NATIONAL ENGINEERING POLICY CENTRE

ROYAL ACADEMY OF ENGINEERING

Meeting challenges from COVID-19

May 2020

The COVID-19 crisis is impacting on almost every aspect of UK life. It is first and foremost a public health crisis but also impacts on industry, business and enterprise, infrastructure and security, public behaviour, and the education of children and adults.

Engineers look after the places they live in. They play a major role in creating and maintaining the infrastructure and systems on which society and the economy depend, such as digital, mobility and healthcare. They create products and services that improve the quality of life, safety and health of their users, are deeply involved in education and research, and lead countless engineering enterprises that contain the seeds of future innovation, productivity and growth.

This note highlights several risks and opportunities that COVID-19 poses for the UK beyond the immediate crisis response, which the engineering community has identified and is providing support on.

It draws on inputs from the Fellows of the Royal Academy of Engineering and partners to the National Engineering Policy Centre, who collectively represent 450,000 engineers across the UK.

Summary

Measures to take during the pandemic to lessen its impact

- National infrastructure resilience and interdependencies: protecting national infrastructure from additional strains and vulnerabilities from the current crisis, which may be exacerbated by interdependencies between them.
- Cybersecurity: mitigating against risks that may arise from large-scale remote working practices.
- Entrepreneurial ecosystem: ensuring the survival and quick bounce-back of R&D and innovation-intensive businesses, both large and small, on which future recovery and growth depends.
- Supply chain agility: understanding and mitigating supply chain disruptions during the pandemic.

Developing an exit strategy

- Infrastructure resilience: sequencing the reduction of social distancing and other interventions to minimise wider risks.
- Data portability and sharing: opportunities and robust engineering approaches to contribute to the lifting of social and behavioural interventions.
- Rebuilding the knowledge economy: measures to restart engineering sectors and investment in R&D.

Building a resilient future

- Building resilience to future emergencies, including through accelerated digitalisation and better understanding of which parts of the system are most sensitive to disruption and how they impact on each other.
- Rapid innovation and scale-up: lessons from the pandemic for better innovation practices.
- Changing attitudes and behaviours: exploring the impact of behaviour change, learning lessons from the crisis and wider implications, for example net zero.
- Addressing engineering skills and diversity challenges, taking advantage of the opportunities created by the pandemic as well as addressing the problems caused by it.

During the pandemic and ongoing social and behavioural interventions

1. National infrastructure resilience and interdependencies

Critical national infrastructure (CNI) are those facilities, systems, sites, information, people, networks, and processes necessary for a country to function and upon which daily life depends.

In the UK, there are 13 national infrastructure sectors: chemicals, civil nuclear, communications, defence, emergency services, energy, finance, food, government, health, space, transport, and water. Not everything within a national infrastructure sector is judged to be 'critical'.

Engineers are working hard to keep basic services such as the electricity network, gas, water supply and communications systems up and running seamlessly. The pandemic and associated social and behavioural interventions may generate a number of additional challenges that could hamper emergency responses if other events, such as flooding and severe weather, cyberattacks, another epidemic or loss of service from another utility provider, were to occur.

Some examples of the additional strains on CNI that should be anticipated and managed are:

- The impact of reduced availability of **workforce** due to illness, self-isolation, caring responsibilities and the impact of COVID-specific safe working practices on operations.
- Anticipating where **routine maintenance may be reduced or disrupted** perhaps leading to missed early warning signs of upcoming failures, for instance in offshore oil and gas and renewable energy. This may include the impact of disrupted supply chains for maintenance and repair materials or dependence on imported goods (for example, water purification chemicals from Europe).
- **Changing demand** on infrastructure, for example the challenges of managing the grid with reduced energy use, increased use of cleaning wipes leading to more wastewater blockages, and local failures with wider knock-on effects.
- **Interdependencies** between different utilities. Understanding which parts of infrastructure are more sensitive to the changes COVID-19 brings about and the potential for knock-on effects throughout the system, which may exacerbate risks.

2. Cybersecurity

A growing number of cyber criminals and other malicious groups online are exploiting the COVID-19 outbreak for their own personal gain. Cyber criminals are shifting their activities, scanning for vulnerabilities in software and remote working tools as more people work from home during the pandemic. There is evidence of increased phishing attacks and propagation of 'fake news' and conspiracy theories.

Additional risks could emerge requiring mitigation:

- Ensuring **organisations' resilience** at a time when software security staff may be self-isolating or ill.
- Protecting against **cybersecurity** risks opened up by new ways of working and operating. For instance:
  - More of our lives are being conducted online, and increased levels of legitimate traffic may make denial-of-service attacks more damaging and more effective.
  - The sharp increase in remote working may increase risks from malware on personal devices or the use of insecure remote access to corporate networks.
- Managing risks to **exploitation and fraud**, which may be opened up by reduced financial checks.

Explainer

A denial-of-service attack is a cyberattack that typically floods the targeted system with requests and traffic to overload and disrupt it and deprive its users of access to it.

Phishing is a criminal attempt to convince you to click on links within a scam email or text message, or to give sensitive information away (such as bank details).

3. The entrepreneurial ecosystem

The COVID-19 pandemic has rapidly and significantly altered the entrepreneurial ecosystem in which the UK's high-tech innovative companies operate, the majority of which are SMEs, including many startups. These companies are a crucial part of the UK's innovation base, often providing the R&D and innovation function for larger companies that have reduced their own R&D and innovation capabilities over recent years. It is vital that this part of our economic system survives the current disruption intact and can push on and grow to scale. The major current impacts are:

- **Funding landscape** – investors are changing their behaviours, reducing investment and preserving funds for existing investments rather than looking for new investments. Some are pulling out of deals and ceasing communication.
- **Access to facilities** – non-software high-tech innovative companies are heavily reliant on labs and specialist facilities to develop their products and services. Many of these activities have halted in the face of non-essential facilities being shut down. This includes universities, offices, manufacturing partners and other test beds.
- **Loss of momentum, skills and ability to plan** – startups are pausing their activities. Their reliance on equity or customer orders leaves limited or no cash reserves to maintain activity. Companies are not able to continue with product development, key recruitment, or progress towards grant and business milestones or plan for the lifting of social and behavioural interventions. This is limiting their preparedness to have the best chance at surviving the crisis and resuming fundraising and innovation activities as the economy recovers.

4. Supply chain agility

COVID-19 has already presented challenges for supply chains and logistics, from the provision of PPE to manufacturing of ventilators and access to the reagents needed to increase UK test capacity.

The global nature of this crisis and constraints on the UK's manufacturing capability will continue to result in shortages caused by worldwide demand. Closed borders and the number of people ill or in isolation may result in skills shortages or missing components in the system that were not assumed to be critical. This is likely to continue into the medium to long term, with examples of challenges ahead including the harvest and post-harvest processing of food and the complex requirements to manufacture diagnostic tests at scale.

In the longer term, as the EU/UK transition period ends, there is a need to anticipate potential emerging issues such as import and export of chemicals or the need for new regulations so supply is not restricted.

- **Identifying the risks of shortages** could increase UK preparedness where key materials and components become difficult to source in the coming months.
- **Agility in manufacturing** can reduce risks, for instance:
  - *Industrial digitalisation* may have a role in facilitating the scale-up of existing production.
  - There have been examples of automotive factories retooling to be able to manufacture medical devices despite different standards applying. Increasing *manufacturing agility between sectors* in the longer term may be beneficial and worth exploring, and we can learn from positive experiences of working at speed through the outbreak.
- It will be crucial to identify those areas most likely to be impacted as the **UK's departure from the EU** takes effect, and to understand which are most critical to sovereign supply chain capacity.

Developing an exit strategy

5. Infrastructure resilience and optimal sequencing to end social and behavioural interventions

The safety and health of the population will be the primary concern when designing the measures to end social and behavioural interventions, while supporting economic recovery.

Alongside medical considerations, such as the use of facemasks and maintaining social distancing, are other practical issues around infrastructure and impacts on business and supply chains:

- Infrastructure is an underpinning element supporting the functioning of the country and the wider economy. It has seen substantial operational changes in recent weeks to accommodate the changes brought about by social and behavioural interventions.
- In sequencing and prioritising a restart to the economy it is crucial to mitigate the risk of sudden changes in demand, and to ensure the restart does not overwhelm supply chains and infrastructure or exacerbate bottlenecks.
- Systems thinking may help to identify parts of the economy that, if released early, could have the most enabling effects on others.

6. Data sharing

As social distancing measures are relaxed, data portability and sharing could play a role in enabling the UK to monitor and understand its effects and identify potential new epidemic waves, among other applications. It will be important to:

- **identify opportunities** to share data and learn from UK and international examples of best practice in existing data sharing initiatives, for example in emergency response situations
- **ensure data is shared responsibly and effectively**. This will include:
  - adopting *robust engineering approaches* to data sharing so that it is assembled, structured and managed to meet clear goals
  - rapidly developing and using *frameworks* that address governance, technical, regulatory, ethical, and security aspects, for example clarity on who is providing oversight and how. GDPR may not always be well adapted to the fast-paced response to the pandemic.
- **consider the ethical implications**. This will include:
  - considering how user and patient perspectives, alongside ethical considerations, can shape technical solutions and ensure their acceptability
  - ensuring that there is transparency for individuals about the purpose of collecting the data, and how it will be used, protected and deleted.

7. Rebuilding the knowledge economy

A knowledge economy remains the best bet for future prosperity, and engineering has huge potential to drive a more prosperous future. Several challenges and opportunities present themselves.

- Rebooting the country's engineering capability. Engineering sectors are diverse and will be differently impacted, so will require different responses. Challenges are likely to include:
  - reliance on heavily fragmented supply chains, especially those with serial dependency and 'as strong as the weakest link', exacerbated by COVID-19, for instance in the construction sector, and the impact of withdrawn orders for instance in the aerospace sector
  - SMEs and other businesses with narrow margins
  - organisations with an older workforce, which may be differentially affected by the lockdown measures.
- Much else will have changed in the economy, which will impact on R&D intensive businesses, including:
  - interruption of the vital skills pipeline following severe disruption to universities, further education colleges and other contributors
  - impacts on private R&D funding as businesses and research funding charities manage the economic downturn and universities manage the impact of the crisis on numbers of overseas students.
- A need to consider overlaps with other societal targets such as net zero, professional ethics and a fairer society.
  - There is a danger that attention will be diverted away from these ongoing aims, or they will be pushed out by the pressure to make up lost economic ground.
  - With advance thought there is a valuable opportunity to put things back in a way that advances social aims rather than hinders them, for instance through targeted use of recovery funding.

Some immediate measures that could help mitigate future impacts on engineering sectors include continuing design work and planning of infrastructure projects (even if construction is delayed), and rapidly progressing construction and infrastructure projects awaiting approval or completion as the economy opens up again.

Building a resilient future

There will be opportunities to learn from the pandemic response and feed into the rebuilding process to ensure a more resilient future. Although these require a longer-term outlook, they may need to be attended to relatively soon if we are to grasp opportunities and mitigate longer-term damage.

8. Building resilience to emergencies.

We must take opportunities to build a stronger and more resilient UK. Opportunities lie in many areas including:

- identifying infrastructure and supply chain sensitivities and vulnerabilities
- using high-fidelity digital models of sociotechnical infrastructure (Digital Twins) in detecting early indications of infrastructure stress and failure
- championing resilient system design and revisiting design parameters to allow infrastructure to mitigate for pandemics and other shocks
- assessing the future resilience of supply chains. Where has the crisis highlighted the need for indigenous manufacturing of critical items and 'sovereign capability' and where are buffer stocks or secure supply chains are more appropriate?
- considering capacity and resilience of medical facilities for the longer term.

For example, the pandemic has highlighted the need for high-speed broadband available across the country and has exposed inequalities resulting from differences in the service people receive.

9. Using lessons from the crisis to accelerate progress.

The crisis has forced rapid changes that have shown where rapid progress is possible and exposed where further progress is much needed.

- **Digitalisation**: the crisis is generating learning about how to accelerate the diffusion and uptake of digital technology and automation to increase UK resilience and competitiveness, for example by facilitating remote working, enhancing supply chain agility and monitoring infrastructure.
- **Rapid innovation and scale-up**: innovation and scale-up have been a crucial component of the response to COVID-19, happening at incredible pace. There is a need to learn lessons to enable rapid innovation and scale-up post pandemic and in non-emergency situations. Issues include coordination and collaboration, rapid and dynamic regulation, open innovation with agile release of IP and rapid open funding schemes, and uptake of innovation at pace, for example in the NHS.
- **Changing attitudes and behaviours**: the pandemic has undoubtedly changed attitudes towards business travel and increased uptake of videoconferencing and home delivery, with implications for both private operators and government contracts. It may also be impacting on public perceptions of data sharing and privacy, for example. There is a need to examine the implications of this behaviour, to examine what worked well and what did less so, and understand and apply lessons for other societal goals such as net zero.

10. Skills and education

There is potential for an interruption to the pipeline of new talent coming from the education system into the sector and a loss to the skills base from the crisis, as well as disruption to school education with additional diversity and inclusion implications. The UK must both mitigate these issues while learning lessons from what did and didn't work well.

- The pandemic highlights the need and opportunity for accelerated *innovation in online learning methodologies* to support workers who primarily acquire or upgrade skills within the workplace, taking into account diversity and inclusion considerations. There may be options for early mitigation, for instance through access to high-quality, well signposted STEM resources hosted on single platforms.
- School closures may replicate the 'summer learning gap' in which pupils from *disadvantaged households* typically regress while those from more affluent and aspirant families consolidate learning from the previous year. The pandemic is already highlighting socially stratified access to resources and high-speed internet connections.
- There is a need to understand and evaluate the impact on pupils from *disadvantaged backgrounds* with a focus on barriers to STEM subjects, and the potential knock-on effect for these pupils being able to then follow engineering careers.
- The crisis raises questions about how to *move to an increasingly digital future* in ways that reduce rather than exacerbate educational inequality.

NATIONAL
ENGINEERING
POLICY CENTRE

ROYAL
ACADEMY OF
ENGINEERING

Royal Academy of Engineering

The Royal Academy of Engineering is harnessing the power of engineering to build a sustainable society and an inclusive economy that works for everyone.

In collaboration with our Fellows and partners, we're **growing talent and developing skills for the future, driving innovation and building global partnership**s, and **influencing policy and engaging the public**.

Together we're working to tackle the greatest challenges of our age.

What we do

Talent and diversity

We're growing talent by training, supporting, mentoring and funding the most talented and creative researchers, innovators and leaders from across the engineering profession.

We're developing skills for the future by identifying the challenges of an ever-changing world and developing the skills and approaches we need to build a resilient and diverse engineering profession.

Innovation

We're driving innovation by investing in some of the country's most creative and exciting engineering ideas and businesses.

We're building global partnerships that bring the world's best engineers from industry, entrepreneurship and academia together to collaborate on creative innovations that address the greatest global challenges of our age.

Policy and engagement

We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

We're engaging the public by opening their eyes to the wonders of engineering and inspiring young people to become the next generation of engineers.

About the National Engineering Policy Centre

We are a unified voice for 39 professional engineering organisations, representing 450,000 engineers, a partnership led by the Royal Academy of Engineering.

We give policymakers a single route to advice from across the engineering profession.

We inform and respond to policy issues of national importance, for the benefit of society.

Contact:
Nick Starkey
Director of Policy
Royal Academy of Engineering
nick.starkey@raeng.org.uk

Royal Academy of Engineering
Prince Philip House
3 Carlton House Terrace
London SW1Y 5DG

Tel 020 7766 0600
www.raeng.org.uk
@RAEngNews

Registered charity number 293074