50 shades of screwed up research

Science has reached a point where its own system is a stumbling block in the path of performing research. We are still bound to a funding and publishing system that was invented before the advent of the internet, which makes it extremely outdated; it can not cope with the rapid information exchange that is possible today. This leads to abstruse obstacles, artificially imposed on scientists just so that journals, which make business out of the scientists work, can survive in the age of the internet. Scientists have become publishing machines competing in rat races. We feel forced to concentrate on what is considered as "sexy" and as a result, forging data has become more appealing and we have to deal with an immense information overload, not being able anymore to distinguish good from bad science.

This paper criticizes the current system of practicing science. I will do so by first describing, what the values of science should be, followed by introducing the "root of the evil" – the current funding and publishing system – which leads to explaining how this system affects those values. I will point out that risk is part of the very nature of research and that publishing should not be dependent on the outcome nor should it be an economic product. Within the last part possible solutions and what aspects those would need to take into account are discussed. Thereby, the usefulness of science is never in doubt, but the manner in which we organise it is.
For the sake of readability, "he" is written wherever "he/she" is actually meant to be.

"Already in the 60s and 70s of the previous century, with their rapid expansion (big science) and institutionalisation of scientific research, visionary authors and administrators warned for a lowering of informal social pressure and control, for a tsunami of data and publications and an excess of shoddy science. They saw the rising influence of strategic behaviour, driven by all sorts of professional but also unscientific interests that had nothing to do with the advancement of science. In the year 2013, we know that these predictions have largely been proved true."

- Science in transition, Position Paper, 2013[1]

"Science in transition"[1] is a Dutch initiative of university professors striving for a fundamental reform of science. With their Position Paper, they identify and entangle various problems about our current system of how science is done and introduce some ideas of improvements. These problems are what the initiators call the shades of grey, which inspired the title of this essay. Furthermore that Position Paper is an important basis for this article.

But before elaborating the discussion of what is going wrong in our current system of how science is done, let us first define how science would ideally be practised.

Ideal values of science:

Robert K. Merton introduced the CUDOS model for defining what the values of science should be[3]:

1) **C**ommunalism:
   Science represents a community of enquirers who work together and share their results openly.
2) **U**niversalism:
   Science is not the project of a specific group of people. This means in particular, that publications of results should not be made dependent upon who the authors are.
3) **D**isinterestedness:
   This term does not mean that the scientist is not interested in research. By contrast, a good

scientist is very interested in any kind of discoveries. As argued in my previous paper ("Science how it should be"[2]), scientists are in general realists whose goal is truth-finding. What "Disinterestedness" actually refers to is that scientists should not be interested in the result in the sense that they are (financially) dependent on one outcome or another. Hence a scientist pursues research only for the sake of acquiring knowledge and not for any economic reasons.
This value combined with "Universalism" makes it clear that a scientist should not hold anything, which is not of scientific substance, against the work of another person.

4) **O**riginality:
Scientists ought to make new discoveries. Replication should only be performed for the purpose of reproducibility, which is one of the characteristics of scientific results (*see value "8) Verifiability").* This value emphasises indirectly the importance of "Communalism" – If scientists don't work together, but instead in secret and in competition with each other, in order to be the first ones to make the discovery, then chances are high that the wheel is reinvented several times.
5) **S**cepticism:
A scientist ought to be critical about their own and other scientists' work.

Aiming for a more complete picture of how science ought to be done I would complement the CUDOS values with the ones of the "The Netherlands Code of Conduct for Scientific Practice"[4]:

6) Scrupulousness:
"Scientific activities are performed scrupulously, unaffected by mounting pressure to achieve."[4] This value involves integrity, which is "the corner stone of good scientific practise."[4]
7) Reliability:
"Science's reputation of reliability is confirmed and enhanced through the conduct of every scientific practitioner. A scientific practitioner is reliable in the performance of his research and in the reporting, and equally in the transfer of knowledge through teaching and publication."[4]
8) Verifiability:
"Presented information is verifiable. Whenever research results are publicized, it is made clear what the data and the conclusions are based on, where they were derived from and how they can be verified."[4]
9) Independence:
"Scientific practitioners operate in a context of academic liberty and independence. Insofar as restrictions of that liberty are inevitable, these are clearly stated."[4]
This value implies in particular that "the publication of scientific research results is guaranteed"[4].

In summary these values represent science as an "ideal community, a group of people disinterestedly sharing knowledge to reach a higher goal." – as stated by the gurus of science, Robert K. Merton, Robert P. Hagstrom and Michael Polanyi[1]. Therefore science ought to be intrinsically objective, cooperative and involving universal sharing of data and outputs.
The (naive) belief that science actually works in accordance with these values has a name – it is called the "enchanted" view of science.[1]
But how does science work in real life? In order to analyse to what extent scientists conform to the values of the enchanted view in reality, it is important to first look at the way scientists are rewarded.

The modern assessment system and how it undermines the ideal values:

When we talk about science like a fairytale, we usually think about the big scientists from up to about 100 years ago. Those scientists could usually read nearly everything there was available about a certain area as back then the information density was still low enough. Moreover, they were mostly "gentlemen" with a huge inheritance, hence financially independent. This fact enabled them to work on and "play around" with whatever scientific question they were interested in for however long they wanted.
However, modern science doesn't work like that anymore. Science is performed by people who were especially trained (by university) and society has decided to fund science (by taxpayers). This imposes the necessity of finding a way of assessing quality of science in order to decide, on which scientific projects to spend funding on. How does this system work at the moment?
Within the current system, assessment and supervision of research are based on short-term "bean counting"[3]: The value of a scientist is a very simple function of his publications, its citations and the so-called impact factors of the journals in which those publications appeared. The more citations and the higher the impact factor – which only haphazardly correlates with the real significance of his research –, the "better" the scientist and the more likely is it that he receives funding in the future.
Hence society started using proxy measures to decide which scientist/ project to fund[3] and this changed fundamentally how science is performed as scientists had to adapt to these measures.
This fact leads to the question of what fundamental problems this assessment system entails.
First of all, it undermines the values of the enchanted view:

Ad 1): Communalism

This value is only met to a small extent in the present system. Scientists from the same institutes might work together and cooperation between institutes is also possible. But it is normal in the current scientific world to be in competition with each other in order to be the first to publish new results. Therefore often data is only shared by scientists after they have "milked" them for their own papers. *The Economist* reported in their cover story "How Science Goes Wrong"[13], that the Editor of the *Annals of Internal Medicine*, stated in 2008 about 60% of researchers would agree with sharing their raw data if asked and this decreased to 45% in 2013. In our current system, where science is funded upon economic principles and marketing it is no wonder that there is competition for the best jobs (including scarce PhD & Postdoc positions), grants and awards. The personal interest of the researcher does not automatically correspond with the higher goal of science. This yields many, sometimes bad, sometimes even fraudulent publications which do not serve science, but which scientists need to advance their careers.

Ad 2): Universalism

Within the current system of science it actually does matter who you are; it is easier to get a paper published if you are well known, have won awards and if your previous papers achieve high citation rates. Even though there is at least no bias against scientists from certain ethnical groups, scientists from developing countries who can't afford subscription or publishing fees (*see d) on page 5*) might get excluded from the publishing system and are therefore put at a disadvantage when it comes to competition for funds.

Ad 3): Disinterestedness

Unfortunately this value cannot be met in our current system. As less and less science appears to be an individual intellectual quest, but new ideas and concepts are coined within complex socio-political and cultural relationships, the scientist is forced to

deliver interesting (so-called "sexy") results in order to publish in prestigious papers and receive funding for future work.
Additionally, when assuming an idealist picture of the noble scientist seeking truth, disinterested in the kind of outcome, we miss out considering a very important aspect of scientist: scientists are still humans. For humans it is generally important to feel important and needed. Hence, if a scientific result promises glory and prestige, it is natural for the scientist to strive achieving this particular result.

Ad 4): Originality

This value is also threatened by the "publish or perish" dogma. As scientists need to publish in order to receive funding, they often publish "the smallest publishable unit"[3]. This means that results are split up in as little bits as possible in order to get more papers out of them. Therefore, consecutive papers often replicate what has already been presented in previous papers.
Furthermore, the bureaucratic and dogmatic character of the assessment system causes the "scientific genius" to cease[5]. Creativity is severely suppressed by the heavy publishing pressure. Additionally, because the funders decide on the topics which receive money to be investigated, risky ideas, which are mostly the ones which turn out to be revolutionary, are less likely to be funded. Another reason why creative minds are threatened to go extinct is, because of the fast-moving nature of today's world. We are too distracted and don't have any time anymore to let our minds "float" (i.e. give the mind a break from having to focus), which is one of the basic requirements for creativity.

Ad 5): Skepticism

In principle scientists are good at being critical. But if the criticism threatens the "sexiness" or publishing-value of the results, then, within our current system, scientists might feel forced to be less critical or even to manipulate the data in some way to increase their sexiness. The latter is called fraud and represents the violation of following value:

Ad 6): Scrupulousness

For the same reason as discussed in the previous point, the current publishing system challenges the scientist's integrity. The rewarding system itself gives potential to fraud as it is a very efficient way to publishing articles if one skips the research part partly or completely and rigs or even invents data (see recent cases of fraud, e.g. the Staple case[14]).
Furthermore, science is much more disorganized than one would expect from an ideal scientific community.
The Position Paper phrases these problems very nicely: "Some of them [scientists] have no objection to rigging their data, others are borderline incompetent and still others accept money from the pharmaceutical or the nuclear industry. Scientific practice is nothing more and nothing less than a noisy market place where obscurity, flagrant mistakes and even discord, but also coincidence and disappointment engender creativity, innovation and democratic counterforce."[1]

Ad 7): Reliability

The reason for publishing in our current system is not motivated by reliability, but actually by the necessity of complying with the "funding game" in order to survive as a scientist. In this sense, scientists are forced to being disingenuous by their own system.
Furthermore education is the victim of the pressure to excel and to acquire funding.

Teaching is severely neglected in our current system because a research leader is held in higher esteem than an education professor as research received the funding (too little goes to education) and wins renown, but it is impossible to become a (top) professor through brilliant education performance[1].

Ad 8) Verifiability:

This value is severely in danger for two reasons:
First, as explained under *Ad1) and Ad6)*, complete sharing of all data would either threaten the scientist's ability to compete or would reveal that the scientist performed some tweaks on his data in order to make it comply better with the results wanted by society.
Second, because of digitalisation, the advent of the internet and the need to publish, nowadays the world has to deal with an immense information overload. The quantity of information increased so dramatically – already in 2012 we had to deal with one Million publications per year[12] – that the number of scholarly publications has become so large that nobody can keep up with his own discipline anymore: "does last week's Economist not offer more information that the seventeenth-century citizen was given during his whole life?"[1]. This results in the need for hyper-specialisation and a lack of overview. Furthermore this fact challenges the reproducibility of science: scientists cannot possibly attempt to verify or falsify all published results. As reproducibility is one of the characteristics of scientific results, we need to ask at this point, to what extent we can still trust that our results correspond to true facts of our universe.

Ad 9) Independence:

As long as a funding is made dependent on the number of publications and the "sexiness" of the results presented, scientists can in no way be described as working in the context of academic independence, just as they cannot be disinterested (*see Ad 3)*).

In addition, the current assessment system carries other negative consequences with it:

a. The product of science should be knowledge and not economic product. The best way to save knowledge for other people and for the future might be writing a paper about results, but if funding is made dependent on citations of published papers, then papers are turned into an economic product. In this case science is no more distinguishable from industry and hence no more trustworthy. In other words, sharing knowledge should be the reason for publishing and not money.

b. Citations or the sexiness of a topic don't have to correlate with the real significance of a scientist's research. Any kind of knowledge that brings human kind closer to truths about the world should be paid the same kind of attention, even though it lies in human nature to be more interested in certain topics than others. This is another reason why the value of "Disinterestedness" is threatened.
Moreover, playing the "game" is fundamentally different from being a good scientist. Knowing what actions to take and how to behave in the scientific world in order to receive funding does not necessarily involve being good at research.

c. Too much time is "wasted" on writing papers and proposals just for the purpose of acquiring grants and not with the intention to share knowledge (*see Ad 1)*). That means in turn that too little time is left for the real job of the scientist's actual research.

d. Scientists are the slaves of their own system:
It is absolutely absurd how journals (which are businesses) and the traditional publication system work: Not only do subscription fees need to be paid for in order to have access to published papers, but oftentimes scientists also need to pay for publishing their data in journals. In addition, complete transfer of copyright from the author to the publisher is often asked for. In order to grant back the rights that enable the author to use their own paper for teaching, distributing etcetera, the author needs to pay again. In the end the journals get paid several times for the work that was performed by the scientists. In times of the internet, administrative costs can by no means justify the fees that add to the burden of the taxpayers once – or better three (publishing, access and user-rights) times – again. A lower limit for profits of commercial publishers can be estimated as being on the order of 35%[15], which is the kind of profit made by business like Google and Microsoft[19].

As our current assessment system leads to violations of all the values of the enchanted view, which describes how science ought to be done, we must find a different way of deciding on what research topic to fund. But this turns out to be a very complex challenge as, when trying to evaluate the quality of science, we run into the "Accountability dilemma"[3]. This states that the science projects that will lead to applications and the impact those applications have on the society are by definition unpredictable.

The importance of "non-sexy" results:

Exactly because it lies in the nature of research that results are unpredictable I strongly believe it is very important for us to realise that it is simply the nature of research that some results are not sexy. Experiments can go wrong, results can be the opposite of expected and ideas might lead nowhere. This is part of the research process. In my opinion, the value of a scientist should not be defined by the sexiness of his discoveries, but by his compliance to the values of how science should work.
In fact, the idea of the natural philosophers* (who only later would call themselves scientists), when they initiated the first ever published journal "Philosophical transactions" in the middle of the 1600s, was to improve the way of argumentation. To meet this intention, the journal needed to fulfill two requirements: openness of the contents (publishing not just the claims of an experiment but how exactly it was done) and speed, to guarantee synchronization of the scientific knowledge and argument across the community of natural philosophers. Hence scientific revolution was created by scientists and not the printing press, which was only the tool for communication[20].
Therefore I agree to the implication of the principle "Independence" (*see 9)*), namely that the publication of all scientific research results must be guaranteed. Hence, within the current system, I do not criticize the need for a scientist to publish his results but rather the reason why he does it. Results must be published in order to share the knowledge acquired, even if it is about an experiment that went wrong, was performed wrongly or an idea that didn't work out.

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* At this point I would like to express my discontent regarding philosophy's reputation among scientists. Most of the scientists I have met talk about philosophy as if it was some kind of "esoteric" approach to truth finding. By contrast, philosophy is the breeding ground of different ways of thinking. As mentioned above, it is only a recent development that professionals who perform science call themselves scientists instead of "natural philosophers". The fast advancement of technology is responsible for the border that is placed between philosophy and science as it shifted the driver for discoveries from ideas to tools. As the latter get more developed, it takes more time for a scientist to become capable of operating those instruments. Which in turn means that nowadays there is less time for deep and critical thinking and especially looking at problems from different angles, which is what philosophy is all about. As explained in the article "Is Science driven by ideas or tools"[25], both are crucial parts and essential views of science and we need both of them to get a complete picture of our universe. Therefore I think it is important for scientists to become more open minded again and realise that philosophy has and should have always been an important part of their career.

It is equally important for science to know what doesn't work as it is to know what works, as we wouldn't need to do science if we knew everything about what doesn't work as expected in our universe. Additionally the funders, the government and other shareholders will have to realise that scientific findings need time to prove themselves in the real world, which means that these funds must also be ready to commit to long-term and risk-bearing research.
Hence we should also consider funding so-called "risky" ideas and there "needs to be more room for research aiming to answer complex questions"[1]. This is also asked for by Abraham Loeb (Harvard University) in his Paper "On the Benefits of Promoting Diversity of Ideas"[6] – it addresses astronomy research but holds for science in general: "Of course, it is difficult to know in advance which exploratory path will bear fruit, and the back yard of astronomy is full of novel ideas that were proven wrong. But in order to make the discovery process more efficient, telescope-time allocation committees and funding agencies should dedicate a fixed fraction of their resources (say 10-20%) to risky explorations. This can be regarded as affirmative action to promote diversity of ideas, which is as important for the progress of science as the promotion of gender and ethnic diversity."

A reason why it is so hard to convince funders to spend money on risky ideas is because science is commonly perceived as THE profession that offers security, guarantees indisputable knowledge and supplies absolute certainty. We assume that science provides unequivocal answers as we grow up with school science books that provide answers for every question. But, contrary to the impression conveyed by textbooks, most problems in practice have more than one plausible answer; and many have no answer at all[21 & 22]. Furthermore the paradoxic belief that science produces knowledge that is free of values – and therefore deserves funding – needs to be reconsidered. First of all – in these days of priorities for research, values count enormously and second, as scientists are humans, their values are always dependent on the societal or institutional system in which they are performing science.
Therefore, Jerry Ravetz – one of the founders of the "Science in transition" movement, proposes that we need to develop a new understanding of science that is based on the management of uncertainty and quality, instead of believing that science is the simple production of truth[21]. This is what he calls the "Post-Normal Science" – a system of science where the awareness of limitations is built in – as opposed to "Normal Science" which is merely an old-fashioned technical expertise. For that we need to critically look at the Baconian optimism, that everything can be ultimately known and that such knowledge will inevitably be for the good and distance ourselves from a pure technocratic approach – the belief that "science exists as a neutral means to achieve value-free knowledge and to provide skills appropriate for achieving stated ends"[23]. We need to understand that knowledge is the product of people who are neither infallible nor holy and that complex environmental systems include two key properties: radical uncertainty and plurality of legitimate perspectives[22]. Therefore any science and environmental policy needs to take these aspects into account: "When facts are uncertain, values in dispute, stakes high, and decisions urgent the traditional guiding principle of research science, the goal of achievement of truth or at least of factual knowledge, must be substantially modified. (…) It is when the textbook analogy fails, that science in the policy context must become post-normal. Here, the guiding principle is a more robust one, that of quality" [22].

Is Open Access (partly) a solution?

Randy Schekman, who won the Nobel Prize for medicine in 2013, speaks out against how the scientific world is "disfigured by inappropriate incentives" in his article "How journals like Nature, Cell and Science are damaging science"[7]. He describes the problem that top journals often only publish the "flashiest" work and how they artificially restrict the number of accepted papers only to boost their impact factor.

To break the "tyranny of the luxury journals", he asks his group to only publish in open access journals and also asks other scientists to take action, which leads me to the question:

Is open access an approach to the solution for a better scientific system?
In order to answer that question, let us first elaborate what "open access" is and how it works:

Open access means the "unrestricted online access to peer-reviewed scholarly research"[8]. There are two main routes that an author can follow to make their research articles available as open access[9]: *open access journals* and *open access repositories* – both are available to their readers free of charge.
The former is called "gold" open access: The journals are financed by publishing fees (on the order of several hundred US dollars[8] per paper), hence the only difference compared to the traditional publishing system is a pay-to-publish rather than a pay-to-read business model, and thus this route doesn't really represent a revolutionary change.
The other way of publishing via open access is called "green": Here online repositories are used to store digital duplicates. This doesn't serve as a replacement for traditional publications, but exists alongside them.
In addition, there also exists a third way – the "hybrid" open access: An increasing number of traditional publishers have started to offer so-called "open access" options as part of their publishing service. Typically this involves paying an additional fee ranging between 1000 and 5000$[8] (even though the publishing cost of the journal is already covered by subscriptions)[9].

Open access therefore solves the problem of ownership: Scientific data should not be owned by anyone in particular as it was the taxpayers who funded the scientists specifically for the reason to discover and provide knowledge. Hence, in an open and democratic society, all information (with the possible exception of information that is a threat to safety) should be available to anyone in order to "break down the wall that divides humanity"[19].
On the other hand, it has been argued that there is greater potential for bad science to be published in the open access way. This however is not a good reason against open access as the quality of a scholarly journal is a function of its authors, editors, and referees, not its business model or access policy[10].
A better argument for why open access is not yet the complete solution is that open access shifts the burden of payment from the readers to the authors, which doesn't solve the problem that scientists (or ultimately the public) need to pay to publish their own work. Therefore the obstacle that stands in the way of freely sharing knowledge (the product of science) still exists within open access. Additionally, no matter what way – gold or green – the scientist chooses, he is still dependent on publishing in journals which generate impact factors and may contribute to higher citation levels, which doesn't solve the problem of fund acquiring.

Therefore it must be concluded, that – even if scientists follow Schakman's appeal to only publish "open accessly" – science remains in a dilemma. In order to drag ourselves out of this situation we need to answer the following questions[3,19]:
What does science produce? Does it have to be results or can it also be method-development?
In what way can knowledge be translated into value for money?
Who can be a scientist?
How can we identify valuable scientific ideas?
How else can we assess quality of science if not via publications, citation rates and impact factors?
How else can we estimate the impact the research results have?
How should it be decided which part of science should be funded?
How is science incorporated into government policy?

It lies outside the scope of this paper and a one-person-endeavour to find an answer to all those questions, but I would like to introduce some ideas that would be the basis of possible solutions:

Considerations for approaching solutions:

Firstly, according to the Position Paper[1], to the aim of determining the value of science, the idea of hybrid fora, mixed committees of researchers and public users, was proposed. That would avoid journals (and related impact factors) having the unilateral power of deciding which science projects should be funded.

Secondly, I strongly believe that publishing should not involve a business model. The nature of science should be different to the nature of economy. As described extensively above, scholars are paid by research funders and/or their universities to do research; the published article is the report of the work they have done, rather than an item for commercial gain. Surely, "article processing charges" by all means need to be covered – as part of the research funds, just like computers, experimental machines and all equipment that a scientist needs to do science is also paid for by the funders, but individual human beings should not be given the chance to make money out of the scientist's work merely by owning a journal.

Thirdly, "science as a whole would benefit enormously if open sharing of data became common practise"[18]. This was the mutual agreement among the scientists who attended the Human Genome Project conference in Bermuda in 1996. The result of this historic conference was the "Bermuda Agreement", which states that "all human genetic data should be immediately shared online"[18] in a database called "GenBank". In order to make this possible, several major scientific grant agencies agreed to make this immediate sharing a mandatory requirement for receiving funds to work on the human genome. Hence this solution accounts for the need of publication for the sake of knowledge sharing. This excellent example shows that data sharing is possible and beneficial for the advancement of science by fostering the collaboration between scientists, relieving the "incredible competitive pressure from ambitious young scientists"[18] and making science more efficient, by "speeding up the rate of all scientific discovery"[18].
Fourthly, we should strive for a reward system that distances itself from the goal of producing scientific papers (which – as we have elaborated – is the root of the evil), but must accommodate and account for the initial motivation of a scientist to share knowledge. Relieving scientists from publishing pressure would make it possible to contribute to open access sources like "GenBank" or "Wikipedia" for the sake of making discoveries and sharing knowledge. It is not for nothing that social media theorist Clay Shirky once said: "We have lived in this world where little things are done for love and big things for money. Now we have Wikipedia. Suddenly big things can be done for love."

Last, but not least, we need to realise, that double standards prevail in science[1]. Science is a paradox in that, as a social activity, it is not different from other social systems. We must admit that scientists are also "just" human beings and that science therefore will never be the ideal community that the enchanted view describes. Nevertheless, I do think that this is a reason for us to at least strive to approach the above listed values. By defining the values of how science ought to be done in order to deliver results that are objective, reproducible and accessible to anyone, we at least know what we need to work towards.
Of course – taking into account human nature – fraud can always happen, but its potential will be much decreased if the scientist doesn't feel forced to cheat by his own system. Fraud within our current science system therefore should be regarded as a symptom of system failure rather than a sign of human evilness.
Furthermore, being human, scientists want to feel valued; they need – just as other human beings –

recognition of their work and prestige. After all, reputation is the only social capital researchers possess[1]. In order to pretend disinterestedness, this "intellectual pride"[16] is usually masqueraded as "a desire to serve mankind" [16]. With her novel "Frankenstein", author Mary Shelley illustrates how involvement in research can contribute to dehumanization[16&17], which includes[17]:
1. the psychological effects of voluntary isolation;
2. suppression of human affections;
3. loss of the ability to appreciate natural beauty;
4. the naive optimism that knowledge will inevitably be for the good of all;
5. the desire to be always the first to discover something;
6. the delusion that one's research is for the benefit of humanity;
7. the fanatical desire to complete a project whatever the human cost.

Therefore, if we do not want scientific members of our society to be dehumanized and degraded to efficiency machines, we need to recognize that inherent human needs are characteristics of scientists as well as of members of the general public. As such they need to be taken into account when working towards better a rewarding system, which fosters genuine science instead of favouring "sexy" topics like the current one does.
Being realistic does not mean that we completely need to abandon the Baconian optimism nor the technocratic approach, but that scientists can no longer kid themselves and the public about the fact that they are human. I believe this would not only improve a scientist's lifestyle (because he no longer has to live up to unrealistic expectations) but would also prevent the scientific system to be the breeding ground for disingenuous scientists.
As Jerry Ravetz points out, we need a new approach to problem-solving strategies in which the role of science is appreciated in its full context of the uncertainties of natural systems and the relevance of human values[22]:
"However free our will may be, our thoughts and hence our actions are constrained by the socio-cultural systems in which we are nurtured, socialised, educated and indoctrinated. Those systems are always imperfect; our ideals are always being betrayed and our personal investments are always being threatened. (…) We all struggle to defend our integrity and, in that struggle, we may well do stupid or cruel things. But we can all change, and some actually manage to do so. Along with decay, complex systems have the capacity for radical change and renewal. That is our ground of hope."[24]

Conclusion:

This paper has shown that a combination of approaches is important: no kind of journal that is a commercial business should be supported and the quality of science needs to be assessed differently in order to remove the barriers that prevent scientists from complying with the values governing how science ought to be done. The internet was originally developed to share information among scientists, so why would they continue to be the slaves of journals, if there are means to publish in an open access way? Accessibility of scholarly knowledge and evidence should be maximised and in so doing openness and transparency should be enforced[11].
"We are in the midst of a great change in how knowledge is constructed" [18] – but we actively need to work on breaking the dynamics of the current "publish or perish" system to fully accommodate this change.
After all, we have seen that if funding policies get changed, the practice of science will eventually change as well, therefore now is the time to talk openly about the problems of our scientific system and work towards solutions.

Just like Frankenstein for my whole life I have been a "scientific rationalist and passionate idealist"[16] and as such for too long I have believed in the "myths about science as the only place on earth where none but the completely disinterested and the exaltedly inspired are making the most

beautiful discoveries" whereas in reality science is rather comparable to a "top sport that operates at a high level and on the cutting edge"[1]. And you may ask why scientists let themselves be fooled by clever businessmen owning journals? The dynamics of the system are so complex that scientists don't feel like having the power to change something so they adapt. But in the end it is our choice as scientists if we want to pursue our jobs for the sake of money and participate in the rat race or – to use Shirky's words – if we are motivated by love, hence our passion for discoveries. If we decide for the former, humanity is doomed, if we decide for the latter, we can no longer turn a blind eye on the current "publish or perish" system.

I'd like to conclude with a quote from the "Science in transition" Position Paper:
"In the end it won't be enough to cut out the affected tissue as soon as possible, in the hope that the infection is not systemic and that the rest of the body is still healthy. This is an illusion. The committee investigating […] fraud had the idea that this might concern a system failure." – We must start treating the problem and not the symptoms.

Exciting times are ahead.

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