

Deep Mind – Task Ideas

The following activities have been developed to support the teaching of elements of KS4 and KS5 work within Science as well as Design and Technology, and aim to:

- Engage students in aspects relating to the discovery and development of new healthcare technology
- Encourage the exploration and understanding of the practical and ethical considerations of modern healthcare technologies
- Support understanding of the impact of technological advances on society and the responsibilities of scientists, engineers, funders and political bodies.
- Enthuse interest within students around the future of brain machine interface technology

Duration

The Deep Mind film lasts 30 minutes. Task 1 will last a further 45-60 minutes depending upon the size of the class. The other tasks will last a further 30-45 minutes plus time for research and writing.

Target Audience

The film covers topics within both the KS4 science and KS4 Design and Technology curriculum. It would be suitable for older KS4 and KS5 students. Younger students may find the material challenging.

The film and tasks supporting the film may also be of benefit for older KS4 and KS5 students studying Drama and Theatre Studies, Film and Media Studies, English and Politics. Teachers should be aware that the film does contain some strong language.

Background

Deep Mind explores the possible advances that neural technology could offer healthcare before posing some of the ethical considerations around ownership and accessibility. Who should have control over patient data? Should people be allowed to profit from the misfortune of others? And should medicine be for some or for all?

Deep Mind has been written and developed by Operating Theatre in collaboration with and in response to medical research being led by Newcastle University. The Controlling Abnormal Network Dynamics using Optogenetics (CANDO) project is developing a new therapy designed to treat focal epilepsy. Epilepsy is a neurological condition where the brain temporarily becomes overactive resulting in seizures. Affecting approximately 1 in 100 people, there are a range of medications and therapies to prevent these seizures. However, not all patients respond to or are suitable for these treatments meaning that they continue to have life affecting seizures. Therefore, CANDO is attempting to use a technique called optogenetics to provide a new treatment option for these patients.

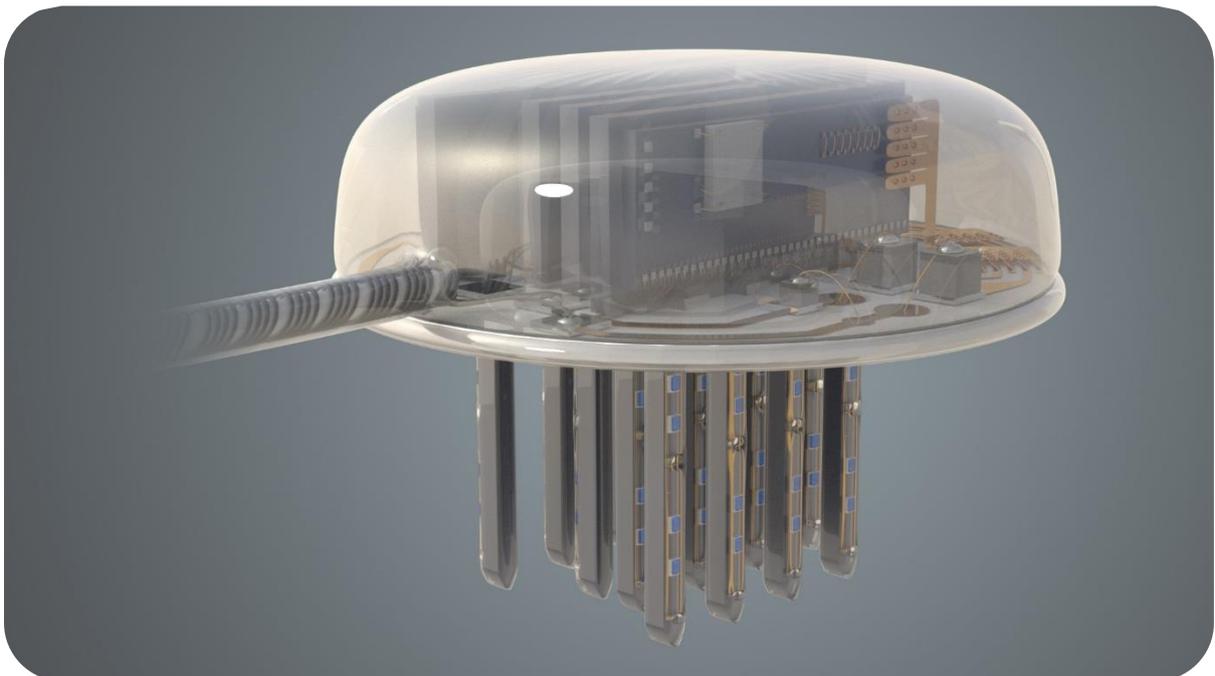
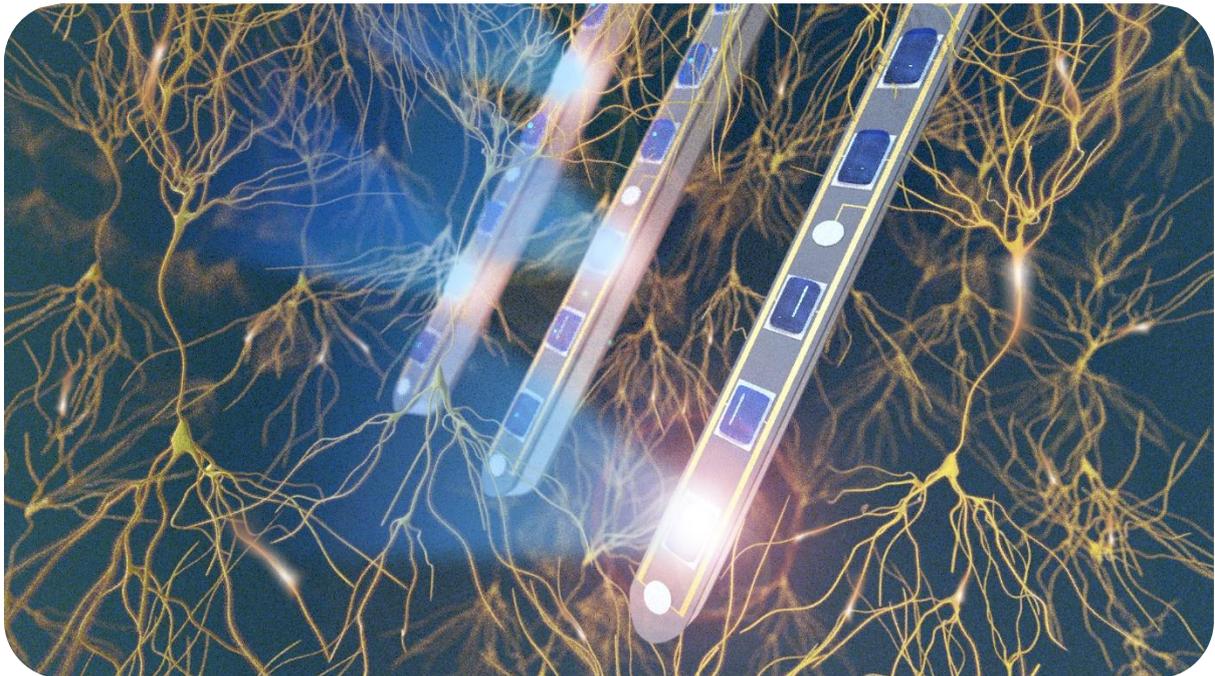
Optogenetics uses light-sensitive proteins called opsins to control the activity of neurons within the brain. The CANDO therapy will involve a combined gene therapy medicine and bioelectronic implant. The bioelectronic implant will monitor the electrical activity of the brain for abnormal activity, delivering light stimulation when necessary to prevent the development of seizures.

DEEP MIND

The technology is being developed for the treatment of focal epilepsy and there is also the possibility of it being adapted to treat a range of other neurological conditions. But there is also the possibility that the technology could one day be used for non-medical reasons. Although at present, there is not the current understanding of the human brain to be able to do so. And with companies such as Elon Musk's Neuralink investing huge sums of money into other neurotechnologies, the possible future is wide ranging.

The film was funded by Wellcome and the Catherine Cookson Foundation. The CANDO research project is funded by Wellcome and the Engineering and Physical Sciences Research Council (EPSRC).

For further information on the CANDO project, visit www.cando.ac.uk.



Task 1 – Time or Safety? The Importance of Independent Ethical Decisions

AIMS: For students to prepare and act out a short scene between two characters that is mentioned as having occurred in the film.

SKILLS GAINED AND PRACTICED:

- Development of skills required for using persuasive language, notably making arguments and counter-arguments supported by logical reasoning
- Applying knowledge gained to develop a feasible scene
- Group work and discussing of ideas

BACKGROUND: In the film, Bella accuses Mark of persuading their terminally ill colleague Paul to test the Apogee implant before it is ready for human trials.

BELLA: *Paul told me. He'd been clicking away at the morphine drip. I think he probably didn't even realise he was telling me.*

MATT: *Paul told you what?*

BELLA: *That you persuaded him to try Apogee. When it was hot. Before we sorted it. When it wasn't safe to trial properly. When you knew he would be risking his life.*

MATT: *That's not true. Absolutely not. I told him that it was too risky and that it was way too soon.*

TASK: In pairs, develop a scene between Matt and Paul as they discuss testing the Apogee prototype device in Paul. Was Matt the protagonist, pushing Paul into the decision as Bella thinks? Or had Paul's mind been confused by the morphine, with Matt telling the truth about being the unwilling assistant. The scene should end with both Matt and Paul agreeing to go ahead with the trial.

To support this task, a short piece of script designed to help start off a scene is available in Appendix 1.

KEY POINTS FOR DISCUSSION:

- Development of the Apogee device is at a key point where there is preclinical laboratory data but knowledge of how that might translate to humans is limited.
- Data from animal testing and computer modelling is not completely comparable to data from a human model.
- At the time of the scene taking place, there are still issues with the Apogee device that have been identified by PNN from the preclinical testing. It is not at the stage to move to human clinical trials.
- Data from a human would provide vital supporting evidence to the team of the safety and efficacy of the device, helping to secure the future of PNN and Apogee.

- Paul's terminal illness would mean that should something go seriously wrong, the impact on Paul would not be huge.
- However, Paul has a family. If he has limited time left with his family, why should he risk that time by testing the implant?
- This sort of testing without regulatory approval would be illegal in the UK. If authorities were to find out about it, then it could bring an end to Apogee and PNN.

FOLLOW ON WORK:

- Discuss in groups other situations where similar ethical concerns may occur. For example, the rush by countries and companies to develop the first COVID-19 vaccine. What might happen if a therapy is rushed through without being sufficiently tested? The risks are highlighted by the need to temporarily put on hold the Oxford trial due to a potential Severe Adverse reaction to the vaccine.
- Who should be the first people to test new treatments? Should they be healthy volunteers or patients who may benefit? Would anyone be willing to volunteer to test a new treatment such as a COVID-19 vaccine?



Elisabeth (2013) monotypes with chine-collé. *The Portrait Anatomised*.
Susan Aldworth.

Task 2 – Medicine for some or Medicine for all

AIMS: For students to write a short speech responding to the end of the film. Students can be asked to perform their speech in front of others.

SKILLS GAINED AND PRACTICED:

- Development of the use of persuasive language, make arguments for actions supported by logical reasoning.
- Applying knowledge to develop a feasibility speech
- Public speaking

BACKGROUND: At the end of the film, Bella is about to go and talk to the Board, explaining what she has done to all of the data behind Apogee.

BELLA: *I want to go and speak my mind in a full and frank manner to the Board. I don't think they're going to want to stay for dinner when I'm done with them...*

TASK: Write a speech for Bella to give to the Board justifying the decision that she has taken. Remember that it has been done in response to the actions Matt took to allow BlackRock to view the data relating to Apogee and the potential privatisation of Apogee. This would likely result in the technology being only made available to those who can afford it and not for the benefit of everyone as Bella intended. Students should bear in mind the impact that this decision will have on Bella's career.

An example speech is provided in Appendix 2.

KEY POINTS FOR DISCUSSION:

- The Board is likely to consist of people who have invested a lot of money in Apogee, in the hope of seeing returns on their investment. As such, they are unlikely to be happy with hearing that all of the data relating to Apogee has been destroyed, alongside, in all likelihood, their investment.
- Bella, with the help of Sparta, has destroyed the architecture behind Apogee, making the data inaccessible. Therefore, anyone wanting to recreate Apogee would essentially be forced to start from scratch.
- This has been done in response to Matt allowing members of a venture capitalist group to see private data without the approval of the company.
- Apogee has been developed with the agreement of its founders, including Bella and Matt, that it would be used for the health of the wider public.
- A buyout from a private corporation, could result in the device being developed and used for non-health matters such as in the military. Such uses would be against the ethos of PNN.
- The Apogee device would result in the collection of vast quantities of data from users that could be exploited by governments and private companies for their own benefit.

- As a device, Apogee is ahead of its time, meaning the regulations and legislation necessary to oversee the collection and use of such vast data are not yet strong enough. to ensure complicity.

FOLLOW ON WORK:

Discussion around whether healthcare should be available for all and how healthcare should be funded. Students could compare different healthcare systems around the world, eg USA vs UK.

Students to look at current neural implant technology being developed such as by Elon Musk's Neuralink. While the initial development is with a healthcare perspective, future uses may diverge. Elon Musk envisages a future of computers linked directly to the brain. What are the potential benefits and ethical concerns around this?



Andrew Carnie and Susan Aldworth, "Enlightenment no 10", 2015,
monotype print, 80cm x 70cm

Task 3 – The Political Influence on Healthcare

AIMS: For students to develop a newspaper article, writing for a particular newspaper, either tabloid or broadsheet and either left wing, right wing or neutral.

SKILLS GAINED AND PRACTICED:

- Development of journalistic writing to develop an opinion piece supported by logical reasoning.
- Research and analysis of opposing viewpoints relating to topic
- Applying knowledge to write an informed piece of writing
- Group work and discussing of ideas

BACKGROUND: It could be argued that the ideology behind PNN and Bella is Socialist. And that this viewpoint would never be able to survive in the Capitalist world they live in. It could be argued that Matt's choice to engage with BlackRock is driven more from a desire to maximise the potential success of Apogee as opposed to maximising his potential income from it.

MATT: *Half of the commissioners don't understand what a neural interface really can do. I couldn't let it die a death.*

And then later:

MATT: *You always were a brilliant scientist but with no idea about the real world. Nobody was going to let Apogee do what it was designed to do.*

TASK: Write a newspaper article responding to the cancelled launch event of Apogee and the subsequent destruction of data by Sparta. What might the consequences be for the future of the Apogee technology? Was it a piece of over the top self-indulgency, out of touch with reality? Or was it an important stand against the ownership of vast amounts of personal data by governments and corporations and the potential exploitation for military and governing uses. The article need not be the student's own point of view.

An example article to support ideas or discussion is available in Appendix 4.

KEY POINTS FOR DISCUSSION:

- Apogee was being portrayed as a life changing technology that could improve lives but has then been destroyed. If it was so good, why has it been destroyed to the potential detriment of citizens?
- For too long governments and corporations have been collecting and analysing vast quantities of data for their own benefit. At last, someone is taking a stand saying that regulations need to be put in place before organisations can be trusted with more data.
- The collection and analysis of mass data is already being used to benefit and improve lives especially in healthcare through the identification of key trends and outliers.
- Many technologies developed in one sector are transferable to use in other industries, making the most of inventions.

- If the technology could be utilised to reduce the risk to soldiers who are putting their lives at risk, is there not an ethical obligation to help them?
- PNN are not the sole company developing this sort of technology. However, they were the one company further ahead than everybody else.

FOLLOW ON WORK:

Students to discuss the current levels of privatisation within the NHS. Has the use of private providers improved services for patients? Current examples for discussion include the Test and Trace system as well as the COVID-19 testing system.

Students to discuss the influence of politics on the health service. Should the balance of power over the NHS lie with government or within the NHS itself?



Blue Matter (detail). Still from 4 channel video work. 25 mins. Andrew Carnie 2019.

Task 4 – Lessons from Medical Device Scandals

AIMS: For students to undertake a piece of research into a medical device or technology that has been in the news due to a scandal.

SKILLS GAINED AND PRACTICED:

- Undertaking of research into a topic
- Separation of facts and opinion on a controversial topic
- Applying knowledge to write a structured essay

BACKGROUND: During the film there are various references to the Lansing ruling.

BELLA: *We always said we wouldn't let anything get in the way of the science. We wouldn't be governed by the market. We wouldn't become another Lansing.*

While the film does not go into detail about what the Lansing ruling is, one suggestion is it refers to a neurological implant that was rushed out before it was ready. This push of profit before people resulted in safety issues that might have been identified with more preclinical research.

Over the last few years, a number of medical devices have been withdrawn following investigations into side effects. These include metal-on-metal joint replacements, implantable contraceptives, breast implants and surgical mesh. Many of these devices are released onto the market without clinical trials because regulations allow approval of devices that can be shown to be similar to devices already on the market.

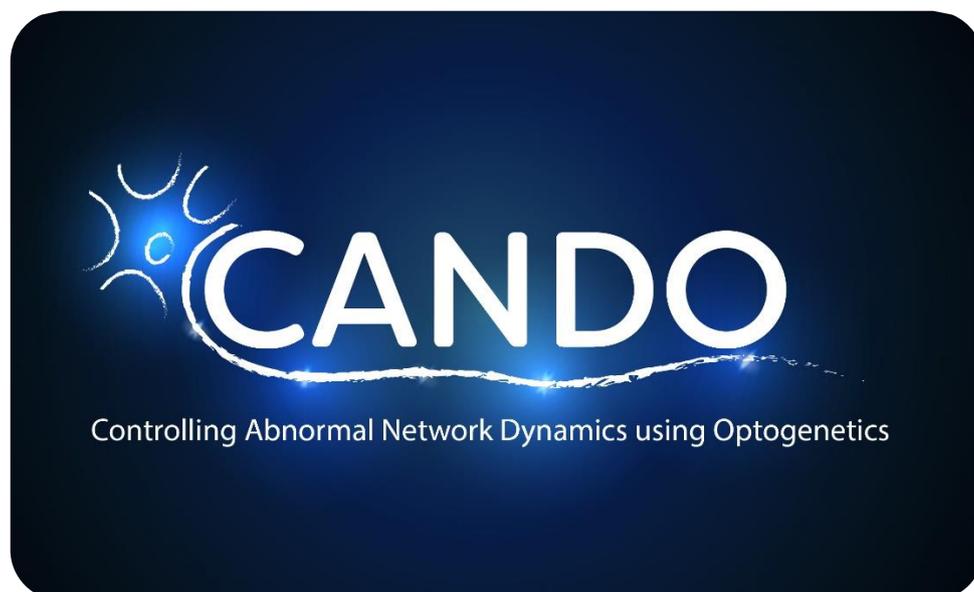
TASK: Investigate a medical implant that has been in the news due to failures in the device. Devices to explore may include breast implants, metal on metal hips and spinal implants. Why did the devices fail? How were the devices tested before gaining marketing approval? Are they still approved? For reading about medical implant scandals, explore the series of reports produced by the Guardian newspaper in 2018 - <https://www.theguardian.com/society/series/the-implant-files>.

KEY POINTS FOR DISCUSSION:

- Regulations aim to provide a balance between ensuring that enough evidence is collected to suggest new products are safe and beneficial and ensuring that they can be made available to patients as soon as possible.
- The regulations for medicines and medical devices are slightly different with higher levels of evidence generally required for medicines.
- The evidence required for medical devices depends upon the type of device it is and the existence of similar devices already on the market.
- There have been a number of high profile device failures, causing pain and misery to many people.
- Current medical device regulations mean that many smaller companies can successfully develop and bring to market devices without the support of larger companies.

FOLLOW ON WORK:

Brexit will allow the UK greater control over their ability to regulate new medical devices. Students to explore and discuss possible changes to medical device regulations. Should regulations be eased to ensure that UK citizens get access to the latest medical devices earlier or should rules be tightened in order to reduce the likelihood of further scandals from faulty devices?



Appendices

Appendix 1 – Introductory Text for Task 1.

Matt: Knock, knock. Ok for me to come in?

Paul: Visitors are always welcome. Especially from fine gentlemen like yourself.

Matt: Fine gentleman? The morphine must be doing its job then. How are you coping?

Paul: As well as can be expected for someone expected to die in the next few months.

Matt: Sorry. Inappropriate question.

Paul: It's alright. What do you say to someone in my condition? How is the implant coming along?

Matt: You've been told not to worry yourself about work.

Paul: I need the distraction. Everybody is wanting to do everything for me. I'm bored out of my brain. Are the latest animal studies looking good?

Matt: The results are positive but we're still getting noise which is affecting the software. There's also been an issue with the encapsulation on some of the devices. We'll need to make further adjustments.

Paul: But moving in the right direction?

Matt: Yes, but you know what it's like. Just because it's working in one model doesn't mean it will work once we get to human trials. We've just got to test the shit out of it and hope for the best.

Paul: That's all you ever can do.

Matt: It would make such a difference if we could just get some human data. To know we're on the right track. Of course the regulations wouldn't allow it. But you know what I mean? To get some data that shows the implant will respond in the human brain the same way it does in the animals.

Paul: But that couldn't happen, especially with the encapsulation issue.

Matt: Even if it was allowed, you'd have to be mad or desperate to agree to it.

Paul: Desperate like about to die?

Appendix 2 – Example Speech for Task 2

Members of the board. Today is a very significant day in the life of PNN. When Matt, Paul and myself decided to set up a company we wanted a name that would inspire and that would tell people about what we stood for. 'Prima Non Nocere'. PNN. First, do no harm. Everything that we do would be led by that.

And that was what led us to Apogee. What drove us forward during the difficult times. Knowing that we were doing something that would do no harm. Today we introduced the world to Apogee. The technology that would help everyone live longer, healthier lives. Unfortunately today will become significant for a different reason. Significant as the day that Apogee becomes no more. A decision that has not come likely. You see, over the last few weeks I discovered that someone was no longer following our guiding principles. A couple of days ago Matt Jamie provided members of Black Rock Equity access to data behind Apogee. To engage with an organisation that could never do no harm. A group that have never thought for a second about the harm they do in their endless search for profit. The thought of what Black Rock might do with the technology and data provided to them by Apogee is unthinkable.

Tallied with the ineptitude and corruption seen in this country's government, I was left with no option but to come to the decision that the world is not ready for Apogee. I therefore made the decision to ask the Sparta organisation to find a way to destroy Apogee. The software that Sparta created has ensured that no data related to Apogee and the technology behind Apogee will be retrievable. Apogee is no more. I still believe in Apogee and hope that someday in the future, the world will be ready for it.

Now I appreciate that this is not the news that you were expecting and that you will almost certainly have a number of questions. However, I ask that you hold on to these questions until you see the full comment to the board that will be forthcoming. In the meantime I suggest you make use of the free bar. Thank you.

Appendix 3 – Example Article for Task 3Infighting Leads to the Rapid Fall of Ground-Breaking Technology

The launch of an innovative neural implant descended into chaos yesterday after it was revealed that the technology had been sabotaged by one of its own creators. Data for the Apogee device, described at a public launch as 'a revolution in public healthcare', was destroyed by lead scientist and co-founder Bella Arnott with the help of notorious left-wing group Sparta. Sources close to the project suggest that the attack was as a result of a disagreement over the future of the company.

Apogee was supposed to be the first of a new kind of neural implant capable of translating brain activity into information about the body's health and delivering correcting stimulation to ensure perfect health. While similar technology is being developed by other companies, PNN had appeared to have won the race to be the first to master it, being years ahead of rivals. Their withdrawal will no doubt lead to a doubling down of effort in competitors to be the first to a market that could be worth billions.

An implant that can diagnose and treat before symptoms appear has been seen by many as a holy grail in healthcare. Research conducted over the last twenty years appeared to suggest that changes within the brain, as the body's central control, would prove the key. The benefits to individuals would have filtered into the economy as demand on healthcare systems dropped and fewer work days were lost to sickness. PNN, a company founded by three university friends, appeared to have surprised many with their successful reveal of Apogee.

Success, however, was short-lived as tensions caused by discussions with investment group Black Rock by fellow founder Matt Jamie erupted. The disagreement between Jamie and Arnott appears to fall on how the presence of Black Rock might have influenced future directions for the Apogee technology. At present the company has been funded through a series of research grants from charities and research councils allowing them to concentrate on the use of the technology in healthcare. Arnott is believed to be against private investment, under the belief that it would impact on their core tenet.

Private companies have led the way in healthcare, investing billions into research. As a result, the world has seen an influx in new medicines and technology that has made us healthier than ever before. Agreements between companies and governments have ensured that new treatments become available to everyone while allowing companies to profit from their work and continue investing in new treatments. The world has relied on these companies and investors, people willing to put their money on the line, for the benefit of society.

The problems at PNN have now appeared to deprive the people that they claim to want to help. The public can only hope that other research groups are not so stuck in their ways and that they can work with interested parties for the greater good.

PNN ironically stands for 'first, do no harm'. Unfortunately, the decision to sabotage their own work appears to have done only the opposite.