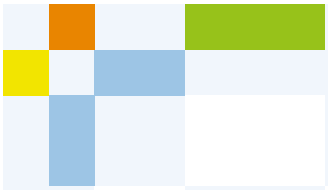
acatech POSITION PAPER

Responsibility in Companies and Institutions for Sustainable Technology Development

acatech (Ed.)

acatech
NATIONAL ACADEMY OF SCIENCE AND ENGINEERING



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The acatech POSITION PAPER series

In this series, the Academy publishes position papers on strategic engineering and technology policy issues. The papers contain concrete recommendations and are aimed at decision-makers in government, science and industry, as well as interested members of the general public. The position papers are written by acatech members and other experts and are authorised and published by acatech's Executive Board.

All previous acatech publications are available at www.acatech.de/publikationen.

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Foreword

The people who develop new technologies and bring them into use have a huge responsibility. As well as being responsible for jobs and the future development of our society, they are responsible for ensuring that an empowered, informed and critical public is fundamentally confident that new technologies benefit society as a whole and not just the privileged few "at the top".

This trust is not a given. At our 2016 Annual Meeting, the then German President Joachim Gauck said "I don't, don't want to, and will never understand how a nation that is able to set strategic goals and open up and embark on pathways to the future in so many areas can also be a nation that so often lives in a permanent state of cultural malaise. It just doesn't make sense to me. There is a disconnect between what we feel and what we are capable of. Why is it that we are so reluctant to make use of all that innovative potential and enthusiasm for finding solutions, as if it were a currency that can't really be trusted? I can only hope that things are very different in five years' time or so, when another President is standing here talking to you."

This cultural malaise becomes even more deeply ingrained every time the principles of responsibility are broken, especially if there are tangible negative consequences for people and the environment.

This position paper attempts to determine exactly what responsibility means in the technological sciences and to initiate a debate about the changes needed to strengthen responsibility on a long-term basis. Returning to the words of Joachim Gauck, people's trust is lost much more quickly than it is gained, and it will take time to overcome our cultural malaise. For individuals, research institutions, companies and acatech itself, responsibility is the key to winning that trust.

Prof. Dr.-Ing. Jan Wörner
acatech President

Karl-Heinz Streibich
acatech President

Executive Summary

Anyone who develops technologies and brings them into use bears a corresponding responsibility. However, specialisation and the growing complexity and interdependence of technological, social and environmental factors are increasing the risk of diffusion of responsibility.

Consequently, the time has come to take a fresh look at the key questions associated with responsibility: Who is responsible? What are they responsible for? And who are they responsible to? In this context, the definition of responsibility is wider than the colloquial sense of "having caused something" – it also comprises the assignment of responsibility within groups or organisations, for example. The assignment and assumption of responsibility require a knowledge of the subject, object and normative body. As well as having a responsibility towards their employers, colleagues, customers and users, researchers and engineers also have a responsibility towards society and a responsibility to protect the public interest and the environment.

Simply assigning responsibility to individuals or groups is not enough on its own to create a stronger culture of responsibility in the development and use of technology. People in positions of responsibility and the institutions they work for must also be willing and able to fulfil their responsibilities.

Accordingly, companies, organisations and institutions must work to develop and strengthen a culture of responsibility and ensure that it receives the appropriate recognition. If someone is to assume responsibility for something, they must be empowered to take the relevant action and be able to align individual and organisational behaviour with overarching guidelines. Agreed procedures for dealing with suggestions and complaints within an organisation should form an integral part of these guidelines.

This acatech POSITION PAPER aims to stimulate a discussion about how to strengthen individual responsibility in the technological sciences. Drawing on topical examples that raise questions of responsibility, it sets out to review and develop the rules and structures for taking responsibility in the technological science community represented by acatech, but also in companies with a research focus and in technological science research institutions. Based on the results, a series of recommendations are proposed for the Academy's future work:

- Formulation of an ethical mission statement for the Academy
- Responsibility in the selection of topics
- Establishment of an in-house ombuds system
- Identifying and addressing responsibility issues as part of work on different topics

The establishment and development of ombuds systems in companies should also be contemplated.

Finally, ethical principles and learning to take responsibility should be incorporated into education and training, for instance by augmenting the courses on offer with interdisciplinary content.

This acatech POSITION PAPER aims to stimulate a debate on responsibility in the technological sciences – not only within the technological sciences community and its academy, acatech, but also within organisations, companies and government agencies with a research and technology focus.

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- Dr. Holger Brackemann, Head of Research Division and Deputy Chairman of the Board, Stiftung Warentest (Phone, 15. 02. 2019)
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1 Introduction and aims

Motivation

Technology and the technological sciences are constantly in the firing line, be it when projects like the Elbphilharmonie concert hall significantly overrun their original schedule and budget, when HGVs can no longer use the bridge over the Rhine at Leverkusen, when digital platforms don't take data protection seriously enough, or when it becomes apparent that testing procedures have been circumvented, as in the case of the NOx trap defeat devices.

On the other hand, science and technology are well regarded in Germany. Empirical studies of how citizens, community groups and society as a whole view science and technology have consistently found that people in Germany are not technophobes – instead, they treat each case on its merits, weighing up the risks and opportunities.[1] That said, there are certainly concerns, for example about the way in which large-scale technology projects are managed in Germany.[2] Criticism is also often levelled at the selection criteria for technological products and infrastructure. For instance, are environmental and social impacts properly considered in technology assessments and infrastructure planning?

Technology has always come in for criticism, and still does today. To take one topical example, the outrage surrounding the diesel emissions scandal was sparked by the revelation that software was being used to manipulate emission values, so that vehicles met the emission limits during testing but significantly exceeded them in real-world driving conditions. Incidents and affairs like this, that have clearly quantifiable impacts on the environment and other areas, have reignited the debate about the ethical responsibility of corporations that provide engineering services.[3] Public disappointment is exacerbated by the fact that this kind of behaviour flies in the face of the climate action, air quality, noise control and energy transition dimensions of the Sustainable Development Goals (SDGs) promoted by the United Nations and adopted by many businesses.

Project background and goals

Responsibility means being accountable for the consequences of an action, including all the personal and legal ramifications. It is a term that is important in our legal system, in our sense of values, and in the world of politics where, for example, committees of inquiry seek to establish where the political responsibility for an incident lies.

Responsibility also plays an important role in science and technology where, as well as trying to increase our knowledge and push back the boundaries of what is possible, the relevant actors must also consider and be accountable for the potential impacts of science and technology. Advances in science and technology are making responsibility in technology development more relevant than ever.[4] The public and professional debate about "responsibility" in science and technology development and in how technology is used had already begun before the first atomic bombings of Hiroshima and Nagasaki shocked the world 75 years ago. However, it only started to receive widespread public attention during the 1950s. The debate became even more prominent during the 1970s and 1980s due to the political controversy surrounding the use of nuclear power and the burgeoning environmental movement. Hans Jonas introduced the philosophical concept of responsibility into the professional and public debate in his book "The Imperative of Responsibility"[5]. This was accompanied by the development of the discipline of technology assessment, first and foremost by the United States Congressional Office of Technology Assessment (1972–1995), followed by the establishment of corresponding institutions in Germany.[6]

Hans Jonas' definition of responsibility encompasses both the professional/technical and ethical/personal dimensions in the context of the technological sciences and the design and application of technologies. It motivated various professional

1 | See e.g. TechnikRadar 2018 in: acatech, Körber-Stiftung 2018, and the largely unchanged findings in acatech, Körber-Stiftung 2020.
2 | See Renn 2008, Hampel/Zwick 2016.
3 | See the anthology edited by Beck/Kühler 2020.
4 | See Grunwald 2021.
5 | See Jonas 1979.
6 | E.g. the Baden-Württembergische Akademie für Technikfolgenabschätzung (AFTA), Stuttgart (1992–2003), the Institute for Technology Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT), which was established in 1995 to replace the previous institute founded in 1977, and various parliamentary bodies such as the Office of Technology Assessment at the German Bundestag (TAB), founded in 1990.

associations such as the Association of German Engineers (VDI) to develop codes of ethics for their members.[7]

This can be interpreted as a response to criticism of the traditional concept of responsibility. The growing complexity of our technological, organisational and economic systems means that we increasingly lack the knowledge required for responsible decision-making. And while in some cases we are aware of this shortcoming, in others we turn a blind eye. The question of whether we should make moral judgements about people because they lack knowledge and of how to deal with "not knowing" remains the subject of heated debate to this day.[8] Moreover, most technology, economic and policy decisions are taken by teams, committees and institutions such as parliaments and public authorities, but only rarely by individuals. This makes it difficult to hold any one individual personally responsible, resulting in a diffusion of responsibility. The concept of responsibility has become blurred by factors such as globalisation, the economisation of almost every area of our lives, and the tremendous increase in the power of technology – including digital technology – on a scale that is very difficult for the lay person to fully comprehend.[9]

The influence of new technologies on society continues to grow to this day. At the same time, the public now has more ways than ever before of influencing technology design. The fact that more and more social groups[10] are able to influence the development of technology raises new questions in the debate on responsibility. Responsibility has always also included compliance with legal and technical requirements (rules, norms, government guidelines). This means that its significance is not confined to the conduct of professional association members or R&D lab workers – it is also relevant to the companies that develop, manufacture, operate, maintain, upgrade and dispose of technology.

Accordingly, it is also important for companies to take responsibility. In this context, companies are not just a "legal person" but also a "responsible person" (i.e. the "subject" of the responsibility). The same applies to public administrations, authorities and/or organisations. It also applies to training and professional development in technology-related subjects such as mechanical engineering, electrical engineering, IT and civil engineering, and basic sciences like physics, chemistry and biology. Legal responsibility is essentially defined by the type of company that a business is registered as and the corresponding roles that hold legal responsibility within the organisation. However, it is harder to establish the ethical responsibility of organisations and especially of individuals within them.

The aim of this position paper is to discuss the issue of responsibility in the context of the current debate, with specific reference to companies and institutions involved in the technological sciences, engineering and technology design. We hope that this position paper will encourage responsible conduct in the scientific and technology design communities and stimulate discussion regarding how it can be promoted.

Our first aim is to broach this topic and initiate a discussion with acatech's scientific Members and the organisations that they are professionally responsible for (university institutes, corporate research departments, other academies of science, professional bodies, etc.), and with the members and employees of the companies represented in acatech's Senate. The discussion is also relevant to professional communities, employers' associations, trade unions, teachers' associations, training and professional development organisations, supervisory authorities (from the TÜV certification authority to health authorities, environment agencies and trading standards authorities), politicians (with responsibility in this area), (representatives of) the media, interested members of the public, and bodies working on similar topics, such as the German Ethics Council.

This position paper summarises the findings of a project group that came together to tackle this important and complex issue. We hope that it will provide the starting point for an in-depth debate about how to define and promote responsibility in all the above-mentioned areas of the technological sciences, in research and practice and in the relevant regulatory authorities.

7 | See VDI 2002.
8 | See Bechmann, Stehr 2000.
9 | See Vogt 2020, and more generally Seibert-Fohr 2020.
10 | See e.g. acatech 2016.

2 Responsibility in companies and institutions

The production, deployment, operation, upgrading and disposal of technology have impacts on people, the environment, institutions and society as a whole. Ever since we started discussing the issue of responsibility for these impacts, we have been confronted with an as yet unresolved problem: in today's world, the technological and economic decisions being assessed are hardly ever taken by a single individual. As a result, it is difficult to hold individuals morally responsible or legally liable, since the impacts – including the negative impacts – can only be attributed to groups of people such as development teams, company boards or committees. In the legal context, the problem was solved by making it possible for companies that take this kind of decision to be held liable as a whole (corporate liability). In this context, a company that acts through its internal bodies (e.g. its board of directors, general assembly, etc.) is referred to as a legal person.[11] However, the problem has yet to be solved in the realm of ethics, since this field has no equivalent to a legal person – the concept of a collective "moral person" does not currently exist.[12]

A working definition of responsibility

Before delving deeper into this topic, it is first necessary to reach a consensus on what responsibility actually means. Responsibility is a multi-faceted and long-established concept with roots going all the way back to the birth of law and philosophy in the advanced civilisations of the ancient world. As such, it may be necessary to settle for a shorthand, *working definition*.

According to best practice dating back to Roman law, the concept of responsibility describes a tripartite relationship: someone is responsible for something to someone. Underlying this is the notion that people are responsible for their actions before the courts. In other words, a person must "answer" (Latin: "respondere") for their actions to a court if summoned to do so. The English "responsibility" and its French equivalent "responsibilité" share this etymology.

This tripartite relationship gives rise to three key questions:

1. Who is responsible?
   (e.g. an individual, group, company, institution, organisation, generation ...)

2. What is someone responsible for?
   (e.g. actions, omissions, products, product quality, services ...)

3. Who/what is someone responsible to?
   (e.g. the law, their conscience, God, history, the future, an agreement, a contractual partner, a company's management ...)

Various other aspects can be added to this basic relationship:

4. How long is someone responsible for something?
   (timescale, warranty and liability issues, direct and knock-on effects)

5. On what basis are they required to take responsibility?
   (the law, guidelines, rules of conduct, moral convictions, etc.)

6. How much do they know about the potential consequences, and how does uncertainty about the consequences affect the question of responsibility?
   (limited knowledge of consequences, acting in the context of uncertainty, the precautionary principle)

7. What other sanctions can be applied for violations of responsibility apart from those laid down in liability law, professional conduct rules and the law governing associations?[13]

It is vital that compliance with or violation of the responsibility assumed should be assessed on the basis of these key questions – and how this is done is equally crucial. Taking responsibility involves establishing the facts in keeping with these key questions, and analysing and assessing the impacts, the areas impacted, the chains of effects and the impacted parties.

11 | See Hübner 1996, p. 117.

12 | See Stahl 2000, Thorhauer 2016. Business ethicists tend to be more receptive to the possibility of collective responsibility than ethicists concerned with the moral philosophy dimension, who continue to focus on individual responsibility. For an overview, see Wieland 2001.

13 | For a detailed discussion of responsibility in engineering, see Hubig/Reidel 2003. A breakdown of the different types of responsibility (based on the answers to the questions above) can be found in Ropohl 1996, pp. 74–82.

Individuals take responsibility due to intrinsic motivations such as wanting to be honest, a sense of justice, or a moral sense, but also due to extrinsic motivations such as material and non-material incentives (praise/recognition, remuneration, etc.). However, the assumption of responsibility by institutions is complicated by the above-mentioned problem of diffusion of responsibility, which arises from the relationship between the responsibility of an institution's individual members and the responsibility of the institution as a whole. In addition, there is a lack of clarity concerning the attribution of responsibility to institutions as a whole and the sanctions that can be taken against them in those cases that are not codified in law.

There has been renewed international interest in the topic of responsibility over the past ten years or so. Ethical and precautionary issues associated with various new technologies such as genetic engineering and nanotechnology led to the emergence of the Responsible Research and Innovation (RRI) model that was initially promoted mainly through the European Union's Framework Programme for Research. It was not long before this approach was adopted all over the world[14], making responsibility a central ethical and research policy concept.[15] RRI focuses on the responsible organisation of processes and structures in research and development, addressing both the role of public research and R&D in industry and business.[16]

In recent years, the "transdisciplinary" approach has become very popular in basic and applied research and in research into practice-oriented instruments and implementation processes. Transdisciplinary research identifies research questions relating to approaches, impacts, instruments and methods through a close dialogue between researchers, practitioners and representatives of civil society (stakeholders). The research process, including claim and efficacy testing and (interim) evaluations, is carried out jointly by the participating actors. Importantly, the same applies to ongoing evaluation of the practical application/implementation stages.[17]

Transdisciplinary work and research processes involving collaboration with other scientific and non-scientific actors are now also being used in the field of engineering. An interdisciplinary and in particular a transdisciplinary approach is essential for any scientific discipline focused on delivering sustainability goals. This is due to the sheer breadth of actions and impacts relating to the economy, the environment, social affairs, public health, cultural heritage and the lives of future generations.

The diversity and complexity of the areas impacted and the variable spatial and above all temporal extent of the impacts (short-term, medium-term, long-term) makes it harder to make claims about the risk of undesired and unforeseen impacts with any confidence. Observation coupled with complex analytical techniques can help to remove some of this uncertainty, or at least characterise it more accurately. Consequently, the potential impacts that could or should come about as a result of research in the technological sciences and its possible applications in the above-mentioned areas should be addressed right from the methodology stage. In this context, sustainability should be a key normative principle.[18]

In view of the above, it would seem appropriate to suggest that (applied) research and development should ultimately have a responsibility to support and protect the economic and environmental wellbeing of societies and their economies. Innovation should include the creation and promotion of conditions that enable the foreseeable impacts of new technologies and their applications to be assessed. This should be a central goal in the development and management of technological science institutions and the critical optimisation and development of research methods. This responsibility can actually be viewed as a moral duty, an interpretation that can be traced all the way back to Francis Bacon: "The real and legitimate goal of the sciences is the endowment of human life with new commodities".[19]

Responsibility for engineers

In their professional practice, engineers and their professional partners in the disciplines of physics, chemistry, biology and mathematics have at least a partial responsibility not only for the products they develop and the services they provide – such as vehicles, control technology, machinery and traffic

14 | See Grinbaum/Groves 2013.
15 | See Owen/Bessant/Heintz 2013, Hoven et al. 2015, von Schomberg/Hankins 2019. The different models encompass everything up to values-based design, and in some cases even return to virtue ethical approaches; see Vallor 2016, p. 120.
16 | See Iatridis/Schroeder 2016.
17 | See Krohn/Grunwald/Ukowitz 2017, Renn 2019.
18 | See Renn 2019, Vogt 2019. It should be noted that an approach to science that focuses on values like these is still extremely controversial within the philosophy of science.
19 | See Bacon 2017, Book 1, aphorism 81.

systems – but also towards people in different forms of employment (employees, public servants, (self-employed) entrepreneurs). This responsibility encompasses impacts in areas such as

- (technical) safety,
- health and safety in the workplace,
- environmental sustainability including climate protection,
- resource utilisation/consumption including financial resources,
- performance and
- functionality.

The impacts are thus felt in social, economic, environmental and cultural areas, affecting people's physical and mental wellbeing, the environment and the lives of future generations. It is important to address the specifics of the social, temporal and spatial impacts, since those affected and the respective drawbacks and benefits may be completely different from one case to another.

In this context, codes of conduct or ethical guidelines adopted by professional associations[20] can be extremely useful for interpreting vague legal terms such as "the current state of knowledge". Moreover, codes or guidelines adopted by professional associations are binding for their members in the event of a conflict about legal decisions relating to the "state of the art". While employment law takes precedence over guidelines of this type, they in turn take precedence over all civil law agreements.[21]

In the course of their work, engineers take on responsibility towards employers, companies, shareholders and company partners, other employees, customers, users and society as a whole. This means that, as with other professional groups, they share responsibility for the common good.

Responsibility of and within companies

If responsibility is to be taken in companies, organisations and institutions, the agreements governing their actions (guidelines, codes of conduct) must be effective. To ensure their relevance, these agreements must therefore be binding. Generally, this means company-wide compliance guidelines that must be observed by all employees, both in-house and in their interactions with their professional community or other members of their industry.

The drafting of these guidelines should be informed by "discursive processes" between the company management and employees from different levels of the hierarchy, professional associations, civil society organisations, the general public and, where appropriate, policymakers and the media.

The establishment and continuous development of guidelines, rules, etc. and the associated responsibility should be explained and discussed in training and professional development settings. After all, they make an important contribution to communicating values both internally and externally, strengthening the company's competitiveness through image building, and employee and customer identification with "their" company (self-image, social recognition). They also contribute to the common good by enabling products and services that help to deliver benefits for society, notwithstanding any potential side-effects.[22]

20 | E.g. VDI 2002.

21 | See Hubig/Reidel 2003, pp. 17–18. For codes of ethics and information about compilation of these codes, see Maring 2021.

22 | Responsible corporate behaviour is currently often discussed in the context of Corporate Social Responsibility (CSR). The different areas of responsibility focus on what responsibility should be taken for, e.g. operational aspects (such as responsibility for the value chain and market), or stakeholders and interest groups (such as responsibility for investors or employees and HR management). See Bundesministerium für Arbeit und Soziales (Ed.): Die DIN ISO 26000. Leitfaden zur gesellschaftlichen Verantwortung von Organisationen, 2011. URL: https://www.bmas.de/DE/Service/Publikationen/a395-csr-din-26000.html

3 How are companies currently dealing with responsibility? Findings of expert interviews

In order to initiate a debate within acatech, the obvious next step after defining the concept of responsibility was to carry out interviews on this topic with the companies and institutions represented in the Academy. Exploratory interviews were employed to ensure that the full spectrum of issues was covered.[23] The interviews focused on how each company or institution deals with the topic of responsibility both externally (e.g. through its corporate strategy) and internally (e.g. through training measures, management culture).

When selecting the interviewees, the companies and institutions were clustered according to different criteria (e.g. by industry). Another pragmatic criterion was the ease with which they could be accessed via the acatech network (primarily Senate companies). This allowed patterns and similarities to be identified during the analysis stage, providing the basis for the nuanced recommendations presented at the end of this paper.

Responsibility in the automotive industry

The automotive sector is the cornerstone and poster child of German industry. As such, it is particularly important for this industry to address the topic of responsibility. A representative of automotive manufacturers Audi was interviewed.

The interviewee said that there is a fundamental understanding that responsible conduct within the company creates sustainability in the sense of the company's future viability. Responsibility must be demonstrated to the organisation's members, who must also act responsibly themselves. There are two kinds of strong corporate governance. Good corporate governance engenders reliability and facilitates clear decision-making. Conversely, a climate of fear may also arise: if employees are put under pressure, they may resort to illicit practices (such as using software to manipulate emission figures) in order to protect their own careers. To prevent this kind of manipulation and ensure robust decision-making, it is vital to allow different opinions, dialogue and even dissent at every level of the hierarchy.

The company offers a range of training and education measures on topics such as integrity, compliance, competition law and the code of conduct, and these are being continuously strengthened. In 2018, for example, Audi launched its Together4Integrity programme.[24]

Responsibility in a life sciences company

Although it operates in a different industry, Bayer is comparable to the automotive companies in terms of size and global presence. Since 2015, the company has been transforming itself from a chemical manufacturer into an international life sciences group. Global strategies such as the acquisition of Monsanto are deemed to have been justified from a business standpoint, even if, despite the fact that the takeover was carefully prepared by Bayer, the company paid a high ethical and legal price in the wake of a huge public controversy. Ever since it was founded, the company has provided strong support for regional culture, sport, schools and social facilities. Other examples of taking responsibility include the Bayer Science & Education Foundation and the company's cultural department. In this context, the interviewee stressed that the company's "LIFE values" will not be affected by the transformation of the business. The acronym "LIFE" (leadership, integrity, flexibility and efficiency) describes the values and management principles that the company is committed to following.[25]

Like Audi, Bayer also provides training and education on topics such as compliance. In addition, it offers industry-specific professional development courses on questions such as "What is green genetic engineering?" and "Why did we get involved with Monsanto?".

From conglomerate to digital corporation

Siemens is a company from yet another sector that is comparable to Bayer in terms of size and global footprint. It has developed its portfolio from electrification to automation and digitalisation in industrial applications. Responsibility has been very high on the company's agenda since at least 2007, when it had

23 | The interviews were conducted by the project group leader and the project coordinator.
24 | See https://www.volkswagenag.com/de/news/stories/2018/05/integrity-is-everyones-business.html [Retrieved 01.02.2021].
25 | See https://www.bayer.de/de/unsere-werte.aspx [Retrieved 26.01.2021].

to pay a huge fine as a result of the bribery scandal in its telecoms division. Assuming and implementing responsibility in the sense of compliance has become an extremely important part of Siemens' corporate culture since that time. The responsibility of each employee towards the company (ownership culture) and towards society (Business2Society) also plays a key role within the business.

Today, the company has clear Business Conduct Guidelines governing its relations with customers, business partners, employees and suppliers. Compliance officers support implementation of these guidelines in the day-to-day activities of every part of the business. Siemens views responsibility as a core value and competitive advantage. In keeping with this approach, responsibility and the benefits for customers and society are also kept in mind when pursuing new technological developments ("technology with purpose"). Responsibility remains a core value of all Siemens companies, including the recently spun-off medical technology and energy businesses.

Responsibility in IT companies

This brings us to global IT companies. As in the automotive industry, this sector also has a distinct cluster of businesses with similar challenges in the field of responsibility. Google – or its parent company Alphabet – is an innovation driver with one of the highest market values of any company in the world. Its unbureaucratic corporate culture and lean hierarchies are particularly attractive to younger employees.

But what are the implications of this corporate culture for corporate responsibility? In 2018, Google became one of the first tech companies to publish and voluntarily commit to a series of principles[26] regarding the development of technology and the associated responsibility. This is not merely a statement – it is intended as a means of actively transforming the business. Internal processes are being actively adapted to and aligned with these principles, while employees receive regular training on topics ranging from bias and ethical issues to compliance and data protection. Interestingly, the principles also explicitly list technology applications that the company will not pursue, for instance certain applications involving weapons and surveillance.

"Google is no ordinary company and we don't plan to become one". This is the message that is constantly conveyed to its employees, who are challenged to think big and outside the box, and receive targeted support to do so. This is in marked contrast to the mentality and hierarchical structures of many traditional companies. Google's management by objectives and key results approach challenges employees to deliver the best possible outcomes by constantly setting themselves concrete, quantifiable goals.

Global semiconductor manufacturer Infineon Technologies is the largest producer of semiconductors in Germany and one of the ten largest worldwide. According to its own vision, "Globally functional structures from Germany to Malaysia promote a dialogue with all ethnic groups and cultures". Infineon requires its employees to follow its Corporate Social Responsibility (CSR) Policy and Business Conduct Guidelines.[27] These conduct guidelines set out the principles for ethical collaboration both within the company and with the company's partners. Their aims include promoting a culture of openness and respect among employees. As far as external corporate responsibility is concerned, the company engages in a dialogue with international organisations such as NGOs, but also with its neighbours at a local level.

Intel is another semiconductor manufacturer, although unlike Infineon it is headquartered in the US. The CEO of Intel Germany gave a presentation at the project conference (see appendix). Intel sees corporate responsibility primarily as a matter of data ethics. The interview with the company highlighted the importance that it attaches to "ecosystem management". In addition to an internal Ethics & Compliance Oversight Committee, Intel has a strong commitment to diversity, and the company offers its own professional development measures on gender issues.

How are family businesses different?

Unlike the corporations referred to above, the Harting Technology Group is a family business where the Chairman of the Board's position is still occupied by a member of the Harting family. Harting is a leading global supplier of industrial connectors. Family businesses can have a different approach to ethical and moral questions, since individual senior executives can leave their personal mark on how the company is run across several generations. As a supplier, Harting receives questionnaires and codes of conduct from its customers on issues such as human rights and the environment. As well as having to complete and comply with them itself, the company must also pass them on to

26 | See https://ai.google/principles/ [Retrieved 28.04.2021].

27 | See https://www.infineon.com/cms/de/about-infineon/investor/corporate-governance/compliance/business-conduct-guidelines/ [Retrieved 26.01.2021].

its supply chain and check its suppliers' compliance with them. The key challenge here is standardisation in order to manage the ever greater complexity associated with all the different requirements. Consequently, Harting follows the ISO 26000 international standard on social responsibility in organisations. A key internal goal is to standardise corporate social responsibility requirements in order to create a level playing field that allows sufficient freedom for social engagement.

Insurance and consumer protection

Munich RE is a global corporation with a very different profile. Unlike other large international companies, Munich RE considers responsibility an operational matter directly linked to the commercial interests of the business. Questions relating to sustainability and responsibility affect investments in climate protection, the energy transition, artificial intelligence (AI), etc. The group can exert an influence in this area, for example by refusing to insure companies where over 30% of the electricity they use comes from coal-fired power plants, or by considering whether to keep insuring dam building projects. Should an insurance company go beyond the statutory requirements by ceasing to provide insurance for coal-fired power plants and dam construction projects? And to what extent can an approach like this be reconciled with Munich RE's financial interests? Favourable insurance terms for sustainable energy projects, for example, could send out a strong signal to the global market. The company's sustainability criteria are aligned with e.g. the World Economic Forum and the Sustainable Development Goals (SDGs).

Responsibility is also an operational business matter for the non-profit German consumer watchdog Stiftung Warentest, which provides consumer reviews for everything from clothing to milk prices. The Stiftung Warentest has to find ways of covering its costs, for example by publishing a magazine. Responsibility begins with the choice of topics covered in the magazine, with product sustainability playing an increasingly prominent role in recent years. For Stiftung Warentest, transparency is key to building trust when it speaks to the companies it is investigating and visits their main production facilities.[28] The organisation employs a double verification approach where a product is evaluated scientifically (e.g. by laboratory testing) before being reviewed by journalists (who present the findings for consumers and customers of Stiftung Warentest).

Responsibility in a research organisation

Responsibility is also a central theme at one of Germany's largest research organisations. With approximately 28,000 employees, the Fraunhofer Society for the Advancement of Applied Research is the largest applied research and development organisation in Europe. Although the Fraunhofer cooperates with the private sector in its development work, as with acatech, it does not pursue the interests of any private company. The Fraunhofer's understanding of responsibility relates first and foremost to its sustainability strategy.[29] Mirroring acatech's approach to technology design, the Fraunhofer emphasises the importance of responsibility in the design of its projects and the selection of its research priorities, drawing on the criteria established by Leopoldina and the German Research Foundation (DFG) on "Scientific Freedom and Scientific Responsibility – Recommendations for Handling Security-Relevant Research".[30]

The concrete measures taken by the Fraunhofer include an internal advice service (that provides advice on ethics by phone or email) and a code of conduct with a social responsibility section that focuses on "scientific responsibility and ethics" and "business ethics and corporate responsibility". In the case of research activities that involve significant threats to human dignity, health and the environment, it is also possible to convene the Ethics Committee for Security-Relevant Research. The purpose of this committee is to identify ethical issues in projects from an early stage and make the researchers aware of the need to consciously address, within their own area of research, the interactions between technological, ethical, social, economic and environmental systems and their future impacts.

Responsibility for infrastructure projects

Responsibility is a key challenge for the public authorities charged with realising technological and scientific infrastructure projects. Special institutions exist to help with or guarantee the completion of these government projects. Industrialised nations started building technological and scientific infrastructure as

28 | E.g. Schoenheit/Hansen 2004.

29 | See also the project "Nachhaltigkeitsmanagement in außeruniversitären Forschungsorganisationen" (Sustainability Management in Non-University Research Organisations). Part of this project involved drafting guidelines on the principles and processes of sustainability management: https://www.nachhaltig-forschen.de/startseite/ [Retrieved: 28.04.2021].

30 | See DFG/Leopoldina 2014.

long ago as the 19th century, and this has since become an established part of the State's role.

Most government scientific and technical agencies are legally structured as a subordinate authority. Their duties typically include:

- Testing, analysing and licensing (Federal Motor Transport Authority, bureaus of standards, trading standards authorities, National Metrology Institute of Germany, Federal Institute for Materials Research and Testing, Paul-Ehrlich-Institut (Federal Institute for Vaccines and Biomedicines), Federal Environment Agency)
- Providing government ministries, and in some cases also the public, with advice in their area of expertise (Federal Office for Information Security, Federal Office of Civil Protection and Disaster Assistance (BBK), National Meteorological Service)
- Ongoing development of technical standards (several different institutes collaborate within DIN) and government regulations
- Research and development, insofar as this is necessary to discharge their duties (there are more than forty departmental research institutes, the largest of which are the National Metrology Institute of Germany, Federal Institute for Materials Research and Testing, Robert Koch Institute, Federal Institute for Risk Assessment, and National Meteorological Service)
- Representing Germany on international bodies
- Maintaining the technological infrastructure (Federal Network Agency, the civil protection organisation "Technisches Hilfswerk", Federal Office for the Safety of Nuclear Waste Management)
- Construction (the structural engineering institute "Deutsches Institut für Bautechnik", Reactor Safety Commission)

In addition, in many of the German federal states, the practical implementation of public services and infrastructure is either entirely or partly in the hands of the public sector. This includes rail transport and aviation, postal and telecommunications services, housing and the water, gas and electricity supply. In Germany, as elsewhere, many of these services have been largely privatised or are delivered by entities with a private legal form but with public participation. Since this public involvement is seen as a question of practicality rather than a fundamental part of their mission, these companies are very different to the government's technical agencies and should therefore be classed as private sector organisations (e.g. the rail company Deutsche Bahn).

Deutsche Bahn (DB) is an example of an organisation that used to be state-run but is now a private sector company in which the German government is the majority shareholder. DB's overarching strategy is to combine mobility with sustainability and innovation. One example of the company taking responsibility – in the sense of doing business sustainably – is its commitment to work towards using only green electricity. Deutsche Bahn is a company that dates back to the first Industrial Revolution, but is now transforming itself into an Industrie 4.0 organisation. This transformation is occurring across every area of its activities, from the technology it uses to its management model. At present, the question of responsibility is particularly relevant in the context of digitalisation. For example, the company has established an open data portal and the Web-based learning platform DB Lernwelt. DB has developed its own Corporate Digital Responsibility programme that includes Responsible AI as a strategic issue. Multiculturalism and diversity are also key themes for DB, not least in the context of its international passenger services.

Responsibility in federal agencies

The fact that the technical agencies are independent from the ministries they report to as far as technical matters are concerned has a number of implications. A high percentage of the people they employ are engineers and scientists whose working methods tend to be closer to those of their own discipline than those of typical civil servants. Thus, although they are subject to statutory ministerial oversight, the technical personnel do have a certain degree of independence and can enjoy a considerable amount of discretion. This means that they also have greater-than-average responsibility for the consequences of the measures taken in the above-mentioned areas.

In the age of digitalisation, the Federal Office for Information Security (BSI) is one of the most important government agencies. The BSI is overseen by the Federal Ministry of the Interior (BMI). It is responsible for cybersecurity hardware and software and also

acts as the supervisory authority for strengthening consumer protection. The BSI mainly discharges its responsibility towards consumers through its service centre and newsletter, and by answering their inquiries. It also aims to address the growing digital/social divide, which is exacerbated if, for example, only a small percentage of users are able to afford regular updates to fix security bugs. The key questions are "What responsibilities do consumers, businesses and policymakers have with regard to cybersecurity?" and "Who can have a concrete influence on cybersecurity?" The BSI's remit includes cyberattacks and attacks on the federal government's IT security. While it is not a regulatory authority itself, the BSI can put forward proposals for legislation aimed at giving consumers and users personal responsibility for managing their own data.

The Federal Highway Research Institute (BASt) is a research institute of the Federal Ministry of Transport. As in all similar federal agencies, scientists and engineers account for a relatively high percentage of BASt personnel. Around half of its 400 employees are scientists working on topics such as highway planning, highway design, safety and traffic statistics.

There is a growing trend for federal ministries to delegate technical responsibility to subordinate agencies. However, this poses challenges in terms of responsible decision-making within the ministries. Moreover, the BASt is carrying out less and less research itself and is instead awarding research contracts to external contractors. As a federal agency, it has to bridge the gap between policy and research.

Digitalisation is having a major impact on all our infrastructure, and the road network is no exception. Accordingly, the BASt has recently established a new digitalisation department. It is interesting to note that the additional technical expertise required to staff this department is coming mainly from the private sector rather than universities.

Although the responsibility for decision-making ultimately resides with policymakers in the relevant ministry, the federal agencies play a very important role in the transfer of technological and scientific expertise.

4 Summary of expert interviews

In many of the abovementioned companies, organisations, institutions, government agencies and other entities, training in and active support for a "culture of responsibility" are important themes for management and employees alike.

As well as open, discursive processes, other key requirements include encouragement and incentives to take responsibility, and rewarding people within the organisation for contributing ideas, suggestions, etc. about products, services and service performance and their potential (knock-on) effects. Accordingly, a "culture of responsibility" calls for the internalisation of rules of conduct that enable mutual trust, the attainment of common goals and values, and positive effects arising from the recognition of those who take responsibility.

Training in and promotion of a "culture of responsibility" requires appropriate processes and instruments for determining, communicating and reflecting on one's own personal responsibility in conjunction with clear competences and rules.

Building trust internally within a company or any other organisation requires the participation of all the stakeholders in the drafting of the guidelines and the design of the processes, structures, competences and instruments. The right to object is also key. This includes constructive criticism, suggesting improvements, flagging up instances where the guidelines are not being followed, and other supportive contributions.

Constructive criticism means that the person criticising something declines to take responsibility on a specific matter and passes responsibility for this matter to their superior(s). By doing so, they promote critical reflection on the content and implementation of technical regulations and statutory requirements.

An interesting analogy came to light during the project group's discussion of the results of the expert interviews. Civil service law provides for a "right of remonstrance" (Section 63.2 Federal Civil Service Act (BBG)) that allows the directives and instructions of a civil servant's superiors to be formally challenged on the grounds that they are unlawful or unreasonable. In these instances, responsibility is not taken on by the individual and is passed back to the superior(s) in question.[31] However, the civil servant must carry out the instruction if the person higher up in the chain of command also deems it to be legitimate. As well as a Military Complaints Regulation, the Legal Status of Military Personnel Act also establishes the institution of the Parliamentary Commissioner for the Armed Forces. Any member of the armed forces can contact the Parliamentary Commissioner without going through the military hierarchy. Processes like this can play an important part in the scrutiny and, where necessary, amendment of instructions, and in passing responsibility back to a superior e.g. in connection with liability and the law of obligations.

Civil service law is by definition not applicable to private companies, organisations and institutions, or to employees who are not civil servants. Nevertheless, it is worth trying to replicate the benefits of the right of remonstrance by introducing corresponding organisational elements, structures and processes in ordinary employment law.[32]

One instrument that could be used in this context is an ombuds organisation with ombudspersons or ombuds offices where anyone can make a complaint without fear of punishment. The ombudsperson or ombuds office then mediates the dispute in accordance with predefined rules and procedures.

In order to ensure the long-term effectiveness of the relevant structures and processes and prevent counter-productive side-effects, it is vital for employees to be involved in their design, implementation and ongoing development. The topic of taking responsibility should also be addressed in the training and professional development setting, and the relevant instruments,

31 | *"There are three stages in the remonstrance procedure. First, the civil servant must raise their concerns about the lawfulness of an official instruction with their immediate superior. If the immediate superior maintains that the instruction should stand, the civil servant can take their complaint to the next person up in the chain of command. If they also find the instruction to be legitimate, the civil servant is obliged to carry it out. The only exception is if the official instruction would result in demonstrably criminal or improper conduct that violates human dignity or in some other way transgresses the boundaries of management's right of direction. The right of remonstrance has a dual function. On the one hand it supports self-regulation within the civil service, while on the other it exonerates civil servants from prosecution under liability and disciplinary law in cases where they are issued with an unlawful instruction."* See https://www.dbb.de/lexikon/themenartikel/r/remonstrationspflicht.html [Retrieved 29.04.2021].

32 | In this context, it is necessary to discuss how to effectively distinguish between legitimate whistle-blowers and people who simply complain for the sake of complaining or who are intentionally trying to damage an organisation.

processes and organisational structures should be the subject of continuous evaluation.

While the main role of the processes and structures of an ombuds organisation is to act as a safeguard, they can also be a vehicle for constructive and critical suggestions, observations and creative enhancements relating to products, production processes and/or services. Ultimately, when an employee uses the remonstrance procedure or contacts the ombuds office, they are indirectly taking responsibility for their own actions and for the wellbeing of their company or organisation. In doing so, they are responsibly helping to prevent undesirable, improper, counterproductive and indeed "irresponsible" side-effects and potentially illegal or morally unacceptable impacts (ensuring that the technological state of the art, the rules governing technology and the state of the art in R&D, etc., are all observed). The freedom that a well-designed right of remonstrance can facilitate when discussing a technological development within a business can help to identify potential abuses even at the design stage.

Public enterprises and institutions

In public enterprises and institutions, the goals and frameworks for product quality and production and for service performance are determined through a dialogue with the whole of society regarding the following criteria:

- justice and social equity,
- public service function,
- budgetary management of the allocated funds and resources,
- safeguarding of public goods,
- sustainability (Sustainable Development Goals) and resilience (adaptability), and
- inclusion and participation.

Some public enterprise employees may still be civil servants and therefore have recourse to the right of remonstrance. Nevertheless, an ombuds structure should still be provided to ensure that all employees are treated equally. Ombuds offices review the criticisms and suggestions that they receive and submit them "anonymously" to the relevant line manager or to the company management.

Public administrations and political bodies

The general goals of legality, lawfulness and reasonableness are specified for the different technical policies, administrations and disciplines and are implemented using legal and technical oversight instruments in the shape of

- goals and targets for policymaker and public administration conduct,
- introduction of norms, technical regulations and technical standards and monitoring of their implementation, and
- implementation of – mainly empirical and model-based – a priori impact assessment procedures, and in particular a posteriori impact assessment procedures.

Possible failings and obstacles that can cause variation in the assessment and monitoring of responsibilities include

- failure to properly explain the relevant goals,
- impact assessments that are too narrow in scope,
- lack of assessment, failings and biases in the assessment process,
- failure to adequately clarify who is impacted,
- failure to adequately highlight innovative, alternative solutions, and
- unofficially putting loyalty before professionalism at different management levels.

Failure to meet legal requirements, act legitimately or ensure adequate protection carries consequences that can lead to personnel, institutional or organisational changes. However, it is often not possible to clearly identify the responsible people or organisational units. Moreover, in some cases, the violation of the rules is disputed or counteracted by other rules relating, e.g. to reasonableness. Consequently, in addition to legal consequences, other forms of attributing and taking responsibility are widely employed in the world of politics, for example committees of inquiry, parliamentary questions and certain kinds of investigative journalism. However, these often serve vested interests or seek to sensationalise the facts.

The different perspectives, interests and goals of the various actors involved in political negotiation processes are at least partly debated in the public sphere. The debate can thus be informed

by very different groups, with new groups emerging regularly, as seen, for example, in the recent rise of the "Fridays for Future" movement. The media plays an important role as a mediator between the public and industry, higher education, the public administration and other players, and also performs an important monitoring function.

Engineering firms and planning offices

The operational activities of public administrations and government, and of public enterprises and institutions are at least partly outsourced to planning offices and engineering firms which, in principle, are subject to the same requirements and goals. This theoretical transfer of responsibility must be put into practice when dealing with contractors, through

- a requirement to observe defined goals and values,
- comprehensive impact studies, evaluations and assessments, and
- systematic efforts to identify counter-productive impacts.

Most contractors will flag up matters requiring clarification, issues with targets, assessment requirements and situations where the principles of lawfulness and reasonableness could be violated. In some cases, they may even refuse to perform the task in question, despite the significant financial risks that this entails. Professional planners and engineers provide consultancy and support services for interest groups – services that are very much focused on specific interests. They thus help to represent the interests of these stakeholders, not least because they are able to put forward technical arguments to support groups of people who lack the same capacity to articulate and push through their own agenda. Even if their primary task is to represent the interests of a particular group, however, it is nonetheless incumbent on them to ensure that they do not undermine their professional responsibility by omitting or failing to properly assess certain issues when carrying out impact analyses. Rather than being seen as bad for business, drawing attention to shortcomings in this area should be regarded as a fundamental requirement for enabling responsible conduct among engineering professionals.

Universities, training and professional development organisations

These organisations can and must be enabled to take responsibility on the basis of stated objectives and impact assessments, to employ appropriate instruments and methods, and to carry out integrated evaluations. This can be achieved through

- communication of basic philosophy of science and ethics content, both in special curriculums (interdisciplinary courses) and in technical curriculums that incorporate content on how to implement ethical principles in practice,
- teaching content that communicates potential ethical principles, values and the associated – social and technological – rules and norms, including examples of the development and promotion of a willingness to take responsibility,
- explanation of pitfalls and undesired impacts, and of appropriate monitoring and prevention strategies, including transparent handling of cases where damage has occurred,
- communication of processes and structures for clarifying professional responsibility within companies, and
- communication and demonstration of models, discussion of examples and models.

These are the requirements and conditions that are key to achieving the urgently needed strengthening of responsibility in society, industry, government and the public administration. Their integration into training and professional development programmes should focus on practical implementation and must be mandatory – it is not enough simply to offer this content as an optional extra.

5 Recommendations and outlook

Conditions for taking responsibility

Based on the conversations and discussions with company representatives, at the project conference (see appendix) and within the project group, it is clear that in order to clarify responsibility and ensure that responsibility is taken, processes must be established that allow institutions, associations, academies and networks of actors to recognise ethical standards and incorporate them into their day-to-day activities. As well as content and objectives, these must also address procedures, structures, organisational forms and competences.

Accordingly, the recommendations and proposals below set out concrete ways in which companies and institutions can take responsibility in practice rather than simply paying lip service to it. The goal is to help companies, public authorities and research institutions to recognise when they need to take responsibility and how they can do so, so that they can then translate this knowledge into action. The recommendations also aim to help employees contribute actively and responsibly by making suggestions and through whistleblowing. This calls for both an open suggestions system and an anonymous, confidential whistleblowing system.

Several different conditions must be met for institutions to take responsibility. These include the facilitation of responsible decision-making and a values-based approach. It is also vital to be informed about the impacts, consequences and side-effects of business activities, the products and services developed by an organisation, and its financial decisions. Expertise in value orientation and moral judgment is also necessary so that ethical evaluations can be made.

When it comes to translating values into criteria, it is important to find ways of bridging the gap between the two – how do you translate an organisation's stated values into specific criteria? For example, which criteria should be used to measure the "safety of a machine"? Are criteria such as the machine's hazard potential, inbuilt safety guards or accidents per operating hour actually useful or sufficient? And how do the environmental and social impacts square with the company's values?

It is vital that everyone with an active role in the institution, especially technical personnel and management, should have the specific diagnostic skills that allow them to make the relevant judgments, particularly when it comes to assessing and communicating risks of every kind. This type of judgment faculty can be described as the ability to relate a general knowledge of the principles, general basic standards and values recognised by an organisation to specific problems and actions. It involves bridging the gap between priorities (technically referred to as precedence graphs) and compliance with the basic standards that a company has voluntarily committed to uphold. Arriving at an appropriate judgment in individual cases also involves reflecting on the aims of actions in a way that considers alternative actions, search spaces for other types of action, the potential consequences of an action and – in relation to external circumstances –the specific context of the action.

Changing conditions and challenges

The diagnostic skill requirements involved in taking responsibility for compliance with purely technical criteria are relatively simply structured and easy to operationalise – engineers have access to differentiated product quality criteria. The main challenge is simply to select the right indicators and manage the corresponding processes. While this may sometimes be technically challenging, relatively uncontentious guidance is available in the form of laws, ordinances, DIN standards and the technical guidelines of professional associations.[33] However, laws alone are no substitute for responsible conduct.

Artificial intelligence is a particularly topical example.[34] The extremely challenging task of developing DIN standards for artificial intelligence is being addressed by a steering group that has been tasked by the German government with producing an AI standardisation roadmap in cooperation with the German Institute for Standardization (DIN).[35] The parameter explosion in machine learning and big data requires new software

33 | E.g. VDI guideline 3780 on technology assessment, see VDI 2000, and the ethical principles for engineers, see VDI 2002.

34 | See also acatech 2020, DIN et al. 2020.

35 | See Steering Group for the Standardization Roadmap on Artificial Intelligence (AI), https://www.din.de/de/forschung-und-innovation/themen/kuenstliche-intelligenz/fahrplan-festlegen/steuerungsgruppe-ki/steuerungsgruppe-fuer-die-normungsroadmap-zu-kuenstlicher-intelligenz-ki-483350

verification and certification processes so that it is possible to attribute legal and ethical responsibility.[36]

The Steering Group for the Standardization Roadmap on AI is ultimately concerned with strategic responsibility, since the diagnostic skills required in this context involve assessing the consistency and scope of the performance features for an entire technology field. In other words, they are tasked not only with the selection of criteria but also with their extrapolation and hierarchisation – and in doing so they must take intended and unintended side-effects (e.g. rebound effects) into account, as well as alternatives and new search spaces. Knowledge that transcends the individual science and engineering disciplines is particularly important in relation to potential undesired developments and opportunities for abuse. This includes knowledge about societal, political, social, cultural, environmental and economic factors and their dynamics.[37]

Is it enough for companies to focus solely on profit maximisation? In this model, managers benefit society indirectly by acting in the interests of the market. Authors such as Rebecca Henderson[38] make the case for a different approach. Henderson argues that Environmental, Social and Governance (ESG) indicators should be used as well as economic indicators – a practice that has in fact already been adopted, e.g. by investment funds and reinsurers.

Proposals for processes in companies, institutions, organisations and associations

The overall establishment of clear values and goals and their operationalisation in the manufacture of goods and performance of services calls for close cooperation between investors, board members, corporate management and all other management levels, and employees and their representatives. In a social market economy, it is also necessary to cooperate with the legislative and executive branches of government and with civil society.

There are a number of obstacles to open discussion within companies and institutions, including loyalty conflicts, concerns about damage to one's career, trade secrets and hidden agendas. These obstacles must be openly addressed if a culture of discussion is to be created. Ultimately, it is up to the organisation's leadership to put in the time and effort needed to convince people that they can speak freely.

It is important to establish and communicate arrangements within the company, institution or organisation for submitting in-house suggestions or criticism about products, services and their impacts. In view of the numerous potential risks – especially for lower-ranking employees – in terms of damage to people's careers, perceived disloyalty or alleged failure to take responsibility, these arrangements should be regulated by agreements. The agreements should establish whether submissions must be made on the record or whether they can be made anonymously, who they should be addressed to, the correct format and method of submission, and how submissions are reviewed within the organisation. The concept of ombuds offices or ombudspersons provides a useful model in this context. This concept was proposed by the VDI as long ago as 2003, and has been adopted and implemented by several research institutions and universities. In 1999, the German Research Foundation established a committee known as the "German Research Ombudsman" to provide advice and act as a mediator on questions of "good scientific practice".[39]

Another example is the right of remonstrance in the civil service (see above). This model could be adopted in the Works Constitution Act and/or in individual company collective bargaining agreements, albeit with the proviso that if a remonstrance is dismissed by a company employee's immediate superior, the employee then has the right to bring in an ombudsperson. In the case of ombuds offices with more than one ombudsperson, the individuals in question would need to be appointed by mutual agreement between the company management and the works/staff council.

By clarifying and attributing responsibility, and in particular by passing responsibility back to the decision-making levels within an organisation, ombuds systems and the associated processes

36 | See Mainzer 2020.
37 | See also Kornwachs 2003.
38 | See Henderson 2020.
39 | The Fraunhofer Society has established a comparable system in the shape of an Ethics Committee that is convened on an ad-hoc basis, see https://www.fraunhofer.de/de/ueber-fraunhofer/corporate-responsibility/ethik-in-der-forschung/kommission-fuer-ethik-in-der-sicherheitsrelevanten-forschung.html. The committee's statutes can be found at https://www.fraunhofer.de/content/dam/zv/de/ueber-fraunhofer/corporate-responsibility/Satzung%20KEF%20Fraunhofer-Gesellschaft.pdf [Retrieved 01.02.2021].

can live up to people's expectations of them. The reason they work is that they guarantee the anonymity of those who bring complaints to them, while at the same time making it possible to combine loyalty and a sense of responsibility.

Recommendations

The recommendations outlined below set out how the different actors that, in the project group's view, are particularly concerned with the question of "responsibility in the technological sciences" could address this topic going forward. As well as acatech itself, these actors include companies and actors in the field of education and training.

Responsibility in the Academy

There are four ways in which the National Academy of Science and Engineering can pursue the issue of responsibility:

1. Formulating an ethical mission statement for the Academy

This would involve formulating an "ethical mission statement on taking responsibility" that would apply to the work and stances of the Academy as a whole and of its individual members (it could, for example, be incorporated into the Academy's existing mission statement). The mission statement should support the development and adoption of assessment and working processes in the Academy and for its project work, for the selection of the topics it addresses, and for the framing of public debates (these could be incorporated into the Academy's quality management guide). The areas covered would include collaboration and participation in technical communities, the conduct of members in their specialist field, (a priori and a posteriori) assessment processes that acatech members are responsible for, and acatech's involvement in providing advice for research policy, economic policy and policy on technical issues. The mission statement should encompass the full spectrum of relevant areas, such as the Sustainable Development Goals (SDGs), sustainability, climate (Green Deal), justice and social cohesion. It should also address issues relating to resilience and adaptability. Moreover, the mission statement should clarify what is meant by "trust" in the services provided by the technological sciences, technology and engineers, and exactly what their responsibility involves.

2. Responsibility in the selection of topics

acatech could establish a process for assessing and selecting the topics that it addresses in its own work that places even greater emphasis on the economic, social and environmental impacts for current and future generations. This would require a set of tools for assessing the relevant topics, operations, methods, products and services before work on a technological innovation begins, during its development and after its introduction. The acatech Executive Board would take a decision based on the results of the assessments.

3. Establishment of an in-house ombuds system

acatech could establish an in-house ombuds system with an ombuds office and one or more ombudspersons to deal with complaints and suggestions. This would facilitate critical reflection and help to resolve potential and identified economic and political dependencies.

4. Identifying and addressing responsibility issues as part of acatech's work on different topics

While there have been changes in the overall climate, such as the "moralisation of markets"[40], the public debate on corporate ethics and the emergence of "ethical shares", it is also true that some organisations only pay lip service to corporate social responsibility and similar concepts as part of their marketing and image strategies. acatech should engage actively in debates on sustainability and its relevance to technology design. This may include topics such as the Supply Chain Act (in the meantime this law was passed in summer 2021),[41] carbon tax,[42] data tax

40 | See Stehr 2007.

41 | The UN adopted its Guiding Principles on Business and Human Rights in June 2011. See https://www.globalcompact.de/wAssets/docs/Menschenrechte/Publikationen/leitprinzipien_fuer_wirtschaft_und_menschenrechte.pdf. In its National Action Plan (NAP) (see https://www.auswaertiges-amt.de/blob/297434/8d6ab29982767d5a31d2e85464461565/nap-wirtschaft-menschenrechte-data.pdf) for implementing the UN Guiding Principles, the German government opted to rely on voluntary participation by businesses. However, this proved to be insufficient (see https://www.bmz.de/de/themen/lieferketten/index.html). Consequently, as well as introducing a NAP monitoring process, it also launched a legislative initiative. However, this was subsequently paused. The EU Justice Commissioner has since announced draft European supply chain legislation (see https://www.business-humanrights.org/de/eu-justizkommissar-k%C3%BCndigt-gesetzentwurf-f%C3%BCr-europ%C3%A4isches-lieferkettengesetz-a [Retrieved 01.02.2021]).

42 | See the corresponding ESYS position papers.

and the definition and implementation of future technological and environmental standards.[43]

As well as the four points outlined above, there are a number of additional aspects relating to policy advice and science communication. This is important in view of acatech's involvement in the public debate on general responsibility in technology and science, and on responsibility with regard to specific technological or scientific questions such as artificial intelligence (AI), genetic engineering, biodiversity, the reversibility of technology, and sustainability. It is especially important for the Academy to address these aspects in its dialogue with government, civil society, businesses, professional organisations and the media.

The Academy's science communication work and policy advice provide valuable input for the public and policy debates, explaining the implications of different technologies and setting out the available courses of action.[44] It is thus vital that this work should be guided by the normative principles of honesty, trans-parency, openness, and a willingness to engage in discussion and listen to criticism.

Accordingly, acatech should consider introducing sanction systems for "dishonesty" and positive feedback and reinforcement for exemplary instances of people taking responsibility both within and outside of the Academy.[45]

Responsibility in businesses

Companies must engage in an in-depth discussion of their internal and external responsibilities, with the ultimate goal of creating both a supportive institutional framework and processes for internal reporting of potentially unethical conduct.

Both positive and negative examples can make a useful contribution to this discussion. As well as providing in-house presentations and discussion platforms, companies should empower people to speak up and promote a culture that tolerates mistakes, at least up to a point. The appointment of compliance officers and the introduction of business conduct guidelines or codes of conduct in conjunction with the relevant training can also make a significant contribution.

Companies should also contemplate the establishment and development of ombuds systems. These systems could be incorporated into the company's employee participation structures and processes, with clearly defined competences and procedures. If these systems are to be effective and successful, the company or organisation will need to internally agree on and establish common processes for their development and adoption, as well as for the corresponding training measures, the establishment of ombuds offices and the appointment of ombudspersons. The companies represented in the acatech Senate can and should lead the way in this regard.

43 | For example, critical reflection about the European Ambient Air Quality Directive only occurred late on in the implementation and enforcement stage, meaning that more than a decade went by without taking advantage of technological developments.

44 | See Weitze 2020, p. 68.

45 | Jeremy Bentham was among the first to discuss non-monetary compensation systems. For more on compensation systems, see Kornwachs 2009.

Responsibility in education and training

People tend to be more willing to take responsibility in practice if they learnt about the relevant rules and norms during their education and training. It is impossible to overstate the importance of role models in strengthening these attitudes.[46]

Ethical principles can be incorporated into teaching and training – indeed, learning to take responsibility through the demonstration of best practices involving people and processes working in concert should result in better learning outcomes. This applies in general to teaching in educational settings (schools, vocational colleges), and to people starting a new job, be it in a personal or school environment or within a particular social group. Here too, people can be helped to reflect about their future role and duties in their job and in their professional community.

Ethics and technology assessment should be important components of STEM study programmes, so that part of these programmes' content once again has a clear interdisciplinary focus. Cultural studies should be included alongside philosophy (ethics and philosophy of science), the social sciences and economics. Although in some cases the repeated calls for these changes were heeded, this progress is now increasingly being lost. At several universities, the percentage of interdisciplinary content in study course curriculums is once again being progressively reduced. Far from calling for a return to the old studium generale approach, the aim is to genuinely expand the breadth of the engineering courses on offer by augmenting them with carefully integrated content about their philosophical, historical, sociological, psychological and environmental dimensions.[47] Teachers with the relevant practical experience will have more credibility and will be better placed to provide compelling examples thanks to their professional experience of dealing with and resolving situations that involve taking responsibility – not least when doing so meant criticising their superiors and company management.

Conversely, it would also be desirable for humanities, law, social science and economics courses to offer a compulsory "introduction to modern technologies" module. This would ensure that future decision-makers have at least some familiarity with the technologies they are making decisions about. While some engineering courses offer an introduction to philosophy, there are no courses introducing those who do not study engineering or STEM subjects to nature and the environment and the ways in which technology harnesses them for human purposes, with all the associated opportunities, risks and limitations.

There is also a need to systematically educate policymakers. The coronavirus crisis has highlighted the fact that political responsibility requires a basic understanding of science and technology – a theoretical understanding of fundamental scientific principles is key to science-based responsibility.

46 | Content relating to responsibility has already been partly incorporated into some university engineering courses, e.g. courses on the Responsible and Ethical Conduct of Research at Stanford University (https://doresearch.stanford.edu/training/responsible-conduct-research [Retrieved 28.04.2021]) or at the KIT Academy for Responsible Research, Teaching, and Innovation (https://www.arrti.kit.edu/ [Retrieved 28.04.2021]). For an early example, see: Recommendation of the Association of German Engineers (VDI) Concerning the Integration of Interdisciplinary Content in Engineering Courses, VDI 1990. For an example from the field of chemistry, see Weitze et al. 2017, especially Part IV "Chemie und Gesellschaft" in der Chemieausbildung (chemistry and society in chemistry education).

47 | See VDI 1995, VDI 2018 which, among other things, call for technology assessment skills (p. 11 ff.).

6 Conclusion

People are unlikely to take responsibility unless there are consequences for failing to do so.[48] If someone breaks the law, they are punished or held liable for the damage caused. But responsible conduct goes beyond the letter of the law, and it is here that complicated conflicts and ethical dilemmas can often arise. In many cases, however, people simply lack the courage and determination to systematically apply their own ethical rules, not least when doing so has unpleasant consequences for many of those involved. acatech, too, must consider how it deals (either publicly or internally) with companies, institutions and individual scientists who seriously violate the principles of responsibility. In the worst cases, acatech should be prepared to expel them from the Academy.

In an age of global crises such as pandemics, climate change and environmental pollution, it is more important than ever to use science and technology to detect problems and help find solutions. But this can only happen if the relevant actors in government, industry and civil society are confident that leaders in the fields of science and technology are responsibly committed to the public interest and to sustainable development. If this confidence is undermined by deceit, narrow self-interest or a lack of transparency, there is a danger that society could waste the potential – in terms of expertise, the ability to make sound judgments and the willingness to take responsibility – that is so badly needed to tackle present and future challenges. Everyone who holds a position of responsibility in the fields of science and technology must pay particular attention to these three factors and establish rules to ensure that their joint potential is harnessed. To this end, we need policymakers who understand the key role of science and technology in the 21st century and use it to underpin their policymaking process and decisions.[49] But it is equally important for scientists, entrepreneurs, managers and engineers to include responsibility right from the outset in every decision they make and to act accordingly. If they can do that, then there is a much better chance that we will be able to find and implement good solutions for the major crises of our time.

48 | Ropohl 1996, p. 153 with reference to Aristotle, p. 330 ff. re. the need for sanctions to have legal teeth.
49 | See Mainzer 2020, p. 27.

Appendix

Conference programme "Responsibility in the Technological Sciences"

14 October 2019, 14:00–18:30
Berlin-Brandenburg Academy of Sciences and Humanities, Markgrafenstraße 38, 10117 Berlin

Time	Agenda item	Speakers
14:00–14:15	Introduction	Klaus Mainzer, Technische Universität München
14:15–15:15	Podium Moderator: Udo Lindemann, Technische Universität München	Sicco Lehmann-Brauns, Siemens AG Nicolai Martin, BMW Group Michael Metzlaff, Bayer AG Peter Felix Tropschuh, Audi AG
15:15–15:30	Keynote	Christin Eisenschmid, Intel Deutschland GmbH
15:30–16:30	Podium Moderator: Christoph Lütge, Technische Universität München	Gisela Eickhoff, HARTING AG & Co. KG Christin Eisenschmid, Intel Deutschland GmbH Christian Pophal, Infineon Technologies AG Max Senges, Google Germany GmbH
16:30–17:00	Coffee break	
17:00–17:15	Social responsibility in companies	Wolfgang Stark, Universität Duisburg-Essen
17:15–18:15	Podium Moderator: Klaus Kornwachs, Universität Ulm	Renate Bleich, Munich Re Holger Brackemann, Stiftung Warentest Volker Brennecke, VDI Cornelia Reimoser, Fraunhofer Society
18:15–18:30	Closing remarks	Dieter Spath, acatech President

Conference outcomes

The project conference "Responsibility in the Technological Sciences" was held in Berlin on 14 October 2019. acatech engaged in lively discussions with representatives of manufacturing industry, IT companies, service providers and industry associations. The key ideas, recommendations and outcomes of these discussions are outlined below:

- In companies that have a weak culture of responsibility or none at all, it is important for responsibility to be officially recognised and for employees to learn to accept the consequences of taking responsibility. The ability to openly raise questions of responsibility within the company is key. This involves more than simply establishing a compliance department – a culture of responsibility must be embedded and continuously developed within the business. Employees must "translate" the corporate values into their own actions, for instance through the development of an ownership culture that can be summed up by asking whether, as members of the company, they think that they would like to be their own customers.
- A culture of trust must clearly set out the potential consequences of internal criticism, e.g. the costs of quality defects and safety guarantees. Consequences remain an abstract concept unless they can be backed up at a legal or personal (ethical) level. It is vital to prevent a climate of fear from arising in the first place, and this means not punishing people for being honest.
- Companies have responsibility at several different levels. They are responsible towards their customers, shareholders and employees. An important principle is to act as you would like yourself to act if you were your own customer. But in a social market economy, companies also have a responsibility towards society and the wellbeing of future generations.
- Trust exists at several different levels. People trust individuals and organisations if they are transparent. They trust products that are good and reliable. And they trust companies that follow ethical principles in deed as well as in

word.[50] Consequently, companies that focus solely on financial success are less highly regarded in Germany.

- Corporate Social Responsibility (CSR) requires the stakeholders to have intrinsic motivation, otherwise it can be akin to the sale of indulgences, or in the worst cases nothing more than lip service. CSR is a question of corporate culture, shaping a company's identity and the values that it upholds. Consequently, companies need business models that are compatible with these values. These must be supported by incentive and reward systems[51] and clear rules about what is and isn't acceptable. It is not enough to simply publish a code of conduct – it must also be widely accepted and implemented in practice.
- When conflicts inevitably arise between a company's different goals, they should not be swept under the carpet. The public does not like it when – as they often do when resolving this type of conflict – companies put their financial interests first without communicating the criteria used to arrive at their decision. Shareholders' interests are also often incompatible with the interests of the economy as a whole.
- One conflict that has existed for many years concerns companies' tax arrangements and choice of head office location (e.g. the practice of transferring profits to a country where they pay less tax). Although not illegal, policymakers and the public view this behaviour as morally wrong.[52] Consistent policy rules and sanctions are often completely lacking, and even when they are adopted, it can be a very slow process. For instance, bribes reported in a company's accounts as "useful expenditure" remained tax-deductible in Germany until as late as 2002. It is also difficult to create a single, common set of values in global businesses that encompass several different cultures.
- As far as employees are concerned, the guidelines for good scientific practice that were drawn up twenty years ago[53] could also be applied to R&D work in companies.
- The conflict between acting ethically and acting in the company's commercial interests cannot always be resolved by individual employees on their own. This raises the question of whether conflicts like this should be brought to the attention of the outside world. Ideally, the employee should first try to resolve the problem internally so that their concerns can be heard. Employees should be able to flag up problems and raise them with successive management levels right up to the CEO. When whistle-blowers publicise problems externally without having first raised them internally, it is a sign that the company lacks appropriate internal processes and structures for articulating different points of view. It is thus vital to get better at listening to employees' concerns internally and ensure that they are able to share them in confidence. International codes of conduct would be extremely valuable in this context.
- The key responsibility questions outlined above must be asked systematically and in a concrete manner. Failure to provide clear answers to these questions will result in diffusion of responsibility.
- Research institutions and scientific and engineering organisations can and must assume part of the responsibility for the products that they have helped to develop and their impacts. While they may not have direct, causal responsibility, in principle these institutions nevertheless operate within an economic, social and government system and influence the debate about responsibility (e.g. its nature, goals and actors) and taking responsibility.
- Some institutions are now providing an ethics consultancy service for businesses. Companies also have internal conflict resolution procedures, for example in their development departments. The key is to ensure that the problem is also routinely addressed at higher levels in the company hierarchy.

50 | The figure of the honourable merchant is frequently cited in this context. This model dates back to the Middle Ages but became popular again in the public debate after the financial crisis of 2008. See Wegmann et al./Zilkens/Zeibig 2009.

51 | See below for the problem of responsibility in the supply chain.

52 | Another view expressed in the discussion was that companies cannot be expected to lobby for changes to tax law that would be to their own detriment.

53 | See, e.g. German Research Foundation at https://www.dfg.de/foerderung/grundlagen_rahmenbedingungen/gwp/ombudsman/ [Retrieved 01.02.2021].

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acatech advises policymakers and the general public, supports policy measures to drive innovation, and represents the interests of the technological sciences internationally. In accordance with its mandate from Germany's federal government and states, the Academy provides independent, science-based advice that is in the public interest. acatech explains the opportunities and risks of technological developments and helps to ensure that ideas become innovations – innovations that lead to greater prosperity, welfare, and quality of life. acatech brings science and industry together. The Academy's Members are prominent scientists from the fields of engineering, the natural sciences and medicine, as well as the humanities and social sciences. The Senate is made up of leading figures from major science organisations and from technology companies and associations. In addition to its headquarters at the acatech FORUM in Munich, the Academy also has offices in Berlin and Brussels.

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Anyone who develops technologies and brings them into use bears a corresponding responsibility. However, specialisation and the growing complexity and interdependence of technological, social and environmental factors are increasing the risk of diffusion of responsibility.

This acatech POSITION PAPER aims to stimulate a debate on responsibility in the technological sciences – not only within the technological sciences community and its academy, acatech, but also within organisations, companies and government agencies with a research and technology focus.