

COVID 19: Engineering a resilient future

From ideas and insights to collective engineering advice

June 2020

Overview

The immediate effects of the COVID-19 pandemic are being acutely felt across all aspects of our daily lives. This public health crisis will transform and leave an enduring impact on industry, business and enterprise, infrastructure and security, and on public behaviour and social attitudes. The pandemic's legacy will be experienced by all generations across the whole of society.

Engineering COVID-19 response

As the UK tentatively emerges from lockdown, engineers can play a strong leadership role to identify and manage the socio-technical, economic and systemic risks, which could limit further harmful impact from this crisis, **advising government on how to engineer a more resilient future**.

Engineers build and maintain the national infrastructure and the supporting systems on which society and the economy depend, in digital, mobility and healthcare. Engineers innovate, design and create new products and services to improve the quality of life, and they protect the safety, security, health and wellbeing of the public. Engineers are deeply involved in education and research, leading countless engineering enterprises and projects, sowing the seeds of innovation, future productivity and growth.

www.raeng.org.uk/policy/engineering-response-covid-19-coronavirus

This paper summarises **how engineers can transform their ideas into advice and action, minimising the risks and impact of COVID-19 for the UK, beyond the immediate crisis response, to secure a more resilient future**.¹ It draws upon evidence and insights from Fellows of the Royal Academy of Engineering and partners to the National Engineering Policy Centre (NEPC), which collectively represent 450,000 engineers across the UK.²

This paper contains several case studies that illustrate **how the engineering community has already provided rapid support and advice on the COVID-19 pandemic**.

In annex A, there is a breakdown of NEPC expertise by institution. This includes work completed and work still underway; **a useful guide to help government identify and source the right engineering advice and expertise**.

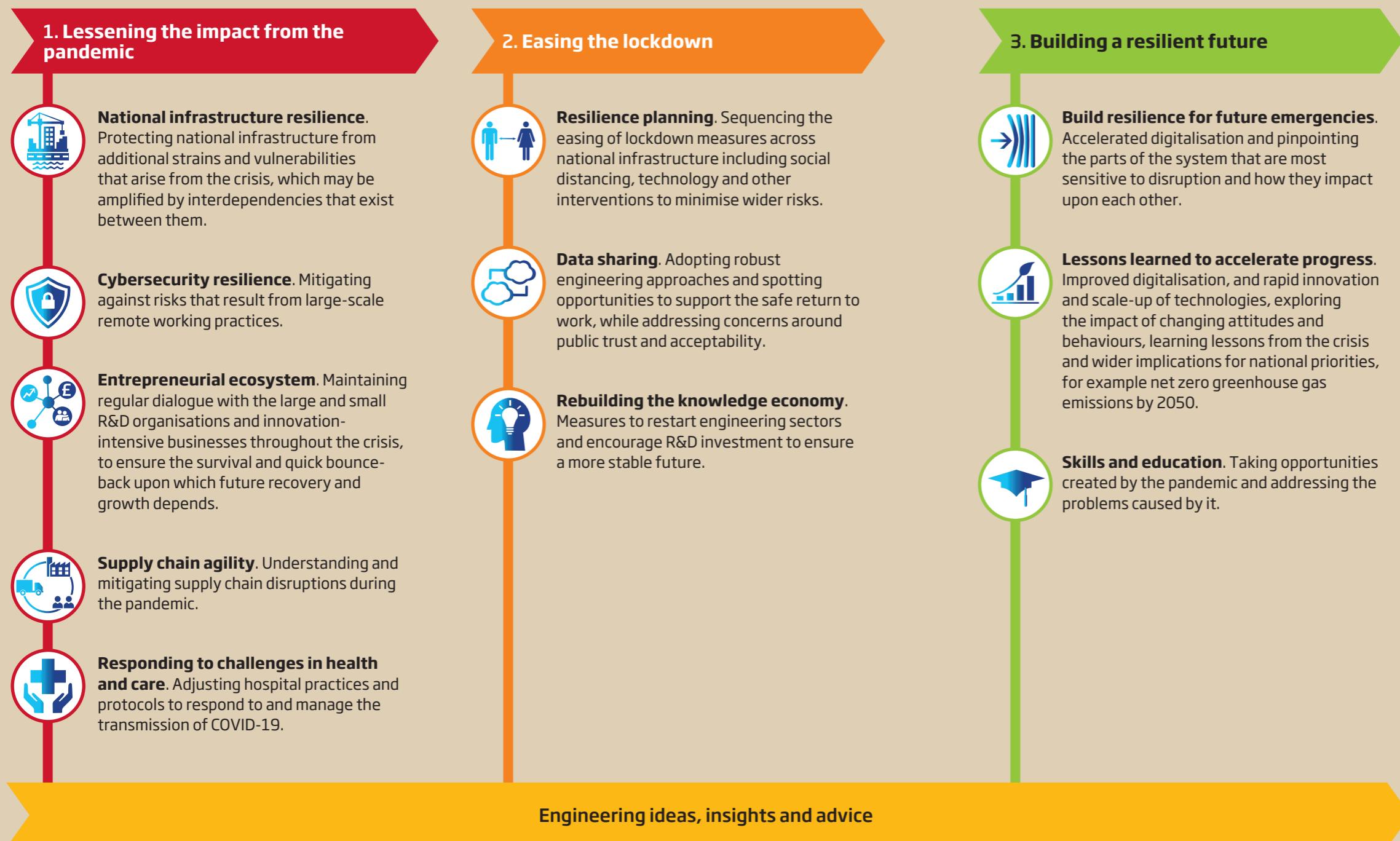
As the UK is still living with the pandemic, and new data and information is emerging every day, the engineering response will need to be agile. This paper presents the engineering response in three stages, recognising that in reality these will be fluid and overlap:

- 1. Lessening the impact**
- 2. Easing the lockdown**
- 3. Building a resilient future**

¹ Meeting Challenges from Covid-19, Royal Academy of Engineering, April 2020, <https://www.raeng.org.uk/publications/reports/meeting-challenges-from-covid-19>

² National Engineering Policy Centre is an ambitious partnership, led by the Royal Academy of Engineering, between 40 different UK engineering organisations representing 450,000 engineers. It provides critical engineering expertise on policy issues of national importance

Summary



1. Lessening the impact from the pandemic



National infrastructure resilience and interdependencies

Critical national infrastructure (CNI)³ are those facilities, systems, sites, information, people, networks and processes, necessary for a country to function and upon which daily life depends.

Engineers keep basic services such as the electricity network, gas, water supply and communications systems, up and running. The pandemic may generate additional challenges that could hamper emergency preparedness and response.

Additional strains may be placed upon CNI, if other risks⁴ and events such as flooding and severe weather, cyberattacks, another epidemic or loss of service from another utility provider were to occur simultaneously or during the recovery phase.

A closer look

Engineers can provide evidence-based advice to minimise disruption and to lessen the impact. For example:

- **Routine maintenance and repair** due to reduced workforce or remote working practices. Difficulty accessing essential supply chains, products and services, resulting in missed early warning signs of failure, for instance in offshore oil and gas and renewable energy.
- **Changing demand on infrastructure.** Managing the grid with reduced energy use, disruption to utilities resulting from behaviour change. Increased broadband demand, and additional burden on sewerage system due to use of non-flushable wipes.

- **Interdependencies between different utilities.**

Sectors comprising the national infrastructure operate as a **system of systems**,⁵ where knock-on effects in one sector can lead to unintended consequences or new risks emerging within other sectors.

Case study: identifying interdependencies across national infrastructure to support resilience planning

Royal Academy of Engineering

The Royal Academy of Engineering convened a workshop of industry sector leads and systems thinkers to test a new approach to identify critical interdependencies across the UK economy, infrastructure and society. A mapping exercise was completed, which highlighted connections between government departments, and between different parts of the national infrastructure, and raises questions about connections that may emerge as a result of COVID-19. This multi-domain matrix method,⁶ which examines the interdependencies that exist between different sectors, could potentially be used in future resilience planning; for locating unintended consequences and determining probabilities of specific outcomes that may result from easing the lockdown.

3 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'. <https://www.cpni.gov.uk/>

4 National Risk Register of Civil Contingencies, 2017 Edition. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644968/UK_National_Risk_Register_2017.pdf

5 A system consists of a group of elements which interact primarily with each other, often these elements from outside of that system will impact upon the system that has been defined and will form part of another definable system. A '**System-of-systems**' refers to the study of how multiple systems interact and impact one another

6 Method developed by Professor John Clarkson, FREng. <https://www-edc.eng.cam.ac.uk/people/pjc10.html>

Lessening the impact from the pandemic



Cybersecurity resilience

A growing number of cyber criminals and other malicious groups online are exploiting the COVID-19 outbreak, shifting their activities as more people work from home.

There has been an increase in reported phishing attacks⁷ and propagation of 'fake news' and conspiracy theories. Cyber warnings have been issued caused by malicious 'password spraying' campaigns targeting organisations such as healthcare policymakers and researchers involved in the coronavirus response.

►► A closer look

Engineers can advise on the following risks:

- **Strengthening organisational resilience** if software security staff self-isolate or are off sick.
- **Raising awareness and protecting against risks** that arise from new ways of working and operating. For example, denial-of-service attacks, increased risks from malware on personal devices or the use of insecure remote access to corporate networks.

Case study: cybersecurity in a COVID-19 world BCS

BCS, the Chartered Institute of IT, held a webinar on how the coronavirus is changing the cybersecurity threat landscape. Cybersecurity experts discussed how a better awareness of current tactics adopted by cyber criminals, such as use of malware and phishing attacks, can help to develop practical, actionable and effective mitigation.

www.bcs.org/content-hub/webinar-coronavirus-cyber-security-threats-and-responses/

The entrepreneurial ecosystem

There has been a rapid change to the UK's entrepreneurial ecosystem, which includes high-tech innovation companies, SMEs, and engineering startups. These form a crucial part of the UK's prized innovation base and seed the R&D and innovation in larger companies where in-house capability has been scaled back in recent years. It is vital that this ecosystem survives the current disruption intact and is supported to advance and grow to scale.

►► A closer look

Regular dialogue with the engineering community is important to understand and manage risks in the following areas:

- **Funding landscape.** Investors are changing their behaviours, reducing investment and preserving funds rather than looking for new opportunities.
- **Access to facilities.** High-tech innovation companies that are heavily reliant on labs and specialist facilities (often classed as non-essential services) for their product and services development. These tech companies have shut down their activities during the lockdown.
- **Loss of momentum, skills and ability to plan.** Startups rely on equity or customer orders to remain business viable. With limited or zero access to cash reserves, many companies are unable to continue with product development and progress against their business plans has ground to a halt. Their ability to survive the crisis and resume fundraising and innovation activities as the economy recovers has been severely hampered.

⁷ A **denial-of-service attack** is a cyber-attack which 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). **Password spraying** is the attempt to access a large number of accounts using commonly known passwords. National Cybersecurity Centre website: <https://www.ncsc.gov.uk>

Lessening the impact from the pandemic



Case study: insights from high-tech innovative startups **Royal Academy of Engineering**

To understand the immediate impacts high-tech innovative startups were facing, and where government interventions might be able to help, a call was put out to companies in the Academy's Enterprise Hub. Within 36 hours 34 companies responded. Their insights were summarised and shared with policymakers across government, resulting in ongoing engagement to inform policymaking and a version has been published online. Rapid evidence will continue to be gathered from this community as government interventions relevant to them come online.

www.raeng.org.uk/publications/briefings-statements-letters/covid-19-immediate-impact-on-high-tech-innovative

Supply chain agility

COVID-19 has already presented challenges for supply chains and logistics, from personal protective equipment (PPE) provision, to ventilator manufacture and access to the reagents needed to increase the UK's testing capacity. The global nature of this crisis combined with constraints in the UK's manufacturing capability will continue to result in shortages due to worldwide demand.

►► A closer look

As the EU/UK transition period ends, anticipating emerging issues such as import and export of chemicals or the need for new regulations to ensure unrestricted access to supplies will be vital. Engineers can play an important role in mitigating against the risks arising:

- **Early identification of shortages in the supply of materials and components.** A strategy in place to meet demand and improve the UK's preparedness including creating an overcapacity.
- **Agility in manufacturing.** Industrial digitalisation to facilitate the scale up of existing production. Skills, capability and capacity transfer across sectors may be beneficial, for example shifting manufacturing capability to medical devices and factoring in different clinical standards.
- **Analysing the impact from the UK's departure from the EU.** Understanding spikes and dips in supply and demand, identifying the pinch points and critical parts of the supply chain to support future resilience planning.

Lessening the impact from the pandemic



Responding to challenges in health and care

Case study: supply chain vulnerability

Industry and NEPC partners

The Academy published an online survey to gather information about current and future supply chain challenges and possible intervention points from across the engineering community.

Analysis of the responses is still underway. However, there are several themes emerging. For example, companies facing failure due to lack of supplies, business continuity issues because of supply chain vulnerabilities and cash flow issues (were identified by 50% of the responses). A shortage of PPE was raised by oil and gas, pharmaceuticals and medical devices, construction and utilities. There are growing concerns about access and affordability of supplies from China, US and Europe linked to the UK's exit from the EU, exchange rates and US-China trade relations. The Academy is currently deciding on the next steps for this work and has been sharing its initial findings with government.

www.raeng.org.uk/policy/engineering-response-covid-19-coronavirus/supply-chains-call-for-information

The spread of COVID-19 in hospitals is a complex problem that is affected by virus transmission routes and the hospital environment itself; specifically, how patients, the public and services interact with it.

►► A closer look

Engineers can support hospitals and protect patients and medical and healthcare staff, by adapting practices and protocols to respond to and manage the transmission of COVID-19. This includes limiting the risk of transmission at multiple points in the system, for example:

- environmental decontamination
- personal and respiratory protective equipment
- hand hygiene
- environmental design.

Case study: managing the transmission of COVID-19 in hospital environments

CIBSE, IHEEM, IMechE, IPEM

Drawing on the expertise from the Chartered Institution of Building Services Engineers (CIBSE), Institute of Healthcare Engineering and Estate Management (IHEEM), Institution of Mechanical Engineers (IMechE) and Institute of Physics and Engineering in Medicine (IPEM) a summary of the wide-ranging engineering interventions was compiled at pace and fed into Scientific Advisory Group for Emergencies⁸ (SAGE) subgroups. Further information can be found here.

www.raeng.org.uk/publications/briefings-statements-letters/engineering-factors-that-will-limit-covid-19

⁸ For further information: <https://www.gov.uk/government/groups/scientific-advisory-group-for-emergencies>

2. Easing the lockdown



Resilience planning

Safely removing the lockdown to get the economy up and running, while ensuring that a second wave of infections does not occur, is a fine balancing act. There will be practical measures that can be deployed, for example the use of PPE, and more difficult logistical challenges, such as maintaining social distancing in diverse and different work environments and on public transport.

A closer look

Engineers can provide useful advice and a practical steer on:

- **Applying operational changes** across the national infrastructure to maintain social distancing when lockdown is relaxed. For example, advice around planning, design, and modelling of passenger flow could be helpful.
- **Change in demand and supply.** The phased return to work could lead to a sudden increase in demand for products and services, putting extra pressure on the supporting infrastructure, for example transport and energy sectors.
- **Deploying systems thinking.** Helping decision-makers to identify which parts of the economy need to come online early, and in what order, to maximise the wider benefit across other sectors of the economy.

Case study: emerging from the lockdown - safely re-occupying buildings CIBSE

As businesses start to consider bringing staff back into work premises, there are several issues that need to be considered for the safety of everyone entering the building.

As airborne transmission remains a possible risk indoors, the CIBSE has published guidance for business owners, managers and employers, which advises on safe working practices and assessing building services when preparing an office for safe re-occupation. The guidance covers requirements for the ventilation system and processes for safe recommissioning of lifts and elevators.

www.cibse.org/coronavirus-covid-19/emerging-from-lockdown

Easing the lockdown



Data sharing

Contact tracing, and the national rollout of the NHS app, is an integral part of the government's strategy to get people back to work, and to get the economy back on track. Challenges around data sharing and portability will become a live and potentially controversial issue, as it links directly with civil liberties and privacy.

A closer look

Engineers can advise on the following:

- **UK and international examples of best practice** in existing data sharing initiatives, for example in emergency response situations.
- **Responsible data sharing.** Using robust engineering approaches⁹ to data sharing, being clear and transparent about oversight, ownership, data storage and use. Rapidly developing and using frameworks that address governance, technical, regulatory, ethical, and security aspects. GDPR may not always be well adapted to the fast-paced response to the pandemic.
- **Ethical implications.** Considering how user and patient perspectives, and ethical considerations, can shape technical solutions and ensure their acceptability.

Case study: contact tracing International engineering academies

The Academy has been convening the expertise from across its global networks to explore challenges posed by coronavirus, from diagnostic testing and PPE to contact tracing. This has encouraged greater knowledge sharing and fostered international collaboration between experts, cutting through traditional geographical boundaries and national interests.

Representatives of government and industry in Estonia, Singapore, South Korea, New Zealand and the UK gave updates on their different approaches to app development and data gathering. Discussions covered a broad range of challenges and solutions, from balancing efficacy and privacy, to engaging the public to use contact tracing apps, and achieving international interoperability. Discussions with international partners such as US and France on future collaboration and follow-up is currently ongoing.

www.raeng.org.uk/policy/engineering-response-covid-19-coronavirus/international-responses

Easing the lockdown



Rebuilding the knowledge economy

An active and resilient knowledge economy underpinned by engineering expertise remains the best bet for future prosperity.

► A closer look

There will be many difficult hurdles to overcome as the economy slowly recovers from this shock, and engineers working in partnership with government, academia and industry can work together on the following:

- **Rebooting the country's engineering capability.** Engineering industry is diverse and since each sector and type of organisation will be differently impacted, a range of responses will be needed. Access to fragmented supply chains will continue to impact on the construction and the aerospace sector, which will suffer from lost orders. Organisations with an older workforce, and SMEs with narrow business margins, will need to be supported as lockdown measures are eased.
- **Supporting R&D intensive businesses** to ensure that the vital skills pipeline, following severe disruption to universities, further education colleges and others, is maintained and actively nurtured.
- **Availability of R&D funding^{10,11}** as businesses and research funding charities manage the economic downturn and universities manage the impact of the crisis on numbers of overseas students.

• Net zero and the sustainability agenda.^{12,13}

An opportunity to explore practical measures for how economic growth can be achieved while being more closely aligned with societal targets such as net zero, professional ethics and a fairer society.

• Mitigating future impacts on the engineering sector.

Continuing with design work and planning of infrastructure projects, even if the construction phase is delayed. Getting projects 'shovel ready' as the economy begins to re-emerge post lockdown

Case study: innovation in a crisis Royal Academy of Engineering

Through an online Q&A series, the Academy is shining a spotlight on how the engineering community has rapidly mobilised its professional expertise in response to COVID-19, learning lessons from innovating and scaling at pace. Highlights include interviews with engineers involved in the VentilatorChallenge UK, the Mercedes and UCL collaboration to produce a breathing aid, and skills and technology deployment at the Nightingale Hospitals. These virtual events are open to the public.

www.raeng.org.uk/events/event-series/innovation-in-a-crisis-online-events

10 Increasing R&D Investment: business perspectives, Royal Academy of Engineering, 2018

11 RADICAL INNOVATION A blueprint for a new UK research and technology funding agency, Royal Academy of Engineering, 2020

12 Net zero: as systems perspective on the climate challenge, Royal Academy of Engineering, May 2020.
<https://www.raeng.org.uk/publications/reports/net-zero-a-systems-perspective-on-the-climate-chal>

13 Sustainable Living Places, Royal Academy of Engineering, due for publication June 2020.

3. Building a resilient future

The process of rebuilding the economy will take time, there will be lessons to be learned from the pandemic response which will inform the recovery process and support a more resilient future.



Building resilience to emergencies

Long-term strategic planning and foresight will need to be deployed. There will be a series of choices that need to be made in the near term that capitalise on opportunities as they arise, mitigate against longer-term damage and build resilience to future emergencies.

A closer look

Engineers can help to build a stronger and more resilient UK; their expertise and knowledge can be harnessed to:

- **Identify infrastructure and supply chain sensitivities and vulnerabilities** including long-term capability and resilience of medical facilities.
- **Champion resilient system design**, revisit infrastructure design standards to mitigate against future hazards, risks and other shocks.¹⁴
- **Assess the future resilience of supply chains**, identify which parts the UK needs to safeguard or develop a national 'sovereign' capability or understand where buffer stocks or secure supply chains are more appropriate.



Lessons learned to accelerate progress

As the UK emerges from the lockdown, there will be an increased appetite for probing and assessing the choices that have been made throughout the crisis. Lessons will continue to be learned as further evidence and commentary emerges, providing a real chance to shape, progress and accelerate economic recovery.

A closer look

The pandemic response has shown that the engineering community can collectively deliver an effective and impactful response in a crisis. Equally, the pandemic has exposed areas where further socio-technical progress is still urgently needed and where engineers can continue to strengthen and support the UK's future resilience planning.

- **Digitalisation.** Learning how to improve the uptake of digital technology and raising awareness about the role of automation.¹⁵ For example, by facilitating remote working, enhancing supply chain agility and monitoring infrastructure.
- **Rapid innovation and scale up.** A crucial component of the response to COVID-19, it will need to be supported and sustained in non-emergency situations. This will require 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.

¹⁴ Rapid review of engineering factors that will influence the spread of COVID-19 in hospital environments, Royal Academy of Engineering, May 2020

¹⁵ Safety and Ethics of Autonomous Systems, Royal Academy of Engineering, due for publication June 2020

Building a resilient future



Skills and education

- **Changing attitudes and behaviours.** Reduced business travel, increased videoconferencing and an increase in the use of home delivery services and will have an impact on how private business and government function in the future. Public perceptions of data sharing and privacy may change with the roll out of contact tracing apps. Engineers will need to understand, respond to and adapt to these changes, to inform future thinking and project design, for example around net zero and the wider sustainability agenda.

It is possible that STEM education, and the pipeline and diversity of new talent coming into the engineering sector will be disrupted, with a net loss in the technical skills base arising from the crisis. It will also be vital to understand the impact of the crisis on efforts to improve diversity and inclusion within the engineering community.

►► A closer look

There is an opportunity to learn from measures adopted during lockdown, including ways of working. For example:

- **Rapid innovation in online learning** to support workers to gain new skills or upskill within the workplace. A chance to develop high-quality, well signposted STEM resources hosted on easy-to-access, single platforms.
- **Social mobility impact.** Pupils from disadvantaged backgrounds suffer from the equivalent of a 'summer learning gap',¹⁶ made worse by the limited access to equipment and high-speed internet connections for online learning. The drive to move to online learning needs to be balanced with accessibility.

¹⁶ Covid-19 Impacts: Schools Shutdown, The Sutton Trust, April 2020.
<https://www.suttontrust.com/wp-content/uploads/2020/04/COVID-19-Impact-Brief-School-Shutdown.pdf>

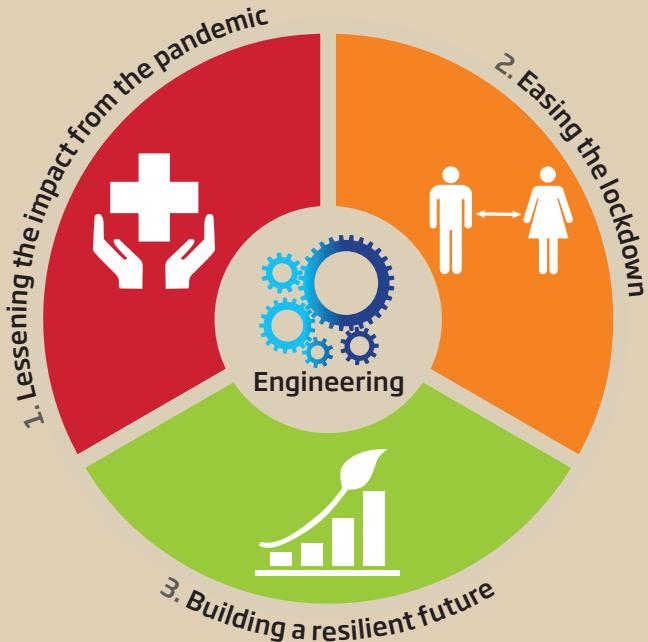
Final thoughts

As the UK emerges from the lockdown, engineers can bring their unique insights and expertise to inform actions taken around socio-technical, economic and systemic risks that may arise. This distinctive engineering thinking, resulting in practical, evidence-based advice, will help to inform and test the feasibility of measures that are rolled out.

As the case studies in this document clearly demonstrate, the engineering community has a proven track record of providing high-quality, rapid, diverse and independent expertise to government in this current crisis. It also has a knowledgeable and expert voice to contribute in future national resilience, emergency preparedness, response and planning conversations.

Over the upcoming months of this crisis, there will be many opportunities for engineers to shine, tackle this pervasive inter-generational challenge, influence and shape longer-term decisions that are critical for guaranteeing a more resilient future.

Engineering a resilient future

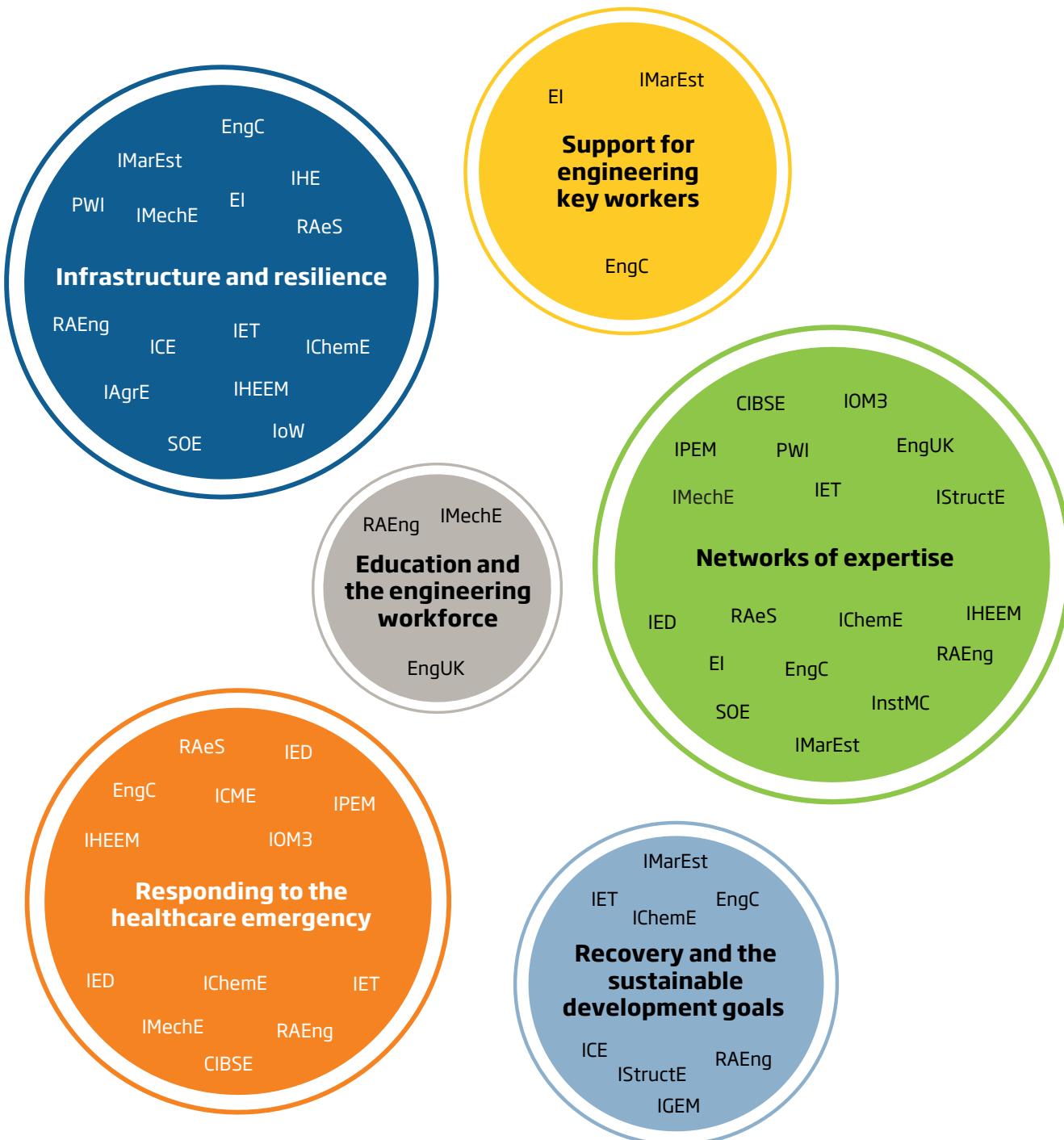


If you are interested in finding out more about this COVID-19 work or you would like to discuss how the engineering community may be able to provide advice to your organisation please contact:

nepc@raeng.org.uk

Annex A

COVID-19 response Summary of professional engineering expertise across the NEPC



Key to NEPC activities

Policy Centre Partner	Active areas and offers of support
Engineering Council (EngC)	UK Standard for Professional Engineering Competence UK-SPEC and the ICT Technician Standard: key ingredients of the up-skilling, career changes and new engineering skills that will be required to meet the post-pandemic challenges. The profession is being supported via appropriate adjustments to licensing conditions and accreditation visits.
	Consideration as to how engineers and technicians who volunteered during the pandemic may be thanked for their efforts.
	A vehicle for considering engineering ethics matters during and post COVID-19 with the joint EngC/RAEng Engineering Ethics Reference Group.
	International insight into the regulatory and professional body post-pandemic challenges and solutions in other countries.
Engineering UK (EngUK)	Detailed expertise of the trends in science, technology, engineering and maths (STEM) educational participation and attainment across academic and technical pathways into engineering.
	Understanding of the barriers (that existed prior to the pandemic and that are only likely to make it more challenging) to increase the number and diversity of young people choosing engineering.
	Research published through a biennial State of Engineering report, as well as a range of research and policy briefings. Research insights and policy advice on the impact of the crisis on the workforce and pipeline are on offer.
	A detailed understanding of what works in STEM engagement, with insight from the student perspective, and a very well-developed network with providers, employers and schools.
Chartered Institution of Building Services Engineers (CIBSE)	Expertise in ventilation, filtration and related topics, including airtightness of buildings.
Energy Institute (EI)	Identifying new risks arising due to changing asset utilisation patterns, workforce social distancing and absence.
	Pastoral and professional support to individual members.
	Support including: production and dissemination of guidance for safe continued working in front line energy operations during the pandemic, for example in the oil and gas and wind sectors; application to COVID-19 of existing human factor methodologies that support assessment and communication around health and safety; disseminating calls to the membership for help being coordinated by other bodies and academic institutions.
Institution of Civil Engineers (ICE)	Revisiting design parameters very quickly to allow infrastructure to minimise and mitigate the effects of future pandemics.
	Developing the ideas for a national infrastructure recovery plan.
Institute of Cast Metals Engineers (ICME)	Support for the MoD and the medical industry with cast aluminium parts.

Policy Centre Partner	Active areas and offers of support
Institution of Chemical Engineers (IChemE)	Active COVID-19 network of volunteers with workstreams covering diagnostic test methodology and production of test kit, rapid scale up of the production of vaccines and treatments, and hospital services and medical supplies including sterilisation processes for PPE and facilities.
Institution of Engineering Designers (IED)	<p>Network of professional designers working on large and smaller scale projects, both immediate and longer term.</p> <p>'Engineers4theNHS' project established to answer immediate calls for assistance from NHS and wider healthcare profession, in conjunction with Keele University.</p>
Institution of Engineering and Technology (IET)	<p>Cross-disciplinary engineering work across: immediate impact of pandemic, effect of social distancing and recovery, with a particular focus on technology to address social isolation.</p> <p>Support the exchange of ideas between engineers across the world.</p>
Institution of Gas Engineers and Managers (IGEM)	Support for BEIS with the challenge of decarbonising the energy system.
Institute of Highway Engineers (IHE)	Transport resilience training course to help highway engineers better prepare for dealing with emergencies affecting the nations highway infrastructure.
Institute of Healthcare Engineering and Estate Management (IHEEM)	<p>Issued national and international callouts to IHEEM's individual and corporate membership for technical and professional support to both NHS England & Improvement (NHSE&I) and World Health Organisation (WHO). To date there have been approximately 150 offers of help and support forwarded directly to NHS E&I and WHO via the International Federation of Healthcare Engineers.</p> <p>Effective engagement with NHS E&I and Devolved Administrations to quickly and effectively disseminate their key messages out to the membership.</p>
	Development of free toolkits to support front-line engineering staff. For example, Medical Gas Oxygen COVID-19 Demand Tool and Medical Gas Cylinder Management and Tracking Tool.
	Published fortnightly international newsletter to share intelligence, best practice and personal experiences with IHEEM's global membership.
	Established a focused Specialist Technical Panel to respond to national and local calls for specialist advice and guidance on the technical engineering challenges raised by COVID-19. This panel is well placed to provide engineering support and resilience to the national policy and guidance functions.
	Developed and published IHEEM factsheets on key topics. For example: reprocessing of PPE (Respirators)
	Working closely with the estates and facilities team at NHS E&I to develop future standards guidance and policy, and in collaboration with RAE, influence Government Engineering policy, including STEM.
	Plan to hold (virtual) events focussing on lessons learned and key engineering themes resulting from the pandemic.

Policy Centre Partner	Active areas and offers of support
Institute of Marine Engineering, Science & Technology (IMarEst)	<p>Network and engagement with marine engineers, scientist and technologist around the world in assisting UK's effort to address the global pandemic, understanding which companies might be in a position to design and develop essential equipment required by the frontline workers such as breathing apparatus and life support systems and how PPE can and will need to be provided to ships.</p>
	<p>Short term activities include a webinar series and papers covering the immediate effects on shipping with other sectors to follow. Longer term projects and initiatives related to COVID-19 and its impact on marine and maritime industries and vice versa (i.e. the role of the ocean in support health) are in development. This will include projects on mental health for seafarers, addressing issues of food security (through fishing and aquaculture Special Interest Groups) in Small Island Developing States and longer term impacts on shipping and the use of humans in transportation of goods (i.e. the rise of autonomy).</p>
	<p>Support for members, through provision of immediate information via a webpage but longer term regarding CPD & membership as the shipping industry and offshore industries will be facing very challenging times over the next 18 months.</p>
	<p>There will be a need for collective, accelerated action to realise the UN Sustainable Development Goals which lie at the heart of the IMarEST strategic plan - and to ensure that a Green (and Blue) recovery is high on the agenda.</p>
Institute of Measurement and Control (InstMC)	<p>Large network of industrial engineers, many of them chartered, from a variety of fields with strong technical knowledge and a willingness to help, including: strong knowledge basis related to digital transformation, possibly instrumentation engineers to volunteer for testing and calibration of equipment and qualified industrial engineers who could review designs, proposals and papers quickly.</p>
Institution of Mechanical Engineers (IMechE)	<p>IMechE at Home are providing access to home-learning educational activities.</p>
	<p>Running a global student competition looking for innovative ideas to tackle the effects of COVID-19.</p>
	<p>Construction and Building Services Division are developing guidelines to support businesses and others back into the workplace by identifying ways to reduce infection control through building management systems.</p>
Institute of Materials, Minerals & Mining (IOM3)	<p>Access and ability to bring together experts, networks, manufacturers and researchers with knowledge of manufacturing sectors, materials and supply chains.</p>
	<p>Honest broker, with the ability to assess calls, cases and disseminate requests openly and quickly.</p>
Institute of Physics and Engineering in Medicine (IPEM)	<p>COVID-19 cross-speciality community of interest: open to members and non members, including clinical and biomedical engineers, clinical scientists, medical physicists, academics from medical engineering departments, experts in ventilation.</p>
	<p>Advice as requested from clinical engineering network and leaders to assist in emergency hospital construction</p>

Policy Centre Partner	Active areas and offers of support
Institution of Structural Engineers (IStructE)	Cascade through to chartered structural engineers who have professional expertise to assist; networks with other professional bodies in the built environment (not necessarily limited to engineers).
Institute of Water (IoW)	Review of waste water treatment in the light of potential pandemic vector transport. Messaging to ensure that hand washing is not accompanied by massive water use increase - people still need to conserve water.
Permanent Way Institution (PWI)	Wide experience in railway infrastructure engineering in the UK and internationally, including the control of real time safety critical works, engineering regimes for the assessment and control of railway system risks caused by managed change and asset deterioration, asset management regimes for railway infrastructure, and designing and managing for reliability.
Royal Aeronautical Society (RAeS)	Support for the spread of learning and development of 'COVID-19 compliant' good practice working techniques.
	Expertise across the aviation, aerospace and space profession to help inform decisions from regulators and governments.
	Corporate partners, such as aerospace manufacturers, are supporting the call to build ventilators and some of engineers have applied for initiatives that are being led by the Royal Academy of Engineering. Airport and airlines are actively supporting repatriation efforts, have repurposed their facilities, switched to cargo operations and donated PPE. From an airport perspective, some have switched to more cargo operations, and others are becoming mortuaries. On the airline front, some air hostesses are retraining to help provide medical support, and the airlines are supporting repatriation efforts.
	Support for those impacted by the large number of job losses in the aviation and aerospace sector, which are expected to continue and last for a number of years.
Royal Academy of Engineering (RAEng)	Specialist groups to identify how to support the industry with new measures that may need to be implemented.
Royal Academy of Engineering (RAEng)	Access to expertise and broad networks across the profession and internationally to respond to and disseminate requests for support, including rapid evidence gathering on PPE, supply chains and hospital decontamination.
	Triaging offers of help from the engineering community and collecting requests for support from the medical community. NHS England requested help with recruiting auxiliary engineers to support the UK's field hospitals. NEPC partners responded eagerly to the call, with 600 volunteers in less than 48 hours, and 1,000 volunteers in total at close of call. Those selected have been working in small teams supervised by NHS Clinical Engineers, ensuring that medical devices and equipment such as ventilators are ready for field hospital use.
	Support with expertise on supply chain resilience, infrastructure resilience and interdependencies
	Identification of intermediate challenges arising from the pandemic that the engineering community can assist with, with NEPC partners.

Policy Centre Partner	Active areas and offers of support
	<p>Knowledge exchange with international partners and funding calls to support the response to the pandemic outside the UK (support grants for African innovators to pivot, Project CARE, Engineering X Pandemic Preparedness).</p> <p>Assessing the impact and support for the UK R&D ecosystem, including innovative startups and large R&D intensive businesses.</p> <p>Resources for STEM education at home.</p>
Society of Operations Engineers (SOE)	<p>Plant maintenance and development, both mobile and fixed assets, fleet maintenance and support to ensure that essential supplies of food, drugs and medical equipment are being distributed across the UK via the road transport network.</p> <p>Support and network of accredited maintenance workshops and technicians for the inevitable backlog of vehicle inspections once the immediate crisis is over and some normality has resumed.</p>

This information is current at the date of publication, new work continues in earnest across the engineering community.

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 partnerships, and influencing policy and engaging the public.

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

What we do

TALENT & 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 & 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.

National Engineering Policy Centre

We are a unified voice for 43 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.

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