World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(REVIEW ARTICLE)

Check for updates

Globally responsible engineering

Aditya Gaurav Gupta *, Aryan Gaurav Gupta and Michelle Tashi Wongmu Bhutia

The Bishop's School Camp, 5-A, General Bhagat Marg, Camp, Pune, Maharashtra 411001, India.

World Journal of Advanced Engineering Technology and Sciences, 2025, 15(02), 845-856

Publication history: Received on 24 March 2025; revised on 05 May 2025; accepted on 07 May 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.15.2.0647

Abstract

Globally Responsible Engineering explores the ethical obligations of engineers in addressing societal and environmental challenges, advocating for a transformative shift in the profession. With over 5.7 million engineers in the UK alone, the sector lacks consistent clarity on its commitment to people and the planet, despite existing codes of conduct like the UK's Statement of Ethical Principles. This paper proposes four key principles—Responsible, Purposeful, Inclusive, and Regenerative—to guide engineering practices toward achieving the UN Sustainable Development Goals by 2030. These principles emphasize meeting global needs within planetary limits, considering lifecycle impacts, ensuring diverse stakeholder inclusion, and regenerating ecological systems. Through participatory and co-design approaches, the study highlights benefit such as enhanced innovation, reduced costs, and sustainable outcomes, while acknowledging challenges like time and complexity. The paper also draws on Kate Raworth's Doughnut Economics model to advocate for a balanced approach that supports social foundations without exceeding planetary boundaries. Case studies, including prison design controversies and the American Institute of Architects' 2020 ethics update, illustrate the ethical dilemmas engineers face. By embedding these principles into education and practice, engineering can accelerate solutions to climate emergencies, biodiversity loss, and inequality, fostering a safer, more just world

Keywords: Globally Responsible Engineering; Sustainability; Inclusive Design; Co-Design; Ethical Engineering; Un Sustainable Development Goals

1. Introduction

Doctors have a moral duty to their patients, first and foremost. Lawyers have a moral duty to justice, first and foremost. But what about engineers?

For a sector that employs 5.7 million people in the UK alone, we continue to have a surprising lack of clarity around our commitments to all people and the planet. Companies and professional bodies require you to understand your professional commitment through understanding codes of conduct (and in the UK there is a Statement of Ethical Principles)[1]. It's critical to understand professional duty, but also to inspire day to day action to meet our responsibility to the societies we impact and our wider ecological systems. At the moment, that is inconsistent. To enable a better world, we must put globally responsible principles into action, every single day.

As we look ahead to the 2030 deadline for the UN Sustainable Development Goals, it is time for us to truly consider the role of engineering and its unique position to make positive lasting change for all people and the planet.

To achieve social and environmental justice, we need those in engineering and those within the wider engineering community to commit to the four key principles of global responsibility. If these principles were to be adopted across the engineering community, it could transform the culture of how engineering is taught and practised. In doing so,

* Corresponding author: Aditya Gaurav Gupta

engineering outcomes (the things we create) would accelerate the response to our ever-changing real-world situation, climate and biodiversity emergencies and vast inequality in the world - helping to create a safer, and more just world.

Figure 1 Industrial pollution in modern era and its need for its eradication.

1.1. These principles are

- Responsible. To meet the needs of all people within the limits of our planet. This should be at the heart of engineering.

1.1.1. Purposeful

- To consider all the impacts of engineering, from a project or product's inception to the end of its life. This should be at a global and local scale, for people and planet.

1.1.2. Inclusive

- To ensure that diverse viewpoints and knowledge are included and respected in the engineering process.

1.1.3. Regenerative

- To actively restore and regenerate ecological systems, rather than just reducing impact.

2. Material and methods

2.1. Participatory and inclusive approaches to engineering

A significant part of globally responsible engineering is deeply understanding the connection between engineering and all people.

2.1.1. Inclusive

In all we do, we should be enabling inclusive and equitable practices to enable improvements to the physical and social environment, allowing all people to be mutually supportive in all functions of life and to develop their maximum potential. This applies to how we design and practice engineering, our rules and regulations (including legal frameworks that protect or can suppress the rights of minority groups), and dominant cultural practices enabling minority groups to participate fully, yet maintaining cultural identity.

Factfile

Project goal

- Developed a new way to farm using less water to feed more people and reduce the carbon footprint of farming

The engineering

- Using ultrasound to disperse mist across plants

Figure 2 Helping people walk with customised splints and braces.

We do not see enough of this principle in how we create solutions. Evidence of inadequate and at times, fatal design continues to prevail in today's societies, from simple examples of not having enough toilets to accommodate women in public spaces or buildings, to the drastic impact of racially biased artificial intelligence on people's freedoms. What would these services look like if there was more collaboration in creating the product? Would it shorten queues or even save lives?

Participatory approaches that include the voices of those using the product or service are essential to ensuring a more globally responsible practice [2].

There are various forms including participatory design, inclusive design and co-design. [3]

Factfile

Project goal

→ Design a ship capable of carrying out research in some of the most remote and inhospitable regions in the world

Key considerations

→ Quiet enough to not impact data, able to house a large number of scientists and able to launch a variety of unmanned vehicles and submarines

Figure 3 Creating an ice-breaking ship for climate research.

These concepts vary and can work in tandem in a lot of cases, they all make space metaphorically and literally for the stakeholders to have their voices heard, respecting the diversity of people in the design process.

Why include participatory design into engineering practices?

2.1.2. Pros

- Creates commitment, willingness to actively support and participate, and accountability to ensuring the purpose of the solution will be met

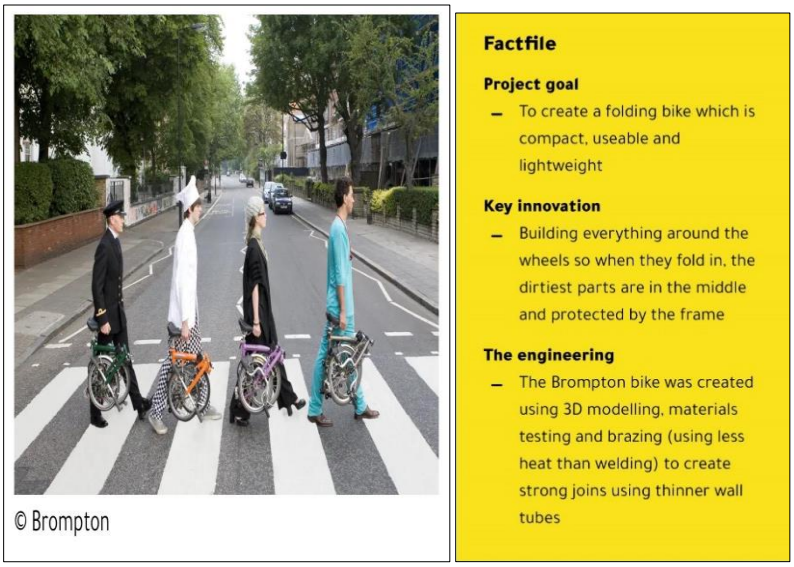


Figure 4 Revolutionising the future of bicycle travel.

- Inclusive/democratic (aims to include as many stakeholders as possible and giving people a voice to those who are sometimes missing from decision making - and reduces assumptions/bias too)
- Adds the ability to diverge and consider broader requirements at the early stages of complex projects (often before significant money is invested in the solution)
- Can reduce significant costs and time wasted during and in particular in later stages of a project
- Increased potential creativity and innovation e.g. diverse perspectives - not just a group of people who already think similarly, skills needed more and more in our ever-changing world.
- It provides more opportunity to assess the best solution, for example, if a rural town needed more transport options by car, instead of creating new electric-vehicle charging points and cars, considering how to introduce car-sharing (social-solution) that reduces the need to build at all (at huge cost-savings too) [4].
- Greater understanding of specific real-world or contextual information (e.g. those that have lived in an area for years helping to verify accuracy of a flooding model or map)
- Sustainable & long-lasting legacy as ownership for success shared by both those with expertise working on projects, and those living in a community.

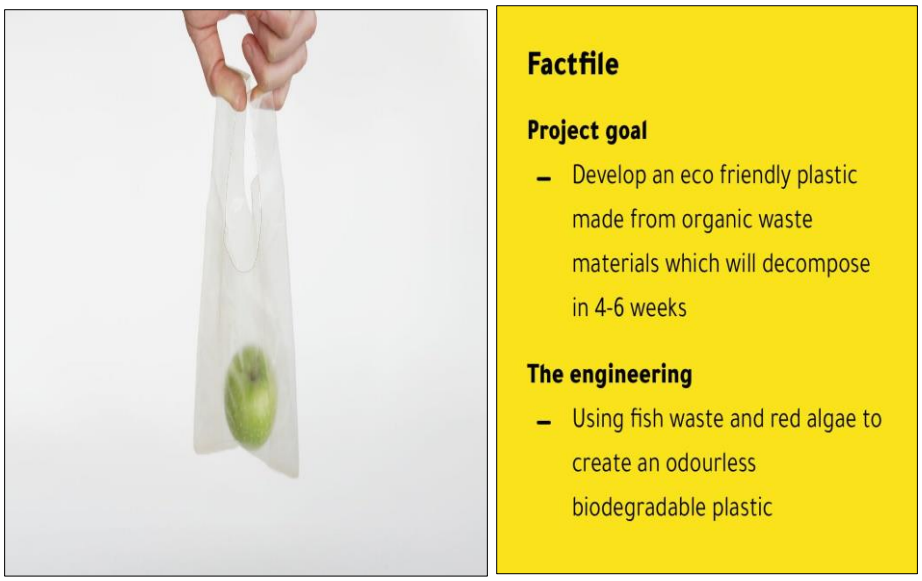


Figure 5 Making an eco-friendly plastic from fish waste.

2.2. Cons

- Typically, time-consuming at the front of the design process
- Can be expensive and hard to express value to traditional clients (but reduce huge cost later down the line)
- Challenge of how to facilitate meaningful engagement process and how to organise working with many people
- Complex (can be chaotic)
- Context-specific - it can be hard to directly replicate process from project to project as may be working with different groups of people
- There is a business case, whereby it is becoming more and more common that demonstrating social value becomes a requirement of projects, and upfront planning and consideration can often lead to smarter and more successful projects. More importantly, it is our ethical duty and forms part of engineer's professional commitments, to ensure that diverse viewpoints and knowledge are included and respected in the engineering process as many of the outcomes of engineering will impact a diverse and wide group. It's about balancing power too, and realising your privilege and opportunity to work in an area that can positively impact many people's lives. At the start, designing out your process for including many perspectives is key, as is the subsequent follow through on this ***inclusive*** principle. [5]

Figure 6 Emotional intelligence and mind set for team work.

There are multiple ways to engage with users and stakeholders in a co-design process. In all we do, we should be enabling inclusion, equity and participation of all citizens. Broadly there are two key parts to consider within your plan, which are your mind-set and methods to enable inclusive and co-design processes.

2.3. What is going to be your approach and mind-set?

Your mind-set and the culture and behaviour within your team is important. To be prepared to be empathetic, expect and be comfortable with ambiguity and absorbing information in a free-flowing way, be open to failure, understand if you will have any underlying bias (and introduce an open process that can challenge these) and be optimistic about the process. If you don't have tools and multiple ways to adapt if engagement is not working, the mind-set alone is limiting.

2.4. What method(s) of information collection will one use? And why?

Methods such as interviews, focus groups, analogous inspiration, role-play, storyboards, immersion, prototyping, mapping/ tracking, monitoring and evaluation processes, introduce feedback systems (e.g. in software design often called alpha/ beta testing) and storytelling are useful but limited if you do not believe the importance of these, so your mind-set is equally important.

2.5. Who will be engaging in the sessions or data collection?

Sharing, listening and working collaboratively with a range of groups, represents diverse perspectives and viewpoints in the design process and accelerates progress to find evidence-based and innovative solutions. Considering who you are designing for is just as important as considering what you are designing, and that means embracing the diversity of humanity.

Figure 7 Cultural diversity and its importance in the prevalent world.

In your project plan you should recognize the aim of the exercise is to hear the perspectives of people in the prison to understand their needs to inform design decisions. Examples of potential people to engage could include:

- Prison inmates and staff members - as direct users of the facilities who can share their needs and challenges with current facilities.
- Local partners/Social workers - who work with direct users of the prison facilities and who could potentially have existing networks and trusted relationships.

Figure 8 UN bolstering existing networks and trusted relationships. [6]

Consider who should be involved in these sessions and that different demographics within the prison will have different needs. Sometimes people have ideas that they are not able to articulate as well through words. Consider practical methods such as mind maps that can be developed through short words or images that may enable participants to rationalize connections and topics. Engaging smaller groups can provide a more relaxed environment and build relationships so people are comfortable sharing their perspectives and ideas in a respectful environment.

2.6. What questions should one ask?

Questions should be framed so that the participants can share their experience and perspectives rather than leveraging an answer. Be open to answers and perspectives that may challenge your underlying assumptions about the participants' experience. Examples of potential question areas could include:

- Specific questions (such as in surveys) could include the accessibility of the facilities in terms of wait times, number and location in the prison.
- Open questions (such as in interviews or focus groups) could be framed around the participants' experience. Allow people to create and own solutions. Be open to responses that may challenge assumptions or gender bias.

2.7. Who needs to be involved in design and delivery?

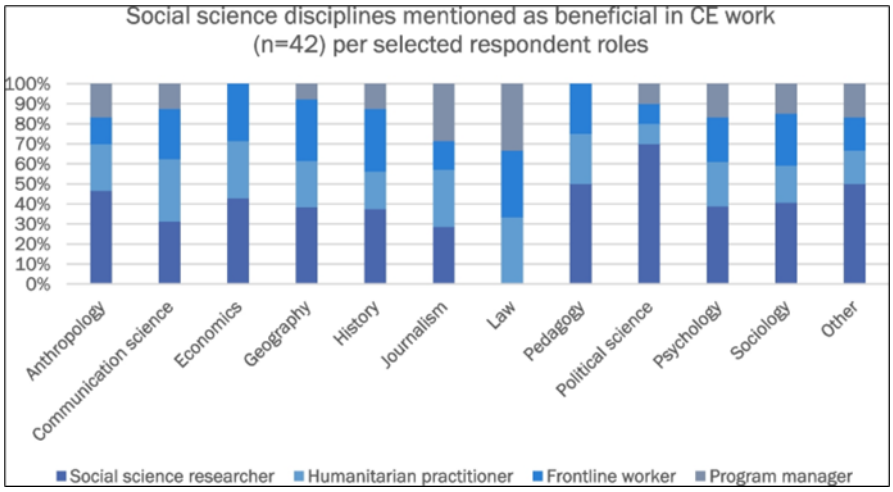


Figure 9 Social Science disciplines and their need in design and delivery

Not everyone can facilitate and communicate effectively with people to run these types of sessions, so it can be worthwhile within your plan considering where you can bring specific expertise to assist. Consider what other disciplines or organisations are set up to be able to bring in this expertise, perhaps you could plan to be engaging with

existing community-based organisations, social workers or social scientists within how your project is executed. Also consider who will be most appropriate to deliver these sessions.

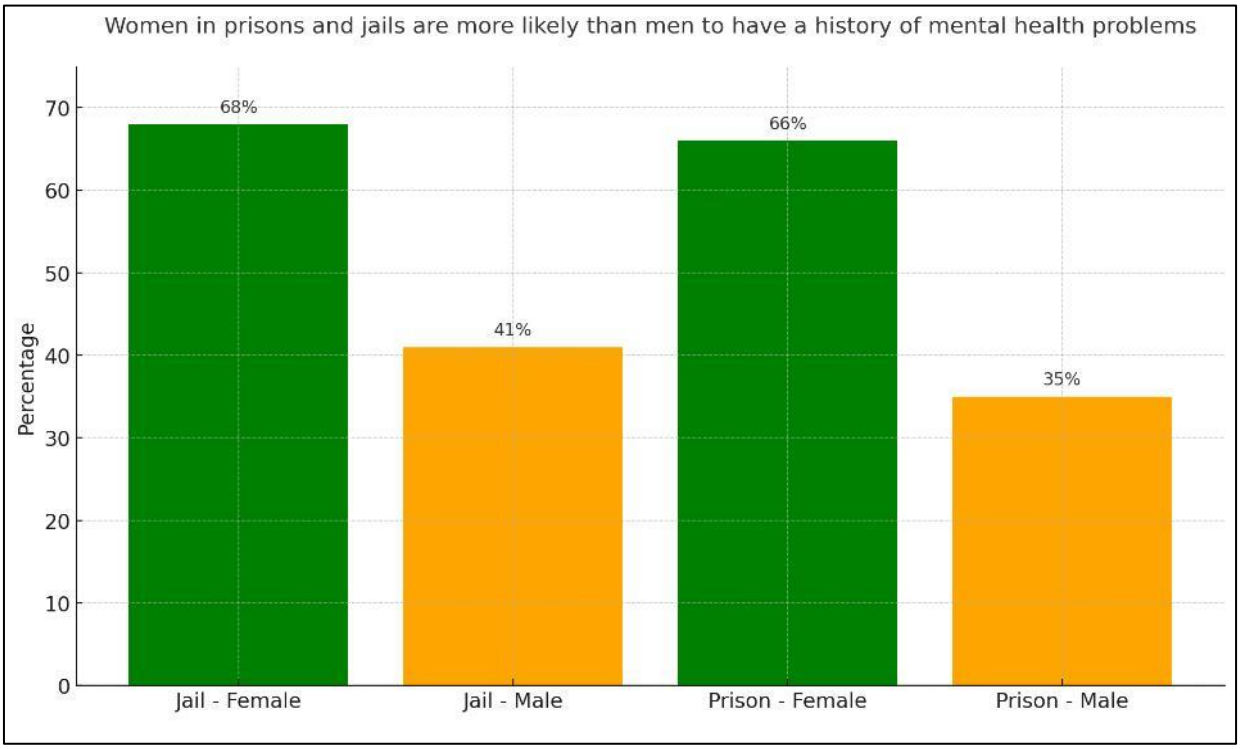


Figure 10 Burgeoning mental health issues among woman inmates.

For example, will inmates in a women's prison feel comfortable talking to men about their sanitary needs and experience? What existing and trusted relationships could you bring into aid delivery?

2.8. At what stage of the project will one plan to run this session?

Co-design can be an iterative process. Sessions should be run at the research stage of the process but you should also consider sessions to gather feedback during the ideation stage. Be open and comfortable with the importance of receiving feedback, and considering feedback loops as critical to the process. Be willing to test new things, learn from failure and keep going.

2.9. What other context-specific considerations should be noted?

Be open to challenging your assumptions about what is required for the context. Consider engaging with experts to understand what the security needs of low-level offending prisons are while enabling respectful design privacy and enable the safety and wellbeing of the people using the facilities in the prison. Examples of potential context-specific considerations could include:

Low-level offending prison: Standardised prison designs are likely to not include the needs of all people in the prison. Low-level offending prisons may not require the same level of security measures as high-level offending prisons. Consider gaining an understanding of the requirements and experience of low-level offending prisons in your plan.

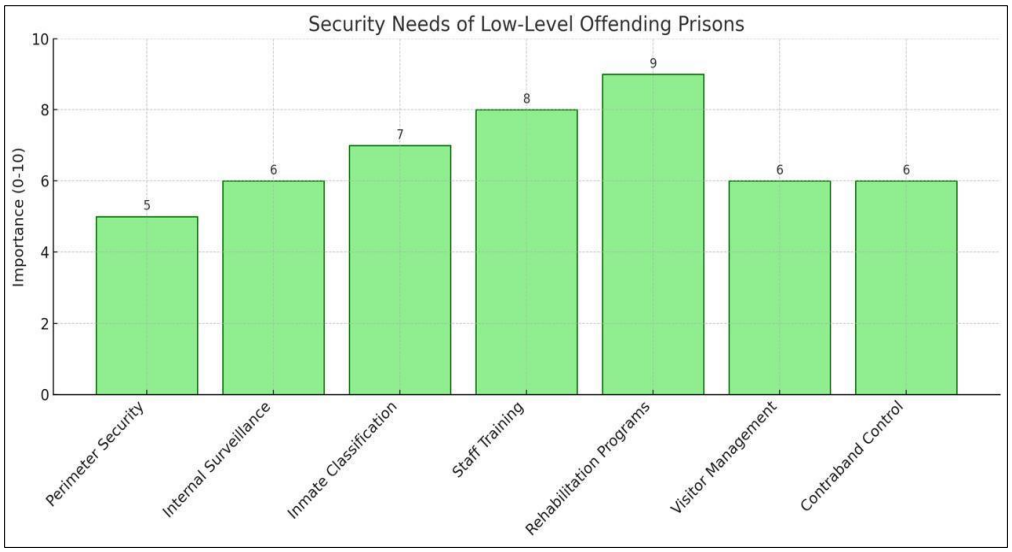


Figure 11 Graph showing the security needs of low-level offending prisons.

Safety concerns: Previous concerns have been raised in other prisons around the safety and wellbeing of all in the prison. In your methods consider how you may approach the topic of safety concerns in a respectful and safe manner. Consider how you could facilitate engagement through existing trusted relationships (e.g. social workers) and anonymise responses

3. Principles in action

Engineering can be controversial, from the materials being sourced to fatal mistakes that can be made. Considering the nuances of these complexities is a crucial skill of a globally responsible engineer.

Working in prisons is just one of the many polarising

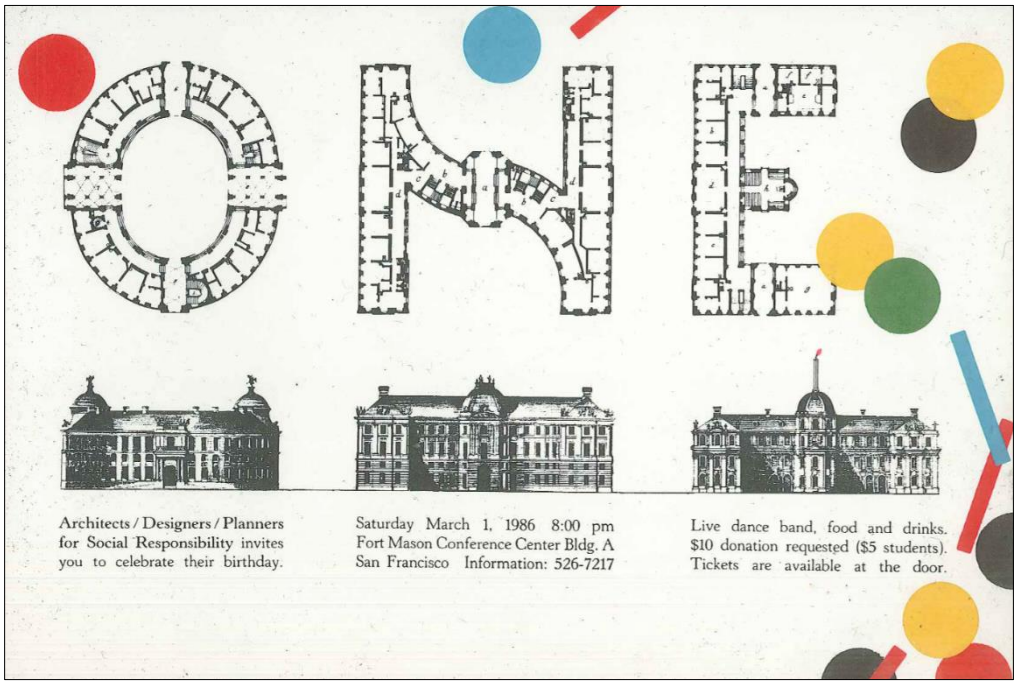
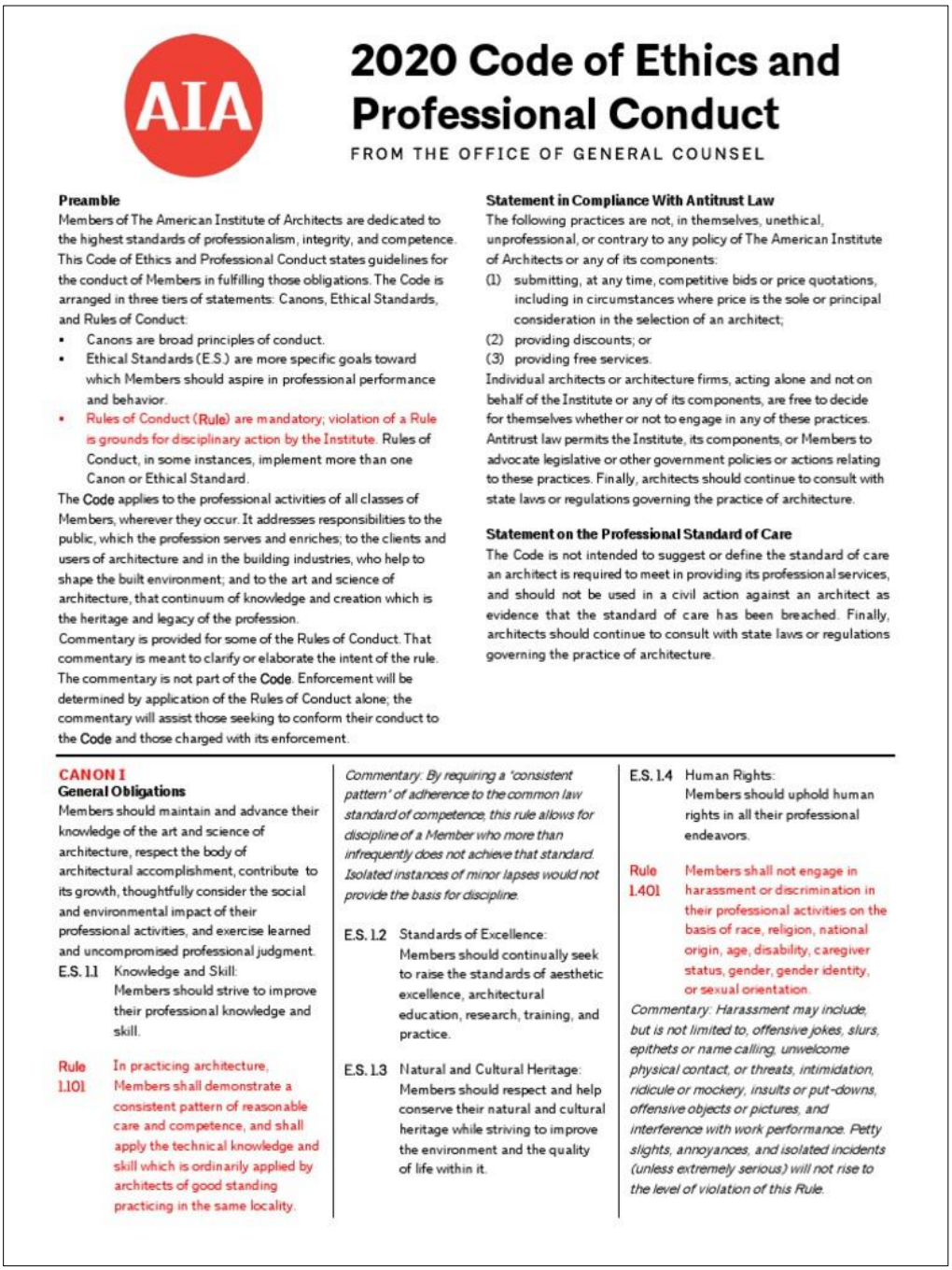


Figure 12 Principles of ADPSR (Architects / Designers / Planners for Social Responsibility). [7]

examples that can be interrogated when considering the reality of ethics in engineering. In 2004, the non-profit organization Architects / Designers / Planners for Social Responsibility (ADPSR) issued a call for architects and design industry professionals to stop working in prisons because of ongoing concerns regarding social justice [7].

In December 2020, the American Institute of Architects (AIA) approved new ethics rules prohibiting members from knowingly designing spaces intended for execution or torture, including for prolonged periods of solitary confinement.



AIA

2020 Code of Ethics and Professional Conduct

FROM THE OFFICE OF GENERAL COUNSEL

Preamble

Members of The American Institute of Architects are dedicated to the highest standards of professionalism, integrity, and competence. This Code of Ethics and Professional Conduct states guidelines for the conduct of Members in fulfilling those obligations. The Code is arranged in three tiers of statements: Canons, Ethical Standards, and Rules of Conduct:

- Canons are broad principles of conduct.
- Ethical Standards (E.S.) are more specific goals toward which Members should aspire in professional performance and behavior.
- Rules of Conduct (Rule) are mandatory; violation of a Rule is grounds for disciplinary action by the Institute. Rules of Conduct, in some instances, implement more than one Canon or Ethical Standard.

The Code applies to the professional activities of all classes of Members, wherever they occur. It addresses responsibilities to the public, which the profession serves and enriches; to the clients and users of architecture and in the building industries, who help to shape the built environment; and to the art and science of architecture, that continuum of knowledge and creation which is the heritage and legacy of the profession.

Commentary is provided for some of the Rules of Conduct. That commentary is meant to clarify or elaborate the intent of the rule. The commentary is not part of the Code. Enforcement will be determined by application of the Rules of Conduct alone; the commentary will assist those seeking to conform their conduct to the Code and those charged with its enforcement.

Statement in Compliance With Antitrust Law

The following practices are not, in themselves, unethical, unprofessional, or contrary to any policy of The American Institute of Architects or any of its components:

(1) submitting, at any time, competitive bids or price quotations, including in circumstances where price is the sole or principal consideration in the selection of an architect;
(2) providing discounts; or
(3) providing free services.

Individual architects or architecture firms, acting alone and not on behalf of the Institute or any of its components, are free to decide for themselves whether or not to engage in any of these practices. Antitrust law permits the Institute, its components, or Members to advocate legislative or other government policies or actions relating to these practices. Finally, architects should continue to consult with state laws or regulations governing the practice of architecture.

Statement on the Professional Standard of Care

The Code is not intended to suggest or define the standard of care an architect is required to meet in providing its professional services, and should not be used in a civil action against an architect as evidence that the standard of care has been breached. Finally, architects should continue to consult with state laws or regulations governing the practice of architecture.

CANON I
General Obligations

Members should maintain and advance their knowledge of the art and science of architecture, respect the body of architectural accomplishment, contribute to its growth, thoughtfully consider the social and environmental impact of their professional activities, and exercise learned and uncompromised professional judgment.

E.S. 1.1 Knowledge and Skill: Members should strive to improve their professional knowledge and skill.

Rule 1.101 In practicing architecture, Members shall demonstrate a consistent pattern of reasonable care and competence, and shall apply the technical knowledge and skill which is ordinarily applied by architects of good standing practicing in the same locality.

Commentary: By requiring a 'consistent pattern' of adherence to the common law standard of competence, this rule allows for discipline of a Member who more than infrequently does not achieve that standard. Isolated instances of minor lapses would not provide the basis for discipline.

E.S. 1.2 Standards of Excellence: Members should continually seek to raise the standards of aesthetic excellence, architectural education, research, training, and practice.

E.S. 1.3 Natural and Cultural Heritage: Members should respect and help conserve their natural and cultural heritage while striving to improve the environment and the quality of life within it.

E.S. 1.4 Human Rights: Members should uphold human rights in all their professional endeavors.

Rule 1.401 Members shall not engage in harassment or discrimination in their professional activities on the basis of race, religion, national origin, age, disability, caregiver status, gender, gender identity, or sexual orientation.

Commentary: Harassment may include, but is not limited to, offensive jokes, slurs, epithets or name calling, unwelcome physical contact, or threats, intimidation, ridicule or mockery, insults or put-downs, offensive objects or pictures, and interference with work performance. Petty slights, annoyances, and isolated incidents (unless extremely serious) will not rise to the level of violation of this Rule.

Figure 13 AIA 2020 Code of ethics and professional conduct. [8]

"We are committed to promoting the design of a more equitable and just built world that dismantles racial injustice and upholds human rights," said the group's president, Jane Frederick.

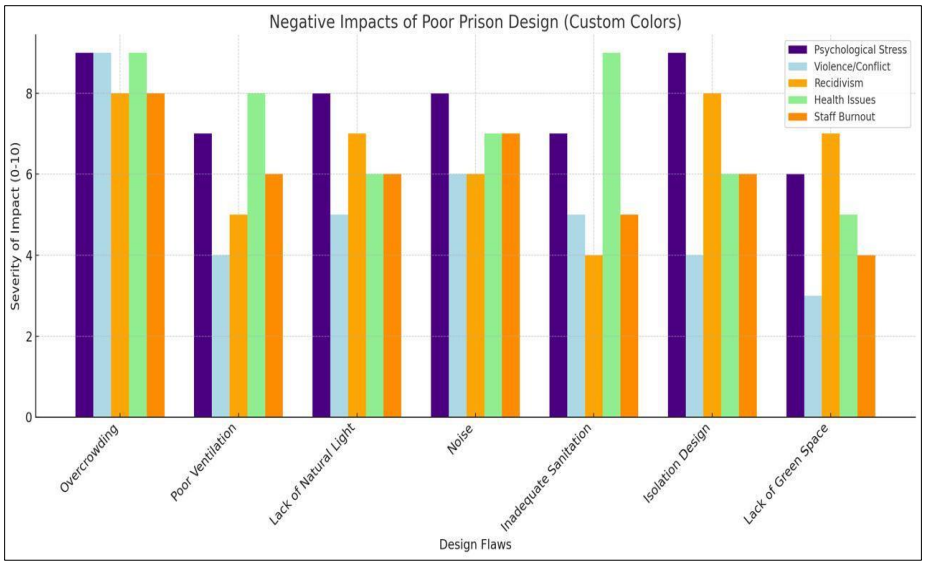


Figure 14 Negative Impacts of poor prison design.

3.1. Arguments against refusing

- Prisons are necessary for a well-functioning society (law & order).
- Engineers can influence the making of better prisons.
- Prisons will be less safe and functional if built without expertise.
- Engineers are not experts in justice and should focus on design.
- Accepting this work helps ensure the sustainability of our company and keeps our team members employer.

3.2. Arguments for refusing

- Current prison system is unjust and/or ineffective.
- Prisons built for profit are more likely to be less humane.
- Engineers and architects ethically should not contribute to injustice.
- Refusal to build prisons can invoke the need for reform in the system.
- If we are the sort of company who would take this job, we don't deserve to stay in business. [9]

4. Results and discussions

The Sustainable Development Goals launched in 2015 and laid out 17 areas to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

Engineering plays a significant role in ensuring the success of these goals. From playing a critical role in many if not all of the goals, to being a significant driver of the economy, whilst also being a large contributor of national and global emissions levels. To successfully embed real change and achieve the UN SDGs we need a shift towards global responsibility in engineering, alongside the changes needed in the overall approach, to how our economies are driven.

One model that offers an alternative outlook on how to embed engineering in a more globally responsible way is Kate Raworth's Doughnut Economics model. The model, illustrated as a ring (doughnut) calls for humanity to focus on living in a safe and just space (within the doughnut), meeting a social foundation for all whilst not overshooting the Earth's planetary boundaries (outside the doughnut), resulting in a planetary breakdown. The model is guided by the United Nations Sustainable Development Goals which include food security, access to energy and water, health and gender equality. [10]

5. Conclusion

This study advocates for a transformative shift in engineering by proposing four key principles—Responsible, Purposeful, Inclusive, and Regenerative—to align the profession with the UN Sustainable Development Goals and address global challenges like climate change, biodiversity loss, and inequality. Through participatory and inclusive

design approaches, it demonstrates how engineering can deliver sustainable, equitable, and ethically sound solutions that meet diverse societal needs while respecting planetary boundaries. Embracing these principles will benefit society by fostering innovative and responsible development, with the way forward involving their integration into engineering education and professional standards.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Adams L, Carter H. (2019). The Impact of Ethical Codes on Engineering Outcomes: Insights from the UK Statement of Ethical Principles. Professional Engineering Review, 12(3), 178-192.

[2] Smith J, Taylor R. (2022). The Role of Participatory Design in Sustainable Engineering Solutions. International Journal of Sustainable Development, 15(4), 221-235.

[3] Lee K, Patel S. (2023). Co-Design Approaches in Engineering: Benefits and Challenges. Design Studies Review, 18(2), 89-104.

[4] Johnson M, Brown T. (2021). Regenerative Engineering: Restoring Ecological Systems through Innovative Design. Environmental Engineering Science, 38(5), 412-427.

[5] Kumar P, Singh V. (2020). Inclusive Engineering Practices: Addressing Social Equity in Infrastructure Projects. Journal of Civil Engineering and Ethics, 25(1), 56-70.

[6] United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. UN Sustainable Development Goals Report, 1-40.

[7] According to ADPSR, issues of racism and human rights in architecture, including the design of execution chambers, have been highlighted as critical ethical concerns [ADPSR Blog, https://www.adpsr.org/blog, Last accessed on 08/05/2025].

[8] American Institute of Architects. (2020). 2020 Code of Ethics Update: Addressing Human Rights in Design. AIA Publications, 7(1), 15-28.

[9] Nguyen T, Garcia E. (2023). Prison Design and Social Justice: Ethical Dilemmas for Engineers and Architects. Journal of Architectural Ethics, 20(2), 145-160.

[10] Raworth K. (2017). Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist. Journal of Economic Perspectives, 31(4), 211-230.