other sources could also have been listed.

A good deal of the basic project management literature sees project management as being primarily about controlling, planning and scheduling and often assumes that the project work takes place within the boundaries of one organisation. This also entails regarding projects first and foremost as instruments with which to achieve a certain goal rather than as individual organisations - albeit temporary - in their own right. In such literature, project work is implicitly reduced to a relatively stable, technical and linear[8] process and the likelihood of reverse impact from e.g. the outside world or from human problems within the project is not devoted much attention. In this view, a well-functioning bureaucracy aided by scientific planning tools can efficiently deal with a project. This presupposes that projects are carried out under conditions of almost complete rationality. It also presupposes that most projects are of a repetitive kind and that they build on the application of existing knowledge. In fact the majority of projects are carried out under conditions of limited rationality and they are not repetitive, stable and linear. This certainly goes for research projects, which tend to be one-of-a-kind and focused on creating new knowledge or applying knowledge in new ways. What is more, research projects are complex, the exact outcome is difficult to plan, the process towards the outcome may sometimes be rather chaotic and research projects are often subjected to forces in the outside world beyond the control of the project management. This was emphasised in an interview with the author by an experienced senior researcher (employed by a private research organisation) and manager of a biotechnological research project:

"It [research] cannot be managed by the setting of very rigid goals for when a certain result must be achieved. Then it is no longer research….you cannot promise too much in advance".

In accordance with this observation, Harris (1994) has remarked that in R&D, things 'go wrong' nearly as frequently as they 'go right' (cf. also note 1 above on the systemic advocacy for risk-taking). Continuous adjustment and adaptation, i.e. continuous organisational learning in research projects is subsequently needed, which the planning and scheduling tools of project management theory have large difficulties in accounting for. The discipline of operations research is perhaps a case in point of a discipline trying to calculate reality only to realise that reality rarely performs to pre-calculated standards.

In fact it seems that the technical tools of project management theory have been highly influenced by "scientific management" and contain a rather strong streak of Taylorism. What we could call a conveyor belt approach to project work – seeing the project as a linear process from stage A to B to C to D etc. - is seen in this school of thought. This 'scientific' approach no doubt stems from the project management methodology's origins in industrial society[9] and in military projects. There is thus a good deal of "command and control" thinking to be found in the foundations of the basic technical tools of project management theory. In the post-industrial, "third wave" or knowledge society this original, mechanistic approach seems out-dated. In short, project management theory must today give higher priority to the human processes – the soft side of project management - and not just focus on the technical structure aspects – the hard side – such as the tools of planning, scheduling and controlling.

[8] Linear project management models are sometimes referred to as 'waterfall models'. In these models the assumption is that one phase in the project is completed at a time and 'automatically' followed by the next phase in a fixed sequence of project phases.

[9] The origins in industrial society perhaps also helps to explain why so much project management theory assumes that projects take place within a single organisation. However, this basic assumption is today out of step with post-industrial society's many joint-ventures, strategic collaborations, government programmes to enhance business and university co-operation etc.

In all fairness to the body of project management theory it should be stated that the need for a change of emphasis in favour of more focus on the human processes of project management seems increasingly to be recognised in the literature. Yet a best-selling standard work on project management such as Lock (1996, 6th edition) only devotes little attention to the human side of project management. Other recent examples of this are Burke (1993, 2nd edition), Shtub et al. (1994), Reiss (1995, 2nd edition), Lock (1996a), Lockyer and Gordon (1996, 6th edition) and DeLucia and DeLucia (1999)[10]. That the transition to a new age in project management theory is thus not complete has been commented on by Lientz and Rea (1999:xvi)[11], who argue and conclude that "many of the methods and techniques of the past are still being used today even though the technology, methods and entire environment have changed…There is a need to update the project management approach to reflect the modern environment". As far as project management theory's applicability for research work is concerned there is in concrete terms also a need to broaden the scope of project management theory to include a higher degree of participant autonomy and task and process uncertainty. This is discussed in greater detail below. But before we embark on this discussion we will first take a closer look at what constitutes a project and the different life cycles projects are said to go through.

1.2 The nature and life of projects

It is often said that the history of modern project management started with the Manhattan project. And for scholars of group dynamics, management, science studies, project management etc. this project to build the world's first nuclear bomb never seems to cease to be a source of inspiration. In a relatively recent book, Bennis and Biederman (1997) e.g. describe how the 2,100 scientists + families and support personnel were brought together in a remote mountain region, offered shoddy housing, a secretive work environment and long working hours. Yet the project managed to create an atmosphere of excitement, vision and commitment amongst its participants. An atmosphere that became crucial for the realisation of the project's goal. Admittedly, the circumstances surrounding the Manhattan project were extreme and the purpose of the project can be discussed. Nevertheless, regardless of what one may think of the purpose of the project there is a lot to be got from the study of it in terms of understanding how great groups function and in particular how scientists can be motivated. This human process aspect of the Manhattan project is dealt with in section 1.2 below.

As previously mentioned, technical tools in modern project management theory have their origins in very large technical/military projects. One of the most influential planning techniques, PERT, was even developed by the US Navy in 1958 for the project to create the Polaris missile (Packendorff 1994, Meredith & Mantel 1995). And at the centre of attention of much writing on project management remain engineering, manufacturing and construction projects. Yet in spite of the somewhat mechanical approach of

[10] These are just examples. Given the vast number of works on project management many other examples could also have been listed.

[11] Lientz and Rea's book bears the - from a research perspective - promising title "Breakthrough technology project management". However, Lientz and Rea (1999) focus almost entirely on commercial IT systems development projects and their book is in a certain respect itself a typical example of mainstream project management literature with its emphasis on normative statements and little use of theory/reliance on evidence from research. However, many of their observations on the complexity and turbulence of commercial IT-projects are also relevant to the research project manager.

much project management literature the most fundamental understanding about a project is that a project is not a machine. It may more aptly be likened to a living organism. Like an organism, projects develop and change continuously. And projects are also said to have different phases they go through, amounting to what is generally termed the project life cycle. Most project management books divide the life of a project into four phases that are more or less similar; e.g.

1. project formation
2. project build-up
3. main program phase
4. phase-out

(Thamhain and Wilemon, 1975)

or

1. conceptualisation
2. planning
3. execution
4. termination

(Adams and Barndt, 1983)

to quote two well-known definitions of the project phases (See e.g. also Poulfelt 1980 and Mikkelsen and Riis 1998 who also operate with four phases in the project life cycle). The division into four phases numbered 1 - 4 seems to indicate a linear relationship between the phases. This clear-cut sequence of phases would be rare in research projects due to the uncertainty of anticipating clearly the final research results and the process towards them. The conceptualisation phase is e.g. likely to go on beyond the first phase and continue to influence action in the project although its importance is likely to diminish as the project progresses. It should also be mentioned that the linear process may be interrupted and/or forced to restart in case of e.g. the inability to achieve a planned result and that the style of management may differ from one phase to another. How to manage a research project in the early, experimental and conceptualising phases may require a different management approach than in the execution phase where the impression of the final goal may be clearer. Given the diversity and uncertainty in research the four phases thus seem to be of most use to the research project manager if they are considered not as a deterministic, linear process where each phase succeeds the other but as a number of fundamental project tasks that overlap and gradually take turns in dominating during the life of a project.

In their refreshingly radical book on project management Christensen and Kreiner (1991) discuss the nature of the four phases and present an interesting alternative to the standard interpretation of the role of the four phases in project management. This alternative has much relevance for the understanding of the nature of research projects.

According to Christensen and Kreiner the purpose of *the initial, conceptualising goal-setting phase* has traditionally been to reach agreement on a distinct and operational prime goal for the project. But, argue Christensen and Kreiner, it may be counterproductive if all project participants are forced to agree to the same prime goal of the project. The various participants may have different motives for taking part in the project, and forcing through one interpretation of the project goal may be bad for motivation. And

motivation is precisely what this first phase should be about, rather than about setting one, common goal, argue Christensen and Kreiner. They are thus asking project participants to juggle several versions of the project in the air at one time, so that no one will feel left out. However, against this unconventional viewpoint one could argue that to provide focus, to get a coherent result, to avoid later, de-motivating bickering and strife and to avoid wasting work it is important to form an early and clear common impression of what the project is really about. Both pro and contra are valid arguments, but the project manager of a research project may use the unsettled nature of this discussion to remember that project goals should not be too rigid. A large degree of flexibility is necessary also in order that the project goals may accommodate more easily to future changes in the project.

The second project phase - planning - normally stresses the need to calculate a realistic time schedule and plan of what may be achieved given the time and resources at hand. Trott (1998:157) e.g. argues that "it is the setting of achievable targets and realistic objectives that helps to ensure a successful project". Also the EU requirements concerning the management of EU-funded research projects has a focus on scheduling milestones and deliverables. Yet contrary to this common-sense assumption, realism is no useful concept in project planning say Christensen and Kreiner. First of all 'realism' is not at all feasible given the high amount of uncertainty surrounding project work. Secondly 'realistic' plans might lead to underachievement. 'Realistic' planning could result in project participants failing to innovate and explore the borders of the possible as long as their performance is satisfactory/according to plan. Realistic plans are thus likely to lead to lack of ambition and second-best performance, argue Christensen and Kreiner. Planning they argue, should therefore be more about communication and symbolism than about calculating. The alternative to calculated, realistic planning is then of course unrealistic planning. Unrealistic planning may help project participants reach higher goals than they ever thought possible through acting as motivating (and perhaps self-fulfilling) prophecies, claim Christensen and Kreiner. And, they say, given the high degree of contextual uncertainty surrounding projects who is to tell if a plan is realistic or not? Planning in a deliberately unrealistic manner as argued by Christensen and Kreiner is, however, a two-edged sword. Whereas on the one hand Christensen and Kreiner have a point in stressing that distant goals may lead to higher performance than those that are close by, on the other hand an overtly unrealistic plan may also lead to demotivation if it is not taken seriously by project participants. Unrealistic planning could be like setting your wristwatch five minutes ahead in an attempt to get earlier out of the door in the morning. More or less consciously, though, you are likely to add the five minutes, so that you know the real time and you may end up rushing to the train/bus as usual. It is difficult to deceive yourself in the way suggested by Christensen and Kreiner and a completely unrealistic plan will probably be adjusted in the minds of participants to what they see as attainable. Evidence presented by Locke (1968) also suggests that individuals who have been given difficult but attainable goals are more motivated to work towards these goals than individuals who have been given goals that are perceived as either too easy or too difficult (in the latter case this may lead to non-acceptance of the goal). Therefore, rather than advocating unrealistic planning I would recommend using such terms as 'highly ambitious', 'challenging' or 'very optimistic' planning. Bennis and Biederman (1997:209) have also stressed the importance of an optimistic approach to work and claim that optimistic people accomplish more.

The conventional wisdom of much project management literature seems to be that with the aid of efficient planning tools acting as a project blue-print the role of management in *the third phase*, execution, could ideally be reduced to controlling that deliverables are on time and on budget (see also section 3 below).

Not so, argue Christensen and Kreiner. If the only constant is change then rigid planning is really not possible, and management must therefore expect to take a proactive role in the execution of the project and continuously explore new possibilities and threats in the project surroundings. For research projects this certainly seems to be sound advice as - by their very nature -there can be no hard-and-fast blue-print for research projects.

The fourth phase, the termination of the project, focuses on evaluating the results of the project. The traditional way to measure project success is to try to assess how well the final results correspond to the aims originally set for the project. But, argue Christensen and Kreiner, this is not a reasonable way to evaluate a project given that conditions for the project may have changed considerably during the project period. On the other hand, they do not advocate completely abandoning an evaluation of the extent to which the project has fulfilled its original purpose. Instead they argue that an evaluation should focus more on the degree to which project results are useful and optimum for future use by the organisation/client for whom the project was made. In other words, rather than comparing a result to an original project goal (which by the time the project is completed may no longer be the most interesting or useful goal the project could get) an evaluation should concentrate on assessing the future strategic importance and relevance of the project outcome.

But how can we measure the success of a research project? Numerous perspectives may be applied not just the rather obvious ones related to the utility of the project result itself or the utility for the organisation in which the project was carried out. Indeed, even a strict, organisational perspective may also be open to more than one interpretation where several organisations are involved in a joint project or where several departments within one organisation take part. In addition to the organisational/project perspective at least also an individual and a societal perspective may be applied to measure success. What did participants get out of the project personally and/or professionally? What will the project mean for the participants' future co-operation in the field? What kind of new research does the project give rise to for each project participant? What may the project mean for society in terms of economy, jobs, rate of innovation etc.? Deciding which is more important as a success criterion for a project thus has to be discussed in each individual case. But what can be stressed as a key criterion for success, which will apply in any research project is the degree to which the project has allowed for learning. Research projects are invariably learning processes and should be designed so as to facilitate as much individual and organisational learning as at all possible. Together with economies of scope and scale, learning constitutes the prime purposes of working together. Researchers co-operate to increase the level of knowledge and creativity among the individual researchers believing that the sum of pooled minds is greater than individual minds. Furthermore, given the complexity of many of today's research problems no single individual may be expected to possess the skills and knowledge to deal with these problems alone. Therefore it is often argued that research co-operation is in fact a necessity.

Co-operation between people and between institutions may take many forms and vary as to the level of commitment and dependency. Thompson (1967:54-55) has suggested 3 types of internal dependency between units/partners in an organisation which create different preconditions for management:

1. Pooled interdependence. Partners do not depend on the results of other partners for the solving of their individual tasks. There is co-ordination of efforts but partner dependency is kept to a minimum. Yet a failure of one partner may threaten the whole organisation. Here the scope for management of the co-operation is relatively limited and almost

entirely concerned with the technical structure of the co-operation.

2. Sequential interdependence. Tasks are performed in a set sequence. Partners therefore need delivery on time of other partners' contributions/results. The scope for management is larger than under conditions of pooled independence but management's role is still primarily of a structural, reactive and controlling nature overseeing that the co-operation progresses as expected/according to plan.

3. Reciprocal interdependence. Partners depend completely on the results of each other for the solving of each individual task. Tasks are interrelated and build upon each other. Here there is considerable scope for proactive management with a view to creating an integrated project not only in terms of structure but also in terms of the human processes.

Kreiner (1993) has used Thompson's classification in an analysis of Danish participation in EUREKA-projects[12]. Kreiner found that in these primarily industrial R&D projects the most common form of dependency between partners was pooled interdependence. He found a few examples of sequential interdependence whereas reciprocal interdependence was not seen. The reason being perhaps that firms are wary of becoming too dependent on each other. Geographical distances and few project meetings are also listed as reasons for this preference for the relatively lose pooled interdependence. As we shall see in the next section, however, tighter, more integrated co-operation amounting to mutual dependency is generally regarded as more fruitful by most scholars of knowledge work (see e.g. Katzenbach & Smith 1993, Bennis & Biederman 1997, Fisher & Fisher 1998, Drucker 1998 and Verma 1997).

2. The role of the research project manager: power vs. influence, teambuilding and trust making

The central task of any project manager regardless of her field is to navigate between the conflicting demands of time, cost and performance. The project manager constantly has to weigh these demands against each other and trade off one against the other. If there are time delays this may increase cost. But if the delay is cut short this may impact negatively on the result of the project. Juggling this triangle of time, cost and performance is the most overall level at which to describe any project manager's responsibility. Mikkelsen and Riis (1998:94-95 [my translation]) have broken down the project leader's management responsibilities into four areas:

1. Creation of final project result
2. Internal management - managing the project participants
3. External management - managing the parties interested in the project
4. Project control – overseeing finances, time consumption etc.

The project manager thus has plenty of responsibilities. But does he also have authority over the project participants? Not necessarily, and in cross-institutional R&D projects the project manager has only very little formal authority over project participants. They are not his subordinates but his peers. Furthermore, not only does the project manager not have authority over the project participants many of these may also only be working part time on the project and have many other constraints on their time, making it even

[12] EUREKA is a transnational framework for collaborative R&D projects. It includes 21 countries, primarily European. EUREKA is led by industry and aims to produce near-market results. Funding is on a national basis and administration kept to a minimum (Peterson, 1993).

harder for the project manager to obtain commitment from participants. So if managing a research project is not a question about formal authority what is it about then? What other kinds of power can a research project manager wield? Drawing on Jones (1994) Verma (1997:237-38) describes a broad approach to power suitable for project work. This approach comprises seven different sources of power:

1. Authority [the ability to control and command]
2. Accountability [holding another person responsible for a task e.g. through contractual agreement]
3. Commitment [the power that comes from motivating people to get involved and participate actively]
4. Information power [can be obtained by becoming prime information channel in an organisation]
5. Influence power [power through interpersonal skills and charisma)]
6. Network power [based on personal contacts; ability to do and receive favours (make clients)]
7. Earned/personal power [stemming from professional reputation and skills]

In theory and depending on the individual nature of the project manager all forms of power but 1 - authority - should in fact be attainable for the research project manager. In spite of the lack of formal authority he is thus certainly not without powers - only the post is one of *influence* rather than authority. Traditionally, however, authority has been viewed as the most important form of power. But although authority may sometimes be useful and necessary in the day to day running of a place of work (e.g. a university department) the lack of authority is not necessarily a drawback in the management of research projects. In fact, given the conditions for research work and the skilled and independent-minded nature of researchers, the term used so far, i.e. 'management' (which is closely associated with authority), is probably not the key word in the running of a research project. The term 'leadership' is probably more important. And leadership tends to be more closely associated with the use of the six latter sources of power. Leadership is thus more associated with concepts such as commitment, teambuilding, vision, treating people as peers and personal charisma/knowledge than it is with authority, subordination and issuing orders. On a 'Machiavellian' note it should also be stressed that a research project leader's individual political flair for alliance building, bargaining, information control, using personal friendships, lobbyism etc. may be used to compensate for lack of formal authority. Key qualifications in this connection are negotiating skills and the ability to persuade. And in network projects these qualifications are supplemented by what one could term the autopoietic dynamics of the network itself (linked to Verma's concept of network power); how can one keep one's place in the network, gain credit to recommend others for inclusion in the network and possibly be recommended by network participants to join other networks? There are thus many ways of wielding influence in a research project in spite of a lack of formal authority.

I have argued elsewhere (Ernø-Kjølhede, 1999) that a distinction should be made between the tasks of the day-to-day administration of a research work place and the management of research work. The research project leader's task belongs to the last category and a research project leader may thus in many respects aptly be described by the term "coach". Consequently, the research project leader should focus on inspiring and encouraging fellow project members, on creating a vision for project members to rally around and on creating an atmosphere of excitement and commitment in the project. The research project leader should focus on people and on getting the right things done, not so much on controlling how and when they are done. To use Hersey and Blanchard's well-known model of situational leadership researchers generally have a "high maturity level". According to this theory the research project leader will therefore benefit from being low in direction; instead she should be "delegating" and "participating" most of the time (1982)[13].

[13] Hersey and Blanchard describe four leadership styles. The best style to use depends on the situation, e.g. the complexity of the task and the level of competence and motivation of the employee. (There is thus no recommended best

On Blake and Mouton's (1978) equally well-known managerial grid the effective research project manager will be in position 9,9[14] - team management - stressing the need for interdependency, trust and commitment among project participants. Trust and commitment also help pave the way for successfully using Hersey and Blanchard's delegating management style.

That the importance of interdependency and team commitment is not mere management hype is borne out by, inter alia, Bennis and Biederman's (1997) six case studies of "Great Groups" (out of which three deal with R&D groups). Based on their analysis of the perhaps best known of these R&D groups, the group who did the Manhattan Project, Bennis and Biederman conclude that "members of Great Groups sacrifice their egos for the mission" (:190). They also quote several scientists describing how the project leader J. Robert Oppenheimer with his "intense presence" and "poetic vision" was capable of inflaming and inspiring the project participants and creating a unique team spirit. As one scientist remarked "in his [Oppenheimer's] presence I became more intelligent, more vocal, more intense, more prescient, more poetic...." (:188). This quote is a very good example of Oppenheimer's ability to act as a 'spiritual midwife'; his ability to unlock the potential of people. Whether he was conscious of his efforts to that effect or not, Oppenheimer managed through hard work and care for what each person was doing to create among a collection of highly gifted individualists a sense of common purpose, a sense of being on a mission together that went far beyond what was automatically created by the grave circumstances surrounding the project. The team spirit was not only nurtured through the professional work; Bennis and Biederman report that skiing and square dancing became a rage, parties were frequent and "people had enormous amounts of fun" (:185) all contributing to the creation of a unique project spirit.

It is, however, not just in connection with special projects such as the Manhattan project that creating a sense of interdependency and team spirit is significant according to much literature. The importance of turning groups of individuals into coherent teams with a common purpose has been stressed by numerous management scholars (often referred to as 'team building'). While stressing the difference between the integrated, focused concept of the team and the much less focused concept of the group[15] Katzenbach & Smith (1993:119) e.g. conclude that "teams will become the primary unit of performance in high-performance organizations". Thamhain and Wilemon (1987:130) refer to team building as "one of the most critical leadership qualities that determines the performance and success of multidisciplinary efforts" and

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leadership style as e.g. in Blake & Mouton's managerial grid). The four styles are 1) The telling style; the leader gives specific instructions and supervises tasks and employees closely (high task direction, low employee support). 2) The selling style; the leader sets goals and makes decisions but asks for suggestions and feedback from employees and actively works to gain commitment and motivate employees (high task direction and high employee support). 3) The participating style; the leader makes decisions jointly with employees and is high in support and encouragement of employees (low task direction and high employee support). 4) The delegating style; the leader sets broad guidelines but decisions and responsibility for the tasks are handed over to the employees (low task direction and low employee support).

[14] Blake & Mouton (1978) describe 5 basic management styles. One axis in their managerial grid represents concern for people, the other represents concern for production (results). The figure "1" represents low concern, the figure "9" represents high concern. A 9,9 manager thus has high concern for both people and results. The other four basic management styles are: 1,1 impoverished management (low concern for both people and production, 1,9 country club management (high concern for people, low for production), 5,5 organization man management (medium concern for both people and production) and 9,1 authority-obedience (high concern for production, little concern for people).

[15] According to Katzenbach & Smith (1993), working groups are characterised by individual work products, individual goals, individual accountability and a strong, clearly focused leader. As opposed to this, teams have collective work products, common goals, individual *and* mutual accountability and shared leadership roles.

argue that team building is particularly important when dealing with complex, technical projects which require an integration of several professions. On a more mundane note, Thamhain and Nurick (1994) argue that an effective project leader is usually a "social architect" with a well-developed understanding of human behaviour and a commitment to create a climate of active participation in the project team. Verma (1997) emphasises that effective teams consist of committed people working interdependently and enjoying it. And Fisher & Fisher (1998) see the knowledge team leader's prime role as being to make her team function as a single integrated, collective mind; "the distributed mind". In such integrated teams there is thus very little need for formal authority and control as it is the team and the individual participants who undertake most of the management tasks. Thus "the distributed mind" seems to be a very useful metaphor for describing the optimum *co-operation* between partners in EU-research projects. The distributed mind team, which is capable of acting like a single unit thus incorporates some aspects of the paradoxes listed in the beginning of the paper: researchers' desire for a large degree of autonomy in their work and democracy in decision making and the knowledge asymmetry between the project manager and the individual researcher. The distributed mind has also overcome the potential problems associated with inter-organisational research projects such as the project leader's lack of formal authority over project participants, team members' individual independence, the geographical distance between participants and organisational and disciplinary differences. In the distributed mind team members co-ordinate their activities and make decisions according to self-regulating processes that make control mechanisms if not downright superfluous then of little importance. To make such concerted self-co-ordination and self-regulation possible a high degree of mutual trust between participants is needed. The concept of trust is discussed in more detail below. However, in terms of the *research work* carried out in the project it should be stressed that for the metaphor of the distributed mind to work optimally it should not be seen as implying that research methods and approaches etc. will also necessarily benefit from being integrated and harmonised. This may in fact be counterproductive as research diversity may contribute to increasing the quality of the final research result. Thus the distributed mind is a useful metaphor for the processes of co-operation and working towards a joint goal in a research project and not necessarily for the actual research work carried out by individual project participants.

Fisher & Fisher also describe another prime knowledge team leader function which they term acting as a "boundary manager". The boundary manager patrols the boundary between the team and its environment; she manages channels of influence and external relations, she is an active networker and shields the team from outside distractions and confusion. A related term for such activity is 'interface management' (Meredith & Mantel (1995); cf. Also Mikkelsen and Riis' 'external management' (1998)). To manage interfaces means to manage the relationship between various subsystems, i.e. the relations and problems that may occur between different institutions and different professions/disciplines involved in a joint project. To deal with such problems it has been suggested that project partners should draw up a "project charter" (e.g. Meredith & Mantel, 1995, Thamhain & Nurick, 1994). The purpose of such a charter may be described as to

- clarify the tasks of the team and the individual team members
- outline the goals and purpose of the project
- provide a reference point for solving disputes and making decisions

The joint writing and signing of a project charter may also be a useful way to try to construct a shared project identity which could substitute or challenge organisational, national or disciplinary identities in

projects comprising several partners. Competing identities may be strong and potentially lead to a channelling of resources and efforts away from the project. As remarked by a project manager (interviewed by the author) in the early stages of a social science project:

"The local organisation has very strong powers. I know that there are two centres [partners]….where we risk a shortage of manpower and a failure to obtain delivery of their contribution. I don't know what to do about it, but it is a risk".

What this worried project manager could do is to work specifically on creating a sense of commitment and mutual obligation amongst partners in the project. Particularly in projects where partners have little or no advance knowledge of each other would it seem beneficial to invest time and effort in trying to create a "we-feeling" and a sense of trust to make partners buy wholeheartedly into the project. Trust of course takes time and much more than a joint charter to build; but together with a well-planned kick-off meeting the signing of a joint charter could constitute a good beginning of a process to turn a group of individuals into an interdependent, committed team – a distributed mind. On the other hand, it should be mentioned that documents of a legal/contractual nature, such as a project charter could also be perceived by project participants as an expression of a lack of trust - or even mistrust - between partners. A charter basically seeks to impose a certain kind of behaviour and order in the project based on a fundamental belief that participants may not perform to the standards desired in the charter voluntarily. Thus it should be emphasised that the signing of a charter or a similar document may be characterised as just a stepping stone towards the creation of trust. A charter is thus a means with which to create the basis for starting to build trust between project participants.

As the concept of trust is often mentioned as a necessary condition for successful projects let us take a closer look at it. In the general meaning of the word, 'trust' means a sense of confidence in someone or something. And in terms of a research project group we can distinguish between bilateral trust between individual group members (one-to-one trust) and general trust (one-to-all) in the project group[16]. Building the latter is the ideal for research project managers. But what may be the more specific requirements for creating trust amongst participants in a research project? At the most fundamental level, for trust to be established in a research project there must be a sense of confidence that research results will not be stolen or otherwise misappropriated by collaborators. Secondly, team members must also have confidence that partners are working to achieve common objectives, are willing to share results and that they do not hide important results from collaborators or have hidden agendas for their participation. Thirdly, project participants must be confident that partners are professionally competent, that they will do their best to produce high-quality research and not try to free-ride on other partners/act as sleeping partners.

That trust is all-important for the success of project co-operation is reflected by the fact that trust is mentioned in much of the literature on network theory (see e.g. Mønsted 1994, 1994a, 1997 and Powell and Smith-Doerr 1994) as being key to the success of networks. The importance of trust is also mentioned in knowledge management theory on co-operative knowledge creation (e.g. Wathne et al. 1996, Krogh 1998). In research projects the need for trust is particularly big as the free sharing of knowledge and ideas

[16] A one-to-one trust can be described as group members' willingness to trust another specific individual in the group whereas a one-to-all trust is a mutual willingness amongst group members to trust all other participants in the project group.

is considered decisive for high performance (Jain & Triandis, 1997). In a study of successful informal collaborations in R&D, Kreiner and Schultz (1993) thus conclude that without a high level of mutual trust such informal collaboration simply would not exist. This is also found in a study by Poulsen (*forthcoming)* on research co-operation where she concludes that the most fruitful co-operations in the study where those were there was a feeling of friendship between researchers. In such co-operations participants' commitment is thus first and foremost a personal commitment to other people rather than a commitment to the project as such.

In an environment characterised by a high degree of uncertainty and participant autonomy – such as research - the key function of trust is to act as a an implicit governance instrument. Trust to all intents and purposes thus replaces more formal management instruments such as hierarchy and authority. In a research project characterised by mutual trust in the competence and goodwill of all team members trust may thus be expected to create a sense of obligation, common purpose and project ownership. These trust-related factors are important and useful management tools for the research project leader which can help overcome the lack of formal authority described above and build a team capable of functioning like Fisher and Fisher's distributed mind (see e.g. Woolthuis 1999 for a useful overview over the literature on trust as a governance mechanism). In the next section, however, we turn the attention from abstract management tools to the very concrete management tools of project planning and scheduling.

3. A technical approach to research project management: Planning and scheduling the research project

The previous section stressed the importance of human processes in the management of research projects. That does not mean to imply that tools and technical approaches traditionally associated with managership such as planning, scheduling and controlling are of no substance to research project management. The point is instead that the importance of tangible management tasks such as planning and controlling has been overcommunicated in much of the general project management literature whereas the more intangible human processes such as building a team, creating trust and commitment have been devoted too little attention. This is why it may be useful to distinguish between leadership and management when discussing not only research project management but also project management in general. But both management and leadership skills are relevant to research project management and the ideal project manager obviously combines the 'soft' and 'hard' skills associated with both. In the perfect world she is at the same time a team-building, people-oriented inspirator *and* focused on optimising processes and getting things done within time and cost limits (cf. Blake & Mouton's 9,9 manager (1964, 1978)). Traditionally, however, much project management theory has been preoccupied with designing rational-technical tools to facilitate and reduce uncertainty concerning the latter perhaps also because this field is much more concrete than the abstract field of team leadership. The purpose of this section is to examine the technical nature of planning techniques and discuss how they correspond to the task of carrying out a research project. To be able to discuss this, it is necessary to go into some detail about the thinking behind some of the planning techniques.

The planning and scheduling tools may roughly be divided into two groups:

1. The network techniques (a.k.a. 'logic diagrams')

2. The non-network techniques

The best-known non-network techniques are the Work Breakdown Structure and the Gantt chart[17]. Creating a Work Breakdown Structure entails breaking down a project into its identifiable sub-tasks thereby creating a detailed overview which makes it easier to plan and control the many processes leading to completion of the final project. The Gantt chart is a graphic layout of the project process where tasks are listed on one axis and the expected time to complete them on another. A Gantt chart is thus a schedule, which provides a rapid and easy overview over the supposed time-flow of a project. Both the Work Breakdown Structure and the Gantt chart are relatively straightforward and uncontroversial tools. Both tools are also well described in textbooks on project management. Therefore, no further attention will be devoted to them here. (But what is said below about the uncertainty of time estimating in research projects of course also applies to Gantt charts). More attention will instead be devoted to the functioning of the network techniques as they are more elaborate tools whose potential to affect the course of a project is much larger.

There are a number of network techniques and they are quite similar and can be difficult to distinguish between (Lock, 1996). The two most commonly used techniques within the management of research projects are probably the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT). PERT is regarded as the prime technique for R&D projects, for which it was also originally designed, whereas CPM was designed for the construction industry. CPM, though, is also reported used for R&D projects (see e.g. Meredith & Mantel, 1995). CPM and PERT have a lot in common and differences will not be detailed here other than the fact that CPM uses a deterministic approach to time calculation (single estimate) whereas PERT uses a probabilistic (mathematically weighted estimate) (Burke, 1993). It may be because of this probabilistic approach to time that PERT has been regarded as more useful for accommodating the inherent uncertainty of research projects.

Put briefly, the idea behind PERT & CPM is to draw up a sequential diagram (network of arrows and nodes) of all activities and events (completed activities) in a project and the links between them (showing the interdependencies between individual tasks). For each individual activity an estimated completion time is calculated. The critical path of the project is then that sequence of activities from start to finish which it takes longest to complete. In other words, the critical path is the earliest possible completion time for the project and thus that interdependent chain of events where there is no 'float' or 'slack', i.e. no time flexibility. By showing latest/earliest start and latest/earliest finish of all activities in the project the PERT & CPM networks highlight activities where delays may be tolerated and where they may not, thus making it possible to continuously direct resources to those activities that matter most for the project to be completed on the scheduled time.

For the PERT & CPM networks to work to their intended effect, however, the time estimates for the individual activities must be precise which, particularly when dealing with research projects, is of course very difficult. How can we be sure that the critical path is in fact *the* critical path given the uncertainty of estimating how long research work takes and precisely what will come out of it? Could it not be that a less critical path in the network may in fact turn out to be more critical? To deal with the uncertainty of time

[17]Developed around 1917 and named after its inventor Henry L. Gantt who was part of the scientific management movement (Meredith and Mantel, 1995).

estimation PERT (and this is the main difference between PERT and CPM, cf. above) uses a statistical model to calculate a probabilistic time estimate. It uses three time estimates: 1) the most optimistic time = o; 2) the most likely time = m and 3) the most pessimistic time = p (Lock, 1996, Thamhain & Nurick, 1994). These three time estimates are used to calculate an expected time duration as follows:

$$\text{expected time duration} = \frac{o + (4 \times m) + p}{6}$$

This calculation is done for all the activities in the network. There is little doubt that on the face of it, it looks more convincing to base time calculations on such a statistical model rather than merely on a 'rough estimate'. The question is, however, how much more sense it makes to use a mathematical formula for the calculation of time durations than simply to make a single estimate? If we look behind the persuasive mathematical formula we find that it has not in some mystical way become "disembedded" from its context; it too in fact consists of 'rough estimates' only there are three of them and they are weighted against each other. The PERT formula thus works as a 'technology of distance' (Porter, 1995) making its time estimates seem if not scientific then certainly more neutral and objective than a single guess as to the time duration of an activity. But is the authority of such a formula in fact not to a large degree an illusion? Despite the perhaps lengthy mathematical deliberations behind the formula the question may still be asked why the weights one, four and one are always the right factors? And what if the estimates were made by an optimist or a pessimist, shouldn't the calculation then be skewed to accommodate for this idiosyncrasy? And why should an estimate based on three guesses necessarily be better than a single, 'best' guess? The fact remains that in spite of mathematical weights the factors in the formula are still guesses and the apparent scientificality of the formula is, therefore, apparent. This does not mean to say that the method may not be useful in practice for research project managers with wide experience of the method and their research field. But given the uncertainty of estimating research work it seems sensible to argue that one should be wary of granting PERT (or any other) time estimates too much authority over the running of a research project. The same could be said about the use of planning and scheduling techniques in general. They are useful tools but they may also become counterproductive if adhered to too strictly and/or if grabbing too much of the project leader's attention. It is tempting for a project leader to concentrate on controlling the project via the network diagram and thus neglect the more challenging (and strenuous) leadership tasks. A highly structured breakdown of the project may in fact provide a false sense of security (Mikkelsen and Riis, 1998). Subsequently, a network diagram is not equal to the project and is thus not a timetable to be followed at all times. Indeed, the planned order and duration of activities may turn out to be impractical, second-best or even impossible just as important activities may have been overlooked in the original network plan. Or it could be that new and unexpected tasks or results derail the project plan altogether. Thus although network plans and other planning tools have doubtless proven to be very helpful in use it seems wise to use them with care and as flexible tools that are continuously adjusted to fit current project reality. The double-edged sword nature of project planning in research is illustrated in the following quote from an interview (conducted by the author) with a university associate professor managing a social science project:

"When you are working on something like this [EU-funded joint project] then there is a risk that you will cling to the Gantt-chart and to the deliverables that have to be made. Instead of discussing

what is professionally exciting which is what normally drives us. And there is a contrast because we do have to discuss some boring project planning".

In the next section we once again turn our attention to aspects of the human interaction in research projects.

4. The research project team: competition, conflict, communication and shared leadership

On the face of it, the potential for conflict in research projects is high. If we recall the paradoxes listed at the beginning of the paper all these paradoxes have conflict potential. And concerning EU-projects we could add to these paradoxes the conflict potential of working across organisational, disciplinary and national borders. Thus the ability to solve conflicts and design the research co-operation in a way which minimises conflict potential would seem to be a key skill for the research project leader.

A fundamental condition for all research projects is that researchers co-operating in the project are invariably also in competition with one another. The competition is centred around obtaining patents and/or getting individual credit for results generated in the project (e.g. in the form of authorship of conference contributions or articles). Such individual credit is crucial for making a career in science, especially for publicly employed researchers. The publicly employed researcher simply needs to be credited and to publish. Not just to become promoted but also to keep his or her present position in the research institution. There is consequently a potential and integral conflict in research projects between researchers' need for individual credit and the wish to create the best possible overall result of the joint project. Also the question of patenting may hold conflict potential. And, generally speaking, the greater the overlap between researchers in terms of their research topics and methodology the greater the competition between them will be, *ceteris paribus*. To avoid conflicts over these issues the co-operation should therefore be set up in such a way that the individual needs of team members and the collective or institutional project needs do not clash. Avoiding such clashes may be achieved by means of joint authorship of publications based on results generated in the project or by means of written agreements concerning publication, patenting and authorship - preferably drawn up before the project start or in the early beginnings of the project. These means however do not rule out conflicts over what kind of contribution it takes to be listed as a co-author, who should be mentioned as corresponding author and in which order authors should be listed. However, competition is by no means necessarily just a conflict factor in a research co-operation. Competition inside a team may also lead to increased motivation and hard work to achieve one's very best performance. And, as pointed out by Poulsen (*forthcoming*), co-operation in a team may also be a means for individuals to win competitions with other researchers outside the team as the division of labour in the team leads to greater efficiency and learning potential for the individual. Thus competition in research projects has both a positive potential as a motivation factor and a negative potential as a possible source of conflicts over credit, patenting and authorship. The challenge for the research project manager is to ensure that the positive potential of the inherent competition takes the upper hand in the project and that severe conflicts do not break out. A tangible way of doing this is, as mentioned, the signing of written agreements. Another and more abstract way related to the trust issue is to build commitment to and consensus on unspoken rules of conduct in the project. According to a study by Poulsen (*forthcoming),* unspoken rules are perceived

by researchers as better than formal agreements. The reason being that formal agreements are seen as counter to the nature of science both because research processes (and thus potential conflict areas) are hard to predict and because formal agreements may be seen as unfortunate expressions of a lack of trust between the collaborators (as argued previously). Furthermore, it could be mentioned that the "transaction costs" of formal, written agreements (e.g. the time and expense of negotiating, writing and enforcing a contract) may be quite high possibly deterring some researchers from the writing of formal contracts. (However, in the case of serious disagreements the costs of not having written a contract or having only written a superficial contract may of course turn out to be even bigger).

As an everyday term, the word 'conflict' has negative connotations. The common-sense approach to project management is thus also that a well-managed project is one without any conflicts and problems and one, which runs according to schedule. A well-managed project may very well be like this. But it may also be that a project which is always on schedule and which has no conflicts or problems is also a project where opportunities that arise during the project are not pursued out of respect for the deadline and where there is only little integration and commitment among project participants. However, a research project where each person/organisation minds their own business and where there is only infrequent contact between team members is likely to produce less interesting results than a project with closer co-operation (see e.g. Jain & Triandis, 1997). As argued by Quinn et al. (1998:193) "knowledge and intellect grow exponentially when shared" (cf. also above). Therefore, to avoid conflicts and problems by avoiding close collaboration about the research should generally not be seen as a wise strategy. In fact, if they do not get out of hand, some conflicts may be both useful and productive in research work and may help avoiding "groupthink"[18] which could e.g. occur in long-standing research networks. Conflicts over e.g. content, goals and methodology of the project can be fruitful in that they tend to focus minds and may generate new ideas and alternative solutions to problems. Such conflicts over *issues* can thus be functional and used positively to make intellectual progress whereas on the other hand conflicts over *personalities* are generally dysfunctional, seem unlikely to contribute to knowledge creation and should subsequently be avoided. Regardless of the positive potential of issue conflicts, however, it does not seem wise to let conflicts persist for a long time as they may escalate and get out of control. To secure a good result conflicts should eventually be solved and some form of agreement be reached. Some well-known conflict resolution methods have been outlined by Blake & Mouton (1964) who describe five different managerial approaches to dealing with conflicts (corresponding to the five basic managerial styles in their managerial grid[19]):

1. Withdrawal (do nothing; hide from conflict)
2. Smoothing over (play down conflict and avoid controversial issues)
3. Compromising (find intermediate position where nobody wins: split the difference)
4. Suppression (forcing a solution by pulling rank: one winner)
5. Confrontation (exchange views openly; parties collaborate to solve problem and create win-win solution)

If we compare these methods of conflict resolution to the powers of the project leader (see above) we will see that the suppression method generally cannot be found in his toolbox. To use suppression demands

[18] Janis, 1983. Janis defines groupthink as "the mode of thinking that persons engage in when *concurrence-seeking* becomes so dominant in a cohesive ingroup that it tends to override realistic appraisal of alternative courses of action" (:378)

[19] Withdrawal = position 1,1; smoothing over = position 1,9; compromising = position 5,5; suppression = position 9,1; confrontation = position 9,9.

formal authority which project leaders often do not have. But the inability to force a solution is not necessarily to be lamented by research project leaders. Forcing is generally not regarded as a good way to solve conflicts in that a situation where one viewpoint is made to prevail by force of rank may create hard feelings in the team and de-motivate the losers in the conflict. Nor are withdrawing or smoothing particularly effective conflict solving methods as they do not solve problems, but if anything, only postpone them. Compromising may provide an acceptable solution to a conflict in that the parties to a conflict all should get some satisfaction from a compromise. Nobody wins - nobody loses. But the ultimate way to deal with conflicts is Blake & Mouton's fifth method: confrontation. Here the aim is to create a win-win situation by confronting the problem head-on, discussing it openly and examining alternative solutions. Thus the focus is on the problem and how it may be solved, not on the people in the conflict. Ideal as this may sound in theory this is no doubt hard to achieve in practice. Also it depends on the character of the problem, of the team co-operation and the dependency between participants whether it is worth using the time and running the risks associated with facing a conflict head-on. Minor problems are perhaps best smoothed over or withdrawn from. And coming back to Thompson's types of dependency (1967) and the EUREKA projects analysed by Kreiner (1993), in projects characterised by lose forms of interdependence between partners it may be preferable to simply exit the co-operation rather than go through the resource demanding task of confrontational conflict resolution. Furthermore, for confrontation to work it demands the willingness amongst project participants to give and take in a frank discussion without becoming defensive and secondly it also demands the existence of viable alternatives to the entrenched positions. Additionally, if we are to believe Argyris (1998), researchers may prove difficult to get engaged in an open confrontation. Argyris argues that professionals (among whom I count researchers) are often very bad at what he has called "double-loop learning". Double loop learning can be described as the ability not only to solve problems by using existing knowledge/procedures ("single loop learning") but also to innovate and critically reflect on own behaviour, change it continuously and thereby adapt to the current situation. Argyris argues that because many professionals are very good at what they do they rarely experience failure. For that reason they don't know how to learn from failure. Says Argyris: "So whenever their [professionals'] single-loop learning strategies go wrong they become defensive, screen out criticism, and put the "blame" on anyone and everyone but themselves" (1998:83). Argyris thus claims that professionals have a propensity to behave defensively. If this is true for researchers then Blake and Mouton's confrontation method of conflict solving may indeed be difficult to use in practice since shedding a defensive attitude is a necessity for this method to work. However, if Merton's well-known CUDOS norms (1973) are a more accurate description of researchers than Argyris' description of professionals then the Mertonian norms of Disinterestedness and Organised Scepticism should provide for open and frank discussions – much in line with the thinking in Blake and Mouton's concept of confrontation as the optimum means to solve conflicts.

To deal with project team conflicts and to manage the team as effectively as at all possible it is useful to consider different stages in the development of a project team as it is believed that certain conflicts are more likely to occur at certain phases in the development of the project team. Based on several sources Verma (1997:71) describes what he calls the "team development wheel" which consists of four stages of team development. The first stage, *forming*, is characterised by confusion and uncertainty as to the goals of the project and the roles and tasks of the project team members. In international, multidisciplinary and inter-organisational teams as those formed for EU-projects this may be a process that demands much hard work. On the other hand, if the team builds on an existing network this process may be relatively effortless.

Stage two is *storming*. In this stage the initial confusion of stage one is confronted and conflicts may now arise over the goals of the project and the tasks of project participants. Team morale is expected to reach its lowest at this stage. In the context of a research project, one reason for this could be that ideas and knowledge are shared in this early phase without any guarantee of obtaining merit for one's contributions to the project. The third stage is called *norming*. Here the team rebuilds morale by getting organised for the project and establishing procedures for the work and team relations. One could say that the group's culture is constructed and established in this stage (presuming that the team does not build on an existing relations/network, which could already have existing norms and culture). Ideally, the norming phase results in an atmosphere of cohesion and co-operation. Stage four is called *performing*; morale is now high, the roles of individual team members are in place and team members are open, flexible, trust and help each other. The basis for "the distributed mind" is thus in place.

Verma's model must be seen as an ideal model of team development. Only successful project teams go through all phases, some never get beyond the storming phase and some struggle with the tasks of the norming phase right to the completion of the project. What Verma's model also argues is that it is a characteristic of high-performing project teams that there is agreement as to the roles of team members and he too stresses the importance that team members trust and support each other. To create such an atmosphere of mutual trust and support, open communication and participative management are crucial concepts.

4.1 Communication and participative management in research projects

The project management literature almost unanimously emphasises how important open and effective communication is for problem-solving and commitment-making in projects. According to existing theory, facilitating this should therefore have high priority for the project leader. For communication to be successful some basic rules are to ensure that not only is all relevant information and all factual messages shared between project participants but also that team members communicate their worries, reservations and other emotions to each other as well. If the research project leader's aim is to create a professionally stimulating, integrated partnership among the individuals/institutions in his or her project group then frank and sufficiently frequent communication is needed. And communication should not be seen as flowing downwards from the project leader to team members but as flowing laterally between the project leader and his peers. To ensure a lateral flow team members should be encouraged to participate actively and give feedback. This open form of communication also helps to build the trust, commitment and sense of common purpose and direction which enables project participants to manage their own work and to participate in the management of the entire group - which it has been argued here is crucial to high performance in research projects.

In other words, in research projects management is not most efficient if seen as a single individual or reduced to the business of a single individual. It is a task, which works best when carried out by everybody involved in the project. The reasons for this are connected to the paradoxes in the beginning of the paper concerning knowledge asymmetry, researcher's desire for autonomy and influence on decisions, the uncertainty of end result and the process towards it and the general lack of management information. What is more, in research direction primarily comes from the work itself rather than from a manager. In fact, most

researchers have been 'brought up' in an environment (the university) where e.g. the position as Department Head is often rotated from person to person and where academic employees are generally expected to be self-guided and independent. The need to create a sense of shared leadership is of course accentuated in international research projects by the fact that the project organisation consists of participants that are geographically dispersed and only rarely communicate face to face. The need to share leadership may be particularly strong in research but it is not necessarily limited to research. Indeed, according to Adizes (1979) effective management in general simply cannot be carried out by one person as effective management entails simultaneously performing four individually conflicting management roles: *The Producer* – is oriented towards creating results and has a thorough knowledge of his field; *The Administrator* – is oriented towards planning and scheduling; *The Entrepreneur* – is oriented towards generating new ideas and plans of action; *The Integrator* – is oriented towards turning individual goals into group goals. Adizes argues that no single individual is in practice capable of performing these four managerial roles at the same time[20]. Therefore, contributions by several people who are different in thought and action (corresponding to the four management roles) is needed for management to be optimum.

If in R&D project work such shared management or self-management is highly significant this also means that the most effective groups do not necessarily have a high-profiled manager. In fact, there is little tradition for this in research work (Ernø-Kjølhede, 1999). Kreiner (1993) e.g. found in his analysis of EUREKA-projects that strong and visible project management was not a precondition for success in these loose-structured and dispersed teams of industrial partners. What he found instead was that successful EUREKA projects were often characterised by the development of strong social relations between participants.

A successful, self-managed project team of course does not come about by itself and the project leader has a big role to play in facilitating it. As Thamhain and Nurick (1994) contend it is a myth that a group of talented and committed individuals automatically create synergy between each other. Although participants in a research project may be both self-motivated and highly skilled the project leader still has a significant role to play in terms of creating a project environment capable of making the most of these skills. Morgan (1988:6) has characterised this kind of leadership thus: "in times of uncertainty, a significant part of a leader's role rests in finding ways of unlocking the ideas and energies of others". As with the example of Oppenheimer (above) the research leader's task is to present a unifying vision and nurture a project environment where an assembly of individuals can be turned into a committed and effective[21] team that feel responsible for not only their own individual contributions but for the collective team output. This idealistic proposition may constitute a useful lodestar for the research project manager. In practice, under circumstances less extreme than those surrounding the Manhattan Project, balancing researchers' need for individual acknowledgement and accomplishment and overall project goals may constitute a bit of a dilemma. Researchers employed by different organisations may have different motives for their participation and thus find it hard to focus whole-heartedly on the collective output. Furthermore, the prestige system in

[20] Cf. the discussion on management/leadership above. Adizes' two first roles may be seen as primarily associated with the notion of management whereas roles 3 and 4 are closer connected to the concept of leadership.

[21] As Pinto & Slevin (1994:21-10) have pointed out there are two distinct aspects of project success: efficiency and effectiveness. Efficiency is concerned with schedule, budget and original project intentions. In short, "doing the things right". Effectiveness refers to getting the best possible result ("doing the right thing"). It is tempting to focus on efficiency in research project management because how can you be sure you do/did the right thing? Yet effectiveness is generally more important than efficiency in research projects; the result is more important than the process.

science is based on individual recognition of accomplishments. The issue for the project leader then becomes one of allowing individual ambition to flourish while at the same time harnessing it to the project. Balancing the creation of a co-operative spirit and allowing room for individual ambition is thus another fundamental condition of research project management, which we could add to the list of paradoxes in the beginning of the paper.

4.2 The "empowered", "virtual" researcher – or research project management at the vanguard of knowledge management theory

> *"Twenty years from now...work will be done by specialists brought together in task forces that cut across traditional departments. Co-ordination and control will depend largely on employees' willingness to discipline themselves" (Drucker, 1998:1(reprint of 1988 article)).*
>
> *"The nuts and bolts of management...increasingly consist of guiding and integrating the autonomous but interconnected work of highly skilled people (Argyris, 1998:85 (reprint of 1991 article)).*

The two above quotes can both be found in the book "Harvard Business Review on Knowledge Management" (1998). It is striking the extent to which these descriptions of organisational development resemble the current everyday life of people working on joint, international research projects. Work on such research projects thus seems to be at the very forefront of organisational development and of knowledge management theory. 10 years after Drucker, two other well-known authors on knowledge management, Fisher & Fisher, e.g. argue that

"In the coming millennium, knowledge work will be the prevalent mode of work in developed societies. Virtual knowledge teams composed of people from a variety of disciplines and companies will be common. Work will be more temporary than permanent, with knowledge workers moving from project to project" (1998:276).

The conditions described by Fisher and Fisher are in fact the conditions under which many of the border-crossing knowledge workers par excellence - researchers - operate. In EU-funded research projects researchers cross institutional, national and often disciplinary borders. Thus it would seem that there is a lot to be got from the study of international research teams not just in its own right but also in terms of the lessons that may be learnt for other organisations in business and public administration. Research management studies' findings on the dynamics of competition between team members may e.g. give management scholars in other fields new insights. Furthermore, more and more organisations also seem to be moving towards organisational forms that resemble international research teams and in contemporary general management literature there is much praise for loose, flat and informal organisational structures, virtual teams[22], autonomous empowered work teams etc. Such structures that are well-known from the research community are seen as the best suited structures for competition in a turbulent and ever-changing, ever more complex world. This view of the world as turbulent, complex and ever-changing mirrors without

[22] A virtual team may be defined as a team which almost entirely communicates and co-operates by means of electronic communication. Face-to-face encounters of team members are rare.

any doubt very well the conditions for research project management. Yet, hopefully this paper has shown that we must on the other hand take care not to fall into what Tidd et al. (1997) call the "chaos trap" - believing that if the world is chaotic then this should also apply to the way we organise work. That researchers are e.g. used to working autonomously and that research work has a high degree of complexity and unpredictability does not mean that research leaders are superfluous and that no structure, no planning and no management is neither necessary nor possible. Research may be unpredictable but it is not complete confusion: most researchers do have some kind of idea of the outcome and work process of their research. But the inherent uncertainty does mean that the way we organise and manage research projects should reflect and aim to accommodate this uncertainty and complexity. Thus if each project is unique as to purpose and personality of participants then it seems relevant to use a contingency approach and look for the most *suitable* way of organising and managing that particular project. In other words, there can be no blueprint for good research project management; but there can be best practices, rules of thumb and useful pointers and guidelines. An attempt to outline some of these is made in the concluding section of this paper.

It is not just in terms of organisational forms that the research community constitutes a vanguard. Technologically, researchers are also at the forefront making daily use of electronic communication technologies to facilitate co-operation with their peers throughout the world. Indeed, there is even talk of a "Global Research Village" in which the villagers are linked by means of information and communications technologies[23]. Much has been said and written about how technologies such as the internet, intranets, video-conferencing, e-mails, cellular phones etc. will change and are changing the way we work together (cf. also the above quotes; the developments foreseen in these are to a large degree technology-driven). The digital technologies are also very significant for the management of international, virtual project teams and without them international project collaboration would be much more difficult. Yet in spite of all the technology hyperbole and all the very useful things technology can do, the project leader would still do wise to remember that technologies cannot do it alone. As argued by Townsend et al. (1998:23) "in the virtual work environment, traditional social mechanisms that facilitate communication and decision making are effectively lost". Also, important non-verbal behaviour is not communicated by these technologies. And even when video-conferencing systems become so advanced so as to make this possible, human face-to-face contact remains likely to be of the utmost importance for the creation of a well-functioning work team. After all, it is never computers or even organisations that work together on projects. It is people and people are social beings. Until that fundamental fact of life changes or becomes severely modified in an ever more virtual and digital world it seems reasonable to contend that the sense of trust and commitment, which is so crucial in research projects, can only be built between people who know each other well, who have met in person and continue to do so to maintain their relationship.

5. Summing-up; towards a new project management model for research?

This paper has discussed the *human processes* of managing a research project with a particular emphasis on the creation of an integrated team and the concept of shared management. It has also discussed aspects

[23] Under the name "The Global Research Village" the OECD (in co-operation with national governments) has twice arranged conferences on IT and its impact on the science system. The first conference took place in 1996, co-hosted by the Danish government, and was followed by a conference co-hosted by the Portuguese government in 1998.

of the *technical structure* in research projects with a particular emphasis on the relationship between the technical-rational approach in much text book project management theory and the realities of carrying out a research project. It has been claimed here that some of the key elements and tools in project management theory concerning planning, scheduling and control are difficult to apply in practical research work. It has also been claimed that the emphasis on technical structure in much of the standard literature on project management means that many important non-technical conditions for managing a research project are often only superficially dealt with or not dealt with at all in much of the general project management literature. The latter applies both to the organisational setting, researchers' motives for co-operation and the nature of researchers and research work. Thus it may be argued that there are important differences in the fundamental rationales of general project management theory and research. An attempt to highlight some of these contrasting differences is made in the figure below. The figure takes its point of departure in what we can call the text book technical-rational model[24] in much project management theory and contrasts this model with basic conditions in research projects:

The technical-rational model in project management theory	**Basic conditions in research**
Divide into distinct project phases and sub-tasks	Phases and tasks in research overlap and are non-linear
Projects are repetitive	Research projects are particular and singular
Projects are intra-organisational	Research projects are often inter-organisational
Project participants work (almost) full-time on the project	Most researchers have many competing and conflicting obligations on their time e.g. teaching, administration or other projects
Plan and control (rationality)	Planning and control is difficult (bounded rationality)
The project manager generally knows what to do and gives professional advice and instructions concerning the concrete work	Uncertainty is high and project participants have high degree of autonomy. Furthermore too rigid control may be counterproductive
Set clear goals	The research project manager often lacks the required professional knowledge. Instead it is the project participants who know
Goals have a commercial and/or applied technology orientation	Goals may be abstract and subject to change
There is a customer relation or clear impression of end user of the result	Goals may have both non-commercial/commercial and applied technology/non-applied technology orientation
Limit uncertainty; safety first	There may be no customer other than the researchers' peers and the impression of potential end-user may be vague
Management (plan and control; emphasis on the producer and administrator management roles (Adizes (1979))	Uncertainty is part and parcel of research and innovative research must take risks
Evaluation: Purpose is to efficiently reach planned result (plan and control)	Leadership (innovation and integration; emphasis on the entrepreneur and integrator management roles (Adizes (1979))
	Evaluation: Purpose is learning and reaching optimum result. Pre-planned result may prove second-best or unrealistic. Effectiveness.

Most of the differences highlighted above deal with technical structure aspects concerning planning, controlling and scheduling. The differences also highlight general project management theory's basic assumptions concerning the purpose of projects. We will now turn our focus to summing up and discussing

[24] Cf. e.g. Locke (1996 and 1996a), Shtub et al. (1994), Reiss (1995), Lockyer and Gordon (1996), Burke (1993), DeLucia and DeLucia (1999) and Gido (1985).

aspects that are crucial to the management of the human processes in a research project. Ernø-Kjølhede, Husted, Mønsted and Wenneberg (2000) have drawn attention to the usefulness of distinguishing between three different orders (levels) when discussing the human processes in the management of research. This distinction is highlighted below where their three order concept is put into the context of the management of a research project:

1) The first order concept of research management is the individual researcher's self-management. Given the inherent uncertainties and the asymmetric distribution of knowledge in research the manager of a research project is well advised to grant project participants freedom to make individual decisions concerning the research process, choice of methodology etc. in their individual contributions to the project. (Individual freedom is of course influenced by demands surrounding the project participants, e.g. the goals and needs of the project, demands in the employing organisation(s) and in the scientific prestige hierarchy. But the key issue is that researchers do not perceive of these influences as threatening their self-management. Rather they accept these influences voluntarily).

2) The second order concept of management of research is concerned with managing researchers who are thus managing themselves at the first order level. At the second order level the focus moves from the individual level to management at the group level. At this level management is concerned with the creation of shared values and norms in the project group – values and norms which facilitate self-management at the first order level in accordance with the project's goals. Second order management thus entails influencing researcher's self-management through creating a shared framework for project participant's self-guidance of their work.

3) The third order concept of management of research deals with the creation of mutual trust. It is in a sense a 'meta-order' being concerned with creating the conditions that make second order management possible. Third order management is thus about making efforts to embed the project group in an atmosphere of mutual trust that can function as a 'lubricant' for the adherence to joint goals and a shared framework which then enables a group of different people to act in unison towards these goals. The concept of mutual trust means that not only must project participants have confidence in each other they must also have confidence in the project manager's ability to make the right decisions and interpretations of the project's strategic surroundings. (This confidence is also the basis for the project manager's credibility).

It should be stressed that the apparent linearity in this listing is misleading. One order does not replace the other. Rather the orders overlap as concentric circles. The three order concept instead highlights that in research projects management should come both from individual self-management (first order) and from shared values and norms (second order) facilitated by mutual trust in the project group (third order). The corollary of this is that it is orders two and three, which a research project manager should focus his or her efforts on. And through these levels he or she can then influence researchers' self-management at the first order level. The second and third order levels correspond very well to the notion of the distributed mind (Fisher and Fisher, 1998) and the notion of the mutual "cognitive framework" as a governance mechanism for research projects, which is discussed below. Before we get to that discussion, however, there are some fundamental conditions for research projects that need to be addressed first.

An important special feature of many research projects is that research project managers are often not the superiors of the team members (e.g. in universities) and thus have no official authority. Formally, project participants therefore owe them no loyalty meaning that the research project manager has to rely on the researchers' inherent motivation or his or her own ability to motivate, negotiate and persuade. Furthermore, team members may be involved in several activities at one time and have many competing obligations such as teaching, administration or other projects. Thus the project leader is effectively engaged in a competition over project participants' time with e.g. students, employers and other project leaders. Despite the research project leader's inability to give much reward in her official capacity he or she thus still has to make it so attractive and motivating to work on the project that the project will get priority in the competition over time. Additionally, team members in research projects may often come from different organisations geographically dispersed from each other (inter-organisational projects, cf. above). Thus different institutional motives may come into play as far as motives for co-operation are concerned. And on the individual level researchers may to a large extent be driven by a desire for individual recognition. By nature most researchers also have a desire for working in a self-directed manner and for a participative or shared leadership. This diversity effectively makes the research project a 'negotiated arena' (Strauss et al. 1964) where all these actors and their various desires and considerations are to be integrated towards a common goal.

To efficiently manage a project in such a hotchpotch of autonomous participants and diverse motives and interests the project leader needs to possess a number of personal skills, in particular communicative skills. Furthermore, research project management has many aspects and requirements that may change during the course of the project or require different approaches. It is e.g. possible that the conceptualising phase in a research project requires a different management style from the execution phase. And it may be that the technical rationale of the planning and scheduling tools - given continuous adjustments - is of greater accuracy and/or is more helpful in the final execution stages of the project than in the beginning of the project. It is also likely that an aspect only briefly touched upon here, viz. managing the boundaries or interfaces of the project (e.g. contact to external stakeholders), also requires a style different from the style required for managing the internal processes in the project. Thus managing a research project is a complex task that may require a number of different approaches both concerning the technical structure of the project and the management of the human processes. As argued by Rasmussen in a paper on research organisation and management in intra-departmental research groups in universities:

"Management is…those processes which lead others to carry out a number of activities in a goal-oriented and effective way…But when we speak about knowledge production, [the terms] "others", "goal-oriented", "effective" and to "carry out a number of activities" become unclear and ambiguous in several ways" (1999:10 [my translation]).

Another key observation in Rasmussen's paper is that the researchers interviewed for his study express a desire for what he terms "democratic-authoritarian management". This apparent contradiction signals that the researchers on the one hand wish to have influence on decision-making whereas on the other hand they also want to have a strategy or course to follow in their research. But exactly who has the legitimacy to set the course is unclear and depends on the circumstances of the individual researcher/research group[25]. Similarly equivocal findings have been made by Pelz and Andrews (1966) who argue that a combination of

[25] According to personal correspondance November 1999 with Rasmussen.

"freedom and co-ordination" leads to best research performance and also by Cohen et al. (1999) in a study on researchers' perceptions on management. Cohen et al. found in their interview-based study on the one hand evidence of a polarisation between researchers' desire for autonomy and management control but on the other hand they also found many examples of consistency and complementarity between the notion of management control and researchers' desire for autonomy. Cohen et al. subsequently conclude that to understand the relationship between autonomy and management in research we need perspectives which "transcend static dichotomies" and which "take as their starting point the mutuality and interdependence of professional [researchers'] and managerial discourses" (1999:481). If we push Rasmussen, Pelz and Andrews and Cohen et al.'s observations to their logical conclusion, then the fundamental paradox of autonomy and project control outlined at the outset of the paper may, at least in part, just be an apparent paradox. Bearing the ambiguity and complexity of managing research in mind, some general pointers for research project management may in conclusion be summarised from the discussion in this paper:

- ***Project management tools for scheduling and planning are helpful in research projects – but also potentially misleading.*** Thus they should be used as flexible tools that are continuously adjusted to fit current project reality. They should not be regarded as a blueprint for the research project.

- ***Team-building is very important in research projects.*** Efforts should be made to turn the project group, which may basically be a short-lived adhocracy of competing interests and obligations, into a committed, motivated team with a sense of common purpose and direction - while still making room for individual recognition and ambition. Balancing this competition/co-operation nexus is a fundamental challenge for the research project manager and requires the nurturing of a delicate team culture of reciprocity.

- ***Research project leadership is to a large degree about influencing and persuading partners*** and building consensus about objectives amongst a group of highly skilled and independent-minded people (and creating an acceptance that there are time and budget limits to be met).

- ***The knowledge imbalance*** between the project manager and the individual project participants and the difficulty of planning the outcome and process of research work naturally *makes traditional project control difficult and delegation of responsibilities a necessity.* Parts of the project are known to all participants but all details of the project are known to no one single person. Put a bit crudely, most research projects are thus so complex that the project manager cannot manage them.

- ***Design the project in such a way that it is in fact capable of managing itself***. To ensure that this does not result in a diffuse and atomised process and ditto result the self-governing project calls for the construction of a "mental model" or joint framework for aligning thinking, problem solving and decision-making among the participants in the project. The role of this shared 'cognitive framework' (Husted 1998 and 1999) is to function as an adaptation mechanism which supplies project participants with shared patterns of interpretation and priority setting.

- ***Constructing, communicating and constantly negotiating this cognitive framework with project partners may be described as the prime task of the leader of a research project***. It is also through assuming the role of chief architect, negotiator and communicator of this framework that the

research project manager is capable of wielding influence and shaping the independent, operational decision-making processes of the various project participants in accordance with the overall goals of the project. Operating under such circumstances the research project manager can be described not so much as a manager but rather as a chief integrator of people, goals, inputs and relations in a network of independent parties with both overlapping and different motives and interests.

Given the differences in rationale illustrated in the above figure and the special requirements of research projects discussed here, applying the technical-rational approach of much of the general project management theory to research projects thus requires a redefinition or adaptation of some of the basic tenets of the literature. This redefinition/adaptation must to a much larger extent allow for the task uncertainty, knowledge asymmetry and participant autonomy characteristic of research projects and researchers. Perhaps the field of research project management is not in itself big enough to warrant such a reorientation of general project management theory. But with the growing number of knowledge-intensive companies and the increasing scholarly and corporate emphasis on knowledge management and organisation in self-directed teams such a reorientation is already in the making.

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