Community Engagement with Engineering: Establishing Principles

- Article type: paper
- 22 December 2021
- Number of words in your main text and tables, 3 figures

Authors

Sarah Bell

- BSc BEng MEngMgt PhD CEng CEnv CWEM FICE FCIWEM
- Melbourne Centre for Cities, University of Melbourne, Melbourne, Australia
- https://orcid.org/0000-0001-5289-4358

Evan Boyle

- BA MA PhD
- MaREI Centre and Department of Sociology and Criminology, University College Cork, Cork, Ireland
- https://orcid.org/0000-0001-9117-0926

John Canton

- BSc (Eng.) MSc CEng FICE CEnv MCIWEM
- Retired Director of Public Works, Ministry of Works and Urban Development, Nassau, Bahamas

Zara Khan

- BArch, MA Architecture
- Urban Designer, London, England, United Kingdom

Ruth Quinn

- MEng, PhD
- Department of Civil and Structural Engineering, University of Sheffield, Sheffield, England, United Kingdom
- https://orcid.org/0000-0002-9551-1350

Edward Rollason

- BSc, PhD
- Department of Geography and Environmental Sciences, Northumbria University, Newcastle Upon Tyne, UK
- https://orcid.org/0000-0002-9208-9107

Kieran Tully

- BEng CEng MICE MIET
- Membership Development Officer, Institution of Civil Engineers, London, UK
- https://orcid.org/0000-0003-0143-8971

Sarah Ward

- BSc, MRes, PhD, C.Env, C.WEM, Hon. FCIWEM, FHEA
- West Country Rivers Trust, Callington, England, United Kingdom
- https://orcid.org/0000-0002-1432-4204

Patricia Xavier

- PhD
- Department of Engineering, Swansea University, Swansea, Wales, United Kingdom
- https://orcid.org/0000-0002-5870-9659

Full contact details of corresponding author

Professor Sarah Bell
Melbourne Centre for Cities, Baldwin Spencer Building,
University of Melbourne, Parkville,
Victoria, 3010, Australia
s.bell@unimelb.edu.au

Abstract (150 – 200 words)

Community engagement with engineering is essential to deliver the Sustainable Development Goals and to address wicked problems such as climate change. This paper presents a statement of Principles for Community Engagement with Engineering, to underpin best practice across the infrastructure project lifecycle. The principles are:

1. Supporting sustainable, thriving communities is a core purpose of the engineering profession.
2. Community impacts and interests are integral to engineering design and delivery.
3. Community engagement should begin at the conception of projects, and continue throughout the engineering and infrastructure lifecycle.
4. A tailored engagement approach with clear objectives, processes and expectations should be agreed among all stakeholders, including community leaders and representatives, at the outset of infrastructure decision-making and planning.
5. Engineering and infrastructure projects should identify the diverse needs and aspirations of communities they work with and for, giving special attention to include groups that are typically marginalised.
6. Community engagement should consider how individuals and groups of different race, age, faith, disability, gender, sexuality, family circumstances, economic status, and other characteristics and may be differently impacted by infrastructure development, and may welcome different forms of engagement.
7. Methods of engagement should recognise power inequalities, and enable two-way communication and learning between communities and engineering and infrastructure projects.
8. Information about engineering and infrastructure projects and their impacts should be shared with community members as part of a two-way process, with information being accessible to all people.

Keywords chosen from ICE Publishing list

Codes of practice and standards; Infrastructure planning; Sustainable development.

Introduction

Enabling sustainable and resilient communities is a core purpose of civil engineering. The Institution of Civil Engineers (ICE) Code of Conduct states ‘All members shall have full regard for the public interest, particularly in relation to matters of health and safety, and in relation to the well-being of future generations’. Community engagement can help to maximise and share benefits, minimise and mitigate negative impacts of projects on communities, and improve project delivery and outcomes (Figure 1). Effectively engaging with local communities is a responsibility of engineers at different stages of the infrastructure lifecycle, from conception to decommissioning, and at different organisational levels and career stages, from apprentice and graduate to senior leader and policy maker.

This paper presents a statement of Principles for Community Engagement with Engineering. It begins with review of literature related to community engagement, and its value to engineering projects, with emphasis on infrastructure projects. The paper describes the process of developing the principles, including a first draft based on literature and other examples, which was presented at an ICE Strategy Session to seek feedback from interested members and stakeholders, and then the final principles which were presented to the ICE in 2021.

Community engagement takes many forms, depending on the site, project and community. Whilst it is important to document and share best practice in community engagement with infrastructure, due to the uniqueness of each project and its context, the identification and definition of the relevant “community” and the methods employed will be vast, varied and constantly evolving. The principles provide core guidance to the purpose, value and nature of good community engagement, providing a foundation across sectors, regions and scales of project. They also set out a challenge to the sector to reflect on how project delivery mechanisms and processes can give earlier and greater consideration to local expertise and needs, and work with communities as necessary partners in delivering sustainable and resilient infrastructure. The principles offer insight into how the core knowledge and skillset of civil engineers and other built environment professionals needs to adapt to meet this challenge.

2. Community engagement with engineering

Community engagement is an essential element of efforts by the engineering profession to work more closely with stakeholders and to deliver the United Nations Sustainable Development Goals (SDGs). The UK Engineering Council (2013) defined principles for professional engineers including to 'engage with stakeholders, listening and recognising the value of the perspectives of others, including non-specialists'. The mission of the Institution of Civil Engineers (ICE) Sustainability Route Map (ICE, 2020) is to 'Make the UN Sustainable Development Goals accessible to built environment professionals'. The SDGs require global, multi-stakeholder engagement to mobilise resources, and local engagement to deliver outcomes. Allied to this vision is the objective of 'Embedding the delivery of Sustainable Development Goals into everyday engineering practice'.

Engineers have historically solved problems by designing and constructing functional infrastructure, and are often perceived as relatively dissociated from collective goals such as working with communities and stakeholders (Hoh, 2009; Natarajarathinam et al. 2021). As evidenced by the SDGs and the recent responses of industry bodies (Engineering Council, 2015; ICE, 2020) the profession is now facing challenges that cannot be solved by conventional technical projects. So called 'wicked problems' cannot be solved by a single response, but can only be made better or worse from different standpoints (Seager et al., 2012). There has been a growing emphasis on taking a systems perspective to characterise the environmental and social aspects of sustainability, and this requires a greater ability to engage with communities to understand the problem from the perspective of all stakeholders. Taking a holistic perspective that respects and draws in community information to understand how social factors intersect with technical and environmental systems is essential for tackling wicked problems such as climate change (IEA, 2021).

Construction sites that were once considered to be islands of economic activity may become catalysts for change to deliver better environmental and social outcomes. This new mindset comes with its own challenges. For example, economic activity from infrastructure projects is relatively easy to define in terms of cost and time. On the other hand, environmental and social

value are more difficult to assess and measure using conventional methods, and generally involve a longer time scale than construction projects. Moreover, the legacy of primarily techno-centric engineering education has meant that typically civil engineers are not trained in the terminology of the frameworks used to assess social and environmental value (Natarajarathinam et al., 2021). As engineers widen their remit to include environmental and social value, the extent of success and failure becomes wider than the project boundaries. Engineering teams increasingly deal with wicked problems which by their nature can never be solved entirely, but can be improved with constructive collaboration across sectors, disciplines and stakeholders. Community engagement is a central element of this new way of working, as are the requirements for the sector to review competencies and continuing professional development to equip engineers to competently undertake this work (ICE, 2021).

Beyond statutory and regulatory obligations, the specifics of environmental and social value are likely to be different for each project depending on what local communities value. This variability is why an understanding of needs is recommended by Dobson (2020) and the UK Green Building Council (2020). Community engagement can provide individuals and communities with opportunities to participate in processes whereby local and global values are explored. This could enable communities to consider and make adaptations to their own actions, particularly in reducing climate impacts, thereby contributing to the achievement of net-zero carbon. Engineers can control the embodied and operational carbon but only influence user carbon (Chapman, 2020). Engagement and influence support significant end user changes. The successful influencing of end users may largely determine whether social and environmental goals are met. In the context of the UK's Carbon Net Zero Commitment even strict control on embodied and operational carbon may not be sufficient without 'buy in' from the end user (HM Government, 2021).

3. Community engagement and participation

Community engagement is an umbrella term that covers multiple approaches and methods. It differs from public participation in extending beyond decision-making to implementation and operation, and is an ongoing process. In developing Principles for Community Engagement with

Engineering, community engagement is conceived to include participation, communication, consultation and collaboration between communities and infrastructure clients and contractors, across the infrastructure lifecycle. In recent years, the benefits of effective engagement at reducing conflicts and allowing communities to influence the future shape of the places they live have been increasingly recognised. Addressing the causes and impacts of the climate crisis and other wicked problems requires fundamental changes in the way society and infrastructure function, including embedding critical and well-thought-out practices of community engagement into projects as standard (Sharp, 2017; Ward et al., In review).

There are different levels of engagement that relate to the degree of control and influence the community has on the project. Arnstein's (1969) 'ladder of participation' is an oft-cited example, where increasing degree of citizen control moves the project higher up the ladder. However, the ladder model has been critiqued for lacking nuance and suggesting that projects should be considered failures if they do not achieve full citizen control (Rollason et al., 2018).

More recent conceptualisations of engagement seek to explore the complex and non-linear interactions which occur during projects, for example Wilcox (1994), Plummer and Fitzgibbon (2004), or Mahmoud et al. (2021). Other approaches focus on identifying and addressing common problems and issues, such as 'HEADS UP' (i.e. hegemony, ethnocentrism, ahistoricism, depoliticisation, uncomplicated solutions, and paternalism). HEADS UP is based on the principle that to work towards ideals of justice requires better understanding of the social and historical forces that connect citizens (Andreotti, 2012). A step further, and complementary to but distinct from public or community engagement, is co-creation, which focuses on the co-design and co-production processes that enable a product, service or infrastructure to be designed and delivered in collaboration with a community, customised, or even personalised, to embed their needs, drivers or preferences alongside those of the overarching project (De Konig et al., 2016).

Answering the critique of Arnstein's ladder, it is important to recognise that there is no optimum model for engagement in any given project, and that each engagement level may be evident in

different projects and contexts, depending on external conditions, organisational and political culture, cost, and resources. Although greater citizen involvement in decision-making implies stronger engagement; this may not always be possible or desirable due to planning, regulatory or budgetary constraints which operate at scales larger than individual projects or host communities (Rollason et al., 2018). While community engagement is suggested to potentially move beyond traditional top-down approaches, some scepticism has been offered regarding the degree to which the citizenry and community groups can influence projects (Head, 2007). Alongside this, community engagement is not a linear process. To avoid misunderstandings over the role that host communities will have in any project, it is important to identify and agree on the purpose and limitations of engagement activities with the community, both to provide transparency and allow the community control. In this way 'community engagement' is not a product or delivery which a project might produce, but a process (Reed, 2008; Chow and Leiringer, 2020), which has likely been running prior to any project beginning and will continue to run after project completion.

The typology presented by Wilcox (1994) divides engagement activities in to participatory and non-participatory types (Table 1). What differentiates these is the power relationship between different stakeholders: consultation and information-giving are one-way relationships, either distributive or extractive; in contrast deciding- and acting-together and supporting involve the dispersion of power often to traditionally disempowered stakeholders.

Table 1. Different levels of community engagement. Adapted from Wilcox (1994)

Level of Engagement	Description
Non-participatory Engagement	
Information	Telling people what is planned or sharing knowledge, for example, through leaflets or factsheets.
Consultation	Offering some options, listening to feedback but not allowing new ideas, for example, through surveys or interviews
Participatory Engagement	
Deciding Together	Encouraging additional ideas or options; deciding jointly on the plans, for example, through focus groups.

Acting Together	Different interests decide on what is done and form a partnership to carry it out, for example, through citizen forums.
Supporting	Local groups or organisations are offered funds, advice or other support to develop their own agendas within guidelines, for example, through seed funding.

Stakeholder and citizen engagement is widely promoted to ensure sustainable management of the environment and natural resources. Reed (2008) reviews the literature relating stakeholder engagement in environmental management, including its benefits. The review identifies eight features of best practices in stakeholder participation:

1. Stakeholder participation needs to be underpinned by a philosophy that emphasises empowerment, equity, trust and learning
2. Where relevant, stakeholder participation should be considered as early as possible and throughout the process
3. Relevant stakeholders need to be analysed and represented systematically
4. Clear objectives for the participatory process need to be agreed among stakeholders at the outset
5. Methods should be selected and tailored to the decision-making context, considering the objectives, type of participants and appropriate level of engagement
6. Highly skilled facilitation is essential
7. Local and scientific knowledges should be integrated
8. Participation needs to be institutionalised

Community engagement is emerging as an issue of concern across the infrastructure sector, and as such, there is a growing body of guidance relating to it. The English Environment Agency's 'Working With Others' presents engagement as a step-by-step process to help deliver flood alleviation schemes that are acceptable to communities. However, the relative lack of community decision-making mechanisms and a 'one size fits all' approach have been criticised

(Mehring et al., 2018). The CIRIA Guide C751 ”Communication and engagement in local flood risk management” outlines a range of techniques for engaging communities and provides guidance on selection for particular contexts (Daly et al., 2015). Various community planning toolkits are also available, providing guidance on the issues to consider when planning and designing community engagement (Community Places, 2012).

Despite the development of best practice guidance and increasing awareness of the need for community engagement with projects, many projects proceed without meaningful engagement, or with limited or flawed engagement (Cilliers and Timmermans, 2014). The reasons for a lack of meaningful engagement with projects include high-level constraints on programmes and budgets (Rollason et al., 2018); a lack of education and training for engineers in community engagement (Harsh et al. 2016-); deeply embedded top-down practices (Mehring et al., 2018); and a lack of understanding of the potential contribution that communities can provide (Lane et al., 2018). For example, during preparation for the London Olympics despite initiatives such as a public competition to select suitable names for neighbourhoods surrounding the Queen Elizabeth Olympic Park, there were limited wider public participation exercises that failed to engage with the ‘experience and feeling’ of places, which would have helped to influence and enhance community dynamics (Gold and Gold, 2020). This led to a local legacy of small business failure fuelled by rising rents and homogenisation of the local area, diluting place-based cultural offerings (Duignan, 2019).

4. Drafting the ICE Principles

In 2019 the ICE established a Community of Practice (CoP) on Community Engagement. The purpose of the CoP is to develop and share best practice in community engagement for ICE members, other researchers and practitioners, and people with live, local experience as community members. The CoP identified the need for a set of principles relating to community engagement with infrastructure, to guide best practice and policy intervention. The CoP wrote the first draft of the ICE Principles for Community Engagement with Engineering based on Reed's (2008) features of best practice.

An ICE Strategy Session webinar on ‘The value of community engagement on infrastructure projects’ on 10 November 2020 presented the draft Principles (ICE, 2020). The event was promoted through ICE communications, including social media, and was shared with networks associated with the CoP members. The webinar was held in the morning UK time, to allow international audience members to join from Asia and the Middle East. The webinar consisted of a panel discussion involving CoP members Anusha Shah, Monika Szczyrba, Peter Trimingham and Sarah Bell, who presented the draft Principles. Participants in the Strategy Session were asked to provide feedback on the Principles in a short survey at the end of the event. Individuals and groups also provided more detailed feedback by email to CoP after the event. The comments were coded using inductive qualitative analysis to identify key themes and to identify for suggestions for changes to the principles. The final principles were written to reflect the feedback from the participants and respondents, and further discussion and reflection within the CoP. This section presents the draft principles, the Strategy Session survey results, summary of the themes emerging in the responses, and the final statement of principles.

The draft Principles for Community Engagement with Engineering were:

1. Supporting sustainable, healthy communities is a core duty of every engineer.
2. Technical decisions are social decisions. Community impacts and interests are part of, not separate to, engineering design and delivery.
3. Community engagement should be considered as early as possible and throughout the engineering and infrastructure lifecycle.
4. Communities are diverse. Engineering and infrastructure projects need to identify needs and aspirations of communities they work with and for. This includes addressing how race, faith, disability, gender, family circumstances and economic status lead to different opportunities to engage and impacts for different groups.
5. Community engagement with engineering and infrastructure projects should be based on empowerment, equity, trust and knowledge exchange.
6. Communities should be provided with appropriate information about engineering and infrastructure projects and their impacts.

7. Relevant community groups and stakeholders in engineering decisions and projects need to be identified and represented systematically.
8. Clear objectives for processes of engagement need to be agreed among participants at the outset.
9. Methods of engagement should recognise and account for power inequalities to enable two-way learning between participants.
10. Methods should be selected and tailored to the decision-making context, considering the objectives, type of participants and appropriate level of engagement.

More than 900 people attended 'The value of community engagement on infrastructure projects' webinar which presented the draft principles, and 143 responded to relevant questions in the feedback survey. The survey included open questions to provide suggestions for changes. The survey asked participants to identify their role in the topic of the webinar. Figure 2 shows that 73% identified as engineers, 13% as engagement professionals, 8% as community members and 12% as 'other'. The draft principles were also published on The Civil Engineer blog promoting the Strategy Session (https://www.ice.org.uk/news-and-insight/the-civil-engineer/november-2020/engaging-communities-a-role-for-engineers) and seeking email feedback. 19 people, including representatives of community-based organisations, responded by email to the draft principles, including suggestions for changes.

In response to the question 'Is a statement of Principles of Community Engagement with Engineering needed?', 98% replied 'yes'. The related comments addressed the drivers for a statement of Principles, and further information and suggestions related to the draft statement. Table 2 shows that the highest number of comments related to slow progress of community engagement practice in engineering and infrastructure as a justification for the need for a statement of principles from the ICE. The next highest number of comments related to the cost of engagement, the sheer difficulty of achieving good engagement, and suggestions to incorporate the community engagement and the principles into the ICE Code of Conduct and professional development of engineers.

Table 2: Themes in comments responding to the question ‘Is a statement of Principles of Community Engagement with Engineering needed?’

Theme	Count
Slow progress	6
Cost	4
Difficulty	4
Professional development	4
Code of Conduct	4
Importance	3
Sustainable development	3
Definition	2
Diversity	2
Existing standards	2
Client	1
Trust	1
Collaboration	1
Communication	1
Consistent standards	1
Democracy	1
Education	1
Project lifecycle	1
Vocal minority	1

Survey respondents were asked to rate the importance of each of the draft principles on a 5-point scale from ‘not at all important’ to ‘very important’. Figure 3 shows that the principles were all rated ‘very important’ or ‘somewhat important’ by most of respondents. Table 3 presents the relative ranking of the principles based on a weighted average of the responses. Principle 3 ‘Community engagement should be considered as early as possible and throughout the engineering and infrastructure lifecycle’, received the highest importance rating. Principle 2 ‘Technical decisions are social decisions. Community impacts and interests are part of, not separate to, engineering design and delivery’ and Principle 5 ‘Community engagement with engineering and infrastructure projects should be based on empowerment, equity, trust and learning’ were ranked as the least important.

Table 3: Relative ranking of importance of the draft principles

Draft Principles	Relative Importance Ranking
1. Supporting sustainable, healthy communities is a core duty of every engineer.	2
2. Technical decisions are social decisions. Community impacts and interests are part of, not separate to, engineering design and delivery.	9
3. Community engagement should be considered as early as possible and throughout the engineering and infrastructure lifecycle.	1
4. Communities are diverse. Engineering and infrastructure projects need to identify needs and aspirations of communities they work with and for. This includes addressing how race, faith, disability, gender, family circumstances and economic status lead to different opportunities to engage and impacts for different groups.	5
5. Community engagement with engineering and infrastructure projects should be based on empowerment, equity, trust and learning	9
6. Communities should be provided with appropriate information about engineering and infrastructure projects and their impacts	3
7. Relevant community groups and stakeholders in engineering decisions and projects need to be identified and represented systematically	6
8. Clear objectives for processes of engagement need to be agreed among participants at the outset	4
9. Methods of engagement should recognise power inequalities and enable two-way learning between participants	8
10. Methods should be selected and tailored to the decision-making context, considering the objectives, type of participants and appropriate level of engagement	7

The comments raised in response to the question of the importance of each principle covered a range of issues: the relationship between community engagement and democratic decision making and representation; associated costs, issues related to the specific expression and definition of the principles; diversity; and managing the impact of a vocal minority of community members in engagement processes. Table 4 summaries the key themes raised in the comments.

Table 4: Themes in comments responding to the question ‘How do you rate the importance of each of the Draft Principles of Community Engagement with Engineering?’

Theme	Count
Democracy	8
Cost	6
Expression	6
Professional development	6
Diversity	5
Implementation	5
Vocal minority	5
Definitions	4
Project lifecycle	4
Clients	3

Conflict	3
Transparency	3
Learning	3
Sustainable Development	2
Place	1
Resilience	1

The survey and email responses to the webinar and blog post indicated strong support for an ICE statement of principles. Each principle was revised based on specific criticisms and suggestions provided during the feedback process. Overall comments relating to repetition, brevity and clarity of language also informed the final version. The final principles are:

Principles for Community Engagement with Engineering

1. Supporting sustainable, thriving communities is a core purpose of the engineering profession.
2. Community impacts and interests are integral to engineering design and delivery.
3. Community engagement should begin at the conception of projects, and continue throughout the engineering and infrastructure lifecycle.
4. A tailored engagement approach with clear objectives, processes and expectations should be agreed among all stakeholders, including community leaders and representatives, at the outset of infrastructure decision-making and planning.
5. Engineering and infrastructure projects should identify the diverse needs and aspirations of communities they work with and for, giving special attention to include groups that are typically marginalised.
6. Community engagement should consider how individuals and groups of different race, age, faith, disability, gender, sexuality, family circumstances, economic status, and other characteristics and may be differently impacted by infrastructure development, and may welcome different forms of engagement.
7. Methods of engagement should recognise power inequalities, and enable two-way communication and learning between communities and engineering and infrastructure projects.
8. Information about engineering and infrastructure projects and their impacts should be shared with community members as part of a two-way process, with information being accessible to all people.

5. Discussion

The large number of responses and engagement in the consultation process gives confidence that the results are robust and there is strong support for the principles (93% of 143 respondents). The data indicate that there is wide recognition of the benefits of engaging with communities early and that engineers see their core role as supporting sustainable, healthy communities (Table 3). The support for the principles is represented in Table 2 and stems from the ‘slow progress’ seen to date, the ‘cost’ and the need for ‘professional development’ to

engage with the ‘difficulty’ of community engagement. Adopting the principles would give more explicit direction for those seeking to uphold the ICE’s code of conduct in practice.

It should be noted that the context in which the data has been gathered has a bearing on the support and ranking of principles. Participants were self-selecting, likely with a pre-existing interest in community engagement, and largely drawn from the ICE community of professional engineers (73%) rather than engagement professions (13%) or communities (8%). As these principles are adopted and used, it is worth reflecting on how these principles are seen and interpreted by these different groups, and how impactful community engagement is framed from their viewpoints. For instance, it is notable that the draft principles of ‘methods of engagement should recognise power inequalities and enable two-way learning between participants’ and ‘community engagement with engineering and infrastructure projects should be based on empowerment, equity, trust and learning’ were ranked 8th and 9th by participants. Effective community engagement that utilises ‘deciding-together’ and ‘acting-together’ strategies (Wilcox, 1994) of co-creation, and avoids ‘one-size fits all’ approaches necessarily cedes more control over deciding what matters in a project to the community. The results of the survey show that this is least supported, even amongst a cohort of participants who expressly support community engagement, suggesting reticence by engineers to cede decision-making and expertise to communities. Draft principle 2, ‘Technical decisions are social decisions. Community impacts and interests are part of, not separate to, engineering design and delivery’ was also ranked 9th by participants, and was not included in the final list. The ranking and associated comments indicate that participants largely conformed to a conventional understanding of engineering as a technical profession, in contrast to critical social science reframing of engineering and infrastructure as socio-technical (Bell, 2011). Dialogue and reflection is needed to find a balance that respects and recognises the technical expertise of engineers, alongside the local expertise of communities, and the expertise of those professionals trained to be a bridge between them. If this can be done in a way that reframes community engagement as beneficial to projects and thus engineers, then it is more likely that empowerment of communities will be understood in a more positive light.

6. From principles to action

Sustainable development challenges engineers to deliver projects in the context of wicked problems, requiring greater attention to systemic interactions between economic, environmental, and social aspects. Community engagement is an important way to incorporate social aspects into design proposals and throughout the infrastructure lifecycle. It is also important for engineers to involve clients and users early in the process. There is a common misconception amongst client and engineers that engaging with stakeholders for design development is a great undertaking which strains a project's budget and timeline. This will often discourage many from incorporating community engagement into infrastructure and projects. Here, it becomes important for engineers and designers to actively engage with users from the very start. Working with clients to build a program for engagement helps to create a better understanding of community engagement and how best to incorporate it into design and delivery. This way stakeholders become an integral part of design and operation, rather than an expensive afterthought.

Depending on the nature of the project, community and stakeholder engagement throughout the lifetime of the project may be essential to prevent project failure. Beyond future cost implications, initial funding in recent years has also started to be influenced by stakeholder engagement. Now briefs for many funding schemes in England such as Low Emission Neighbourhoods and the Good Growth Fund, Towns Fund require community involvement in the design phases to be granted funding.

The ICE Principles for Community Engagement with Engineering are adaptable guidelines for best practice when engaging with local communities as stakeholders. They are a starting point to build specific engagement strategies for infrastructure and design projects of any scale. These flexible guidelines are intended to encourage engineers to work with clients, investors, and allied professionals to develop their own action plans which will meet their specific needs. For some projects, maximum input and effectiveness from community engagement will be at concept design phases, and for some it will be at detail design or even operational stages which means not all projects need the same level of community input at the same time. However,

Principle 3 indicates that community engagement should always begin at conception, and implies a clear strategy should be developed and planned at that stage. The methods of engagement can vary, depending on projects, but the core values of all engagement processes are consistent through the adoption of the principles.

Implementation of the principles requires collaboration between engineers and other built environment professions, as well as with communities. Engineers themselves may not undertake all aspects of community engagement work, which may require specialist professional skills and lived experience. As leading actors in infrastructure conception and delivery, engineers are well placed to ensure that the principles are incorporated into infrastructure projects, drawing on diverse skills and professions as required.

Conventional education and professional development of civil engineers has not historically emphasised the benefits of and responsibility for community engagement. Respondents to the survey about the principles highlighted the need for continuing professional development activities in this field. This also presents a challenge for reform of undergraduate engineering education. Inclusive community engagement requires appreciation of diverse viewpoints, understanding of power dynamics, a tolerance of complexity, conflicting information and ambiguity. These are all characteristics of wicked problems, but are not typically included in mainstream civil engineering training and education.

Improving ‘interactional expertise’ in community engagement could enhance engineers’ capacity to work with a wider range of disciplines to improve responses to wicked problems (Seager et al., 2012). Interactional expertise is ‘the ability to converse expertly about a practical skill or expertise, but without being able to practice it, learned through linguistic socialisation among the practitioners’ (Collins, 2004). The principles provide a foundation for engineers to both improve their own expertise and capacity to engage with communities, and to work more productively through interaction with community engagement professionals and community representatives.

7. Conclusions

Engineers are increasingly called upon to work on ‘wicked problems’ for which there is no clear, single technical solution (Seager et al., 2012). Designing and delivering infrastructure to support sustainable development and respond effectively to the climate crisis requires collaboration with diverse stakeholders, including local communities (Engineering Council, 2013; ICE, 2021). Engaging local communities requires new understanding of the role of engineering in infrastructure delivery, including how engineers work with community engagement specialists and established community leaders.

The ICE Principles for Community Engagement with Engineering were drafted from established literature, and finalised after consultation with civil engineers and interested stakeholders. The Principles are intended to be adaptable to suit a range of contexts, sectors and scales of project, and to support engineers at different stages of their career and levels of influence. They provide a foundation for further development of best-practice case studies and guidance, to be shared through engineering education and professional development.

Engaging communities in engineering and infrastructure is necessary for achieving sustainable development. The Principles provide a shared statement of values to underpin how engineers and associate professions work with local communities to realise positive benefits from engineering and infrastructure, also fulfilling professional responsibilities for the health and safety of the public and future generations.

References

Andreotti, V. (2012). Editor’s Preface: HEADS UP, Critical Literacy: Theories and Practices, 6(1), 1-3.

Arnstein, S. R. (1969) A Ladder Of Citizen Participation, Journal of the American Institute of Planners, 35(4), pp. 216–224.

Bell, S. (2011) Engineers, Society and Sustainability. Morgan and Claypool.

CAMELLIA (2020) Community Water Management for a Liveable London, https://www.camelliawater.org/ (accessed 8th April 2022)

438 Chapman, T. 2020 Unwin Lecture: Zero Carbon and Infrastructure, webinar (2020), Institution of
439 Civil Engineers, 8th October, https://www.ice.org.uk/eventarchive/2020-unwin-lecture-
440 zero-carbon-webinar (accessed 16th July 2021)
441 Chow, V., Leiringer, R. (2020) The practice of public engagement on Projects: From Managing
442 External Stakeholders to Facilitating Active Contributors. Project Management Journal.
443 51(1) 24-37.
444 Cilliers, E.J., Timmermans, W. (2014) The importance of creative participatory planning in the
445 public place-making process. Environment and Planning B: Planning and Design,
446 41:413-429.
447 Collins, H. (2004) 'Interactional expertise as a third kind of knowledge', Phenomenology and the
448 Cognitive Sciences, 3(2), pp. 125–143..
449 Community Places (2012) Community Planning Toolkit. Accessed on 19 November.
450 https://www.communityplanningtoolkit.org/
451 Cox, S. et al. (2021) Framework for Defining Social Value, A framework for defining and
452 delivering social value on built environment projects, UKGBC,
453 https://www.ukgbc.org/ukgbc-work/framework-for-defining-social-value/ (accessed 16th
454 July 2021)
455 Daly, D., Jodieri, McCarthy, S., Pygott, K., Wright, M. (2015) Communication and engagement
456 in local flood risk management. C751. Construction Industry Research and Information
457 Association. London.
458 De Koning, J. I. J. C., Crul, M. and Wever, R. (2016) Models of Co-creation. Service Design
459 Geographies. Proceedings of the ServDes.2016 Conference, Copenhagen, Volume 25.
460 From ResearchGate:
461 https://www.researchgate.net/publication/303541138_Models_of_Co-creation
462 Dobson, J. (2020) How can civil engineers create social value?. The Civil Engineer Blog.
463 Institute of Civil Engineers. 25 June 2020. https://www.ice.org.uk/news-and-insight/the-
464 civil-engineer/june-2020/how-can-civil-engineers-create-social-value (accessed 16th
465 July 2021)

466 Dobson, J. et al. (2020) Maximising Social Value from Infrastructure Projects, Institution of Civil
467 Engineers, https://www.ice.org.uk/news-and-insight/the-civil-engineer/june-2020/how-
468 can-civil-engineers-create-social-value (accessed 16th July 2021)
469 Duignan, M.B. (2019), "London's local Olympic legacy: Small business displacement, 'clone
470 town' effect and the production of 'urban blandscapes'", Journal of Place Management
471 and Development, Vol. 12 No. 2, pp. 142-163. https://doi.org/10.1108/JPMD-05-2018-
472 0033
473 Engineering Council (2013) Guidance on Sustainability for the Engineering Profession.
474 Available at:
475 https://www.engc.org.uk/EngCDocuments/Internet/Website/Guidance%20on%20Sustai
476 nability.pdf. (accessed 19th November 2021)
477 Gold JR, Gold, MM (2020) Land remediation, event spaces and the pursuit of Olympic Legacy.
478 Geography Compass 14:e12495.
479 Harsh, M., M. J. Bernstein, J. Wetmore, S. Cozzens, T. Woodson, and R. Castillo. 2016.
480 "Preparing Engineers for the Challenges of Community Engagement." European
481 Journal of Engineering Education 42 (6): 1154–1173.
482 Head, B. 2007. Community Engagement: Participation on Whose Terms? Australian Journal Of
483 Political Science 42 (3): 441–454.
484 Her Majesty's Government (2021). Net Zero Strategy: Build Back Greener. Her Majesty's
485 Stationery Office.
486 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachmen
487 t_data/file/1033990/net-zero-strategy-beis.pdf
488 Hoh Y. (2009). Using notable women in environmental engineering to dispel misperceptions of
489 engineers. International Journal of Environmental Science Education 4 117–131
490 Institution of Civil Engineers (2020) Watch the latest ICE Strategy Session: The value of
491 community engagement on infrastructure projects. ICE News.
492 https://www.ice.org.uk/news-and-insight/latest-ice-news/watch-ice-strategy-session-on-
493 community-engagement

494 Institution of Civil Engineers (2021) Guidance on Attribute 5: Sustainable Development.
495 Available at https://www.ice.org.uk/getattachment/my-ice/membership-
496 documents/attribute-5-guidance/attribute-5-guidance.pdf.aspx
497 International Energy Agency (2021), Net Zero by 2050. A roadmap for Global Energy Sector,
498 https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-
499 10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
500 Lane SN, Odoni N, Landström C, et al. (2011) Doing flood risk science differently: an
501 experiment in radical scientific method. Transactions of the Institute of British
502 Geographers 36(1): 15–36.
503 Mahmoud IH, Morello E, Ludlow D, et al. (2021) Co-creation Pathways to Inform Shared
504 Governance of Urban Living Labs in Practice: Lessons From Three European Projects.
505 Frontiers in Sustainable Cities 3: 80
506 Natarajarathinam, M., Shaoping, Q. Lu, W. (2021). Community engagement in engineering
507 education: A systematic literature review. J Eng Educ. 110:1049-1077.
508 National Infrastructure Strategy, HM Treasury, UK Government
509 https://www.gov.uk/government/publications/national-infrastructure-strategy (November 2020)
510 Plummer, R. and FitzGibbon, J. (2004) Some observations on the terminology in co-operative
511 environmental management. Journal of Environmental Management 70(1): 63–72.
512 Reed, M.S. (2008) 'Stakeholder participation for environmental management: A literature
513 review', Biological Conservation, 141(10): 2417–2431.
514 Rollason, E., Bracken, L. J., Hardy, R. J. and Large, A. R. G. (2018) Evaluating the success of
515 public participation in integrated catchment management. Journal of Environmental
516 Management 228: 267–278.
517 Seager, T., Selinger, E. and Wiek, A. (2012) 'Sustainable Engineering Science for Resolving
518 Wicked Problems', Journal of Agricultural and Environmental Ethics, 25(4), pp. 467–
519 484.
520 Ward, S., Paling, N., and Rogers, A. (in review). Mobilising sustainable, water resilient
521 communities: evidence and engagement across scales. Engineering Sustainability.
522 Wilcox, D., 1994. The Guide to Effective Participation. Partnership Books, London.
523

Figures

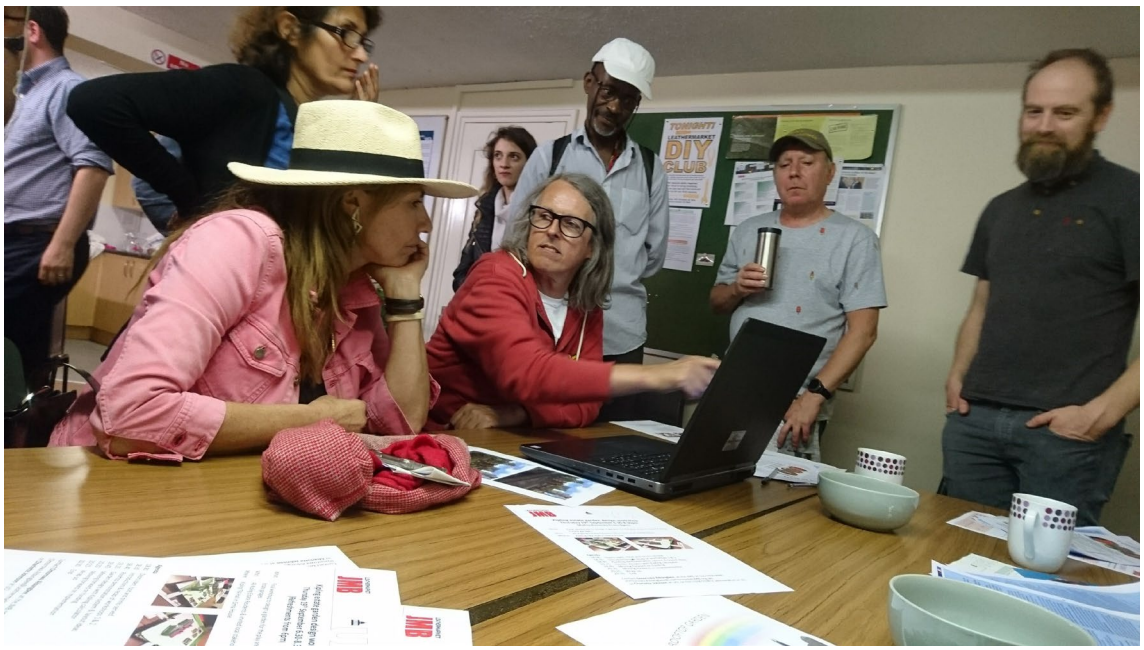

Figure 1. Residents of the Kipling Estate, London in a co-design workshop as part of the Community Water Management for a Liveable London (CAMELLIA) programme (CAMELLIA, 2020).

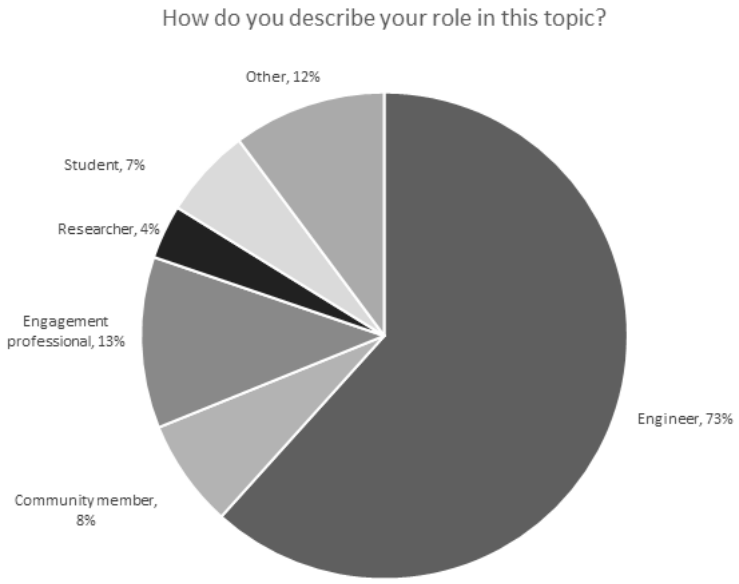

Figure 2. Survey respondents' roles

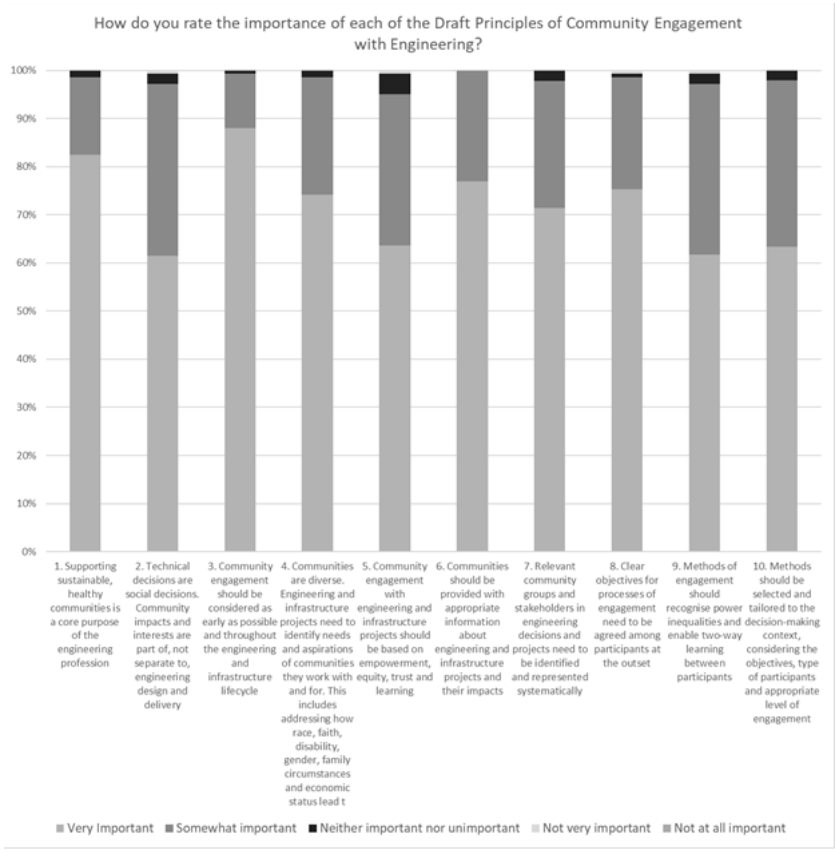

Figure 3. Importance of individual principles