Updating Plans: A historiography of decisions over time ⋆

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Abstract

Plans provide information about how multiple decisions are structured over time, and what the intentions of a particular actor are. As and when these decisions get made, or not made, some parts of plans become irrelevant, while some other new relationships are discovered and considered. Recognising this provides a useful way to interpret the changes in plans by tracking the decisions and vice versa. In this paper, we illustrate the complexities of an ontology of urban systems which are needed to ensure the currency of plans, so that they could be effectively used in urban decision making. Especially, when actors are numerous, jurisdictions overlap, actions are interdependent and interests are unstable, this framework enables us to think about plans in a complex and changing urban environment and make them so that they remain useful.

Key words: Plans, Decisions, Urban Ontology, Urban Processes

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1 Many plans over time and of many Actors

Plans are useful because they consider interdependent sets of decisions ahead of time. These decisions taken at various scales and various times by multiple actors shape the aggregate pattern of cities both geographically and socially (Bourne 1976). Decisions about infrastructure investments or regulatory changes in urban settings are made by groups of actors who are partially cognisant of the intentions of others both within and outside the group. Thus, some of these decisions are informed by multiple plans of multiple actors. However, in making these decisions over time, the plans that inform them also are modified, thus fundamentally altering the relationships between current decisions and those that come after them. Furthermore, the decisions that are made represent a choice among the alternatives delineated within the plans,thus rendering some portions of the plan obsolete. Viewing plans as information that is useful in making decisions demands that the information within them be current and relevant. In this paper, we explore ontological approaches to keeping track of decision histories of various actors over time thus simultaneously modifying and updating plans that inform them.

The paper uses ongoing examination of planning, plan making and use of plans in Champaign, IL to illustrate how tracking and accessing the changing information in plans over time and among actors can help understand how urban development decisions are made. Specifically, we will use plans relating to downtown revitalization, campus planning and community safety to illustrate how plans can and should consider the inherent interdependence of relationships in decisions and policy making within the urban landscape. In doing so, we look for information in plans that are situated *backward* and *forward* in time and *outward* in space and function with respect to other plans and those of other actors, by using both stylised and real cases. We extend previous work to provide illustrations of how an ontology of decisions which accounts for relationships among decisions, actions, and intentions helps us in maintaining the currency of plans.

In subsequent sections, we elaborate on the contingency relationships of decisions within a plan (typified by strategy) and interdependence relationships (typified by design). We then derive the temporal and other orderings of decision chains from these strategies and designs. By observing the decisions that are made and their situatedness in these plans, we archive some portions of the plan material as irrelevant to future decision making. This allows us to explore further relationships between decisions and their outcomes, which have not been envisaged in the previous versions of the plans. We then also touch upon situations in which a subsequent plan completely overrides a previous plans due to fundamental changes in the perceived im-

portance of the relationships and other values which are inherently political. In doing so, we provide yet another justification for developing an ontology for plans in urban situations that is cognisant of the complexities of multiplicities of actors, intentions, goals, decisions and interactions.

2 Decisions and Plans

Plans provide guidance to decisions that are to be taken in different circumstances (Friend and Hickling 1997). Different actors have many plans, which change over time. Each plan considers interdependencies and contingencies among decisions by different actors at the particular time point and provide useful indicators about commitment. Decisions themselves are types of actions (Kaza and Hopkins 2007), made by an intentional actor prior to action. In this paper, we conflate actions and public decisions.

One of the key claims of Hopkins et al. (2005) is that information in plans is organised according to relationships between sets of decisions and actions. Two such kinds of relationships are particularly important to us: Strategy and Design. Strategy deals with uncertainty of actions and outcomes, whereas designs deal with interdependence and complementarity between actions. Such structuring of relationships between decisions helps us understand if and how plans are being used when the decisions get made. In subsequent sections, we elaborate on these relationships and use them to identify how decisions that are based on them could be used to update plans.

2.1 Strategy

The most complicated and useful exercise of planning is to recognise uncertainty of outcomes of actions and plan strategically with respect to goals and criteria. Thus in a particular plan, strategies specify to sufficient depth (figure 1), possible outcomes as well as possible actions in response to those outcomes(Friend and Hickling 1997). If two actions (or sets of them) are considered substitutable with respect to a particular outcome then the resolution of which action to pursue has been left for a future time. These actions are in response to an uncertain situation which characterises the decision situation.

The strategy could thus be represented as a directed graph delineated by events.The representation in figure 1 uses time as opposed to events. Passage of time is one kind of event. The occurrence of any state could be an event(see Worboys 2005). In case there is only one such outcome, such as

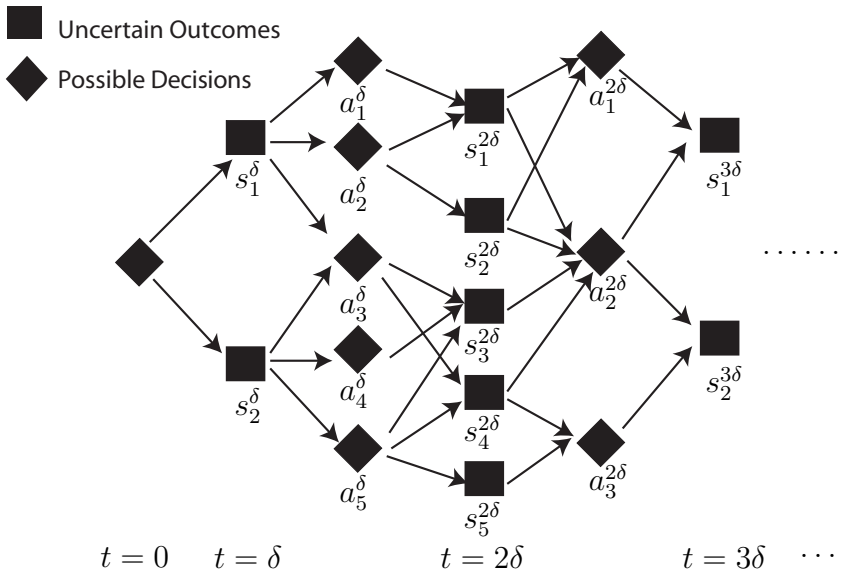

Fig. 1. Relationships between decisions in a Strategy

taking action, there strategy merely represents contingency relationship between two actions. Thus, contingency is a crucial relationship made explicit by the strategy. When only one such contingency relationship is delineated between two actions, Hopkins et al. (2005) call it Policy.

2.2 Design

Fundamentally, design is a tightly worked out set of actions which sit in relation to other actions and when taken together achieve a desirable result. Design can thus be thought of, as an intentional action set, whose member actions are related to each other and the make up is deliberate, and are to be taken in concert to bring about a particular state of the world. Such relationships that are of particular interest in urban planning are spatial relationships such as `adjacency` and `distance` , functional relationships such as `connectivity` , actor-asset relationships such as `ownership` or other actor-action relationships such as `responsibility` .

A familiar example of a design is the design of a building. It can be viewed as an outcome, where the constituent parts fit together coherently. A key point, however, is the design could be that of a building or more elaborately could be that of actions that bring into being the constituent parts (see figure 3). In other words, a construction management plan of a building is also a design, as are the architect's conceptual relationship diagrams, or the detailed construction diagrams. On the other hand, we are also interested in

designs which draw from a social science perspective. Excellent examples include the hierarchical structure of an organisation (e.g. firm). A division of labour in a group working on a project, coherently specified, is a design. Lest it be taken that designs are necessarily static in nature, that need not be so. Any process can be viewed as a state or an outcome and thus specified relationships between outcomes could be relationships between processes.

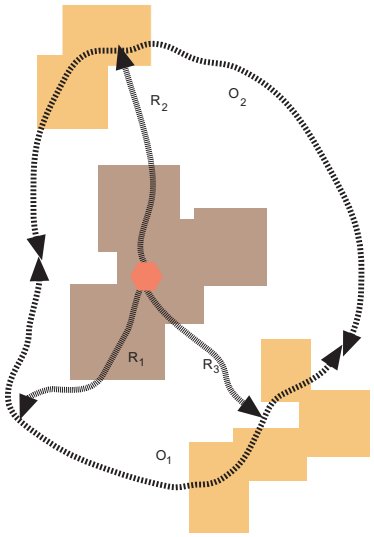

Fig. 2. Infrastructure investments as a Design

The transportation improvements plan in figure 2 could be modelled as a Design. In this case, the three radial links would be considered together because they would only be effective in strengthening the core if all the links were built. And the two ring road links would be considered together because they would only be effective in improving peripheral access if both were built. The response or anticipation of developers would then consider the construction or anticipated completion of combinations of links rather than individual links. This is a very simple instance of design relationship.

A design, however would be that the combinations of R_1 and R_2 has to be done in conjunction with the O_1 and O_2

`ActionSet1(`O_1, O_2, O_3`),`
`ActionSet2 (`R_1, R_2`)`
`NetworkConnect(`O_1, O_2, O_3`)`
`...`
`NetworkConnect(`R_1, R_2`)`
`Precedes (ActionSet1, ActionSet2)`
`Connect(ActionSet1, ActionSet2)`

Broadly construed, we are concerned with the design relationships which are spatial, functional, temporal and mereological in nature. Spatial relation-

ships include distance or qualitative spatial relationships such as front and back (Freksa 1992). Functional relationships are the actor- asset relationships such as ownership, or asset-asset relationships such as connectivity (**?**, see). Mereological relationships such as parthood or membership and subset relationships are treated naively without references to the topological issues raised by (Casati and Varzi 1999).

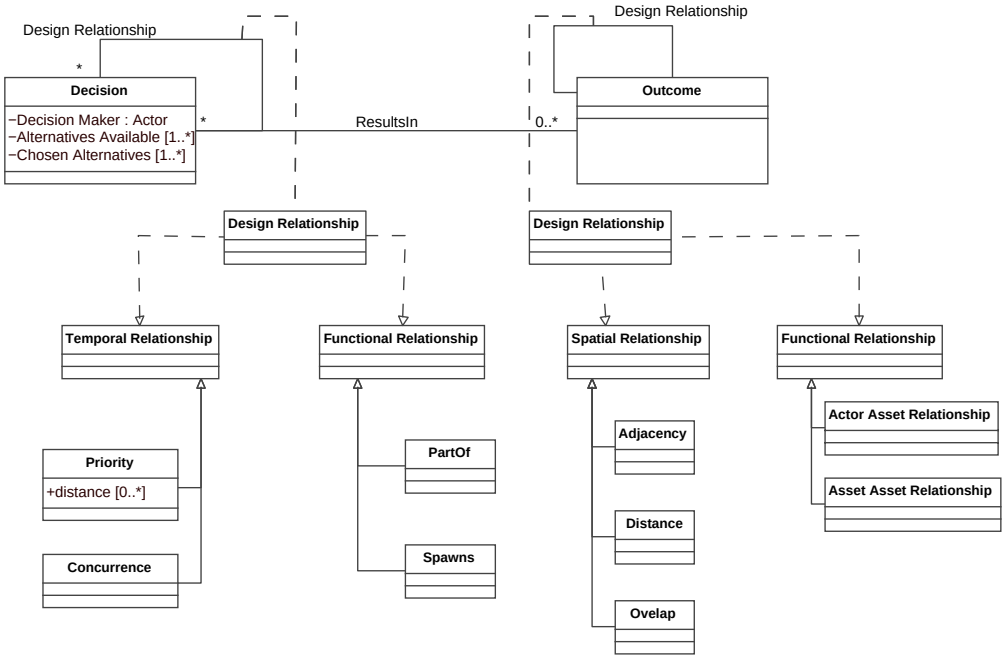

Fig. 3. Incomplete description of Design relationships

Figure 3 specifies an incomplete list of design relationships. Though contingency could also be a design relationship, since it is explicitly dealt with in strategy we do not represent it in this diagram. This, however, points out to an important idea. Plans do not specify a pure design or a pure strategy. In fact, an action which is a part of a design could very well be contingent upon another or substitutable with another. Or the action that is specified as a response to an uncertain outcome in a strategy is a composite action which on close inspection turn out to be a design. For example, if building the a ring road and expanding the transit system are two possible reactions to an increase in traffic volume in the city, each of these seemingly monolithic actions are truly designs.

3 Priority & Contingency

Following the characterisations of Worboys and Hornsby (2004) and Kaza and Hopkins (2007), decisions are events not necessarily rooted in time. Just

as we need to divorce the notions of Assets and Actors from location, we also need to divorce events from inherent underlying framework of time. In this paper, we are limit our scope to decisions that are instantaneous in nature, that is they do not occupy an interval in the characterisation of Allen and Ferguson (1997). However, the decisions may produce effects that unfold and endure over time. For example, a decision to `build (Road)` brings an `asset` into existence, which endures over its lifespan or till another action deliberately brings about its destruction.

Grenon and Smith (2004) and Worboys (2005) distinguish two different modes of representing event relationships. One is SNAPshots of states arranged on the temporal axis, and the other which is primarily focussed on the processes (existence, modification etc.) that occur in a SPAN of time. Both kinds of representation are useful and in fact reasoning for urban systems should consider both modes of representation without too much emphasis on the rigorous and exact translations between the two. Activities, such as shopping, travel, residing etc. are processes and the level of activity — volume of sales transactions, traffic count on a link etc.— are also Snapshots of states.

Since plans are made for contingent futures, the occurrence (or non- occurrence)of a particular future is an event the plan is supposed to address, irrespective of its location on the temporal axis. The temporal location of the event is useful only for the purposes of discerning relationships to other events. Thus, an event set can compose of temporal relationships such as `before` , `lag` , and `temporal adjacency` as primitives, without inferring them from location on the temporal scale.

Furthermore, these relationships are ephemeral and particularistic. For example, a plan of city government may suppose event A is prior to B (building the ring road first and expanding the connectors to the center later in the figure 2) and choose to plan for such a future (by scheduling the capital improvements plan and budgets accordingly). However, the suburban development at the fringes may suppose the opposite precedence relationship – it may be more useful to get to the employment center in the city first than to connect to other fringe development. Especially when the issue is who gets to act on which subset of actions in the design, plans of multiple agents may presume incongruent event relationships. Furthermore, different plans of the same agent may prescribe different courses of actions for event sets, which in different futures may may be related differently.

To update plans using histories of decisions and actions, we consider two relationships which are closely tied to each other but nevertheless offer sharp distinction on reasoning about updating plans. They are contingency and priority.

An action is prior to another temporally. If action A occurs before or after B, then they share a temporal relationship. Temporal priority is a binary relationships which arranges actions on a temporal scale. The crucial difference is that we have to observe the occurrence of both A and B to make judgements about such arrangements. Functional priority implies temporal priority, while not the other way round.

Functional priority is contingency. An action A is functionally prior if it is necessary before the occurrence of B. In other words, if we decide to do B, we have implicitly decided to bring about A or at least observe that A has occurred. If a soil conservation group recognises the contingency of a corridor study and its recommendations as necessary for the building of an interchange I and if it believes that building I is inimical to its goals, then it could reason that lobbying for strong representation of its concerns during the study process would produce an unfavourable recommendation, and thereby not bring about I. This course of action when it is made explicit in their negotiations with the County, which favours the interchange, could enact regulations that conserve the farmland to assuage the concerns of the conservation group.

4 Decision Histories & Changing Plans

Partial Orders thus frame the reasoning for decisions within a plan on the temporal scale. Keeping in mind the adequatist, fallibilist and particularlist model of reasoning and representation (to use the words of Grenon and Smith (2004)), partial orders are sufficient for the purposes of this paper. For example for actions A, B and C, `precedes(A, B)` and `precedes(C, B)` taken together make no claim about the precedence or any other relationship of A and C. If these two relationships are apparent in a plan, an action X is contingent on occurrence of B is also contingent on occurrence of A and C. When decisions are set in the indeterminate future, they are set typically without any reference to the underlying temporal structure but are ordered by the relationships among them.

However, when decisions are taken/observed they are situated in a well-ordered temporal axis. That is, each decision is time stamped. This allows us to reason with the actions and compare them to their situation, set in plans. If a plan A specifies `Contingent (C, D)`, we can infer the temporal relationship `precedes (C, D)`. However,if we observe C_{t_1} and D_{t_1}, thus deducing the temporal relationship `concurrent (C, D)`, then the plan is not useful in guiding us with the reasoning about intended actions and thus need to be updated.

On observing a sequence of decisions by an actor, we can match them to the plans of the actor. In particular, if any of these actions are specified in a strategy, then we can trace the contingency relationships by traversing the directed graph backward to see if any of the previous decisions are identified by this strategy. Furthermore, even when the decisions are not observed, but the outcomes are, then we can speculate on the actions that were taken that led to the outcome [1] . The subgraph that is rooted at the current decision node traversed backward is useful only for archival purposes and does not contribute to any future decision making. Thus, the strategy can be updated by archiving the subgraph.

If any of these decisions match a decision node of a strategy, we should look for decisions/actions that are forward from that node on to consider the effect of the current decision on the future decisions. That is the subgraph of the strategy that is rooted at the current decision node and traversed forward is most useful for determining the contingent decisions. The other uncertain outcomes and decisions that are not a part of either of the two subgraphs are still useful to maintain as a separate strategy for they may be useful in other decision making when such state of the world occurs.

Thus a particular strategy would undergo transformation into multiple strategies, some useful for their historical relevance and others useful for decision making. In particular, the two strategies that are still yet useful could be further elaborated to consider other uncertain outcomes that were not yet identified in the previous version of the strategy. This process maintains the currency of the strategies and therefore that of plans.

If any of the subset of decisions/actions match a part of design, then we can recognise that all the other actions that are part of the design when taken follow the 'design relationships' within the design. That is for assets, O_1 and O_2 `Network Connect`(O_1, O_2) , specifies a design relationship. Even when O_1 occurs without O_2, we can deduce that, if the design is followed, if and when O_2 occurs, O_1 and O_2 are related through a `connectivity` relationship. If, however when O_2 occurs and connectivity is not satisfied then the value of the design lies in identifying how such change affects all the other design relationships, in particular the connectivity relationships, between R_1, R_2 and R_3. Thus, the design is modified to suit the circumstances.

On the other hand, when the plan does get updated, due to a change in circumstances, then previously known contingency and priority relationships may be discarded and new ones are specified. When plans are changed in this fashion, they are changed either due to change in composition of actors

[1] Outcomes are determined by a particular state of the world or a measurement of an attribute of the state. For example, different levels of Vehicle Miles Travelled (VMT) on a highway network could be the various uncertain outcomes.

who make the decisions, change in direction of policies and strategies or different modes of evaluation of the contingencies and interdependencies. Such changes, though not anticipated from a logical system point of view, once made, provide useful information about the relationships between decisions. In this case, the new plan supercedes the old plan by keeping some actions, discarding some, and changing some relationships between them. A case in point is the example below.

The 1974 City of Champaign Comprehensive Plan (Champaign County Regional Planning Commission 1974) addresses the citys core downtown area on less than three pages. Despite noting that Market Place Mall is set to open on the city edge, the authors of the plan emphasize only that the imminent creation of a covered pedestrian mall on Neil Street is an "obtainable and reasonable solution to the problem of maintaining a strong tax base in the Central Business District (CBD) and preserving it as a viable part of the community's cultural life," (p. 87). The only other downtown-oriented actions suggested in the plan are to 'curtail'(p. 87) certain commercial uses on the edge of downtown and to replace a medium density residential district west of downtown with higher density uses to "buffer low density residential uses from the Central Business District," (p. 84).

By the next Comprehensive Plan six years later the attitude toward the downtown has shifted (City of Champaign 1980, Champaign County Regional Planning Commission 1979). No longer just a brief mention, retention of existing users and attraction of new ones has become a more important aspect of the plan. The downtown is mentioned throughout the plan, under topic headings such as 'Growth' (p. 1-2), and 'Commercial Development' (p. 1-4), in which the issue of facilitating a more vibrant downtown through active government intervention is a primary focus, resulting in objectives such as, "Encourage downtown redevelopment and allow flexibility in building codes, but without jeopardizing life safety," (p. 1-5), and "Direct a substantial percentage of new development to areas inside the existing City limits, particularly to the downtown core", (p. 1-2).

By 1992, preservation and revitalization of downtown had emerged as a prominent enough issue to warrant creation of the 1992 Downtown Comprehensive Development Plan (Urbanics and BRW 1992), followed by the more detailed Downtown Plan in 2006 (City of Champaign 2006). Both argue for the focus of substantial city efforts on the limited geographic area of the Downtown, in order to create a space that will benefit the city as a whole. As circumstances and stakeholders change over time, plans change, too. However, certain elements of old plans may have gained traction and persist in reality even as they are omitted from newer plans. The stickiness of these schemes has implications for urban development and there is utility in tracking them through time.

If a strategy A is present in a plan P_{t_1} and B is present in that of plan P_{t_2} with explicit provision that P_{t_2} supercedes P_{t_1} in informing decision making. However, A is only superceded by B only if the same decision node occurs in both A and B. If the subgraph that contains all the decision nodes forward from the all common decision in A be called T, then the directed $A \setminus T$ is still useful information for other contingencies and uncertainties that are not considered in B. Thus, some portions of previous plan are still relevant for decision making.

In the case of design, however, inferring these changes in relationships is a more onerous task. One design may be alternative to another as a whole even if they do not share any constituent action items. Such alternatives are decided based on capability or location constraints or substitutability with regards to intentions (Kaza forthcoming). In such cases, the subsequent plan which explicitly supercedes the original plan, completely replaces the design. Further elaborations are left for future work.

5 Multiple Plans

Now that we can update single plans as and when decisions get made, we must consider the idea of multiple plans informing a single decision situation. Different actors have concurrent plans, some of which are interdependent. For the purposes of brevity, we consider here only those plans where explicit relationships between plans are acknowledged in plans which are still 'valid'. In such cases, the actor responsible for the decision is an attribute of the decision situation and thus the reasoning is no different from earlier sections. If one plan specifies a decision is subsequent to decisions of other actors, and if such other actors identify other contingencies between those actions, then we can begin to reason about further interdependencies between decisions of one actor and actions of another. What becomes interesting, however, is that this provides another justification of the ontology as a standard representational device to encode the plans of all these actors so that such connections can be made.

The University of Illinois Campus Area Transportation Plan (CATS) published in 1999 (of Illinois 1999) argues for enhancing multi-modal transportation access in and around the campus. Some tactics, however, extend well beyond the spatial extent of the campus. On page 74, the plan suggests widening Springfield Avenue where it connects the southern tip of downtown to the northwest portion of campus between Neil and Wright Streets. "In order to widen portions of Springfield Avenue," the plan notes, "it would be necessary to replace the existing viaduct at the railroad tracks to accommodate additional travel lanes and semi trucks. The City of Champaign and

the University should work with [Illinois Department of Transportation] regarding the replacement of this viaduct." To increase multi- modal access within the campus, the Universitys plan is contingent on the plans and actions of other actors well outside the campus; this is not an unusual situation.

Actor `University` has a plan which identifies `Widen Road` as decision contingent on `Replace Viaduct` . However, the actor who is responsible, or has the capability to replace the viaduct is the group of actors consisting of the `City`and the, `Dept. of Transportation`. If either actor balks at replacing the viaduct, then the University cannot expand the road. This has a cascading effect on other plans of the university which were contingent on the expansion of the road, such as if and where to build a parking structure or transit transfer station. Thus, the decision by the Dept. of Transportation, indirectly changes the plans of the University.

Likewise, actors may make plans which directly attach their own future actions to existing or planned actions of other actors. The Champaign Police Department, for instance published a Five Year Community Safety Plan in 1995 (Champaign Police Department 1995). The first goal in the plan was to address the issue of "Total Crime" in the community; the first strategy to address that goal was, "To comprehensively address infrastructure and service needs in threatened areas," (p. 28). The first action under this goal is to "Combine efforts between police and planning departments in the ongoing evaluation of neighborhoods in which to begin to develop specific improvement plans," (p. 28), and to "Integrate neighborhood needs into the multi-year strategy for infrastructure improvement included in the [Capital Improvements Program] and public works maintenance programs throughout the city" (p. 28). By integrating land use and service provision within a policing and safety plan, the Police Department illustrates the utility of being able to track the plans and decision of other actors when making a plan; the police department is relying on the actions of the planning department as a way to combine these two currently unconnected activities in order to serve their own needs.

The indeterminacy of relationships of all actions in plans, provides useful opportunities to expand on existing plans. It is imperative to acknowledge that, to consider and encode 'all' possible contingencies and interdependencies between various sets and subsets of actions is unreasonable expectation of plans and planners. The plans specify only relationships between specific combination of actions that are of particular interest to the decision maker. As and when some alternatives and decisions recede from the decision situations, they provide opportunities to add or reconsider other actions and decisions and how they might relate to decisions that are being considered and yet to be taken.

6 Conclusion

We have illustrated some ways in which keeping track of the decision histories of various actors over time can help inform decisions within urban development situations. These arguments provide a rationale for development of an ontology of plans that recognizes the complexity of decision- making in towns and cities. Subsequent stages of this work must overcome the obstacles to development of such an ontology when multiple plans do not acknowledge one anothers existence, yet are nevertheless contingent and/or interdependent. This situation is common, yet requires a system for unmasking these hidden connections if the system is to be useful. Nevertheless, maintaining the currency of plans is an important application of the ontology of urban systems, so that these different plans over time can be used in decision making by various agencies.

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