NATIONAL INFRASTRUCTURE
COMMISSION DESIGN PRINCIPLES

PRIMARY RESEARCH REPORT

PRODUCED BY
FRAME PROJECTS

This report was commissioned by the National Infrastructure Commission. The views expressed and recommendations set out in this report are the authors' own and do not necessarily reflect the position of the National Infrastructure Commission.

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1. INTRODUCTION

The National Infrastructure Commission (NIC's) Design Group was set up in Spring 2019. Its membership consists of ten experts who are tasked with acting as champions for design excellence in infrastructure. The Group, chaired by National Infrastructure Commissioner Sadie Morgan, brings experience from engineering, transport, landscape and architecture. Its role is to ensure that design is considered from the start of every major, national infrastructure project and that it is integral throughout the process to delivery.

The NIC commissioned Frame Projects to carry out research to support the Design Group in establishing a set of design principles for nationally significant infrastructure. These principles will provide leadership on design quality by setting ambitions and expectations for all major UK infrastructure projects. They will also influence thinking on how good design is embedded within the culture of infrastructure planning and delivery. The Design Group and the NIC intend this project to develop high expectations of design quality to support design champions at board level in key infrastructure organisations, and design panels conducting reviews of developing designs.

A scoping exercise has already been carried out under the aegis of the Design Task Force, which guided the establishment of the National Infrastructure Design Group. It has been informed by three research reports it commissioned which were published in 2018: 'Developing Design Principles for National Infrastructure', 'Value of Design in Infrastructure Delivery', and 'Design and Infrastructure – Sector Review of Attitudes'.

This research report analyses the interviews carried out by Frame Projects to inform the development of design principles for national infrastructure, and a round table event which brought together a range of experts. It should be read alongside the accompanying 'Design Principles Literature Review'. The final output of the project is the 'National Infrastructure Design Principles'.

2. METHODOLOGY

This report analyses the information gathered through a research methodology that included desk research, project interviews and a sector round table. The desk research led to the production of the accompanying 'Design Principles Literature Review', and informed the choice of projects for interview focus. Semi-structured project interviews were carried out in June, July and August 2019 with 35 individuals, using a list of questions to frame discussion. The sector round table was held on Wednesday 17 July 2019, attended by 30 people.

The project interviews and the round table remit encompassed the sectors within the NIC's remit: digital telecommunications, energy, flood, transport, waste, water and sewerage sectors. The same parameters were used for the literature review. This definition, wider than the sectors to which Nationally Significant Infrastructure Projects (NSIPs) apply, was also used for the Design Task Force's 'Developing Design Principles for National Infrastructure' report. It provides greater scope for a full understanding of the potential of design quality in infrastructure, avoiding too narrow a definition and enabling learning from sectors not traditionally seen as related, for example the digital sector.

2.1 SECTOR ROUND TABLE

The round table was held to ensure that a broad selection of senior figures with infrastructure and design expertise were able to provide detailed thinking on how design principles might improve infrastructure design quality.

Attendees included those from the digital telecommunications, energy, flood, transport, waste, water and sewerage sectors. The professional roles fulfilled by attendees included as clients, owners, operators, policy advisers both within and outside government, engineers, architects, planners, construction, surveyors, users, academics and those representing professional institutions and industry bodies.

The discussion was chaired on behalf of Frame Projects by Sam Richards, independent consultant on planning, transport and public realm. The discussion was divided into group and plenary sessions. All attendees were presented with a list of potential themes for design principles, developed from the options presented in the Design Task Force's research base. These are presented below, in the 'Project interviews' section.

Six key questions were posed to help resolve the form, nature content and practical application of design principles. Attendees were divided in groups, selected to create a mixture of professional backgrounds, and asked to discuss these:

1. What should design principles include?
2. What form should design principles take?
3. What will ensure people use them?
4. How can design principles be implemented?
5. How can measurable outcomes be ensured?
6. How can they improve quality of life for communities?

Notes were made of the discussion that took place in each group. The round table then reconvened for a plenary session in which the debates engendered in group discussion were re-examined. The results from the full event are analysed below, alongside those from project interviews.

2.2 PROJECT INTERVIEWS

Telephone interviews were carried out over the course of the research project with selected individuals. These were identified by role, with the aim of ensuring the widest possible range of perspectives were considered in the development of design principles. The project aim was to carry out interviews with people in the following roles:

- Client project lead
- Client design lead
- Client or contractor stakeholder manager
- Contractor project manager
- Local planning authority project lead
- Stakeholder involved in project consultation

Five national infrastructure projects were selected as the focus for interviews:

- Blackburn Meadows Power Station, Sheffield
- Curzon Street HS2 Station, Birmingham
- Thames Tideway, London
- Walney Extension Offshore Wind Farm, Cumbria
- Warrington Flood Defence Scheme, Cheshire

These were chosen to ensure a project belonging to each of the sectors chosen for the project was addressed. The individual projects were selected to provide a geographical spread. They are all high-profile projects within their sectors, and represented a range of stages, from recently completed (within the last five years) to those under construction or still in the design phases. Finally, they include projects which made use of detailed design principles and those that appeared, from a desk research perspective, not to use published principles.

People involved with the delivery of a sixth project, the Government Digital Service's 'Government Design Principles', were also interviewed. The nature of this digital project, in which client and delivery organisation were one and the same, meant that the role profiles used to select interviewees for the five physical projects were not applicable.

Conversations with these interviewees were supplemented by further conversations with individuals with particular expertise to offer, who were encountered or sought out during the research. These additional interviews were undertaken for the following reasons:

- To allow individuals unable to attend the sector round table to contribute their views.
- To include a wider range of views in the project, once interviews had been conducted with those in the roles initially identified, helping to ensuring a broader representation of ethnic and racial groups and of ability types among interviewees.
- To include further perspective from national organisations involved in campaigning on national infrastructure projects, and with experience of contributing as stakeholders to enquiries.

The purpose of the telephone interviews was to:

- Test a set of straw man principles at headline level to identify missing themes, seek views on changes needed.
- Do so by asking interviewees to respond to an initial list of principles in the context of their project experience.
- Seek wider ideas to inform the development and dissemination of the design principles.
- Explore potential support for the principles among key stakeholders.

Those involved in projects from a professional perspective were interviewed using the following questions to provide a basic interview structure:

1. Did you use design guidance or principles on [relevant project]? If so, what form did they take (i.e. were they practical instructions, or broader ambitions)?
2. Do you think design principles did make/would have made a difference to the outcome?
3. What topics would be your priority for inclusion in a set of design principles (top three as prompt)?
4. The following principles are an initial set of ideas, not a final proposal. Do you think they would influence and improve project design if they were applied by a design review panel [provide draft principles headline list – test each separately]?
5. Can you suggest formats or communications methods for design principles other than a list, for example using diagrams?
6. Based on your experience on [relevant project] do you think we should add or change anything on the list?
7. Do you have any other comments on the principles?
8. Who needs to know about and support these principles if they are to work, and in what types of role?
9. Do you think wider changes are needed to enable better infrastructure design, for example process, guidance or legislative changes?
10. Do you know of any exemplar projects where design principles have contributed to improved design, and can you describe how?

Those involved in projects from a non-professional perspective were asked a separate set of questions, chosen to inform thinking on the role that design principles could play in promoting effective community engagement:

1. Do you think the way the completed [relevant project] is designed affects you? If so, how?
2. What involvement did you have with [relevant project]?
3. Do you feel you had an opportunity to influence its design?
4. What would you improve or change about engagement process? Which aspects of the design could have been improved through engagement?
5. What topics would be your priority for inclusion in a set of design principles?
6. Do you think the following draft principles - an initial set of ideas, not a final proposal - could help to improve similar projects in future, from the point of view of local residents [read 'straw man' principles list]?
7. Do you have any other comments on the principles?

A 'straw man' set of principles was developed from proposals included in the Design Task Force's suite of reports. These were intended as a basis for discussion, to prompt agreement and disagreement, not as a final format for a set of principles. In particular, they highlighted areas of potential focus that might be seen as falling within the remit of national infrastructure design principles. They were presented to all interviewees at the relevant point in the interview process.

The following list of principles was used in interviews. The Design Principles show what it means for all nationally significant infrastructure to be of enduring quality, outstandingly well designed. Better design can save money, reduce risk, add value and create a legacy that looks good and works well.

1. Functions well for all users
- Creativity extends functional boundaries to deliver new benefit.
- The experience of using infrastructure is a measure of its quality.
- Design benefits employees, customers, users, neighbours and visitors.

2. People-focused
- Consultation does more than inform communities - it gives them influence.
- Clear relationship with people, whatever the size of project.

3. Partnership and smart working
- Design is integral to the process, from start to finish.
- Continuity of involvement for professionals.
- Multi-disciplinary design teams and time for design.

- Local authorities, and other public and private interests, involved from the start.

4. Easy for everyone to access and use
- Access is fundamental to the project.
- Infrastructure is simple, intuitive and flexible for different users.

5. Responds to place
- Designed for this place and no other.
- Positive impact on its location by looking beyond the site boundaries.
- Uses a full understanding of heritage and culture.

6. Integrated with landscape
- Improves, not degrades, landscape.
- Contributes local landscape benefit .
- Creates ecological gain.

7. Resilient
- Connected to wider systems.
- Adaptable, able to withstand long-term change.
- Flexible, providing spare capacity for future needs.

8. Environmentally transformative
- Takes a lead in delivering systemic change.
- Uses environmentally sustainable methods, materials and working practice.
- Environmentally sustainable to operate.
- Full lifespan planned in from the start.

9. Provides value
- Projects are value for money.
- Future management and maintenance costs are sustainable.
- Reduces and manages risk.

10. Safe and secure
- Safety a central factor, from construction to use to deconstruction.
- Security measures proportionate and necessary.
- Security incorporated early, not added later.

This list was presented to interviewees during discussions, after they had been asked for their views on priorities for a set of national infrastructure design principles, to avoid directing their responses.

3. ANALYSIS – INTERVIEWS AND ROUND TABLE DISCUSSION

Analysis was carried out on the interview transcripts and on the round table discussion to draw out themes from the written record of conversations. This included summarising the basic subject represented by passages of discussion, a qualitative analysis technique known as descriptive coding. This allowed patterns of predominant themes to be identified across the conversations that the researchers held with interviewees.

A similar process was used to explore the themes that emerged from the round table discussions. The format of the event used an opening plenary session, four group discussions and a concluding plenary discussion. This meant that the themes from the event were identified and debated during the final session, so to some extent a preliminary analysis had already taken place. However, for this report the analysis included notes from each discussion session to ensure themes not represented in the final plenary were included in the report.

These predominant themes from both the interviews and the round table were then extracted and grouped or separated, where similarities and differences could be identified. The themes below represent the key combined areas of discussion from the telephone interviews and from the round table. The findings from the research process are discussed, and points that relate to the wider themes are also noted. Although they were often raised by small numbers or single individuals, they are included where they develop or qualify ideas within one of the key overall themes.

3.1 HOW DESIGN PRINCIPLES ARE USED

Those interviewed were asked about their experience of using design principles on infrastructure projects. The application of design principles was also discussed at the National Infrastructure Round Table held in July 2019.

Not every major infrastructure project in the UK makes use of design principles. There is significant variation across sectors and individual schemes in the approach taken, which ranges from the use of detailed, project-level deliverables to projects that do not have any overall design guidance in place. It is possible to deliver high quality design at both ends of this spectrum, but interviewees and round table attendees provided widespread endorsement of the assumption being tested through this research project – that design principles can improve the design quality of national infrastructure.

The opinion was expressed that design principles have a strong role to play in establishing and directing the culture of organisations. They can achieve this by setting the clear, overall aim of reaching best possible project outcome. A directive intentional vision in place should be from the start of a project. To ensure the "design journey" is a positive and effective one, the vision should be widely understood, and be clear about what it aims to achieve. Rules can then be put in place to give the best chance of meeting these objectives.

Some of those working at delivery level on projects equipped with design principles reported that, although they were aware of the nature and content of their project's design quality commitments, they did not find they had a significant impact on day-to-day work. A headline design vision was very important in providing focus and overall direction. A vision for design provides overall guidance, but this must be backed up by project-specific application. A careful balance is needed at this level between design specifics that are neither too vague to have meaning, nor so prescriptive that they restrict innovative design.

Delivery organisations endorsed the role played by design principles, which were very helpful in "keeping them on the straight and narrow." Principles should be in place from the start to ensure they legally incorporated as part of a planning permission. When they work well, they can help reduce the number of design iterations needed, giving designers a sound starting point rather than requiring

them to spend time finding their feet. If designers understand what the clients is looking for, it is easier for them to price and to avoid commercial tension that gets in the way of design quality. However, if design principles are too rigid it can lead to difficulties on both a cost and a time basis.

The point was also made that a design vision should not be provide a reason to lose sight of other aspects of design, not specified in the vision, which also need to meet appropriate standards. A holistic view of design is needed, rather just a “legislative” perspective, to understand where the application of principles will improve the design outcome. This means the opportunity to challenge standards and requirements should be built into projects, to ensure there is no scope for “malicious compliance”: meeting requirements for their own sake, not for the benefit of the project. A clear understanding should be established of what is meant by ‘design’. It should not be taken for granted that all those who need to use design principles will understand that design relates to more aesthetic considerations, or see it as describing a process that encompasses more than their own area of work.

Where design principles incorporate several levels with different amounts of detail, for example an overarching vision leading to project-specific requirements, it is important that the hierarchy and application of these elements is clear. It must be easy to understand how and when principles apply, and who is expected to own and act upon them. This consideration applies to the proposed NIC design principles. As the NIC makes national-level decisions, it was suggested that it is logical that these are pitched at a national level, and intended to provide national leadership. By influencing design quality at a higher level, the NIC can help to improve the “UK’s masterplan”, while leaving space for industries and major projects to produce their own sets of design principles showing how headline national ambitions can be realised at project level.

3.2 CLIMATE CHANGE

The strong and consistent message from interviews and round table discussions, either raised or confirmed by all interviewees, is that major infrastructure has a crucial role to play in reducing carbon emissions and environmental impact. The NIC's design principles should be seen as "post-declaration of climate emergency", and should reflect the need for infrastructure to actively enable and promote environmental transformation. This should be a headline ambition in any design principles, which should set out a clear intention and send a strong leadership message. The NIC was regarded as playing an important role in setting clear expectations on how the environmental impact of infrastructure can be reduced, and how it can contribute to reducing carbon emissions across all areas of society. Its leadership role across a wide range of industries with the power to influence energy generation and consumption, behaviours, ecological impact and material use places it in a particularly important position of influence.

The point was emphasised both in interviews and at the round table, that national infrastructure supplies the mechanisms the UK must use if it is to reduce its carbon impact. Without engaging essential infrastructure systems, there is no possibility that the UK can meet either its existing commitments – net zero carbon UK emissions by 2050 – or future, more ambitious targets. The point was made that infrastructure plays a particularly influential role in enabling reduced carbon emissions. As networks, systems have the potential to generate multiple benefits through harnessing their geographical scale. The central role of infrastructure in responding to the climate emergency should therefore be a fundamental driver for any design principles.

While clear leadership and intent is essential, caution was registered against "jumping on the bandwagon" by enabling unrealistic carbon reduction targets. Interviewees and round table attendees drew attention to the risk that public bodies have committed themselves to achieving zero carbon status within short timescales, with insufficient consideration of how this can be achieved. Ambitions for the design quality of UK infrastructure, including its carbon impact, must be strong and credible.

While it was agreed that all infrastructure has an active and crucial role to play in changing climate impact, it was pointed that the phrase "environmental transformation", included in the test principles, could be seen as ambiguous and that "transformation" is not an inherently positive process. Different phrasing, perhaps using

the word ‘climate’, could be used for a clearer, more direct message. The need to enable networks and connections as an inherent part of the design approach also applies to physical connections. For example, ecological impact can be changed by ensuring that physical infrastructure makes new habitat connections in depleted landscapes. It was felt that the creation of environmental capital and of environmental gain should be a core role for national infrastructure, enabled by design.

This principle does just apply on a national scale: there was a desire to acknowledge that the global impacts of development, including the impacts on other countries of achieving zero carbon targets, should be acknowledged. Good infrastructure design should be understood as including “smarter alignments” with international systems and taking account of indirect, global impact to reduce climate damage.

3.3 ENVIRONMENTAL AND ECOLOGICAL IMPACT

A smaller number of interviewees raised the importance of designing infrastructure to ensure it acknowledges and addresses the ecological emergency that goes hand-in-hand with the climate emergency. However, aiming to minimise the ecological impact of infrastructure is not sufficient: “no net impact is not enough”. The concept of ecological gain, included in the test principles, was challenged. It was suggested that compensation for ecological damage caused by infrastructure should not be accepted as a matter of course, and that the priority should be to prevent damage from taking place at all wherever possible.

The need for infrastructure planning to be based on a robust, extensive evidence base was raised by round table attendees. For example, the choice of location for individual wind farm applications is developer-driven, and each applicant conducts their own research into potential impact. More efficient use could be made of limited ecological capacity if an overview was available of the least damaging site for offshore wind, and if new facilities could be planned on a strategic basis using this information.

Infrastructure has the potential to improve places, as well as impacting negatively upon them, and its potential to provide wider benefit should be harnessed as a matter of course. While environmental impact statements address impact on landscape and habitats, the starting point for an exemplary design approach could be to understand the wider opportunities for positive environmental contributions.

A number of those interviewed emphasised the role played by designers and contractors in controlling resource use. They should be managers of materials and resources, with a crucial role to play in reduce their usage of stuff. It was suggested that circular economy principles should be incorporated into design principles.

A related point was made, that design principles should incorporate management of future risk, and that certain types of environmental impact, such on climate, cannot be separated from issues such as changing demographics. Environmental impact should not be viewed and dealt with in isolation, but acknowledged as part of a network of interlinked risk and demand that infrastructure design can help manage. As well as addressing future need, the influence that infrastructure can have the way people behave, and its ability to shape expectations of the way society will work, should form part of design thinking.

3.4 COST AND VALUE

There was consensus among round table attendees that the true value of infrastructure lies beyond financial value in a broad range of value types, but that cost predominates in driving decisions. This is an issue for major infrastructure, where high profile budget overruns can have a significant impact on public perceptions of ambitious projects, and can have a serious impact on future budgets.

Infrastructure projects are primarily judged on the money they cost to build. However, over the lifetime of a major, long-term investment success is judged on the basis of value for money. These are two different, potentially conflicting metrics, and a great degree of clarity is needed to ensure value can judged beyond the scope of project delivery. Design principles should acknowledge value for money as an important measure of success, but promote the need for less tangible value measures to be given the same status.

Architects interviewed made the point that design fees are usually a small proportion of the overall cost of a major project, for example less than one per cent of total project budget. Saving on these costs at the expense of the later benefits design can deliver, either those that deliver tangible value or those that provide intangible value – including environmental, social and cultural value – is in reality a false economy. There is always a tension between design and cost on a project, and finding a balance will be crucial. The fundamental lesson that good design does not necessarily cost more was raised several times.

A small number of interviewees thought that the pressure on public sector budgets means it is no longer possible to deliver major projects without attracting partnership funding. Although this was considered by those who raised it as a serious constraint on ability to deliver, it was also suggested that the requirement to identify partners could prove beneficial. Understanding potential partners and their agendas, and working together to deliver wider benefit in return for funding, can help to ensure that infrastructure makes links with its context, looks beyond its boundaries and delivers the fullest possible range of values in return for partner investment.

3.5 PERFORMANCE MEASUREMENT

Performance measurement, and the "instrumentation" to enable it, was a prominent area of discussion at the round table. It was pointed out implementation should be a key focus for ensuring design quality, and that the way designs are implemented is an essential part of the design process. In other areas of engineering, such as aerospace, techniques for monitoring implementation and subsequent performance are much further advanced. It was proposed that all designers should be asked what level of instrumentation they will use to achieve their proposed design. Answering this question will help to ensure the right data is collected to implement effectively. It will also mean that engineers can understand clearly whether they have met the design requirements placed upon them.

This discussion also included wider points about data use. Instrumentation is also necessary to allow data collection on performance of infrastructure over the long periods of time it is designed to be in operation. Change is imminent in the availability of measurement techniques, which are rapidly becoming cheaper, easier and more widespread. Soon, therefore, designers will be better equipped to measure how well a structure is performing through real-time data over the long term. This means that the design process can continue after completion, contributing to ensuring infrastructure delivers the long-term value for public money that forms a core element of its remit.

Data should underpin every element of the design process, even as far as the inclusion of insight into the emotional responses of users. If behavioural data is collected, it would provide the user experience with a status that it often lacks in relation to other drivers of design decisions.

Data collection can also provide time to design, an essential requirement of any project. By providing insight to drive collective thinking and understanding, it can enable a shared approach, while prototyping to test ideas is also easier in a digitally enabled world. Flexibility therefore becomes more central to the design process, avoiding the implementation of single solutions across the board and allowing bespoke approaches to address each scenario.

3.6 DESIGNING FOR PLACE

There was no disagreement among interviewees or round table attendees that infrastructure should be designed for its context, in a way appropriate to its particular setting. It was widely agreed that a contextual design response depends on the necessary work being undertaken to understand the local setting, and this information being used to inform design development and decision-making.

An understanding of local distinctiveness is necessary to provide the context for structures to be designed in a way suits their location. This includes aesthetics and materials, but also the wider applicable of design to create local benefit. Involving local people is essential to achieving this, as discussed below. The requirement for infrastructure to enhance the environments people inhabit was emphasised in interviews. This includes the contribution made by infrastructure to the everyday experience of places. Through improving the experience of living in a place, design quality can have a lasting, positive impact on large numbers of people.

The clear message from those who contributed to the research is that for infrastructure to be of a national standard, a consistently high quality of architecture is very important. The nation's infrastructure is a public good and makes a major contribution to perceptions of national identity. The legacy left by its design should therefore be directly addressed by the design principles. National infrastructure should be designed with a long-term national legacy as an upfront objective. However, the long-term contribution of infrastructure can also be in terms of environmental benefit. A full understanding of what landscape context is therefore also needed if infrastructure is to maximise its potential place benefit.

High quality design applies to small, as well as large interventions. Although many infrastructure projects result in large, unmissable structures, there is arguably a greater impact from multiple, small structures such as the nationwide network of mobile telephone masts. Attendees at the round table made the point that design principles should set design expectations for all types of national infrastructure, including those that may receive less scrutiny or attention.

Approaches to enhancing places can include the involvement of artists, which needs to happen at an early stage in the design process, with a creative rather than a prescriptive approach to the contribution they can make – and to the scale they can work on. which could be much wider than that of the project.

3.7 DESIGN BEYOND BOUNDARIES

Most interviewees and round table attendees agreed that designs that are suited to their context must look beyond the boundaries of a project site. The fundamental importance of designing "beyond the red line" was widely discussed in interviews and at the round table, ensuring that the impact of design is understood to be wider than the site limits. This should include responding to growth and regeneration agendas for the wider area. Infrastructure should be "the zip through a place", making use of its ability to create connections. For example, road layouts (either related to new infrastructure, as infrastructure in their own right) can enable or prevent integration with existing townscapes, and make the difference between a project that integrates rather than divides a place.

A wider understanding of place can result in reconceptualising the problem to be solved. For example, flood defence strategy is more effective if it looks beyond the construction of hard defences to softer water management techniques, such as deculverting and sustainable drainage. Alternative approaches such as these are only available by looking further up the courses of rivers and understanding the wider picture. The involvement of landscape architects to develop principles for structures was specifically discussed by a small number of interviewees.

It was clear from interviews that looking beyond the project 'red line' is only possible with the involvement of a wide range of stakeholders, from local people to local authorities, who can provide the context and the links to related needs, proposals and funding needed to unlock benefit beyond the functional aims of a project.

3.8 COMMUNITY AND STAKEHOLDER ENGAGEMENT

Every infrastructure project has a social as well as an economic impact, and engagement with stakeholders led to wide discussion about the role of members of the public, and those not professionally involved in the development process, in influencing design.

Experience of positive public engagement related to the stage at which local people were involved, which needs to be early enough to allow design options to be shaped. Some expressed a preference for public engagement at a very early stage of the process, even before designers are brought on board. If engagement is to have a real impact, it must take place at an early enough stage for designers to be able to respond to feedback. However, it was stated that there should be opportunity for those being consulted to be involved at every stage. Funding for community engagement officers to enable public involvement with major projects, either through local authorities, delivery organisations or contractors, was seen as essential.

Round table attendees and a small number of interviewees emphasised that the role of infrastructure should not only be to function well in itself, but also to enable society to function better. Early public engagement involvement can lead to a design approach that ensures major projects are not just concerned with their function, but can maximise opportunities to deliver social benefit. For example, a flood defence scheme can create new public spaces which form a functional part of the defence system but also enhance local landscape and facilities, adding to quality of place. Ideally, creation of wider benefits would help an infrastructure project to be seen in positive terms by local people.

Major infrastructure is often an inherently difficult proposition for people living in places affected by construction. An investment in national-scale infrastructure, creates national benefit, but the impact is felt at a local level and often by people who will not benefit directly from the new infrastructure when it is finished. There was a call, in interviews, for greater honesty about the way projects are presented and discussed. The argument that investing in economic benefit for the nation will trickle down to individual level has, it was felt, been undermined in the last decade and no longer convinces people. The local conversation therefore needs to begin at a strategic level.

The nature of major construction means that engagement is often focused on the impact of the design, rather on shaping the design itself. A situation where unwelcome disruption and change is inevitable is inherently confrontational and this will always be a problem. However, it was felt that the UK's engagement culture, which is often focused on controlling public reactions and limiting the influence individuals can exercise to avoid undermining project timetables, also makes confrontation inevitable.

Interviews revealed that this extends to campaigning NGOs, which are often engaged in infrastructure only in order to prevent it from being built or, if unsuccessful, to mitigate its impacts. Engagement is, for organisations with a campaigning remit, carries potentially a serious reputational risk as they may be held responsible for the result. Whether or not they succeeded in reducing its impact or improving design, their contribution may not be visible or acknowledged.

Principles for public engagement were seen as an effective mechanism to set expectations. Hybrid Bills and Development Control Orders confer great power on delivery teams and great responsibility. It is therefore essential that major projects focus on people, on an ethical approach, and on the generation of social value – engaging the community through design principles.

However, the standard approach to community involvement in the UK was seen as problematic. In the experience of those interviewees who had responded to consultation, local residents are often given the chance to comment on proposals, rather than being involved in shaping them. This can be seen as an expert-driven, top-down approach that makes limited judgements on who owns relevant expertise. Local people have a detailed knowledge of the functioning and needs of their place, expertise which is invaluable to designers and should be sought out and made available to inform their approach.

The timings of public engagement are important. It must be early enough in the design process for it to be possible to respond to feedback. If it happens too late, stakeholders will have a basis for feeling their involvement was for show, and that there was no intention of allowing them to exercise influence.

An alternative approach explored during the round table is to discover what the vision of the local community is for their place, and to explore how design principles can support it. It was suggested that involving local charities or trusts would improve the design approach from conception stage. Masterplans produced in conjunction with the community have proved a success in

town extension contexts, for example in Cambridge. Involving the community will unlock potential and opportunity, while a conversation that takes place early enough can allow design to change in response to local views.

Design quality can, in fact, be driven by local campaigning and engagement. For example, the campaign against the demolition of the local landmark Tinsley cooling towers in Sheffield gave the site a higher profile which contributed to the desire to produce a replacement of high design quality, in the form of the Blackburn Meadows Power Station.

The views expressed by those involved in digital design were notably the most focused on user experience. It was proposed that user research was essential and that, although time and money are frequently offered as reason not to carry out research, projects would pay later if they do not do so. The process of understanding user needs was based on identifying that the purpose of the web infrastructure is to provide a service. If this is understood, user needs become the absolute priority. While digital services offer a more clear-cut, user-based design challenge than most infrastructure types, there are lessons to be learned from a design approach that begins, without question, with the user.

Clear points were made at the round table about the importance of inclusive design. It was suggested that inclusion should be achieved by focusing on the user experience, as the digital sector does. The human aspect of infrastructure is crucial, and a business case is needed for reducing the negative impact that infrastructure has on users. For example, transport design can either create or avoid stressful experiences, which have a health impact on users. Customer experience should not be separated from design, and the impact on people should be understood as central.

3.9 PARTNERSHIP AND TEAM WORKING

There was widespread acknowledgement across interviews and discussions that a cross-disciplinary, team-based approach is necessary to deliver high quality design. Involving the right combination of professions and roles throughout a project allows each element to be regarded from different perspectives, and a strong relationship established to setting and context. This can lead to team members changing their views on the importance of design, potentially moving from a sceptical to a supportive stance.

The need for clients to ensure that architects are brought into a project at the earliest stage was emphasised by a number of those involved in delivering projects, including interviewees who were not architects themselves but recognised the value of a multi-disciplinary team. The role of the client is essential in setting a project agenda. If this is to be environment and design-based, it is the client that must ensure this is the case. The point, however, was also made that a single public sector client does not always exist to play this essential role by taking control of a project.

Some interviewees noted that the consequences of not setting up multi-disciplinary teams and involving architects in the full process can be the creation of a culture in which the focus is only solving problems from a purely functional perspective. One of the few contexts in which local authorities have resources for change is for highways, which can lead to a situation where a “concrete culture” means that hard engineering solutions can be the default solution.

Both interviewees and local authorities stated that broad partnerships are needed for successful projects, working with a wide selection of stakeholders in an open way. All those with an interest, either public or private sector, should be involved early on.

It was pointed out, not only by local authorities, that major infrastructure projects are frequently delivered by the local planning authority. Therefore, early engagement with a local authority as a matter of course on a project is a fundamental requirement of a well-run project. One interviewee pointed out, however, that local authority cultures can, vary considerably and are set by the politicians that run them and by budgetary constraints. Local authority willingness to engage with design is therefore also variable.

The selection of a design team is a very significant factor in determining the end result. Standard public procurement processes may require designers who have already produced the same type of project, which can prevent design innovation. The design team must also share a design vision with the client, and the entire team needs to have the same understanding of design principles mean. A design vision should be completely embedded in the design, right from the first meetings with contractors, and included in any selection and decision-making systems used as part of the process.

It was emphasised that people occupying particular roles would benefit from the support provided by design principles, including the client project manager and project development manager, and the construction manager and contract managers who are ultimately tasked with delivering the project and applying design principles.

Design principles can expose disconnections between the various professional groups. This can include a potential divide between the way that architects think and express themselves and way engineers, who are likely to be implementing design principles, interpret the information. Any national infrastructure design principles therefore need to be clearly written for the full range of people expected to make use of them. The round table discussion emphasised that engagement with engineers is particularly important.

Round table attendees also made the point that there is significant demand for guidance on how to design infrastructure. The most used section of the Design and Buildings Wiki is the 'how to' section. While this is outside the remit of this research project, it may be an area for the Design Group to consider for further work.

3.10 DESIGN REVIEW

There was support for the design review process from those who had presented designs to review meetings as part of their delivery programme. They endorsed it as an effective tool for promoting design quality. An independent design review process is good at identifying designs that are "not good enough" and applying pressure to ensure they are improved, as well as support to ensure a design vision is not diluted. Collaboration and communication were seen as necessary for the review process to work, so that contractors understand why reviewers make criticisms, and know either how to respond or who to work with to develop their approach. The suggestion was made that independent design review should be required for every major infrastructure project.

One interviewee felt that design review provided best value for money during the planning stage of a project. Once decisions had been fixed in place, there was less scope for panels to influence design and generate improvements. It was also noted that any additional scrutiny and assurance needs to be balanced to ensure it is does not make excessive demands in terms of cost or time.

Some doubt was also expressed that design review panels are in the best a position to fundamentally challenge project teams to do better – and that this job cannot be left to them, as they do not have the power to alter organisational structures, priorities, cultures, or to change the skills and resources available to organisations. The uneven application of design review was identified across the sectors within the NIC's remit, with some receiving little or no review scrutiny. It was felt that design review panels could play a more effective and widespread role across infrastructure sectors if they were equipped to move beyond project level and had a wider role providing broader leadership. Design principles would provide a means to demonstrate leadership, and could prove effective in setting new expectations by setting a high bar for design quality.

While design review is an effective way to improve design proposals, much depends on the role played by the client in writing a brief that prioritises and enables design quality, and in carrying out a procurement process that appoints a design team capable of delivering it. Action was also suggested by round table attendees to exercise influence over the client role – particularly that of public sector clients – in commissioning design. This may require support to be made available for clients at this stage of the process, in the same way that design review supports design quality later on. While design review was seen by interviewees as an effective process, it was not seen as a replacement for appointing a design team with the right skills at the start of a project.

3.11 FORMAT AND LANGUAGE

Interviewees and contributors to the project were asked for their views on the most effective format for a set of design principles, based on their own experiences and on material they had encountered. There was clear feedback from many sources that design principles should be clear, concise and easily accessible if they are to be widely used. One interviewee commented that the test principles were "far too woolly", and should be more direct, as definitive as possible, and avoid too many layers. It was suggested by another interviewee that a tiered structure can have diminishing returns, and that principles should cut straight to the point.

Those involved in web and digital service user design in particular made clear points about the need for simple, clear and easy to remember points to aid communication. Ideally, these would be capable of translation into different contexts and formats, and intended to be repeatable. They would benefit from fitting on a single web page. Asked about the most effective graphic format for principles such as these, most interviewees felt a simple list was the clearest option, although exploring alternatives that could be more visually striking was not ruled out.

There were suggestions that use of two or three "super principles" would reinforce overall impact and memorability. The most widely remembered and repeated principles encountered during interviews and discussions were undoubtedly HS2 Ltd's Design Vision, with its three headlines of "People, Place, Time". This was described as the "bumper sticker" approach. The need to prioritise – i.e. to avoid the temptation to include everything and to focus on what really matters most – was emphasized. The possibility was also raised of different language formats for the principles themselves, which could be expressed as opinion statements, questions or as challenges to which audiences could respond, implying active engagement from the start. The language used influences expectations of involvement and practical engagement, and should provide a strong sense in practical terms of what it would mean to apply a set of principles.

While the need to setting out design objectives and requirements as a framework was widely acknowledged, a number of interviewees involved in project delivery cautioned against its being too prescriptive. They suggested this could stifle design creativity and ability to respond to individual project circumstances. They also pointed out that many infrastructure organisations and projects operate their own sets of design principles, and that the NIC should avoid producing work that could contradict, confuse or undermine organisational design commitments that have often been a long time in the making.

Principle fatigue was raised as a potential problem, with an interviewee suggesting that “there are a million of these types of principles” out there. A new set of design principles, particularly one intended to do a different job to anything that currently exists - and in a different way - should therefore stand out by looking, feeling and being different. This should include projecting a less predictable or corporate atmosphere and aiming to inspire and engage, not only by setting new ambitions but by doing so in a way that is demonstrably different.

A statement providing a definition of good design was seen as beneficial in establishing a clear starting point for everything that follows. However, the definition of good design included in the test principles was criticised for projecting too limited and corporately-focused a view of the potential benefits of design, which would not set the tone in the document for wider stakeholder and public involvement.

The language used to write the test principles was specifically discussed, with repeated requests that it should be simple, non-technical and comprehensible to a non-professional audience. This would help ideas to be regarded as intuitive, obvious, non-negotiable and “common sense”. Principles should be stated in very clear language to communicate a strong message.

3.12 BARRIERS TO DESIGN QUALITY

A number of specific barriers to improving the design quality of infrastructure were raised by interviewees and round table attendees.

Local authorities noted that are no longer necessarily able to afford design advice, and therefore lack the professional expertise they need to fully engage with design development. An interviewee pointed out that, while legislation requires good design, it does not provide the tools that local authorities need to achieve it.

In the experience of interviewees, funding arrangements for larger projects can put significant pressure on local authorities, which are often expected to fund the difference when project costs increase. This means that design quality is value engineered out of projects, and therefore needs to be included from the start to give it the best chance of remaining affordable.

Interviewees were asked about the need for legislation or policy to overcome barriers to design quality, but the response was that cultural and institutional barriers are more significant and problematic. For example, limited planning resources can mean that local authorities are intimidated by better resourced teams on larger projects and are not equipped to engage with them, impacting on willingness to listen to views and ability to safeguard design quality.

The planning system was accused of being “very blunt and ineffective” in terms of ensuring quality of design. Better design education for planners was highlighted as a necessity if local authorities are to shaped design quality more effectively. Design principles help to guide projects through planning permission, rather than last minute requirements being imposed at this late stage.

The potential for stakeholder influence on design depends on the planning context in each particular industry. For example, one interviewee pointed out that the relative novelty of the offshore wind industry means that parameters for design left are still very broad at the point when planning permission is granted, meaning that local authorities and national agencies are obliged to assess designs on the basis of their worst possible impacts. The lack of a design approach at this stage for stakeholders to engage with means they have very limited opportunities to shape the final development.

4. CONCLUSIONS

The work previously commissioned by the Design Task Force makes recommendations about the nature of design principles for national infrastructure, that design principles should:

- Capture an expansive definition of design that goes beyond the aesthetics.
- Be clear, easy to use, and accessible, avoiding jargon.
- Be flexible enough to make provision for a variety of contexts and to anticipate substantial change.
- Encourage excellence as well as bringing the general standard of infrastructure design up to an agreed standard.
- Prioritise and reward innovation.
- Be an integrating force, requiring different disciplines to work together for their drafting and delivery.
- Create improvements in quality of life for communities.
- Have different tiers, with overarching principles clearly linked to more specific principles for sectors and/or projects.
- Be capable of having measurable outcomes.
- Support and integrate with the existing process of design review in infrastructure projects.
- Be 'owned' by client, public, contractors and stakeholders, through their input.
- Be embedded into the structure of project from the earliest stages, and carried through the life of the project.

These conclusions, quoted in the NIC's research brief, were supported by the interviews and the round table discussion carried out as part of this research. None of the features identified as important to the development of successful design principles was substantially contradicted during discussions. More specific thinking was provided on the nature and status of principles, on priority areas for focus, on the format that principles should take, and the language they should use.

4.1 DESIGN PRINCIPLES – PRIORITIES

Overall conclusions can be drawn about from the interviews and consultation carried out that are relevant to the production of national infrastructure design principles:

- A set of national design principles would be, as also identified in the literature review, a pioneering concept with no identified equivalent.
- They should therefore be chosen to play a new, pioneering role in relation to major infrastructure by prioritising, and focusing attention on only those issues that matter the most at a national level.
- Principles should reflect a small number of priorities, rather than a long list.
- Principles should be flexible and not overly prescriptive, so they can form a basis for creative engagement rather than a compliance list.
- The climate emergency should be a visible driver for design principles.
- The environmental impact of infrastructure projects should be viewed in the round by understanding projects through their landscape impact, and their potential to improve the places they are part of – avoiding the approach of simply matching damage to mitigation.
- The design and construction industries have a core role to play in applying circular economy approaches to major projects, and should become resource managers to fundamentally reduce resource impact.
- The tension between project budgets and the wider value provided by major projects is a problem, meaning that design quality is squeezed out and not delivered as intended. A new attitude is needed to design and cost to view it in the context of public benefit.
- Design that is appropriate to place requires a full understanding of local cultural, social, landscape and heritage context, beyond project 'red lines'. Design contributes to national identity through a clear relationship with its place.
- Measurable outcomes are necessary and possible. The means are currently available for projects to measure their success in all the areas specified by the principles, and this will become easier to achieve in future as data becomes more widely available.
- Multi-disciplinary teams and broad stakeholder groups are needed for major projects to achieve their full potential.

- Design review was endorsed as a process for helping to implement design quality but should not be seen as the only solution, with other avenues of influence required - including over the commissioning role of clients, and the organisational priority given to design quality.
- Design principles can only be the start of a process. Other tools will be required, including further thinking about the mechanisms needed to influence other areas of the design process, beyond design review and design champions on boards. This research highlights areas where the Design Group could choose to exercise its influence. In particular, options include the shortage of design skills and resourcing in local planning authorities, and the wide gap in the weight afforded to design between different infrastructure sectors.

4.2 DESIGN PRINCIPLES – FORM

- Design principles should be engaging, inspirational and different.
- Design principles for national infrastructure should complement existing design principles, already in use at industry level.
- The role of national level design principles is different to any other current examples and should therefore be recognisably different, to provide clear leadership across the sectors in the NIC's remit.
- The principles could be written as 'design challenges' to infrastructure sectors, language that sounds more direct and expresses the NIC's particular leadership role.
- Clear, concise, non-technical language is essential if principles are to be widely used.
- A design definition should be included, to make the basic yet essential point that design is much more than aesthetics.

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