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Issue-Based Complexity: Digitally Supported Negotiation in Geodesign Linking Planning and Implementation

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Abstract: Research regarding the complex issues in planning negotiation is sparse. This article aims to shed light on the characteristics of "the negotiation issue" in planning and how to deal with negotiation-related complexity towards planning implementation. It conceptualizes processes of negotiation that are represented/implemented via graphic and geographic elements, where the topology is a crucial factor. Our case study of the CAMKOX corridor at UCL's geodesign workshop provides new insights into the potential of digital negotiations for assessing the characteristics of planning negotiation issues and their associated complexity drivers to enhance the quality of spatiality. The findings provide a detailed description of issue-based planning complexity. A shift of focus away from the products of planning to the negotiation process—as the most important consideration in planning—opens the possibility of implementing "shared" interventions on which there is consensus.

Keywords: planning; negotiation; "the negotiation issue" in planning; planning implementation; consensus

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1. Introduction

As social and environmental pressures mount, the demand for efficient and secure urban and rural land use has greatly increased [1]. Due to this, key players in the planning process—planners and policymakers—need to work with various and diverse policy and management structures. Additionally, they have to contend with shifting and sometimes conflicting territorial interests within the national/regional/local context [2]. The parties need to negotiate since the long-term resiliency of decision-making requires consensus. Further, with funding for public services under increased pressure [3], negotiations over spatial interests must be performed strategically [4] so that authorities can "do more with less."

This article aims to shed light on the characteristics of "the negotiation issue" in planning and how to deal with negotiation-related complexity towards planning implementation. Urban planning can be defined as "the discipline that attempts to balance competing uses of land" [5]. Conventionally, negotiation over space and resources was viewed as an administrative by-product of the planning process. However, during the last decade, the nature and formulation of planning have evolved from a technical and "rational process" to an activity based on negotiation [6]. To "secure desired outcomes without losing sight of core policy intentions", the common attitude is that "the best solutions are those for which there is the greatest agreement" [7]. This view [8,9] suggests that optimal implementation can be achieved through bartering and negotiation [10,11]. As this strategy ensures some level of delivery, it is particularly useful for solving "wicked problems".

Despite the vast influence of planning worldwide, the gap between planning and implementation has grown since the 1980s [12,13], and the phenomenon has been studied at the periphery of other conceptual constructs, such as collaborative planning. According to Baker and Hincks [14], "the intended ends of a plan, remain a disputed element of studying urban planning implementation as what constitutes as a successful outcome is an

inherently political judgement". Furthermore, since programmes, plans, and policies strive to achieve various outcomes, Arshed et al. [15] assume that "adjudging an intervention to be successful is relative to our disposition and perspective, for policies, plans or programmes might deliver benefits to some and increase hardship to others". Recent studies have equated innovative participatory techniques with collaborative planning, and how it relates to rethinking planning [16]. However, while both of these approaches may be useful, the widespread failure to tackle deep-seated institutional mechanisms and the focus on only processes precludes them as a basis for planning practice [17]; this is what brings us back to Wildavsky's [18] "all-or-nothing" definition of successful planning.

In many countries worldwide, the gap between planning, policies, and implementation creates fundamental dysfunction between rationally based planning and incrementally based development control. The inability to design activities that work in conjunction with planning policies, slow implementation, and inflexibility in their application lead reality to lead planning through a series of local ad hoc amendments [19,20]. On the other hand, the planning policy has become one of the key instruments for governments to address spatial, social, economic, and environmental challenges [21]. Hence, the implementation stage of urban planning is seen as a process that follows the prioritized processes of agenda-setting and policy formulation [22].

Human negotiation supported digitally via geodesign software is capable of connecting the theorists with the practitioners [23]. Therefore, this study has particular relevance and importance for town planning in Britain because of the fundamental dysfunction between rationally based plans and incrementally based development controls. Like other planning systems in the West that exhibit planning hierarchies and rational processes [24,25], the British planning system shows irrationality in its inability to produce plans quickly and implement them. Therefore, we aim to think about negotiation, policy, and implementation as a dynamic process rather than a snapshot.

Beginning with a theoretical framework, in the next section, we present digital negotiations toward planning implementation to facilitate a satisfactory outcome based on consensus. The following sections examine negotiation by geodesign in the UK and assess its potential to address negotiation processes over the future of CAMKOX Corridor, following a geodesign workshop that took place at UCL. The last part concludes the paper and discusses the capability of such technology to enhance negotiation methods toward planning implementation.

2. Negotiation-Related Complexity

A negotiation issue is defined as a question or problem that is open to debate and should be resolved to reach an agreement [26]. Despite "the negotiation issue" being identified as an important variable in negotiation [27,28], little is known about its characteristics and how to deal with it in negotiations [29]. Crump [30] finds that there is a "lack of conceptualization of complexity in negotiation in general" and that more research is needed on complex negotiations "before we can build theory or test theory before we can examine negotiation processes to explain negotiation outcomes... we must first describe the negotiation we seek to analyze". It is possible that this gap results from the predominantly experimental approach to research, which simplifies negotiations and leaves out the complexities that generally arise during negotiations.

In real-life negotiations, negotiation issues can be flexible or not even seen by one party at all [31]. Yet, it is important to distinguish between complex and challenging tasks [32]; complex tasks are not necessarily difficult, while difficult tasks need not be complex. Early conceptual works on issue-based complexity describe complex issues as relevant, influential factors in negotiation [33,34]. Sebnius [35] examines linked and unlinked issues and concludes that there is more complexity when there are more linked issues. Issue-based complexity describes in terms of a few features, such as uncertainty or inaccessibility of information [36], a high number of (sub-)issues and the ability to add or remove these issues from an agenda [37].

Though there are no clear concepts regarding the scope of negotiation-related complexity, studies address how complex issues affect negotiations. According to Naquin [38], the more issues on the agenda, and therefore a more complex task, increase a negotiation's ability to integrate but decrease satisfaction among negotiators. According to Thompson [39], more issues can benefit the negotiating process and outcome. There may be a negative impact, however, on the time needed to reach a mutual agreement if many issues are to be discussed [40]. Additionally, issue-related complexity occurs when the issue is complicated because it is composed of many sub-issues. Studies on this topic typically follow Winham's identification of three general negotiation complexity: (1) negotiators use simplified structures to facilitate decision making, (2) complexity reduces the significance of concessions, and (3) complexity increases the likelihood of reaching an agreement. Following Winham's (1977) rationale, Laubert and Geiger (2018) [41] stated that "complexity can be good or bad for an outcome". On the one hand, a negative influence of complexity on the outcome exists if uncertainty is high and the decision-making process is based on assumptions [42]. On the other hand, a positive influence on the outcome exists if the counterpart cannot argue against an agreement because imprecise information makes it a grievous task to reason against a proposal. It is commonly assumed that the lack of research in this area is due to a recent focus on social psychology aspects and the implicit agreement to settle on simple issue designs in negotiation. The study, however, challenges this implicit agreement and sheds light on the conceptualization of negotiation-related complexity in planning toward consensus and implementation.

3. Digital Negotiations towards Planning Implementation

The research for optimal negotiation demonstrates both the promise of the critical approach and the need for scenario analysis (SA) tools to fill the gap between urban planning theory and practice. The concept of negotiation is expanded by Verhage and Needham [43] to include many parties seeking multiple objectives at the same time. Eckley [44] contends that "achieving an appropriate balance in group composition is highly dependent on the individual characteristics" of the participants and the political and social context. Forester [45] and Healey [46] trace "communicative rationality" to Habermas' [47] work, recognizing collaborative planning, allocation, and land-use management and negotiating techniques in particular as a "means to facilitate collaborative decision making" and enhance policy implementation [48]. Ruming [49] identifies negotiation as the process by which "both specific contexts (of the development location as well as the development itself) and broader structural plans come together and are acknowledged". Therefore, planning negotiates to serve as a forum through which public and private interests can be mediated, debated, and finally implemented.

By distinguishing negotiation from dialogue and debate, Baarveld et al. [50] claim that actors are more concerned about reaching an agreement on action, rather than understanding a planning issue. Though certain aspects of rational thinking veer attention away from underlying processes that underlie the creation of space [51,52], recognizing that implementation is the outcome of complex interactions [53], only one of which is planning policy, which sheds light on the importance of negotiation method and skills. In planning, decision-making can lead to highly complex and long negotiations. Few perspectives are offered on how planners are coping with the increasing presence of negotiations in their work. In most studies, planners and developers are viewed as mediators among public, private, and political actors. Several scholars have noted that in the British context, land use and financing issues are kept 'beyond negotiation,' a position firmly entrenched in planning. As a result, planners have a skill set beyond design that can make them ideal controllers, mainly because local opinion on place and design may be best represented by planners [54].

While in the 1970s planning was viewed as a procedural field of activity and finding the best way to implement it was determined through political means, today that task is accomplished by the processes of negotiation and compromise: The process of planning has

evolved from a techno-rationalist activity to a negotiation activity that takes into account the "rules of the game", the resources each party brings to the negotiation, as well as the dynamics of the negotiations and the results [55]. When resources are scarce and political and social conflict is intense, negotiation is one of the most effective methods of resolving conflicts [56]. Negotiations facilitate a satisfactory outcome based on consensus. The most resilient solutions are those for which all parties agree and compromise. Generating consensus ensures at least some degree of delivery, which is particularly helpful when the information is complex, there is a conflict between decision-makers, and there are multiple turns in the system. In this article, we discuss how geodesign can be used to disentangle issue-based complexity in negotiation and discover when and how to utilize complexity using the digital processes of bartering and negotiation to further implement planning policies.

4. Urban Planning, Negotiation, and Geodesign Technology in the UK

Geodesign is a set of concepts, planning methods, and capabilities for engaging multiple stakeholders using sophisticated systems that bring together mapping, decision-making protocols, and assessment tools [57]. Geodesign is unique in its ability to negotiate at various scales and sizes: from the neighborhood to the region. This is important because smart growth plans need to be practical and political. Meetings and discussions are also necessary to resolve difficult differences among stakeholders. In recent years, geodesign has become increasingly popular, and several open-source and commercial tools have been developed to leverage modern Internet technologies. In particular, geodesignhub's capability to replace the tedious and time-consuming process of planning negotiations has attracted scholarly attention [58] with many negotiation workshops worldwide.

Geodesignhub is an interactive approach to planning that "uses stakeholder input, real-time feedback, geospatial modeling, and impact simulations to generate an effective management strategy and make smart decisions" [59]. Through geodesign workflow, policymakers and professionals can develop plans, designs, and share alternatives, allowing an agreement to be generated on the way forward [60,61]. In a digitalization context, communication and coordination become increasingly important as projects become more complex and involve more stakeholders [62]. Using these tools, decision-making can be accelerated and made more effective for planning through consensus-building, transparency, participation, and information distribution. Transparent digital recordkeeping ensures that all positions are always made visible to all project participants.

Geodesignhub is highly relevant to the UK's planning system, where "planning has two distinct roles: creating a policy and making decisions based on that policy" [63]. Efforts were made to bring greater stability to the planning system and "create conditions for effective implementation of planning" a tier system of development plans. Despite some changes, this framework has remained intact, such as the Localism Act 2011 [64].

In relation to the practice of town planning, the inability to produce such plans and implement them swiftly is irrational. Many involved in the process feel frustrated by the inability of activities to interlock with policies in the plans [65]. The British practice has become disillusioned with a hierarchy-based, rational-processed approach to planning. Neither sufficient plans nor timely plans have been produced, and they have proven rigid in their implementation [66]. In recent years, the government has attempted to streamline the process of making plans by recognizing that planning documents must be negotiated and based on consensus. The move toward negotiation planning is in accordance with the paradigm of communicative action [67], a model more attuned to the development control practices used in British discretionary contexts.

5. The CAMKOX Corridor Workshop: Re-thinking Growth in the London Region

5.1. The Research Area

The Cambridge-Milton Keynes-Oxford Corridor, also known as CAMKOX Corridor, includes 30 local councils from Oxford through Milton Keynes and Northampton

to Cambridge [68]. Just north of the Green Belt, it forms the northern boundary of the Greater London metropolitan region with which it is profitably tied. It is also a gateway to the Midlands and the "Northern Powerhouse" (Figure 1). The proposed high-speed rail line HS2 runs from south to north through this corridor. The planned east-west and west-east rail lines linking Oxford and Cambridge through Milton Keynes are intended to enhance connectivity, mobility, and productivity across the region [69]. However, other impacts of growth should also be considered, such as last-mile connectivity and multi-modal transportation, flood risk, social inequities, land consumption, pollution, and loss of the ecological function and integrity of this historical region, including its villages and towns [70–72].

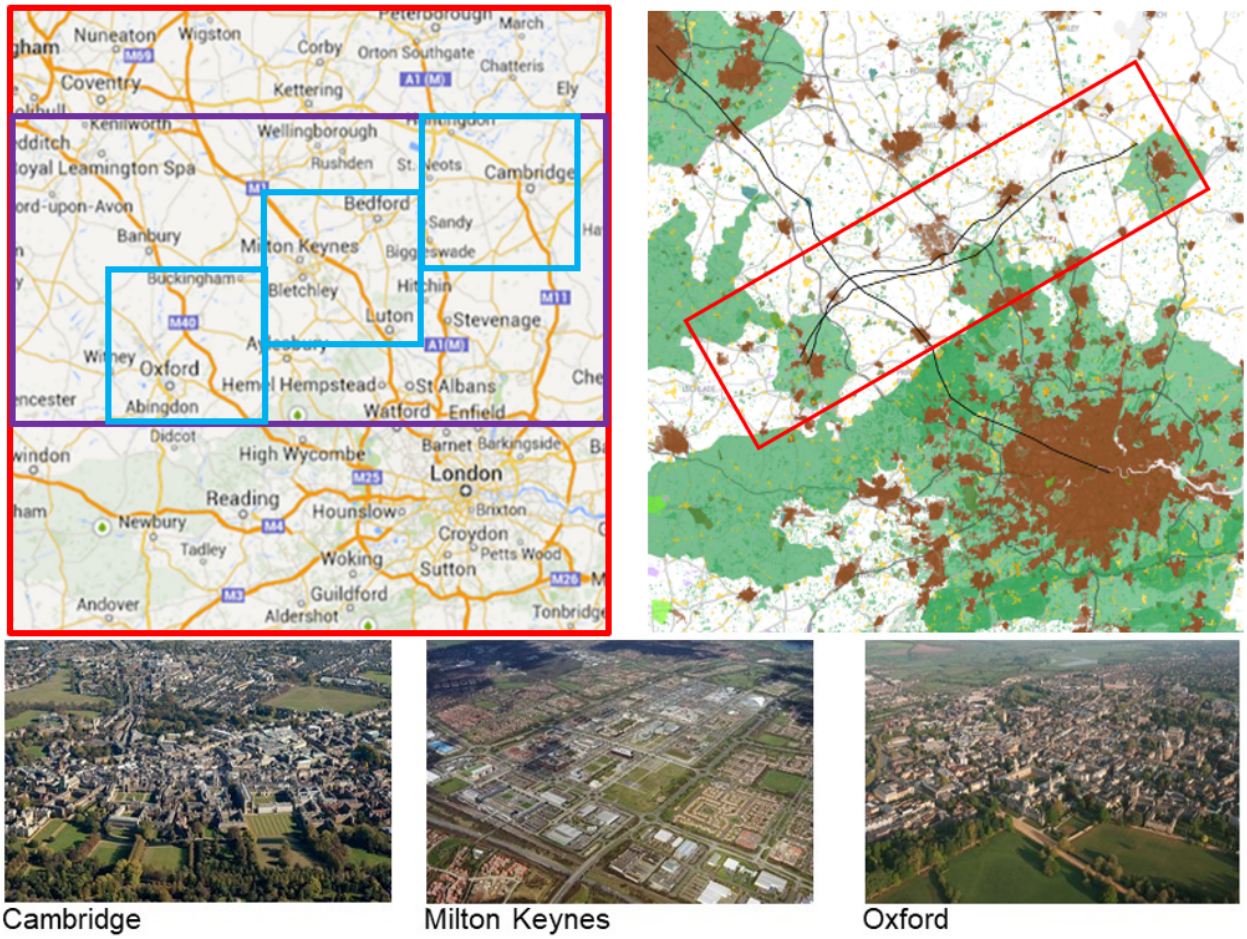


Figure 1. The study region.

5.2. Pre Workshop Stage

The CAMKOX workshop was organized and run by Prof. Steinitz and Dr Ballal at the Centre for Advanced Spatial Analysis at University College London as a two-day workshop in November 2018. In accordance with the guidelines of the International Geodesign Collaboration (IGC) [73], the workshop was organized to understand how geodesign can improve the quality of spatiality in widely dispersed and diverse settings [74,75] (Figure 2a,b).

The pre-workshop organization had four main tasks: Designing the workshop's content, workflow, and timing took about six weeks. The ten IGC systems and the growth assumptions of the National Infrastructure Commission were accepted as the basis of the workshop requirements (Figure 3). The initial polygons of policies and projects for each of the ten systems were drawn from finalist presentations in the CAMKOX Corridor ideas

competition managed for the UK Infrastructure Commission. These were added to and edited during the workshop to become diagrams (Figure 4).

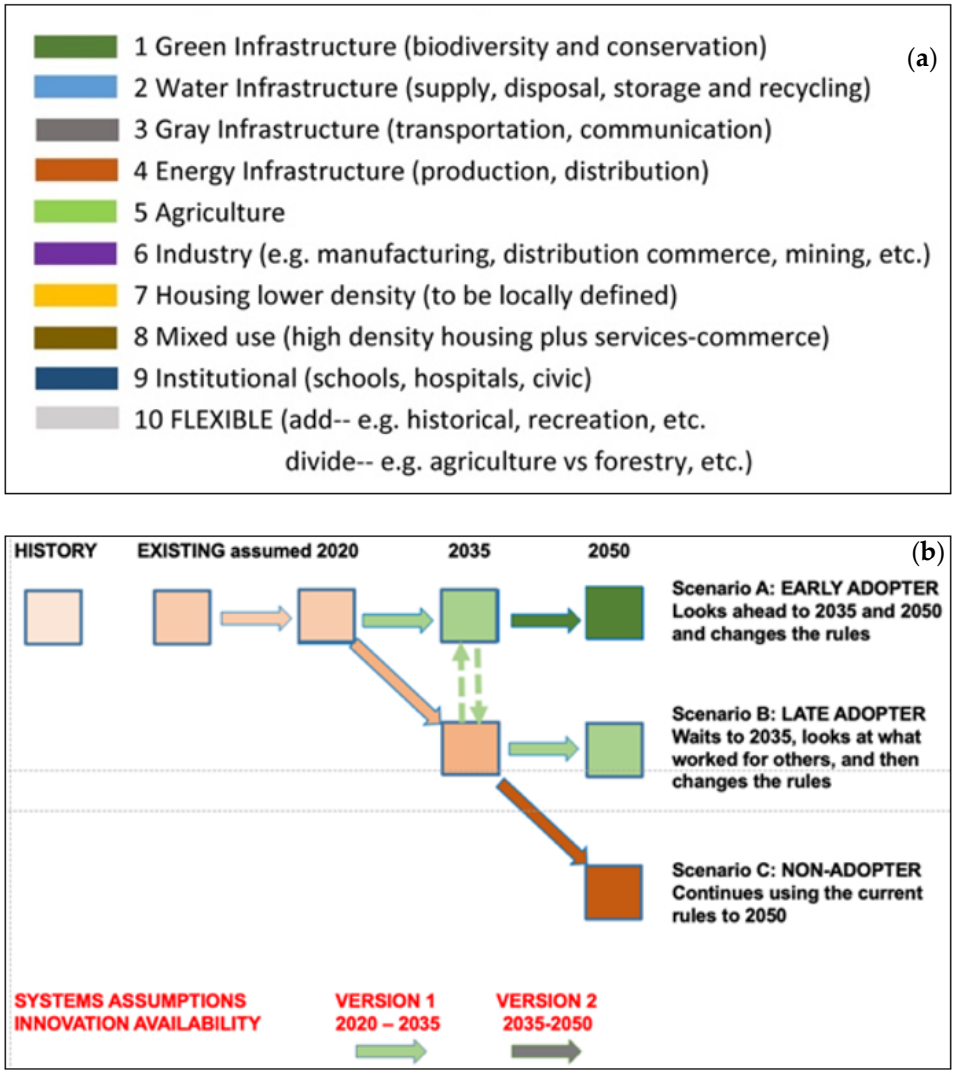


Figure 2. (**a**) IGC resource systems. (**b**) Geodesign scenarios and timelines.

5.3. Negotiations during the Geodesign Workshop

During the first day of the workshop, the participants learned the basic operations of Geodesignhub and were organized into five teams based upon the IGC scenarios of innovation adoption, as well as policies to protect, alter, or maintain the current greenbelts of London, Cambridge, and Oxford (see Figure 5). Each team selected, edited, or added diagrams as part of the Version 1 proposals for 2030 and 2050 (Figure 6). These impacts and costs were assessed at least once for Version 2 and again evaluated (Figure 7).

CAMCOX CASA workshop COST MODEL, in GB Pounds and Hectares and Kilometers. Estimates can vary widely

WATer
Flood management by policy....
but if rights easement purchased as project ....assume 50%
Agricultural land = 40,000/ac + - 100,000/ha ....
Easement at 50% 50,000/ha
Forest land =10,000/ac +-...25,000/ha....
Easement at 50%.....12,000/ha
Use 25,000/ha as default if not specified
AGRiculture,
Conversion to "CEA" (Greenhouses) becomes IND-COM
Avg cost active prime agr land 100,000/ha
Protect as easement at 25%
Use as default easement cost at 25% ....25,000 if not specified
GREen Infrastructure
planting forest from AGR 130,000/ha
Protecting Forest land =10,000/ac +- 25,000/ha...easement at 50%
Use 25,000/ha as default if not specified
ENErgy production
Solar farm 5 acres .....200 kW = 500,000.....2ha....250,000/ha

TRAnsport infrastructure
HS2 80,000,000/km (NIC)
New two track train 30,000,000/km
Train modernization 6,000,000/km
Road 4,000,000/km
Expressway (6 lanes)....30,000,000/km
Use 4,000,000/km as default if none specified
INDustry-COMmerce
conversion to "CEA" (Greenhouses) becomes INDCOM
CEA cost 50,000 / 1,000 sq ft x 100/ha = 5,000,000/ha T = 10
Use as default 5000 sq m = 1800/ sq m...= 9,000,000/ha T = 5
RESidential Lower Density at 30 units /ha
300,000 / unit x 30 = 9,000,000/ha
MIXed com, inst, RESidential Higher Density
at 65 units/ha = 20,000,000/ha
INStitutions
Assume 2+ ha/inst
School 25,000,000 unit cost..... 10,000,000/ha
Hospital 90,000,000 unit cost..... 40,000,000/ha
Use 30,000,000/ha as default if not specified
HISToric tourism
Visual easementsfrom roads vary widely....
assume at 10% for 100m a side 250,000/km

Figure 3. Systems requirements for the CAMKOX corridor.

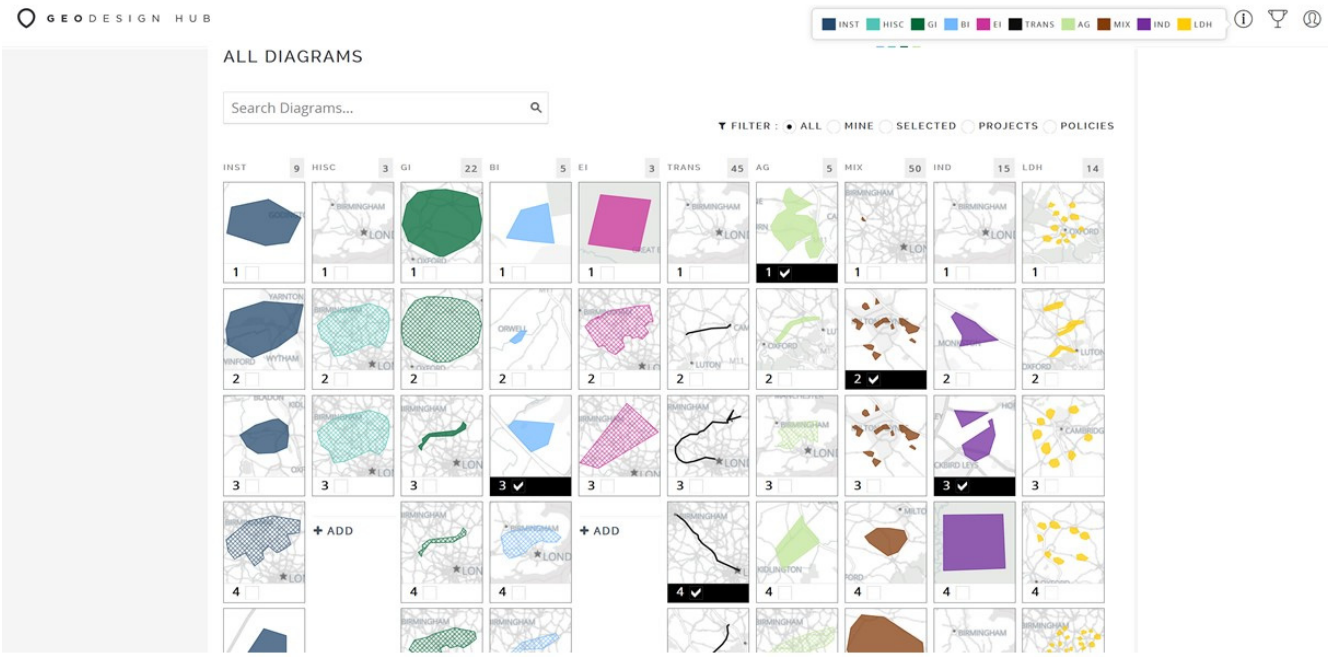


Figure 4. Initial diagrams from The National Infrastructure Commission competition (© Malcolm Reading Consultants, London, England).

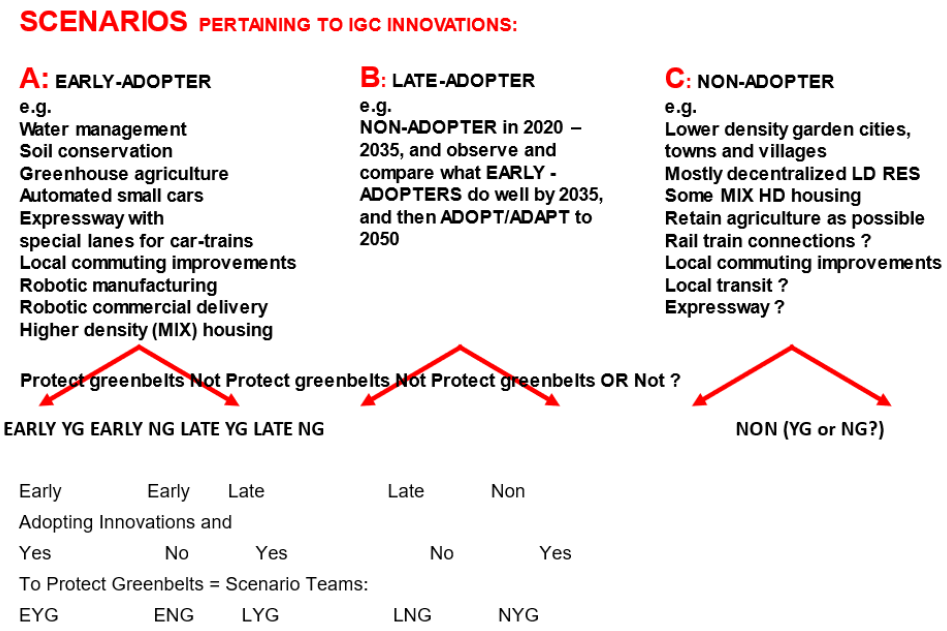


Figure 5. The workshop geodesign teams and their assumptions.

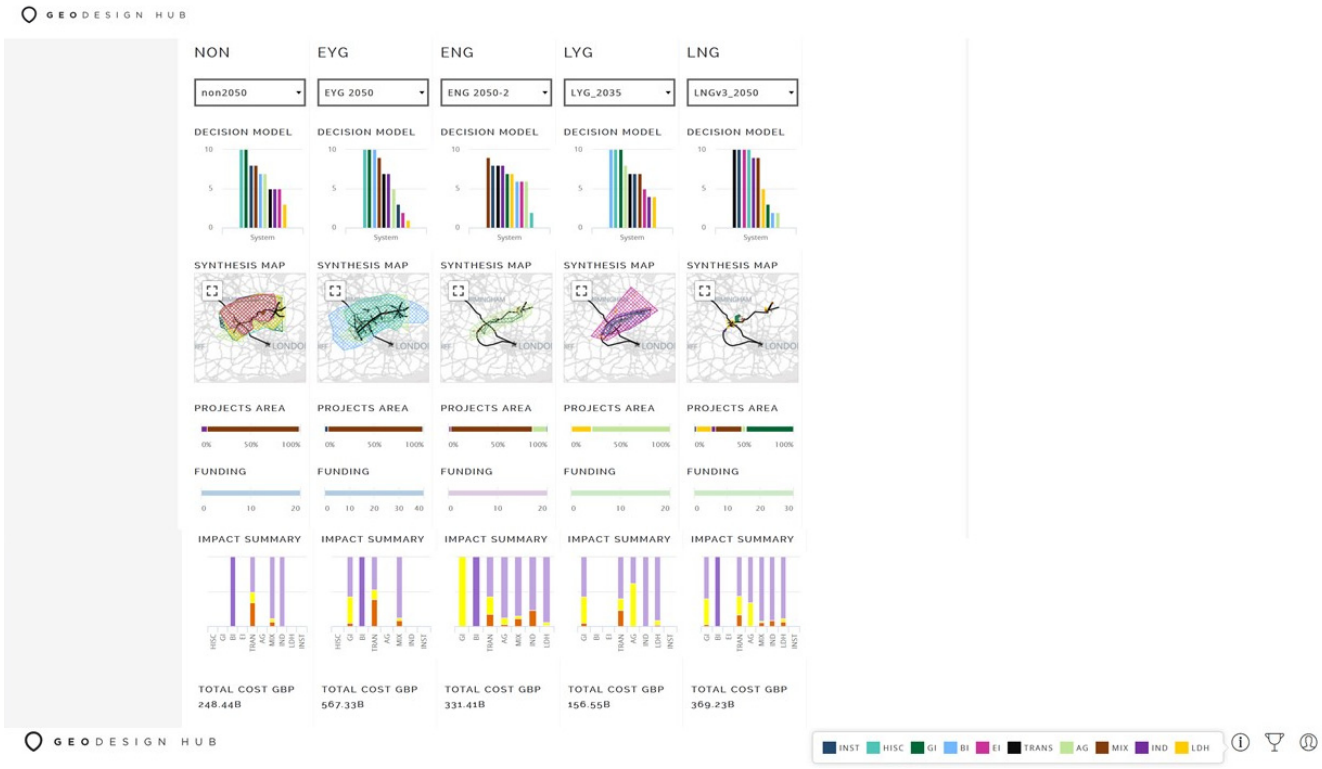


Figure 6. The Version 1 designs.

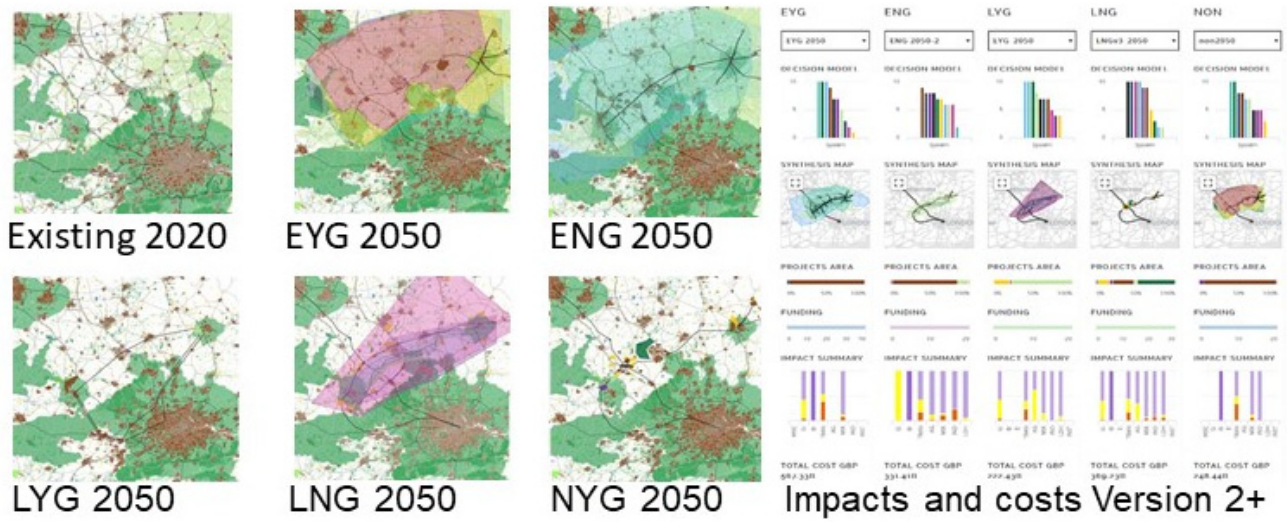


Figure 7. The Version 2 designs at the end of the first day.

The second day started with an informal negotiation as the team knew that one objective of the workshop was to generate a negotiated solution for the region. This set of alternatives was marked as Version 3 and reassessed. The workshop then used a sociogram to determine the mutual proclivities for formal negotiation. Although the sociogram is deeply embedded within the geodesign approach, it is not yet integral within the Geodesignhub system. We used it in the form of a simple excel sheet to find similarities between the values of each group (as they are also reflected in the decision models) and determine which groups can work together. A negotiation between the most compatible teams has been organized (Figure 8) to generate consensus based on the similarity/potential symbioses of the proposed scenarios for 2035 and 2050 (Figure 9).

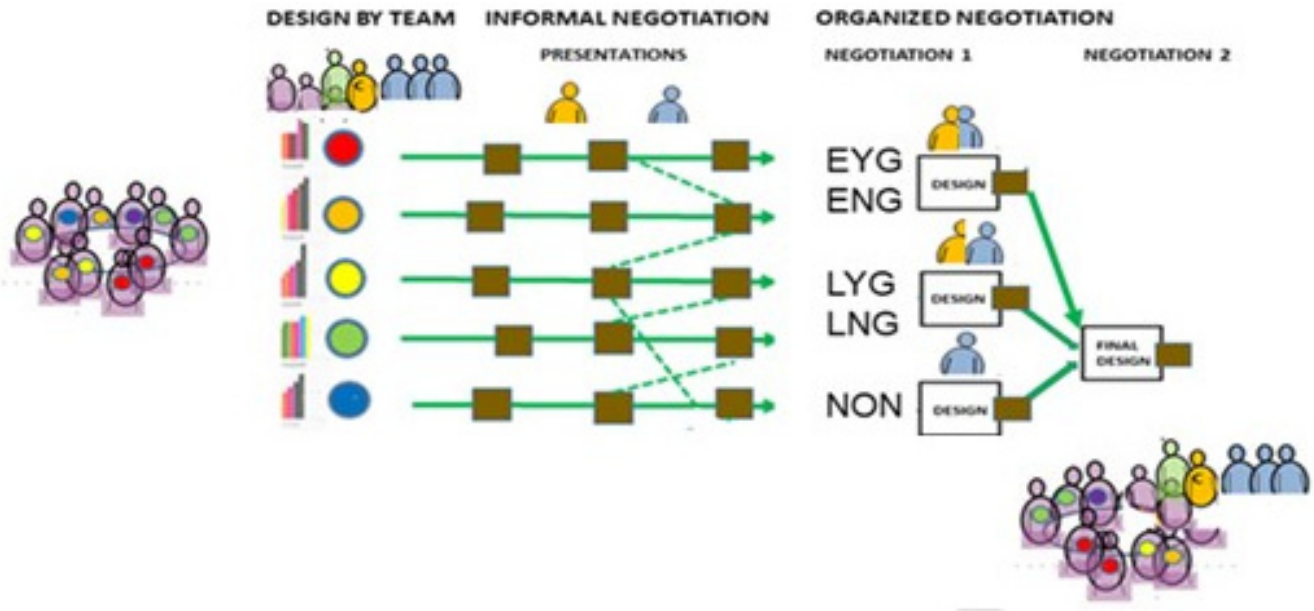


Figure 8. Collaborative negotiation as a geodesign method in the CAMKOX workshop.

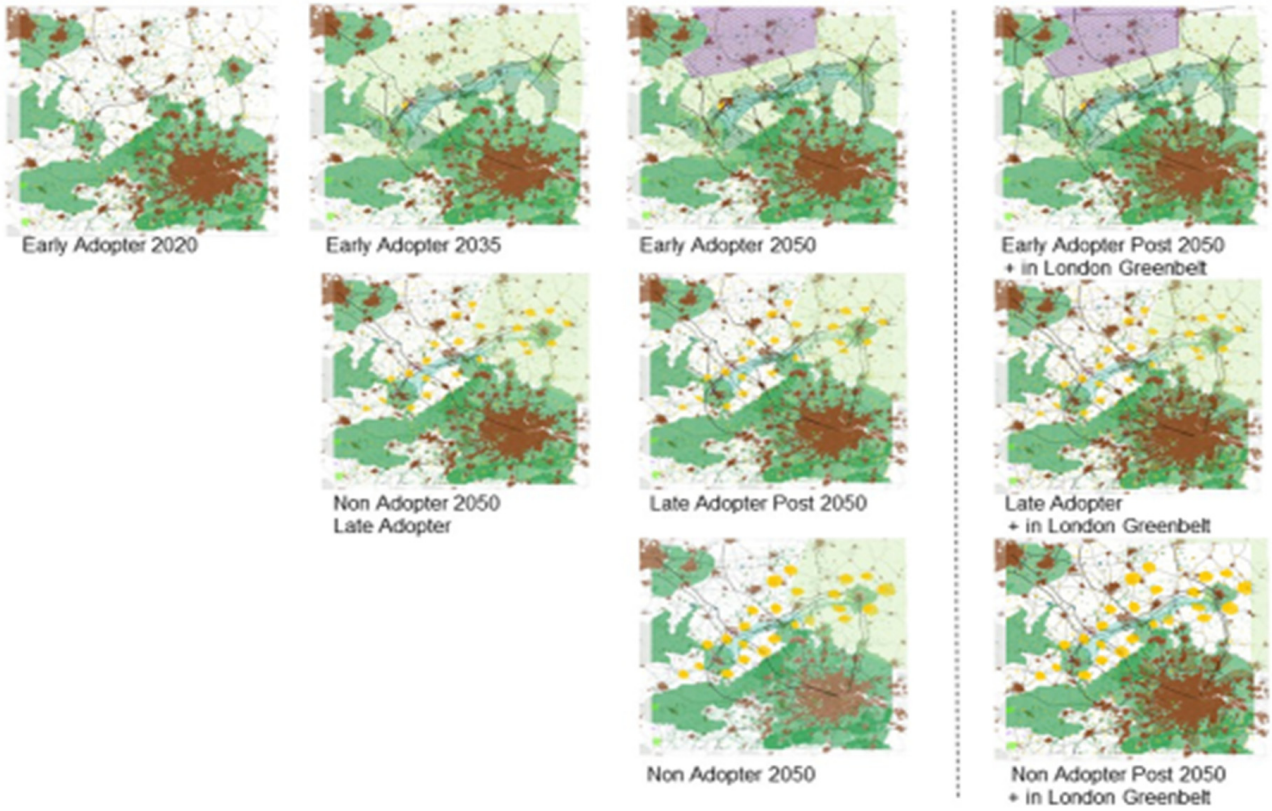


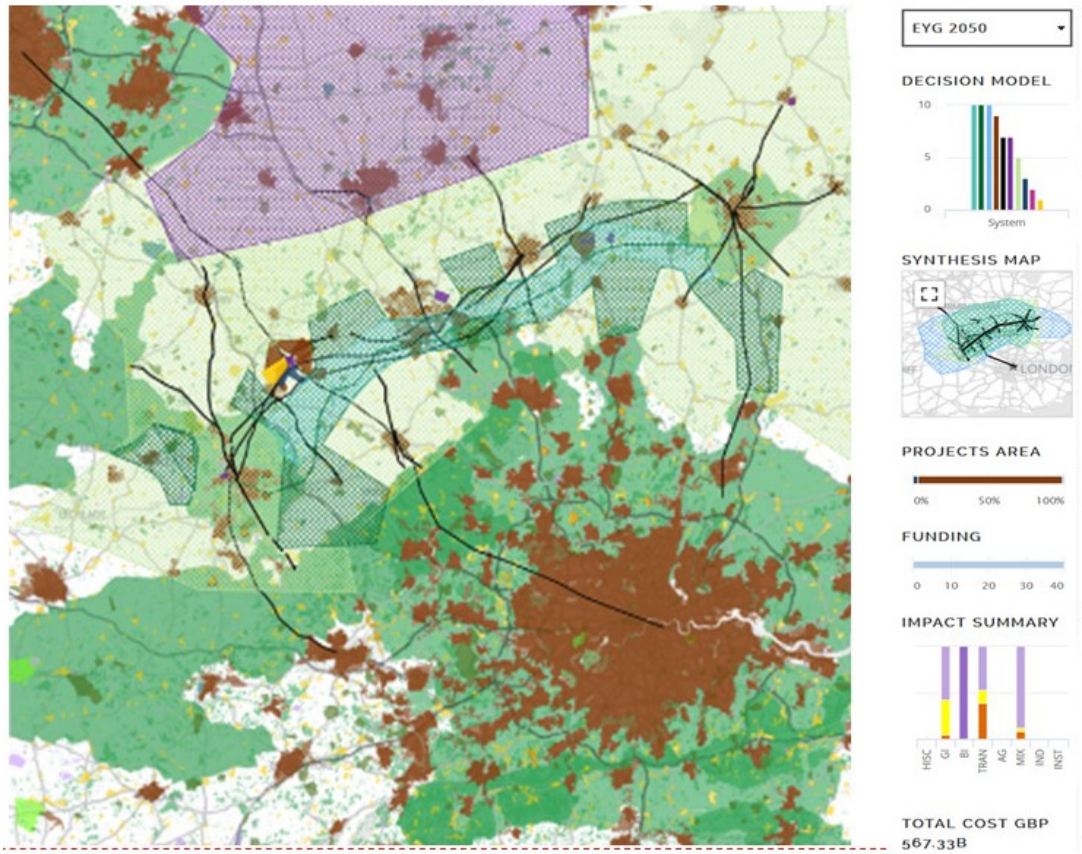
Figure 9. The three scenario designs for 2035 and 2050, and a post-2050 speculation.

Based on the support of GIS data layers related to topography, tenure, social makeup, and the ten systems, the participants had proposed interventions for the many subproblems in the planning of the place while classifying them into projects and policies related to each of the ten systems. The interventions, which were initially derived from finalist presentations in the CAMKOX Corridor competition managed for the UK Infrastructure Commission, were altered according to the teams' preferences to reflect the area as a "topic of negotiation." The overall complexity of the negotiations was first approached by classifying the area into ten basic systems (eight applying to all spatial sites and two particulars to CAMKOX) and by proposing diagrams that represent specific projects or policies related to the site. Then, participants added additional interventions based on their professional experience with similar problems elsewhere and adapted them to the test case of CAMKOX. These are expressed as polygons related to each of the ten relevant systems. Thus, polygons filled with different colors represented projects in these systems (e.g., a blue polygon represented a project of a drainage basin at a particular location), while dashed blue polygons represented a policy (e.g., a surface runoff policy) proposed for a wider area. The lines represented connectivity (e.g., black lines represented roads in the transport system, and green lines represented bicycle paths in the green system). Each polygon is accompanied by a title and a description describing the rationale behind this intervention. The interventions are a variety of principles, characteristics, constraints, and opportunities presented as a system of colored polygons that help abstract and translate the complexity associated with negotiations into easily editable shapes.

The Early Adopter teams (Figure 10a) first protected the region's major assets and then developed urban patterns that were denser than the past development of the area. They introduced conservation policies for prime soils, water, agriculture, and the historic cultural landscape. They retained the London greenbelt but not all of those of Cambridge and Oxford, while also promoting a new national park and large regional expansion of linked conserved landscapes. An important decision was to designate large areas of non-prime soils for conversion to industrial scale, controlled-environment agriculture, based on

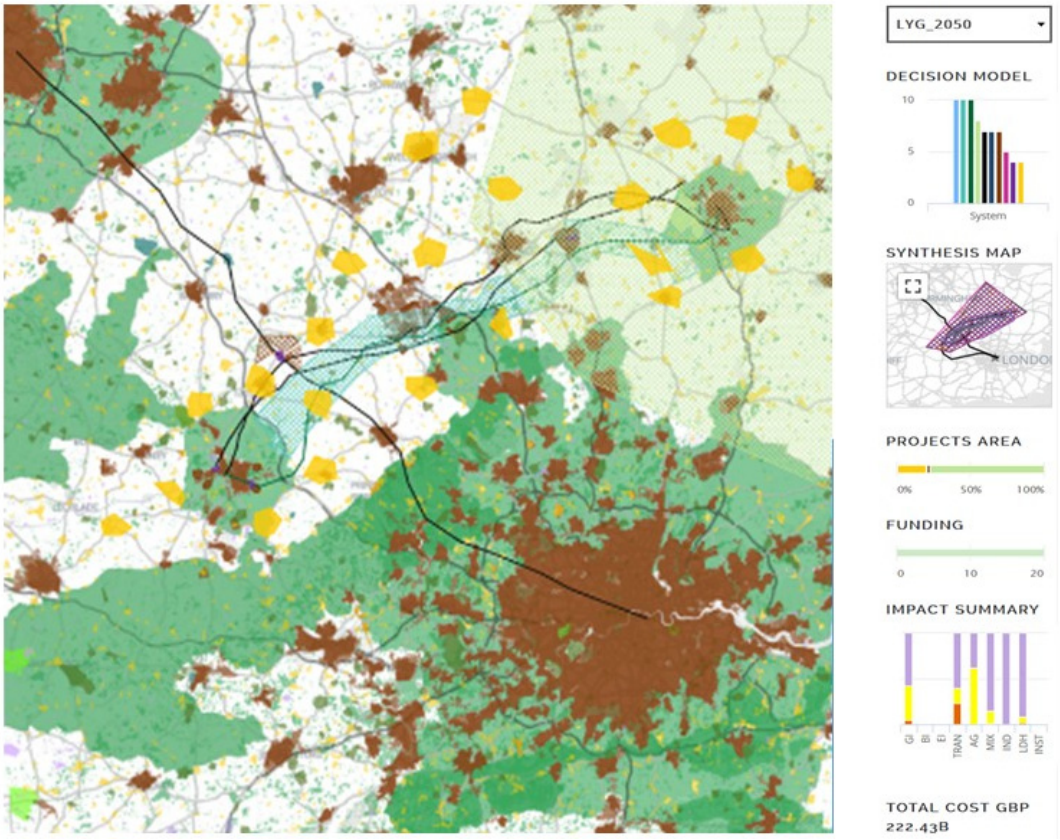
climate change and the need for multiple and more diverse food crops. Urban development was focused on mixed higher density residential and services and concentrated along the CAMKOX corridor. This also retained the highly dispersed pattern of villages and towns. One urban development area which is preplanned by 2035 is at the intersection with HS2 and is based on a proposed multimodal transfer point at this location. The most controversial aspect of their decision-making was to not rebuild the train link between Cambridge and Bedford and to rely on the future development of multimodal transport on roads designed and redesigned for car-based trains. This was in large part a reflection of the existing highly-distributed network of smaller communities and lower overall regional densities. Train links would continue to be improved between the major towns and London and northern cities.

The Late Adopter teams (Figure 10b) reflected the conservative planning attitude to the region, even as they acknowledged the pressures of growth. They adopted the expressway and train plans of the National Infrastructure Commission, relocating and reconstructing the Cambridge to Bedford train line by 2035. Furthermore, they continued to develop low-density areas and distributed growth among many small towns. Milton Keynes is the exception, where there are plans for higher-density mixed development by 2026. They adopted innovative policies and projects to promote mixed-density development after 2035, partly in support of the prior infrastructure investments. Additionally, they proposed connecting the new infrastructure with HS2. The conservation efforts focused on protecting the most visited tourist zones.



(**a**)

Figure 10. *Cont.*



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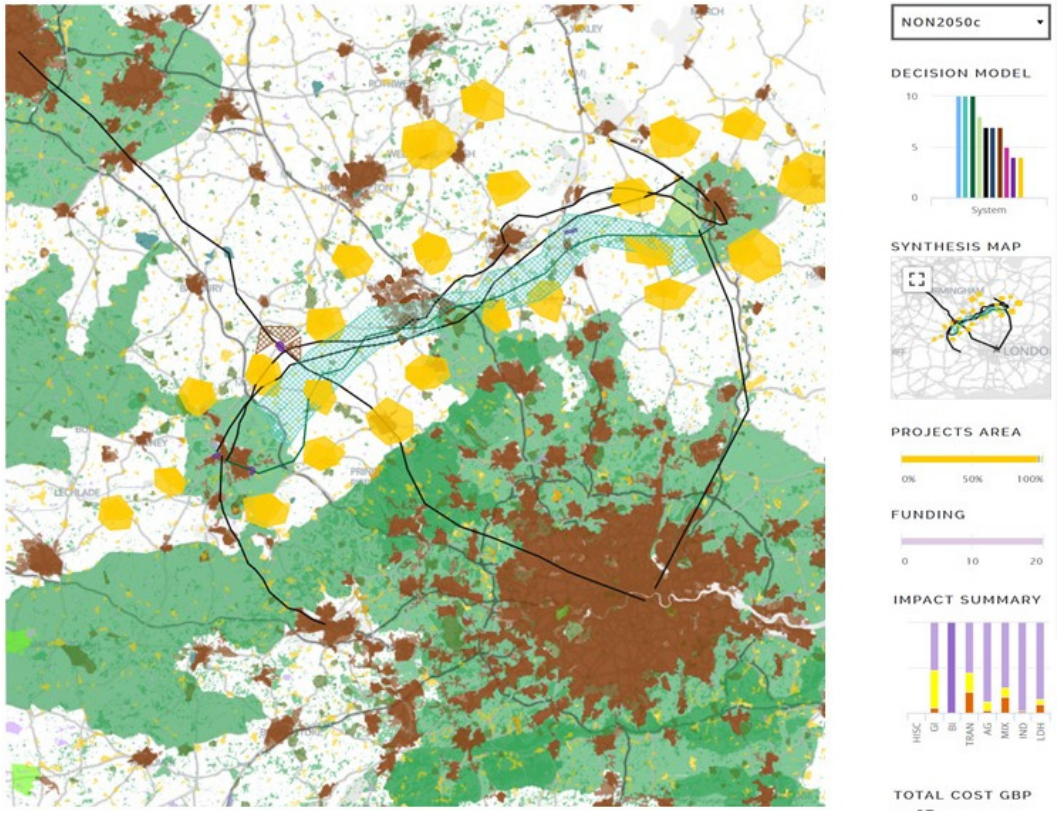

(**c**)

Figure 10. (**a**) Early Adopter 2050, (**b**) Late Adopter 2050, (**c**) Non-Adopter 2050.

Non-Adopter teams (Figure 10c) accepted the National Infrastructure Commission, relocating the Cambridge-Bedford train route by 2035, as well as developing in a low-density manner and distributing growth throughout the area's smaller towns. As part of the conservation plan for the CAMKOX Corridor, the focus is on preserving the agricultural landscape and supporting villages, further expanding the pattern of town-based development.

While the cognitive structures have been abstracted to facilitate decision-making, they have not been simplified. The multidimensional complexity expressed in the ten systems, the division between policies and projects, and dozens of polygonal shapes that exemplify different interventions informed from the supporting layers are not reduced but have faithfully represented the significance of concessions. In addition, the participants were encouraged to "learn about the opponent's strategy" throughout the workshop. Participants had access to all the material and were encouraged to adopt the polygons proposed by other groups. Several good ideas were adopted by the teams, while a few fewer good ideas were omitted. Working together in transparency in the digital system and sharing polygons (representing such values and principles) among groups provided a useful framework for further negotiations. Generally, the polygons that were considered most preferred by most of the groups that chose them were the better ones, so discussions revolved initially around them.

During the final negotiation process (Figure 11), it became clear that the workshop participants favored policies and projects related to higher rather than lower densities for the CAMKOX corridor, and this despite the market favoring lower densities. Priority was given to the protection of the existing high-quality landscape and the historical assets of the corridor. They placed great emphasis on growing the existing settlements along the major corridor spine, but they did this with an emphasis on automated private vehicles in a new highway designed for efficient linking into "trains", rather than an emphasis on rebuilding the train network that formerly existed. The major reason for this was the existing and highly-distributed location of industries and institutions throughout the region and the need for the existing transit system to have additional links to these many locations.

Figure 11. The final negotiated design.

There was also further post-workshop speculation based on what might occur if London made selected areas of its greenbelt available for such development after 2035 or 2050. The Non-Adopter's CAMKOX scenario would meet current environmental and urban preferences, but its train infrastructure, as well as its landscape character, would

likely be severely impacted by financial constraints. In contrast, the Early and Late adopter designs would likely be expandable in their innovative infrastructure and urban aspects while retaining the high-quality environmental character of the CAMKOX region.

6. Discussion

The role of negotiation over spatial planning is unique in delivering complex issues due to its place-based approach as well as its ability to coordinate regionally and nationally. In line with previous studies dealing with how complex issues affect negotiation, this study conceptualizes processes of negotiation that are represented/implemented via the use of graphic and geographic elements, where the topology is a crucial factor. This study aims to assess new insights on the potential of digital negotiations in urban planning, highlighting digital planning's capacity to develop strategies addressing the most pressing issues facing our society: climate change, economic transformation, automation, and social issues. Our case study, planning the CAMKOX Corridor in UCL's geodesign workshop, offers a relevant example of digital planning and contributes to urban planning methods, practice, and technology-mediated negotiation.

Geodesign facilitates collaboration and negotiation among professionals and their clients, as well as between teams of professionals. Map-based negotiations are generally manual, extremely time-consuming, and require many meetings, deliberations, and technical analysis work. Embracing a digital process allows teams to easily share their activities, enabling them to reach a consensus on the way forward through a consensus-building process. By using existing data structures for input and output, planning strategies have been developed using diagrams, and the planning negotiation process has been accelerated so as to ensure the transparency, auditability, and accountability of public decision-making. The users produced and assessed interventions in person and via the internet in real-time and compared alternative strategies. A rich plugin eco-system, project management, and collaboration tools ensure that the negotiated outcomes are implemented and the associated activities coordinated transparently.

The workshop was able to stimulate negotiating approaches to planning in a relatively short time period (i.e., two days, plus the workshop preparation time). Necessary for the CAMKOX Corridor workshop was an open, flexible, and efficient approach to thinking about intra- and inter-system relationships between policies and projects, that is, future-oriented spatially and temporally. The workshop workflow follows Carl Steinitz's "Framework for Geodesign" [76] to describe the territorial processes which characterize the geographical context. Using the three scenarios of early-, late-, and non-adoption of systems policy and project innovations, and reporting the impacts at three time scales, 2020 (existing), 2035, and 2050, the aspects of a complex issue have a positive impact on negotiations. To enable the conceptualization of the scope of the negotiation-related complexity, the digital evaluation models were used to further achieve an agreed solution in a few design cycles of negotiation over the relationships between them.

The region of the CAMKOX Corridor provides a case study of ten systems (water infrastructure, agriculture, green infrastructure, energy, transport infrastructure, industry and commerce, residential lower density, mixed residence and commerce, institutions, and historic tourism) to assess the locational attractiveness and vulnerability related to the most relevant territorial systems. The workshop demonstrated that through digital negotiation on careful land use and spatial planning, we would balance economic, social, and environmental trade-offs and manage their influence and activity, including policies and strategies for conservation and restoration. Furthermore, the great flexibility of this planning support system enables different stakeholder groups to select a set of objectives that best correspond to their interests and to move toward the design process using other change models. Through digital negotiation on careful land use and spatial planning, we will be able to contribute to integrated spatial planning that balances economic, social, and environmental trade-offs and manages their influence, including policies and strategies for conservation and restoration.

This study advances theory and practice by demonstrating how digital negotiation can be used to resolve complex planning issues. Geodesign is used when stakeholders must coordinate for negotiated settlements, but there are differences of opinion on priorities for contested sites with conflicting policies. Often there is a single or multi-issue dispute with diverse stakeholders, a two- or multi-party conflict that is willing but stuck, and it calls for preventive interventions or last-ditch efforts to avoid further costly processes. In contrast to previous and well-cited studies arguing that negotiations with complex issues decrease the ability to learn about the opponent's strategy [77] and affect the ability to find the bargaining range of the counterpart [78], geodesign negotiations toward agreements with complex planning issues are performed digitally in an open and participatory manner, which promotes the ability to learn from the "opponent's strategy" and sometimes adopt it towards mutual agreement. In fact, with an intense, time-bound process that leads to consensus over actions as the common knowledge grows, more and more polygons become shared, and the bargaining range of the counterpart decreases, increasing the likelihood of reaching agreements through negotiations.

Following previous studies asserting that "the negotiation issue" is an important variable in negotiation (e.g., [79]) but that there is a lack of the conceptualization of complexity in negotiation, this study illuminates the complexity of the "negotiation issue" in planning and how to deal with it in a digital planning negotiation process. In line with Fisher (2016) [12], we discuss how geodesign can be used to disentangle issue-based complexity in negotiation and discover when and how to utilize complexity using digital processes of bartering and negotiation to further implement planning policies. Issue-related complexity is associated with issues that are composed of many sub-issues. The issue of negotiation, therefore, takes place here around ten systems, with a wide-ranging variety of projects and policies proposed for each of them. Defining the issues in this way makes it possible to conceptualize the complexity in the urban field and characterize them according to diverse spatial categories on the relationships and contexts between them. Issues of scale, scope, strategic micro- and macro-level, morphology, and cost/benefits, among others, are also addressed to test the sensitivity and validity of the negotiation models. Therefore, and in contrast to Winham's assertions, we can claim that negotiation complexity has three influences on digital planning negotiations: (1) Participants themselves use and offer diagrams to facilitate agreement on decisions. The structured representation of the intervention (a polygon) facilitates communication between participants who come from diverse backgrounds, but it also presents the intervention itself (e.g., a cluster of apartment houses in a specified location); (2) Complexity reduces the significance of concessions when sharing polygons, meaning agreeing on the nature and location of the proposed intervention. Digital records of activity are used to enable analytics of the complexity of decisions made in a collaborative way; and (3) A lack of sharing leads to concessions on less good interventions, thus opening the door to the implementation of "shared" interventions on which there is consensus.

7. Conclusions

This study aims to assess new insights into the potential of digital negotiations in urban planning, shed light on the characteristics of "the negotiation issue" in planning, and how to deal with negotiation-related complexity towards planning implementation. In the midst of the fourth digital revolution, we know that many professions will be displaced and changed. Such changes will affect the planning profession, and it is expected that with digital tools at its disposal, the planning profession can link planners' place-based skills to other professions' expertise to facilitate democratic and evidence-based decision-making. While no automated procedure can replace the profession's vital transferrable skills, such as visioning, analytical skills, problem-solving skills, engagement, negotiation skills, and presentation skills, there is a need to enhance the capabilities, experience, and strategy of the various actors involved and their confidence in how to propose changes for the future.

The ability to understand how planning is negotiated and what opportunities exist to introduce technological methods to the negotiation process becomes central to the activity of planning and at the core of a planner's skills. The use of decision support systems in urban planning has long been a matter of both innovation and contention between traditional planners and scientists developing models and software to support planning processes. In the study, digital negotiation systems were used to simulate negotiation processes involving different types of stakeholders over decisions related to urban management. As multiple stakeholders engage in processes where complex formulations and social interactions morph into varied expectations and perceptions, negotiation plays a critical role.

This study examines the potential for technology to serve as a pathway to a meaningful negotiation method, moving the focus away from the products of planning to the negotiation process as the most important consideration in planning. Concerning its limitations, the workshop brought together experts and colleagues from academia and industry, some of whom had already published plans for this area. However, barriers to planning (e.g., digital divide, disinformation, lack of political freedom, and unfair power distribution) hinder a genuine contribution of single individuals. The challenge is to present complex concepts to a range of actors, not just a small group of advanced users. Engagement with stakeholders and citizens is a key component of success, and many studies are already applying the workshop to different contexts. In the replicability of this exercise, we can explore the diverse effects that negotiation has in its various applications. Collaboration using Geodesignhub means that all data and information needed to reach an agreement are readily available. Users can also drive data analytics through crowdsourcing and participation, which can be used as a tool for consensus-building in planning and development. With digitally-enabled geodesign, teams of professionals, policymakers, the public, and professionals can collaborate and negotiate together more effectively. At the forefront of this effort, geodesign focuses on the "smart citizen"—an informed, engaged, and capable of negotiating and compromising citizen, which is crucial to society's long-term success.

Digital collaborative negotiation is in contradiction with Ayn Rand's famous book "The Fountainhead", about the architect-creator who cannot accept any compromises. However, the case study of the CAMKOX Corridor shed light on the ways in which compromise can help bridge the gap between planning and implementation. None of the participants in the workshop achieved their planning objectives to the fullest extent possible. By reaching a compromise that addresses about seventy per cent of the aspirations and is agreed to by all parties involved in the process, the likelihood of the plan being implemented increases. Indeed, the gap between planning, policies, and implementation causes problems and ad hoc amendments in many countries worldwide.

To sum up, research into understanding and simulating "the negotiation issue" in the planning processes is still in its infancy. There are multiple avenues to pursue with negotiation-related complexity toward planning implementation. Using the geodesign concept and the Geodesignhub platform is a suitable testbed for facilitating digital negotiations toward consensus and implementation. In order to understand how negotiation strategies are formulated and implemented, additional research is needed to develop systematic rules for negotiation in geodesign projects for different stakeholders.

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