Chapter 10
Reflections on Rational Goals in Science and Technology; A Comment on Olsson

Peter Kroes

Abstract In the first part of my comments on Olsson I argue that the question whether or not true knowledge may be reduced to useful knowledge is not relevant for the question whether the goal of science is the same as the goal of technology. The reason is that technology is not primarily an epistemic enterprise. The goal of technology is roughly the making of useful things and the development of useful knowledge is a means to achieve this goal, not the goal of technology itself. Because what is useful is context dependent, the goal of technology is intrinsically context dependent in contrast to the goal of science. I argue that this difference in context-dependency has direct impact on when and how issues about rational goal setting in science and technology present themselves. In the second part I address the issue how the theory for rational goal setting discussed by Olsson relates to the widespread idea that rationality is only operative in the domain of means and not of goals. I argue that this theory, which stems from the field of management, is substance dependent and therefore cannot simply be transferred to science. Finally, Olsson argues that in science it may be more rational to go for the more motivational goal of true belief and not just belief, because the more motivational goal may be more achievement-inducing. I briefly point out that setting highly motivating goals may have serious drawbacks and therefore may not always be rational.

1 Introduction

Olsson compares the rationality of goal setting in science with the rationality of goal setting in management and technology and his main thesis is that "the theory of goal rationality in management and technology can be profitably transferred to the scientific domain." To support this thesis he analyses four debates about the proper goal of scientific inquiry. These debates concern questions about whether belief or true belief (Peirce), true belief or justified belief (Rorty), justified belief or knowledge (Kaplan) and knowledge as mere true belief (Sartwell) may be

P. Kroes (✉)
Department of Technology, Policy and Management, Section of Philosophy,
Delft University of Technology, Delft, The Netherlands
e-mail: p.a.kroes@tudelft.nl

S.O. Hansson (ed.), *The Role of Technology in Science: Philosophical Perspectives*,
Philosophy of Engineering and Technology 18, DOI 10.1007/978-94-017-9762-7_10

considered the proper goal of science. He criticises the conclusions drawn about the goal of science in these debates on the ground that the principles of goal rationality upon which they are based are not generally valid. For instance, Peirce's argument that belief and not true belief is the aim of scientific inquiry is based on the following principle, that he calls Peirce's Principle: if two goals G1 and G2 are end-state evaluation equivalent for a subject S, and G1 is logically stronger than G2, then goal G2 is more rational than G1. Take for G1 the goal of true belief and for G2 belief *simpliciter*. Peirce argues that it is not possible to distinguish one goal from the other and therefore concludes that belief, the logically weaker goal, is the proper goal of inquiry. According to Olsson this principle is not generally valid because it does not take into account the motivational force of goals and therefore it cannot be concluded that G2 is the more rational goal. It may well be that the goal of true belief may be more rational because it may be more achievement-inducing due to its motivational force. In a similar way, by appealing to principles of rational goal setting, Olsson analyses the other debates and questions the conclusions drawn about the goal of science. He also concludes that application of the theory of rational goal setting to science puts into question the pervasive idea in epistemology that there is one, unique goal of science. Instead, it may be more plausible to start from the idea of a system of goals that may contain potentially conflicting goals.

Discussions about the goal of science have a long tradition and much has been written about it by scientists and philosophers of science alike. But as Olsson rightly remarks, the study of goal *rationality* in science, in comparison to the study of goal rationality in management and technology, is a "surprisingly underdeveloped intellectual territory." Olsson's paper is to be commended for venturing into this territory and his applications of the principles of rational goal setting to some debates in epistemology are of great interest because they put these debates into a new perspective (or may even be of help, as he claims, in resolving some of them). But Olsson's paper also raises a number of rather fundamental issues – and it is also to be commended for doing so – about on the one hand the goal of science and technology and about the notion of rationality on the other. In the first part of my comments I will dwell extensively on Olsson's view on the goal of technology, because in my opinion this view has direct consequences for the way he analyses the (rational) goals of science and technology. In the second part, I will raise some questions about what kind of rationality is employed in the theory about rational goal setting in technology and about Olsson's application of this theory to the goal(s) of science.

2 A Critique of Knowledge as the Goal of Technology

By way of introduction Olsson briefly discusses the goal of science and the goal of technology. He observes that there is a widely shared intuition that there is a difference in ultimate goals: whereas science strives after objective truth, technology strives after practical usefulness. He points out that whether or not this implies that there is really a significant difference in goals depends on the question whether scientific truth is different from practical usefulness. From an instrumentalist point of view, he says, this difference may be questioned because of its "pragmatic" interpretation of scientific truth. Even a realist interpretation of truth may be compatible with the idea that theory choice in science is primarily guided by the usefulness of theories for solving practical or empirical/theoretical problems. In both cases, the intuition that there is a difference in ultimate goals becomes problematic.

In my opinion there is something deeply worrying about the way he characterizes the goal of technology. In his *Introduction* Olsson appears to accept the idea that practical usefulness is the goal of technology. From his discussion it transpires that this practical usefulness is mainly to be interpreted as the practical usefulness of the *knowledge* (theories) produced in technology. He is not alone in this interpretation; it is made time and again in the literature. It underlies most discussions about whether or not technology is a form of applied science. Whether one agrees or disagrees with the idea of technology-as-applied-science, technology is taken to be primarily a knowledge generating activity with practically useful theories as its main goal. In other words, technology, just as science, is taken to be an epistemic endeavour. This is, what I would like to call, an *epistemologically biased* picture of technology. Such a picture may be true for the technological (engineering) *sciences*, but that is certainly not true for technology, more in particular engineering. The typical goal and outcome of a technical/engineering project is not knowledge, but a technical artefact or process, like a bridge, a mobile phone, an airplane, a new chemical plant, a coffee machine et cetera. In other words, the making of devices that are practically useful or bringing about desirable states of affairs in the world is the primary goal of technology, not producing knowledge that is practically useful. Of course, the making of (innovative) technical artefacts may involve the generation of new knowledge, know-how and skills of various kinds but this knowledge production is instrumental to the goal of making useful things. If indeed the ultimate goal of technology is to produce practically useful things and not practically useful knowledge (about how to produce practically useful things), then even an interpretation of truth that reduces it to mere practical usefulness does not imply that the goals of science and technology are the same, since the goal of technology is not of an epistemic nature.

It is important to stress this difference in kind of the goals of science and technology, for it puts into question some of the (tentative) conclusions of Olsson's analysis or the way he arrives at those conclusions. He argues for instance that his analysis of goal rationality in science and technology "will shed doubt on some pragmatist proposals" according to which science and technology share the same goal. The reasons for these doubts are related to the motivating force of the notion of truth because of which it may be more rational in science to aim for true knowledge than only for useful knowledge. Given what was said above, I agree with his conclusion about the goals of science and technology being different, but not with the argument upon which it is based. His argument pivots around the assumption that practically useful knowledge is the goal of technology. In my opinion, this assumption mistakes one of the means of technology or engineering for its ultimate goal.

Given that Olsson appears to endorse, in his *Introduction*, an interpretation of the goal of technology in terms of useful knowledge one would expect that he supports this interpretation with examples of goals of technology that refer to the production of useful knowledge. Interestingly, that is not the case. None of the examples of goals mentioned in Sect. 2, entitled *Goal rationality in technology*, refers to useful knowledge. In discussing issues about goal setting in general he mentions examples like the goal of becoming rich and of going to Geneva and with regard to goals in technology he mentions the design of a mousetrap.[1] These examples are much more in line with the idea that goal setting in technology is not about generating useful knowledge, but about making useful things or bringing about desirable states in the world. Of course, useful knowledge about how to realize practical (technical) goals may be crucial in guiding and motivating practical action, but as such it is a means to the goal of practical action, not the goal itself. The generation of useful knowledge about how to build a bridge may be an important step in achieving the goal of building a bridge, but the goal of generating this useful knowledge about bridge building is not to be confused with the goal of building a bridge or the usefulness of a bridge.

My disagreement with Olsson about the goal of technology does not by itself undermine his claim that the rationality of goal setting in technology may be fruitfully transferred to science. My aim so far has been merely to point out that in my opinion it is a mistake to ascribe to technology the goal of the production of useful knowledge. By doing so the goal of technology is put in the same domain as the goal of science, namely in the epistemic domain, and consequently the obvious question of whether or not these epistemic goals are the same presents itself. It remains to be seen whether the ascription of a goal to technology that is different in kind from the goal of science has consequences for the question whether the rationality of setting goals in both domains is similar or not.

3 The Context Dependency of the Goal of Technology

On the face of it there appears to be a difference in the way goals are set in science and technology that originates from or is related to this difference in kind of their goals and this difference in the way goals are set may affect the *rationality* of

[1]Here it might be objected that the example of a design of a mousetrap is an example that confirms Olsson's claim that the goal of technology is useful knowledge, since he is not referring to the making of a mousetrap. However, it is clear that he has the latter in mind, since he writes that the product of a mousetrap designer "should not harm or restrict the freedom of the mouse in any way"; clearly, it does not make sense to claim that useful knowledge (in the form of a design of a mousetrap) as such restricts the freedom of a mouse in any way.

goal setting in both domains. To clarify this difference, let us follow Olsson in his conjecture that the principles underlying the rational theory of goal setting "are just as plausible for scientific goal setting as they are for technological goal setting" and let us assume that by applying these principles to science we arrive rationally at some plausible system of goals for science. As Olsson points out, this system of goals may contain goals that are potentially in conflict; if conflicts arise scientists will have to deal with them in concrete situations. This system of goals then applies to any scientific research project; it is, so to speak, the fixed, overarching end of any scientific inquiry in so far that inquiry is a (purely) epistemic endeavour. In principle, this immutable end determines the rationality of theory choice in science: whenever scientists are confronted with competing theories they ought to opt rationally for the one that brings them closer to this immutable end. In case the immutable end contains conflicting goals problems may arise about what it means for one theory to be closer to this end than another.[2]

If we apply this view on the rational goal setting of science to for instance the study of the physical phenomenon of the rainbow, the following picture emerges. All research projects on rainbows, *qua* scientific research projects, share the same ultimate goal (depending on what is the outcome of the rational goal setting for scientific inquiry the following goals may play a role: to understand this phenomenon, to find out its 'true' causes, to predict the occurrence of this phenomenon et cetera). Once the ultimate system of goals of science in general has been fixed, it can be straightforwardly applied to this specific case and no further (re-)setting on rational grounds of the end of inquiry prompted by specific features of the phenomenon of rainbows is necessary; more in particular, no rational resetting of the end of inquiry on the basis of the outcomes of inquiries into rainbows over time is necessary.[3]

Now, if we shift focus from science to technology the following question arises: What would be the technological counterpart of this immutable scientific end? Given our discussion about the goal of science and technology above, the most obvious candidate is the making of useful things.[4] At first sight this immutable end of technology can be applied straightforwardly to specific cases of engineering, for instance the design and making of a useful car or a useful mobile phone. On closer

[2]In the following I will ignore the fact that the system of goals of science may contain conflicting goals. If we take that into account, the following analysis may become somewhat more complicated because the idea that there is one ultimate goal for science may become problematic. However, the main point concerning the difference in context dependency between the goal (system of goals) of science and technology remains valid.

[3]Of course, over time changes in which features of rainbows were considered to be the most important to study and explain may have occurred; however, that does not imply a resetting of the goal of this research as described above.

[4]According to many engineering codes of conduct the paramount goal of engineering/technology is to serve the public. For present purposes I will assume that this goal is more or less taken account of by the notion 'useful' in the expression of useful things.

look, however, a different picture of the goal of and goal setting in engineering projects from the one in scientific research projects emerges.

Let us have a closer look at goal setting in engineering projects. It may happen that within a specific engineering project the goal set at the beginning of the project, for instance to design a useful car or mobile phone satisfying a given list of specifications, may be achieved without having to readjust the goal during the project. No issues that necessitate a resetting of the goal of that particular engineering project come up and so the goal remains fixed during the project. However, this situation may be more the exception than the rule. Often during an engineering project the goal of the project has to be readjusted on the fly; this may be the case for various reasons arising from developments within the engineering project or its context: because the given list of specifications cannot be satisfied given the available resources, because of changes in the available resources, because of conflicts between various specifications et cetera. Then, a (rational) resetting of the goal of the project is called for. If there are conflicts between certain specifications trade-offs between those specifications will have to be made. What happens in these cases is that the goal of a useful car, which was originally defined in terms of a particular list of specifications, is redefined and so the goal of the engineering project is redefined.

Prima facie, the situation with regard to goal setting in specific scientific research projects may look not very much different from the one sketched above with regard to engineering projects. Also in scientific projects it may turn out to be necessary to redefine the original goals that the project set out with because of unexpected research outcomes or because of contextual developments. Thus, rationality issues about goal setting within research projects in the sense of which research questions to pursue, which experiments to perform et cetera, may come up. However, these rationality issues touch upon the specific goals of scientific research projects, not upon the ultimate end of scientific research. No resetting of that end on the basis of the outcomes of particular research projects appears necessary. All scientific research projects, whatever their specific project goals, appear to share a common, ultimate goal.

It is precisely the idea of a shared ultimate goal that is problematic when it comes to engineering projects. To see why, let us shift attention from individual engineering projects to series of consecutive engineering projects intended to improve on previous versions of a product. Over the years the criteria for usefulness of cars and mobile phones have shifted considerably which is reflected in changes in the lists of specifications for cars and mobile phones. Because of these changes the goals of engineering projects for designing and making cars and mobile phones are also continually changing. Going from one engineering project to the next a resetting of goals occurs and issues about doing this rationally turn up. Various kinds of factors play a role in (re)setting these goals, ranging from market position, legal constraints, consumer wishes, production facilities, financial position et cetera. This diversity of relevant factors may make goal (re)setting in these situations a very complicated matter.

Now it might look as if, similar to the shared overarching goal of all scientific research projects on rainbows, there is likewise a shared overarching goal for all car or mobile phone making projects, namely the design and making of the most useful, best or optimal ('true') car or mobile phone. One argument to support this idea is that from a technical point of view it has proven to be possible to produce in the course of time increasingly better and technically more sophisticated cars and mobile phones. This suggests that there might be something like a technically best, and therefore most useful, design for these technical artefacts. However, in contrast to the science of rainbows there is no such overarching, Archimedean goal in technology. First of all, the notion of the technically best or optimal car or phone does not make sense. Without going into details, one of the reasons for this is that there is no single criterion on which to measure the overall technical performance of cars or mobile phones. Their lists of specifications, even if all strictly non-technical specifications are filtered out, usually contain a number of different criteria on which their performance is to be assessed. It has been shown that under very general conditions it is not possible to aggregate these different criteria into an overall performance criterion on which to assess the technical performance of different design options (Franssen 2005). In such situations, notions like the technically best or optimal car or mobile phone do not make sense and with it the idea that there might be a gradual approach to their realization by successively resetting the goals of engineering projects such that they will bring us closer to these technically 'ideal' objects.[5] That is the reason why the notion of technical improvement should be used with care.[6] Secondly and more importantly, even if the notion of a technically best object would make sense, the inference from technically best to most useful is very problematic. Usefulness is a context dependent notion; what may be (most) useful in one context, may not be so in another. This means that if the making of the best technical artefacts in the sense of most useful ones is taken to be the ultimate goal of technology, this goal is highly context dependent. All in all, as Thomas Hughes, one of the leading historians of technology remarks "From Hunter's monograph historians and students learn about the realities of technology transfer and the absurdity of arguing that there is one best engineering solution." (Hughes 1991, p. 16).

The upshot of the foregoing is that it points to a significant difference in the setting of goals in science and technology. Once the overall goal (system of goals) of science has been set, be it theories that are true or empirically adequate et cetera, no resetting of that goal in specific research projects on the basis of the outcome of those research projects appears necessary. A similar overarching goal for engineering projects is lacking. It may be agreed that making (optimally) useful

[5]A similar kind of reasoning may apply to science in case its system of goals involves various independent criteria for measuring the performance of theories; see, for instance, Zwart and Franssen (2007) who argue that this is the case if a notion of verisimilitude that places content and likeness considerations on the same level is taken as the goal of science.

[6]This does not exclude the possibility of Pareto improvements.

artefacts is the overall, ultimate goal of technology, however, in contrast to the situation in science, this goal is not of much help in fixing (constraints on) the goal of a particular engineering project: How to derive specific lists of specifications for engineering projects from the goal of making a useful car or useful mobile phone? For each individual engineering project as well as in series of engineering projects goals have to be set and reset or readjusted on the basis of 'historically contingent' considerations about what is considered to be useful. There is no predefined goal for a particular engineering project – the technically best, let alone most useful, car or mobile phone – that so to speak by default drops out of the ultimate goal of technology. The reason for this is that usefulness of technical artefacts is a thoroughly context dependent notion and because of this contextual factors play a primary role in the rationality of goal setting in engineering projects.

This difference in (the rationality of) goal setting in particular research and engineering projects reflects a rather fundamental difference in what science and technology in my opinion are about. In its core, science is about creating abstract epistemic artefacts whose aim is to faithfully or reliably represent a pre-given world; this aim remains unaffected whatever aspect of the world is studied and once the criteria for a faithful or reliable representation have been set they apply indiscriminately to any scientific research project. *Prima facie* a similar kind of reasoning may be given for technology, namely technology is about the creation of (physical/material) artefacts for usefully intervening in the world. Whatever kind of technical artefact is being created, this aim remains the same, analogous to the case of science. However, with regard to (the rationality of) setting goals there appears to be a crucial difference between creating abstract artefacts that faithfully or reliably represent the world and physical artefacts that are useful for acting in (changing) the world. What it means for representations to be faithful or reliable and the epistemic criteria for assessing their faithfulness or reliability are taken to be context independent, whereas what it means for a technical artefact to be useful is a historically contingent matter and the criteria for assessing their usefulness are intrinsically context dependent. In case the epistemic criteria for faithful or reliable representations would be as context dependent as the criteria for practical usefulness, there would be a real danger of a thorough (cultural) relativism of scientific knowledge.

It may be objected that this difference in context dependency becomes less pronounced or even disappears when in a pragmatist or instrumental spirit the goal of science is taken to be the creation of abstract artefacts (such as theories) that are useful. However, much depends upon how the notion of usefulness is interpreted. It may be interpreted in an epistemic or in a practical (technical) sense and the two are not to be confused. If it is taken in an epistemic sense, then a strong case can be made that the above difference still remains. To illustrate this, take the following quote from Olsson with regard to Peirce's pragmatism:

> We recall that, for Peirce, belief or opinion is, by definition, that upon which an inquirer is prepared to act. Hence, Peirce is proposing to reduce the goal of scientific inquiry to the goal of attaining that upon which we are prepared to act. Peirce's enterprise could be interpreted as presenting the TU-intuition [the intuition that science has truth as goal and technology

usefulness; PK] with a direct challenge, especially if the kind of action that is referred to is practical action, a reading which is not alien to Peirce's pragmatism.

For Peirce the goal of scientific inquiry is the "fixation of belief"; this is an epistemic goal: it is the production of useful knowledge in the sense of beliefs upon which we are prepared to act (also in practical matters). This usefulness of a belief (knowledge), however, is not to be confused, as Olsson appears to do, with the usefulness of a practical action that we are prepared to perform on the basis of it. We are more or less back to our earlier example of the difference between the goal of producing useful knowledge about building bridges (on the basis of which knowledge we are prepared to act) and the goal of building bridges and the usefulness of bridges. Even if the goal of scientific inquiry is interpreted in a pragmatic way as some form of useful knowledge, this goal may be largely context independent. In scientific inquiry the goal may be useful knowledge in the sense of the fixation of beliefs on the basis of which we are prepared to act no matter what our particular practical goals are. This is very much in line with Peirce's idea that truth is what the community of inquirers converges upon in the long run. This convergence in useful beliefs, beliefs upon we are prepared to act, does not imply a convergence in practical (technical) usefulness of the actions (or their outcomes) based upon these useful beliefs. In the field of practical usefulness it is much more difficult to make sense of the notion of a convergence of usefulness; again, there is no convergence to something like the most useful car or mobile phone.

To conclude this part of my comments, I have argued that the question whether or not true knowledge may be reduced to useful knowledge is not relevant for the question whether the goal of science is the same as the goal of technology. Furthermore, if the making of useful things is taken to be the goal of technology, then the goal of technology is intrinsically context dependent in contrast to the goal of science and this difference in context-dependency has direct impact on when and how issues about rational goal setting in technology present themselves.

4 What Kind of Rationality?

I now turn to Olsson's analysis of the *rationality* of goal setting in science and technology. As already pointed out, Olsson's thesis is that a particular theory of rational goal setting of technology and management can be fruitfully transposed to science. This theory of goal setting is known under the acronym SMART: rational goals should be (S)pecific, (M)easurable, (A)chievable or (A)ccepted, (R)ealistic and (T)ime-bound. This theory has been further elaborated by Edvardsson and Hansson into a framework that Olsson refers to as the SMART+ theory of rational goal setting. One question that immediately comes to mind is what kind of rationality is involved in this goal setting. Indeed, there is a long tradition in philosophy to deny that goals may be set in a rational way. As Hume remarked "Reason is, and ought only to be, the slave of the passions . . . ". Since the fixation of goals or ends falls outside the province of reason or rationality, he (in)famously claimed that it is not contrary to reason "to prefer the destruction of the whole world to the scratching of my finger" (Hume 1969 (1739–40), pp. 462–3). According to this tradition rationality can only do its work in the realm of choosing the right means when goals are given and therefore the only form of rationality is instrumental rationality. So considered, the notion of goal rationality appears to be rather an oxymoron, the more so since the SMART+ theory of rational goal setting is borrowed from the field of technology and management in which 'instrumental thinking' plays a dominant role.

Olsson does not address this question, but Edvardsson and Hansson do (Edvardsson and Hansson 2005). They point out that their framework for rational goal setting does not concern substantial aspects of goals, but "non-substantial, or structural, properties" of goals such as consistency of goals (p. 344). They refer to various non-substantial properties mentioned in the literature on goal setting in private and public management such as "clear, concise and unambiguous, within the competence of man, challenging, measurable, evaluable, integrative, complex, dynamic, transdisciplinary, applicable, participatory and understandable" (pp. 344–5). They propose an outline of a systematic account of these non-substantial requirements on goal setting which pivots around four non-substantial criteria for rational goals, namely, goals should be precise, evaluable, approachable and motivating.

The question I would like to raise here is whether their theory of rational goals really concerns non-substantial aspects of goals and thus may be expected to be generally applicable in any context of goal setting. To raise some initial doubts about this: is, for instance, the requirement of goal consistency really substance independent? It may not be rational for me to set the goal of going to Geneva this evening and staying at home this evening. But what about raising your children and having the goal of protecting them from harm and the goal of fostering an independent, autonomous attitude in them? As any parent may have experienced, on occasion these may be conflicting goals. Does this mean that it is irrational for me to have these conflicting goals? Let me focus on the SMART criteria. In my department these are used in my yearly review with my superior. I have always been troubled by the question whether these criteria of goal setting can be sensibly applied to scientific work. If not, then this raises serious doubts about Olsson's thesis that the theory of rational goals from management and technology may be fruitfully applied to science.

One line of reasoning that leads to doubt the non-substantial nature of the SMART criteria goes as follows. These criteria have been developed and are used by managers with certain substantive goals in mind; a prominent one among these goals is that they want to be able to control and evaluate the projects for which they are held accountable by their superiors. To that end, they see to it that agreements with project collaborators about project goals and resources are stated in a way that allows them to evaluate the outcome of projects in an uncontroversial, intersubjective ('objective') way. Here the SMART criteria do their work; they help managers and their collaborators to set goals that may be assessed in unambiguous ways (for example, in my yearly review, the outcome of my research is measured in terms of the number of papers published in ISI-journals, not in terms of whatever substantive progress I may have made in my research). In this way, these collaborators in turn can be held accountable for their work. From this perspective, the SMART criteria are simply an instrument to help managers to achieve their substantive goals, which means that they are not substance-independent, but directly related to or derived from particular goals. What gives the SMART criteria an air of being non-substantive is that they are operative at the managerial meta-level and put only very general constraints on setting particular substantive goals for projects. But the managerial level has its own substantive goals and the instruments to realize these goals, of which SMART is an instrument that helps managers to fix the goals of projects in a way that is conducive to the realization of their goals. According to this line of reasoning the kind of rationality involved in rational goal setting as discussed by Edvardsson and Hansson falls squarely within the domain of instrumental rationality and is fully compatible with the widespread and long-held idea that rationality is only operative in the field of means and not of ends.

Another way to question the non-substantial nature of the SMART criteria is to apply them to science directly. Thus, in order for the goals of a scientific research project to be rational they should be specific, measurable, achievable, realistic and time-bound. Typically, one would like to impose these criteria on the goal of a PhD research project. A PhD-student has to prove that (s)he is able to become an independent researcher and in order to assess whether that is the case, the project goal better satisfies the above criteria to a large extent. Otherwise the PhD-student might be blamed for the failure of a project, whereas in fact the thesis supervisor was to blame because of setting an unachievable goal. Note that in this case the SMART criteria are instrumental to a specific meta-level goal, namely the goal to offer a PhD-student the possibility to prove that (s)he is able to become an independent researcher. So, we are more or less back in the managerial situation described above: the SMART criteria are applied in order to set rationally a substantive meta-level goal, which results in very general constraints on setting the substantive goal of the PhD project.

What about applying the SMART criteria to the goals of research projects when there are no meta-level goals as in the case of PhD projects? Then the SMART criteria operate, so to speak, on the level of the ‘intrinsic’ goal of the research project. It appears that they may be applied fruitfully to routine like research projects in which the same research questions and experimental procedures are employed (for instance, the same experimental procedure for yet another sample of a particular kind of substances). But for innovative, explorative, open ended research projects it may be much more difficult to formulate goals that satisfy the SMART criteria. At the frontiers of science, not only research goals, questions and outcomes are usually heavily contested, often it is not clear whether some goals are achievable, let alone that it is possible to set time constraints on achieving certain goals. If the SMART criteria are really non-substantial constraints on rational goal setting, one would have to conclude that rational goal setting in these domains of science is not possible. Instead of going for this conclusion, I am inclined to question the claim that the SMART criteria are non-substantial. They have been developed within a specific (managerial) context for particular kinds of activities. That they are not applicable to certain kinds of scientific research projects – the kind which is usually considered to be most valuable for fostering the ultimate goal of science – may be due to the fact that the SMART criteria are to a large extent substantial in nature (or context dependent). Then the conclusion to be drawn is that the goal underlying the SMART criteria does not fit certain kinds of activity going on in science. Note that this conclusion partly undermines Olsson's main thesis that the principles of rational goal setting in management and technology can be fruitfully applied to the rational goal setting in science.

5 Conclusion: Rationality and Motivating Goals

My final point of comment concerns Olsson's claim that it may be more rational to go for the more motivational goal even if the end states of the more motivational goal are not evaluatively different from the end states of less motivational goals. That is the reason why he rejects Peirce's Principle and Peirce's conclusion that the goal of inquiry is just belief and not true belief. In his opinion epistemologists in general have failed to take into account the motivating role of visionary goals in their debates about the goal of science, in particular the goal of aiming for objective truth. In his *Conclusion* he writes:

> Curiously, this failure seems deeply rooted in pragmatist writings [...] without its apparent incompatibility with other features of pragmatism being clearly brought to the fore. I am thinking obviously of the pragmatist claim that what matters in philosophy is what makes a practical difference, from which it is concluded – to make a long story short – that truth cannot be a goal of inquiry. But the fact of the matter is that he goal of truth should rather be cherished by pragmatists as a goal which, due to its tendency to move inquirers to increase their mental effort, is as practice-affecting as one could have wished.

For Olsson there seems to be no doubt that the visionary goal of objective truth plays a positive role in science:

> Indeed, the goal of true belief, or the goal of truth for short, does sound more inspirational than the goal of settling belief. Many people, not least those equipped with a scientific mind, will go to almost any length to find the truth of the matter, sometimes even in practically insignificant affairs. Disregarding the special case of religious faith, comparatively few would be willing to incur similar personal and other costs for the sole gain of settling a corresponding opinion.

This may sometimes indeed be the case. However, in my opinion there is also another, negative side to the coin of aiming for objective truth in case objective truth cannot be distinguished from mere belief, which seriously undermines the claim that it is more rational to go for objective truth than just settling belief as the aim of inquiry. From the perspective of rational goal setting, the worry that I have is a general one, namely, that it may be questioned whether any goal that combines the properties of being highly motivating and being not (fully) end-state evaluable may be a rational goal in the sense of achievement-inducing. Objective truth as a visionary, strongly motivating goal may seduce inquirers to think that they have (partly) attained that goal. Once that is the case, they, to paraphrase Olsson, will go to almost any length to defend ‘their truth’ of the matter and they can do so precisely because the goal of objective truth is not end-state evaluable or not evaluatively different from less motivating goals. According to Kuhn’s analysis of science we see this behaviour also in science (Kuhn 1962); some scientists stick to an old paradigm ‘no matter what’, whereas others ‘convert’ to a new paradigm. That is the negative side of the coin of aiming for highly motivating goals that are not (fully) end-state evaluable. Here, Kuhn’s analogy with religious conversion is telling; scientists may become dogmatic about their own truth. In my opinion, the dangerous sting in Olsson’s analysis is exposed precisely by his reference to religious faith in the last sentence of the above quotation. The detrimental effects of the strongly motivating goal of objective truth when it comes to matters of religion are too well known to be spelled out in more detail and suffice to show that, after all, it may not be rational to opt for a strongly motivating goal when that goal is not end-state evaluable or not evaluatively different from less motivating goals.

References

Edvardsson, K., & Hansson, S. O. (2005). When is a goal rational? *Social Choice and Welfare, 24*, 343–361.

Franssen, M. (2005). Arrow’s theorem, multi-criteria decision problems and multi-attribute design problems in engineering design. *Research in Engineering Design, 16*, 42–56.

Hughes, T. P. (1991). From deterministic dynamos to seamless-web systems. In H. E. Sladovich (Ed.), *Engineering as a social enterprise* (pp. 7–25). Washington, DC: National Academy Press.

Hume, D. (1969 (1739–40)). *A treatise of human nature*. Harmondsworth: Penguin.

Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Zwart, S. D., & Franssen, M. (2007). An impossibility theorem for verisimilitude. *Synthese, 158*, 75–92.