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(Actor-) Network mapping of housing systems employing social network analysis tools: the case of medium-density dwelling design in Australia.

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Abstract

Housing design and provision exists within the highly complex social and technical networks of the human built environment. The tendency of design professionals to objectify the built edifice in isolation from these networks results in a failure to recognise the profound influence they have on the evolution of urban form- the 'human environment.' In the current era of environmental uncertainty prescriptive urban strategic plans frequently promote the evolution of existing environments over time. In the context of Australian urban plans new 'medium-density housing' in existing urban areas is prescribed as an antidote to continued unsustainable suburban expansion. To effectively design and implement change in any given system an understanding of the complexity of that system and its networks is required. Recognising the roles of both human and non-human actors in housing design and provision this paper proposes a means of mapping the actor-network of medium-density housing design. The network mapping focuses on the flow of design related information between actors and proposes the use of social network analysis tools to identify important network attributes and facilitate system intervention. The proposed actor-network mapping approach is neither housing nor built environment specific, but applicable to design within existing, stabilised systems.

Keywords:

System design, network mapping, actor-network, social network analysis, housing design

Context: Australian medium-density housing

Current strategic urban plans for numerous Australian cities promote consolidation and intensification of activity in existing urban areas. These plans respond to the need to curb urban expansion and increase infrastructure efficiency, whilst seeking a more equitable and sustainable urban future.[1] The implementation of these plans requires a shift from traditional low-density, free-standing dwellings to 'medium-density' housing (MDH), such as terrace houses or apartments.[2] The

[1] Such Strategic plans include: The 30 year plan for Greater Adelaide, 2010; Directions 2031 and beyond, WA Planning Commission 2010, Plan Melbourne, 2013; (Draft) Metropolitan Plan for Sydney to 2031 'Your Future Sydney', 2013.

2 Medium-Density Housing (MDH) is a term employed by the majority of Australian strategic urban plans. It refers to a housing typology with more dwelling units per hectare than traditional low density development. It does not benefit from a consistent definition across all jurisdictions: the 'Planning Strategy for Metropolitan Adelaide' 2011 defines it as 4-10 stories & 35-70du/ha, the New South Wales Strategic Planning documents describe it as development between 25 and 60 net du/ha (NSW Dept of Planning, 2011) and in Queensland the only descriptor is a height of up to 5 stories (Brisbane City Plan, 2014). This project describes MDH as multi –occupant buildings of 3-5 stories in height with a net density of 65-130 du/ha.

30 year plan for greater Adelaide, as one example, places emphasis on the role of MDH in providing "a new urban form". The MDH typologies proposed by the strategic urban plans are readily visualised in the policy documents and sit well within the design capabilities of the local architectural industry. However, there are some significant barriers to uptake including:

- the long tradition of the free-standing family home as the 'Great Australian Dream'[3]
- the perception of MDH as inferior to the free-standing family home[4]
- the high rate of home ownership, including the desire to own one's own 'piece of dirt'[5]
- the mismatch between household desires and currently available MDH products[6]
- the lack of opportunity for individual households to have input into MDH design and construct dwellings to personal specifications[7]

Considering these barriers it is not surprising to find that, despite the intention of the strategic urban plans, the majority of residential growth in Australian cities continues to occur outside policy designated growth areas and in these areas the large single family house persists with little variation.[8]

It is within this context of proposed urban renewal and resistance to change that the presented project is set. Focusing on the mismatch between prospective MDH residents' desires and the housing products available it is proposed that increased owner/occupier input in MDH design would enable many barriers to MDH to be progressively overcome (Palmer 2014) encouraging it to be viewed as an acceptable alternative to the existing 'Great Australian Dream.' It is only with acceptance of MDH that the strategic urban plans promoting 'containment, consolidation and centres' (Troy 2006) will be able to realise the sustainable urban futures they propose.

3 Influenced by post World War II policies Australia has the third highest rate of home-ownership among OECD countries (Economist 2002), with approximately 70% (ABS 2010) of households owning a free-standing family home on an individual plot. This rate of home ownership has been relatively constant since the post WWII period of suburban expansion.

4 Privately-owned multi-unit housing (25% of national stock) has a lower owner-occupier rate of one third (Troy 2012), meaning two thirds are privately tenanted. Tenanted dwellings are characterised by high rates of relocation, with only 13% of people in rental housing likely to reside at the same address as they did five years prior compared to 71% of owner-occupiers (ABS 2010). Medium density housing is subsequently viewed by many low-density housing owners as an undesirable housing type to have in one's neighbourhood due to high rental rates and increased mobility.

5 The 2011 census shows three quarters of occupied, privately-owned houses in are free-standing suburban dwellings (ABS, 2013). Of these, 77% are owner-occupied (Troy 2012) with the remainder privately rented.

6 Focusing on Sydney and Melbourne (Kelly 2011) sought to understand the 'trade-offs' households are willing to make given decreasing housing affordability. In comparing 'trade-off' preferences with actual and new housing stock a significant unmet desire for medium-density housing up to 3 stories was identified in both cities, with only 41% of Sydney residents and 48% of Melbourne residents preferring to live in detached housing given current market prices. Another 2011 study in Adelaide (Fischer&Ayturk) found those attracted to higher-density housing did not view the products currently available as meeting their lifestyle needs. These two studies reveal a notable shift in acceptance of medium density housing partially driven by financial constraint. They also show this shift is not accommodated by existing housing provision systems.

7 These tenure differences between low and medium/high-density housing have steered the evolution of two distinct housing provision systems over time. The dominant low-density provision system provides for the construction of dwellings on an individual contract basis; with a household contracting the construction of their chosen house on their chosen parcel of land to accommodate their personal desires and lifestyle. The medium/high density provision system, in contrast, is predominately speculative with design choices made by developers and builders based on generic preconceptions of the future occupants desires and guided primarily by economic outcomes.

8 The low density family dwelling continues to dominate new housing supply despite abundant literature identifying its unsuitability to adapt to future environmental and demographic change; Sydney being a rare exception (Kelly 2011).

So the questions become: Why do we have the MDH designs we have? How can MDH design and provision involve more user input? To address these questions requires a detailed understanding of the MDH provision system is needed.

Why we have [the MDH designs] we have…….BLACK BOXES.

As complex, city wide proposals integrating systems of transport, servicing and community infrastructure strategic urban plans show a tendency to over simplify the complex context of housing provision. Jacobs (2006) argues that traditional geographies have 'black-boxed' the building as an immutable artefact:

> *they do not interrogate the socio-technical processes by which that there-ness materializes: the process of construction and use of the building , the various modes of authorship and ownership, the day-to-day complexities of maintenance and servicing. (p.11)*

Similarly, I suggest that current urban plans demonstrate a tendency to 'black-box' housing types, including medium-density housing. The existing MDH provision system is sufficiently complex that urban plans, in Bruno Latours words, "draw a little box about which they need to know nothing but its input and output" (Latour 1987, pp. 2–3).

Such 'black-boxing' of MDH perpetuates repetition of the status-quo through the limiting of controversies essential to the development of alternatives. 'Black-boxing' in this context restricts knowledge and influence to existing actors and hence the existing MDH provision system becomes 'locked-in' (Lovell & Smith 2010), repeating existing design and reinforcing the perception of medium-density housing as an inferior housing alternative. Within the MDH 'black box' the traditional craft-based construction systems of low-density housing are replaced by more commercial construction systems and contract-based (demand led) provision replaced by speculative (supply led) provision. Hence, unlike traditional low-density housing, MDH owners and occupants are not able to engage with housing production systems. The absence of owners and occupants from the MDH production sub-system leaves control of dwelling design in the hands of developers and financiers whose primary objective is to maximise development profits. Hence fundamental decisions about housing design, amenity and usability are made via a risk adverse lens privileging exchange value over use value.

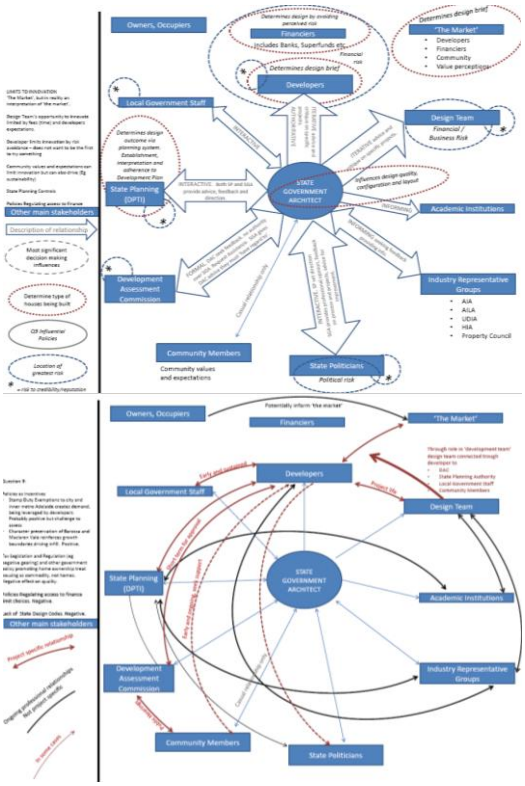
For urban plans to achieve the urban futures they propose I suggest the 'black-box' of MDH must be confronted – transformed to remove the dominance of developer and profit driven decision making. Developed to "describe why and how we have the science and technology that we do" (Cressman 2009) Actor-Network Theory (ANT) offers a means to uncover why and how we have the housing that we do. In discussing the relatively recent application of ANT to Urban Studies, Brenner et al (2012) categorise three modes of employing ANT in relation to Critical Urban Theory: empirical, methodological and ontological. A methodological application of ANT to the urban context is proposed here, in which "Assemblage (ANT) is presented as a methodological orientation through which to investigate previously neglected dimensions of capitalist urbanization."(Brenner et al 2012, p.125) This enables the empirical analysis of research 'objects' through a political-economic framework with the potential to observe "flows of energy, value, substances,….,people and ideas" (2012, p.125). Bijker and Law (1992) define this flow as the intermediary or language of a network,

that which "passes between actors in the course of relatively stable transactions"(p.25) In this case, to address the question of why the MDH 'black-box' produces the housing it does, the intermediary of the network is the flow of design information used to make design decisions .

ANT mapping inside the 'black box'

To commence a mapping of the flow of design information in the existing MDH provision network the actors in the network were established employing the ANT definition of an actor as "(a)ny element which bends space around itself, makes other elements dependent upon itself and translates their will into the language of its own" (Callon and Latour 1981 p. 286). In order to represent the network as effectively as possible information has been gathered from a variety of sources including existing literature, texts, and semi-structured interviews with key industry stakeholders (as described in Table One). This complies with the two main methodological approaches advocated by ANT: 'following the actors' via interviews and ethnographic research, and examining inscriptions. (Williamson&Parolin 2013, p420)

Table One: Data gathered from Stakeholder interviews to inform ANT mapping



The semi-structured interviews generated ego-centric maps[9] focusing on the informant's relationship with other stakeholders. They describe the nature of these relationships, be they (for example) collaborative, directive, adversarial, interactive, regulatory etc.

They also record the informant's perception of who makes key design decisions and what these decisions are influenced/informed by.

The informant's perceptions of relationships between other actors are also recorded.

Interviews were completed with stakeholders representing

- City planners
- Urban designers
- Commercial Developers
- Construction companies
- Architects
- State government architect
- State urban development authority

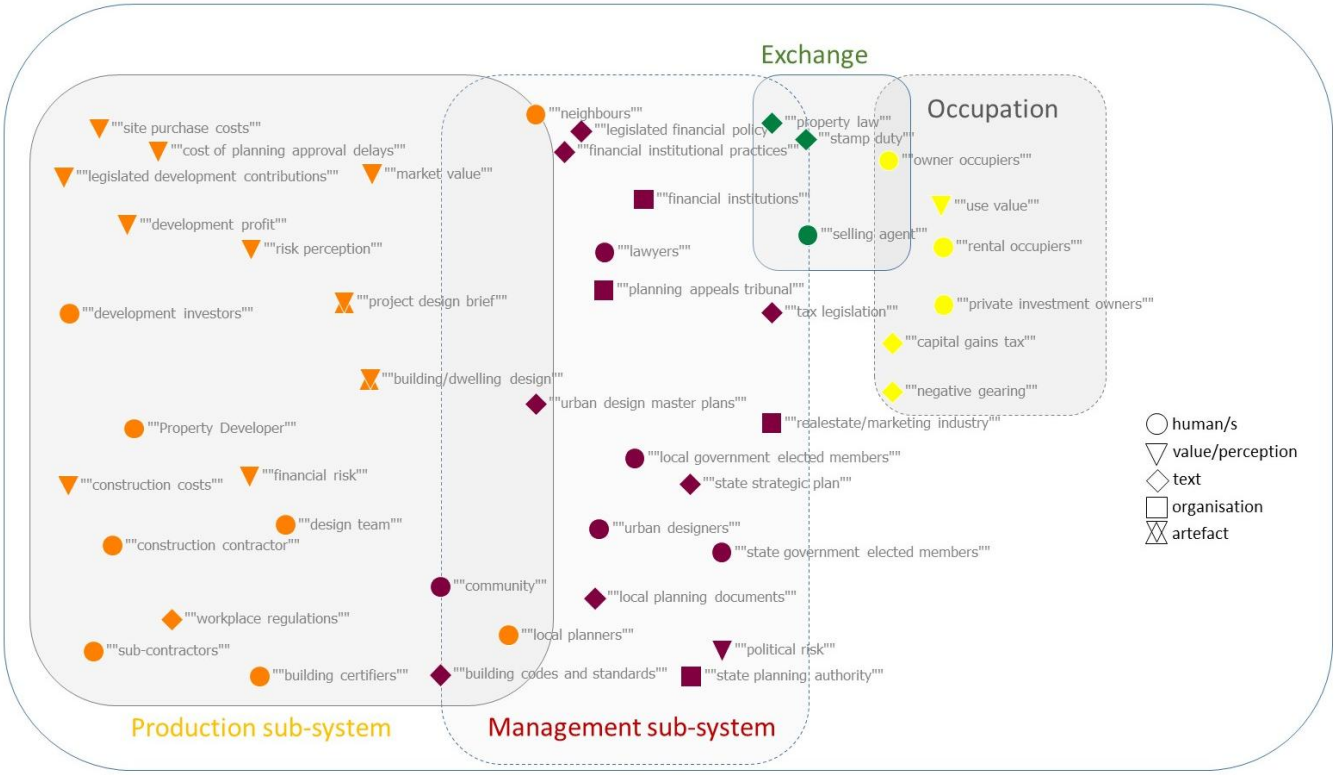
This information has been used to determine both the actors in the network and, importantly, the flow of design information between them. A complex range of more than 40 human and non-human actors were identified with more than 120 intermediary flows/ connections. The actors and intermediary flows identified constitute a stabilised network which, having formed over time through a variety of translations and inscriptions (Callon 1986), has been offering MDH to the Australian market for an extended period of time. That is, they represent the contents of the stable 'black-box'.

[9] Chan & Liebowitz (2006) describe ego-centric data collection in their discussion of the application of SNA to knowledge mapping.

In mapping this network, the interest to the project is to open the 'black-box' and observe its contents: to visualise the actors it contains and how design information flows between them to result in the MDH designs we have today. That is to say, the proposed mapping does not intend to map the preceding, or historic, translations and inscriptions which led to the stabilisation of the network and subsequent creation of the 'black box.'

For the purposes of organising the mapping in a logical manner relevant to industry, reference has been made to the four sub-systems of the Australian housing system described by Burke and Hulse (2010). These being Management, Production, Exchange, and Consumption, all of which are seen to be influenced by economic, legal, administrative, social and demographic, environmental and political contexts. Located in the mapping by their primary sub-system, the actors are identified as human and non-human via the actor icon, with non-human actors divided into four categories of texts, organisations, values/perceptions and artefacts (Figure One).

Figure One: ANT Mapping of 'Black-Box' showing Actors by Sub-System



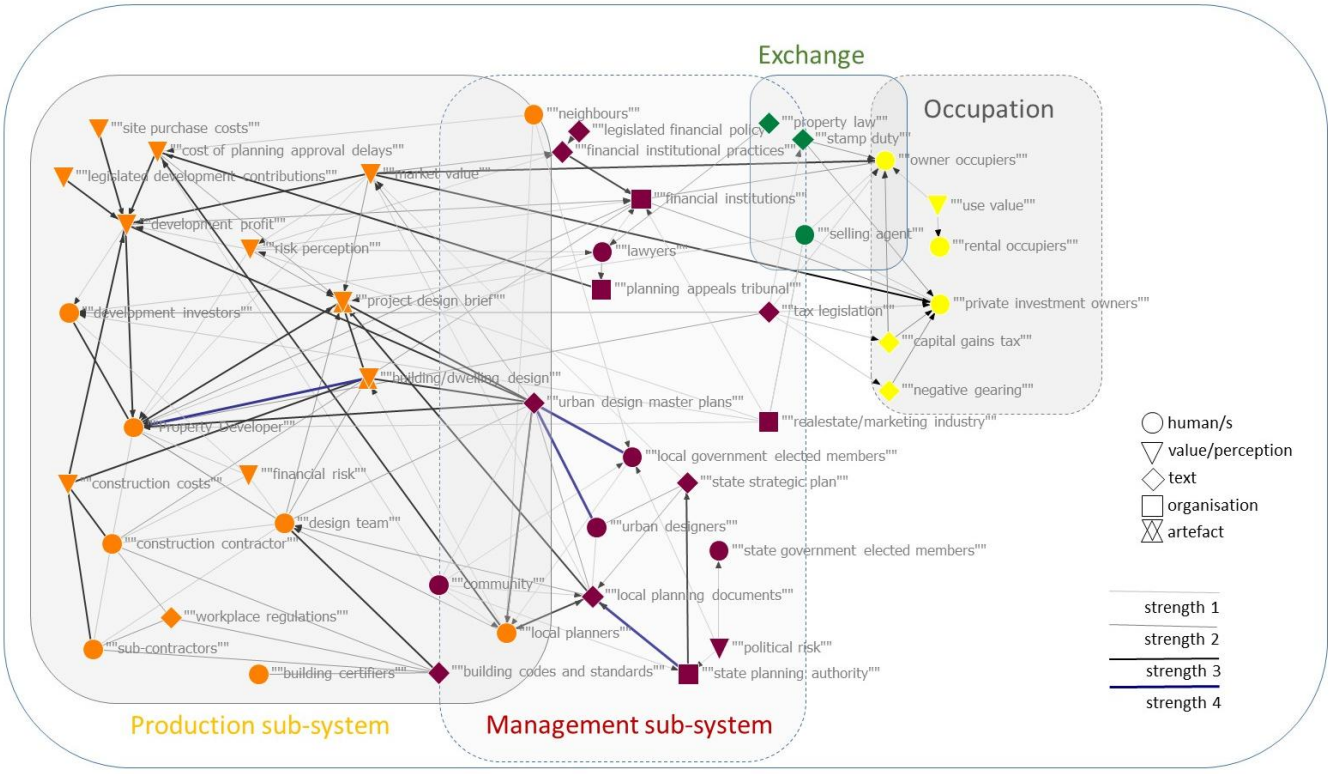
Whilst the sheer number of connections observed between actors begins to represent the complexity of the network and design information flows, it is critical to recognise also the different types of information flows which occur. Discussing the limits of ANT in relation to creative practices like design and architecture Rose (2013) notes that whilst it can recognise stronger and weaker links it "isn't very good at differentiating between different kinds of links." In the mapping approach proposed here, this limitation is overcome by focusing upon a single 'kind' of link – flows of design information - and correlating variations within these by strength. For example, as a prescriptive text the National Construction Code ('Building Codes and Standards') has aa authoritive influence on design. It does not enter into discussions or negotiations with its fellow actors but provides directive information for implementation. In contrast the influence of 'market value' on 'private investment

owners' is considerably more subjective and individually variable. Based upon the literature review and stakeholder interviews six types of intermediary flows between actors have been identified in the network with four different strengths. These are summarised in Table Two and applied to the ANT Mapping in Figure Two using directional connections to indicate the flow of design information. It is worth noting that the same network of actors could also be examined in regard to an alternative intermediary. For example, financial flows, professional relationships etc. But, the focus on design information is used here as the aim is to ask the question "why do we have the MDH designs we have?"

Table Two: Intermediary Flow Types Utilised in Mapping

Intermediary Flow Type	Strength	Example
Provides input/opinion for design decision making	1-Low impact on design outcome	'Community' provides opinion to 'State Planning Authority' during public consultation on 'State Strategic Plan.'
Sets boundaries to design decisions	2	'Local Planning Documents' set boundaries for 'Design Team' to generate design proposals
Provides propositions for consideration by others		'Design Team' provides design propositions for consideration by 'Property Developer'
Limits future design decisions by others	3	Development Investors agree to fund a project with set conditions, limiting subsequent decisions made by Property Developer
Determines/prescribes set design decisions		Building Codes and standards directly inform Design Team with prescribed solutions to safety, amenity, fire standards etc.
Takes actions / makes final design decisions	4 -high impact on design outcome	Property Developer makes decision to proceed with proposed building/dwelling design or not

Figure Two: ANT Mapping showing Actors & Flows of (directional) design information by Strength



Introducing SNA tools to ANT Mapping: defining network characteristics

Whilst the resultant network shown in Figure Two integrates all network information gathered, it fails to readily provide the reader with an understanding of why the 'black box' being observed produces the MDH designs it does. What are the main influences on design understandings? Who are the key decision makers? and Which actor(s) hold the greatest power over the final housing outcomes? From an ANT perspective, one might reframe these questions as: Who/Where are the mediators, the focal actors and the obligatory passage points within this black box?

> *FOCAL ACTOR one who acts to align the interests of a diverse set of actors with their own interests (enacts translation) (Callon 1986)*
>
> *MEDIATOR: actors who 'transform, translate, distort and modify' (Latour 2005 p.39)*
>
> *OBLIGATORY PASSAGE POINT: A situation that has to occur for all of the actors to be able to achieve their interests, as defined by the focal actor (Callon 1986).*

ANT literature does not specify particular methods or tools to identify the network attributes it defines beyond the principle of "following the actors." As Ponti (2011) states:

> *ANT does not provide hard and fast rules to "operationalize" the described principles and approaches; nor does it offer a set of clear rules to guide researchers through the research process (LAW, 1992). How researchers try to uncover and define which networks exist in a given setting, how actors translate their ideas and interests, and which forms these translations take depend on the specific research situation. (p.41)*

In this specific research situation (the opening of the 'black box') I propose the use of Social Network Analysis (SNA) tools to assist in defining and describing actor attributes within the existing network; in the knowledge that in "ANT descriptions and explanations cannot be separated." (Ponti 2011, p2) In particular it is proposed to employ the SNA analysis measures of 'in-degree', 'out-degree', and 'betweenness.' In the 2012 book "Mapping Controversies in Architecture," Yaneva states unequivocally that social network analysis tools are not relevant to studies employing Actor-Network Theory because "as argued extensively by ANT, networks cannot be reduced to social relations only" (Yaneva 2012, p.95 referring to Callon, 1986) It is my contention that this view requires further interrogation and that in certain circumstances computational tools developed for` social network analysis can offer useful insights to observers of actor-networks. Indeed, a hybrid ANT / SNA approach to support network centric healthcare solutions has been previously advocated by Wickramasinghe and Bali (2009), which similarly suggested the use of SNA analysis techniques to provide an understanding of a network observed through an ANT lens. Thompson (2003) concludes in a comparison of network theories in relation to markets and hierarchies, both ANT and SNA consider a network as a set of relations between actors and techniques; and both explain network outcomes as "*variations* of network structures."(p23) SNA analysis provides a means of measuring and observing such variations of network structures irrespective of the properties of the actors and the intermediary in circulation.

By mapping controversies in architecture Yaneva seeks to develop a network mapping tool which is capable of documenting multiple facets of controversies which occur in specific architectural design projects, a new methodology for following debates around contested urban knowledge. In the case of Yaneva's controversy mapping of the London Olympic Stadium, the network representation

demonstrates the human actors (individuals and organisations) and the flow of different 'kinds' intermediaries (described as concerns) including cost, usage, legacy etc., all of which are observable over a dynamic time scale. The data mapped is drawn primarily from media and other public representations (or performances) of the controversies in the design process, which as Abrahams (2012) notes, is a problematic divergence from typical ANT data collection which historically seeks data directly from the study group. The flow of information is mapped by 'concern' (eg legacy, design etc) but within each category of 'concern' different 'kinds' of flows (Rose, 2013) are not accounted for, merely the number of flows along a given path. Regardless of the debate regarding validity of data collection (and hence data credibility) proposed by the 'Mapping Controversies in Architecture' methodology, it is clear that the resultant representation of network dynamics and tracing of dialogues over time produced by this methodology is not possible with SNA tools, which typically result in static representations of a network at a given point in time. However, I argue this does not exclude the use of SNA tools in ANT studies as stated by Yaneva, but that the usefulness of SNA tools in ANT network mapping depends upon the facets and attributes of the system one seeks to observe.

With regard to the research project discussed here, the primary aim is to observe the actor-network which exists inside the stabilised 'black box.' As such, the dynamic tracing of controversies to describe the historic processes of translation (and controversy) over time is not required and the static network representations generated by SNA tools can provide useful insights to design.

Three common measures employed in SNA to describe network features are in-degree (number of directional ties to the actor), out-degree (number of directional ties from the actor), and betweenness.[10]

> *An actor with a high in-degree is regarded to be prominent or to have high prestige, as many other actors seek to connect with them. An actor is often said to be highly influential if it has a high out-degree as it is able to make others aware of its views.*
>
> *Betweenness is the extent to which a particular actor lies between the various other actors in the network. The actor with high betweenness plays an important 'broker' or 'gatekeeper' role with a potential for control over others. It may extract 'service charges' and isolate actors or prevent contacts. Such an actor thus has a great influence over what flows in the network (Hanneman 2001). (Chan and Liebowitz 2006, p24)*

Clear correlations can be seen between the attributes prescribed in SNA and ANT if the apparent conflict presented by the intermediary, or currency of the network, is temporarily set aside. In-degree and out-degree can be seen to describe focal actors while the notion of the 'gate-keeper' role identified by betweenness can be seen to describe actors connected to obligatory passage points. At this point, reintroducing the intermediary (which in the case of SNA networks happens to be social connections but in the case of ANT may be any intermediary constituting the currency of the network – for this project, design information) does not negate the correlations identified. Nor, I argue, does it invalidate the proposition that software tools developed for SNA, measuring degree and

[10] Numerous measures and mathematical definitions of betweenness exist in SNA, such as betweenness centrality, ego-between etc. Whilst these are not discussed in detail here, it is proposed the ego-between measure is most suitable to the use of SNA tools in ANT analysis being proposed.

betweenness through quantification of network flows, can be used as a computational tool to observe the same attributes in ANT analysis of a stabilised 'black box' network.

The notion of some actors being more 'prominent', 'influential' or 'important' within an actor-network appears to contradict Latour's 1992 assertion that there is no structural difference between large and small actors, between a major institution, a single individual or a mundane object. However Bijker and Law (1991) remind us this assertion does not suggest all actors are equal nor have the same possibility of influence or alignment; that the main differences between macro and micro actors is the number of actors they can arrange according to their objectives. Hence, in the same way SNA tools can be used to determine key players, power and control in networks whose currency is social connections, they can equally be used to determine focal actors, mediators and obligatory passage points in ANT networks with alternative intermediaries.

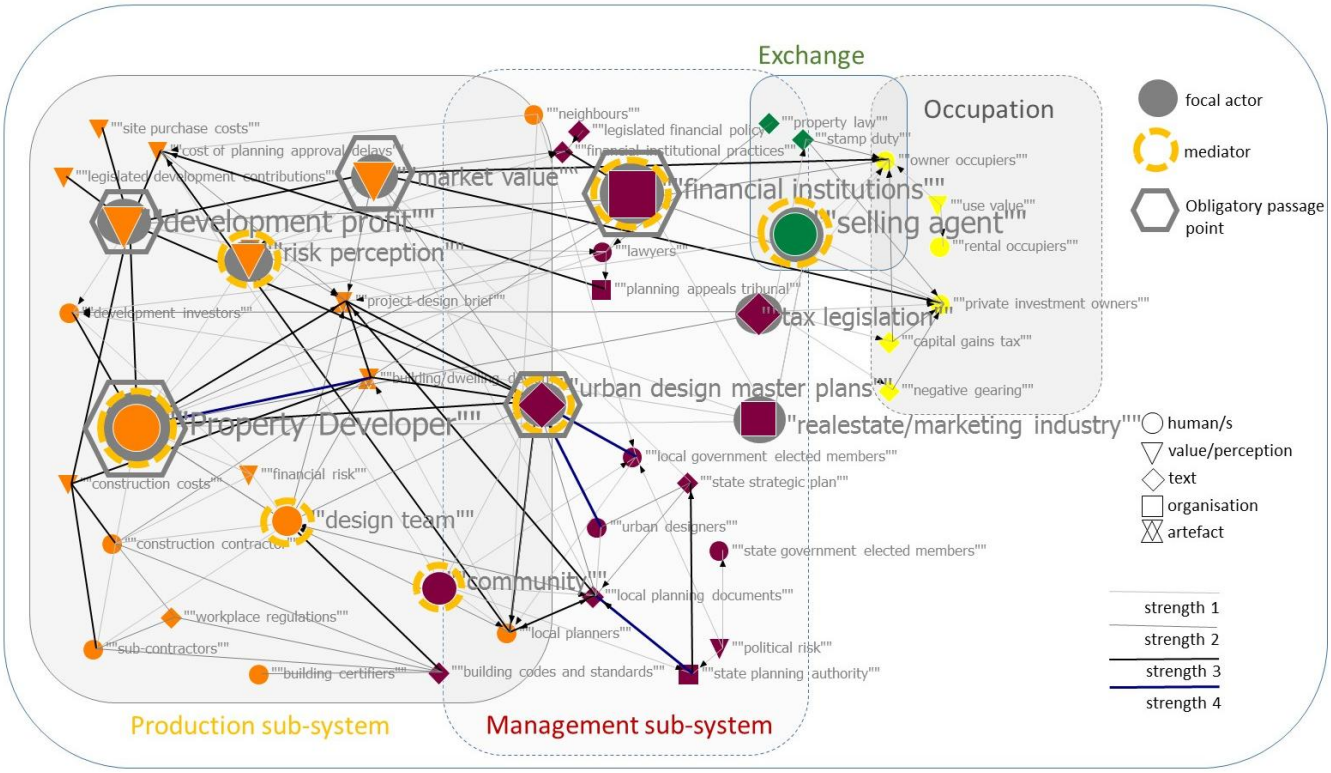
Table Three below indicates the SNA Tool measures which have been utilised to observe the MDH actor-network shown in Figure Three. The table also notes observations made in the process of applying these measures to the particular network being analysed.

Table Three: Defining ANT Network Characteristics through correlation with SNA Measures.

ANT Characteristic		SNA Measure	Summary of Observations for MDH 'black box' network[11]
FOCAL ACTOR one who acts to align the interests of a diverse set of actors with their own interests (enacts translation)		• high(est) in-degree and/or out-degree in network • high 'between ness'	• Property Developer has highest in-degree, far exceeding any other actor in the network. • Measure of out-degree highlights the importance of non-human actors: market value, risk perception, realestate/marketing industry and urban design master plans. The design team and community are the human actors with the highest out-degrees. It also shows the most influential subsystem to be management, described by Burke and Hulse as "housing and housing related policy at all levels of government." • Between-ness (in this case measured using Ego-between) identifies development profit, financial institutions, realestate/marketing industry and selling agents as focal actors. Again, this measure highlights the importance of non-human actors in design.
MEDIATOR: actors who 'transform, translate, distort and modify'		• high in-degree and/or out-degree actor with capacity for translation (not fixed/prescriptive) Determining mediators requires the observer to combine the in-degree and out-degree measures provided by SNA tools with system/network knowledge.	Property developer, risk perception, financial institutions, selling agents, , urban design master plans, design team and community are all identified as actors with high in-degree and/or out-degree measures capable of translating incoming information and enrolling other actors in translation. For example, the property developer, as the highest in-degree actor in the system gathers design information from a diverse range of sources (actors) and translates this information to maximise outcomes from their unique actor-perspective. By contrast, market value has a high out-degree measure making it a focal actor in the network, but does not play a translation role in relation to design information flows. Hence it is not identified as a mediator in the 'black box'
OBLIGATORY PASSAGE POINT: A situation that has to occur for all of the actors to be able to achieve their interests, as defined by the focal actor (Callon 1986).		• high in-degree and/or out-degree actor who sits in a network position which gives them the power to allow design decisions to become reified. • focal actor providing prescriptive design information (eg regulations) Identifying actors in 'control' of Obligatory Passage Points (OPPs) requires the observer to combine the measures provided by SNA tools with system/network knowledge.	The highest in-degree and out-degree actors have been previously identified as focal actors. Whilst it is possible in some systems for non-focal actors to be identified as being related to OPPs this is not the case in the system being observed. OPPs are identified here as market value, development profit, financial institutions, urban design master plans and property developer. That is, if a proposed MDH project does not provide adequate development profit (informed by market value, financing and urban plans) the property developer will not proceed or will modify the design proposal before proceeding.

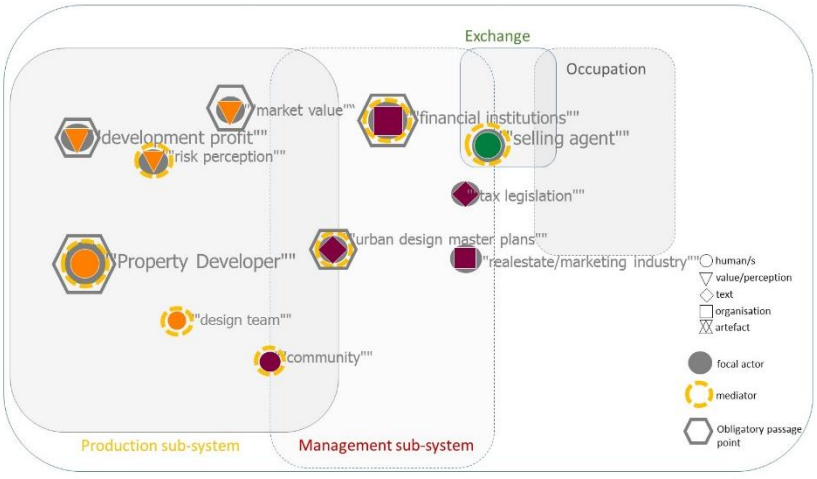
[11] This analysis utilised UCINET and NetDraw Software.

Figure Three: ANT Mapping with Focal Actors, Mediators and OPP's identified using SNA Tools



This process identifies eleven actors as the key actors in the network. Not all of these actors were expected to be identified, with both the real estate agent and tax legislation being surprising but logical key actors. It is worth noting that the residents of the housing, be they owner occupiers or rental occupiers, are not determined to have a key role in the design decision processes, which is shown to be dominated by the management subsystem, the property developer, market value and risk perception. Through the analysis conducted occupants and use value were identified via the SNA tool metrics as amongst the least influential and least connected actors in the network. There is also a notable lack of significant human actors who might be seen as advocates for good design or innovation.

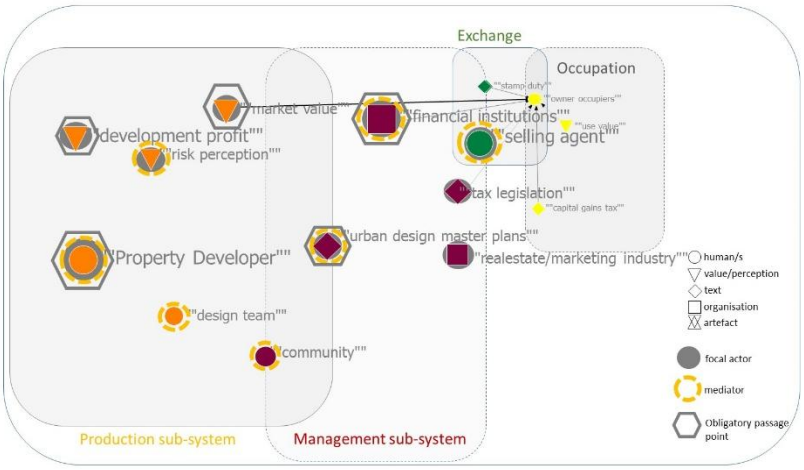
Figure Four: Simplified ANT Mapping showing Focal Actors, Mediators and OPP's only.



Using social network analysis tools has enabled an alternative view of the actor-network system, somewhat simplified and uncluttered by minor actors.

This is not to suggest minor actors are to be put aside.

Figure Five: Simplified ANT Mapping showing Owner Occupier Ego-Network.



On the contrary, the simplified view enables detailed analysis through superimposition of ego-networks or other path flows for detailed examination.

Shown in Figure Five is an ego-network for the building occupier, showing them to be very weakly connected to human key actors, identifying an opportunity for system improvement.

Employing this approach, the researcher/designer is able to identify and visualise multiple levels of detail within a complex, stabilised network; to understand why the 'black box' produces the outcomes it does. In this case, "why we have the MDH designs we have." Similarly to Gartner & Wagner's ANT mapping of Information Technology systems (2009) this approach "describes the status of the network at a crucial point rather than its development in time."(p.203)

This static description suits the objective of 'unlocking the black box.'

The next challenge is to determine how this approach can assist in formulating opportunities for change: to reconfigure the 'black box.' For the research at hand such reconfiguring aims to facilitate MDH design outcomes for occupants that support the shift in housing types proposed by the strategic urban plans discussed previously. Creating equivalent mappings of alternative network configurations offers an opportunity for comparison.

Alternative boxes: How to get [the MDH] we want……..

A small number of innovative examples of MDH are being pursued in Australia by groups seeking to navigate an alternative housing pathway. Four such groups are currently being observed by the author, all of which are located in Melbourne and all of which seek to modify existing design processes to increase occupant participation in dwelling design. Represented in Figure Six below is a preliminary mapping of the MDH provision system being established by one of these groups. In this example a group of individuals form a company which purchases land and acts as a private developer. At completion of project the company is dissolved and individual dwellings sold to members. The company composed of the individual members takes 100% of the building and development risk. No marketing or developer costs are incurred and no stamp duty tax is payable, reducing the cost of realising the individual dwellings. Resultant property values in the initial project completed in 2013 greatly exceeded costs, realising a significant profit (or saving) for members as compared to an equivalent market product.

Figure Six: [PRELIMINARY] Simplified ANT Mapping showing Focal Actors, Mediators and OPP's only for an alternative MDH provision system.

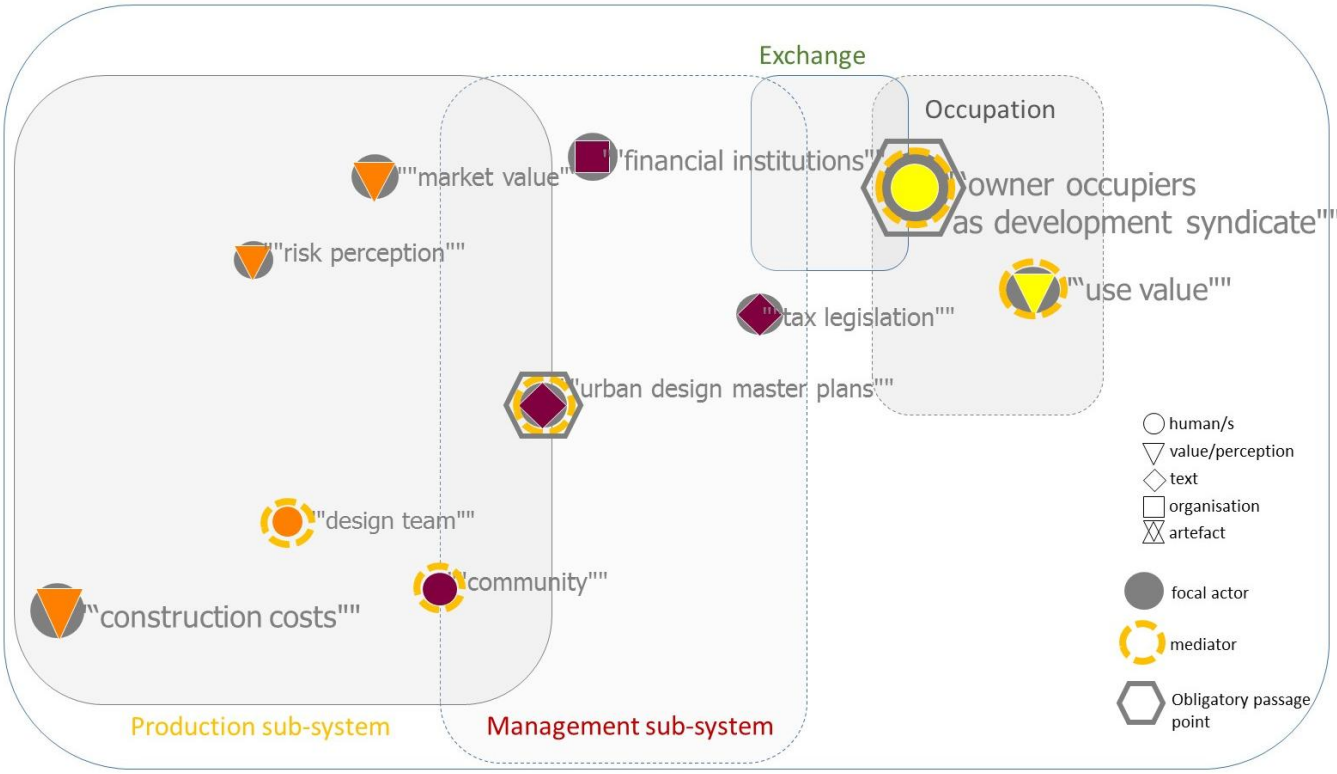


Figure Six shows that, unlike typical MDH provision, the occupants are focal actors, mediators and obligatory passage points. That is, they hold the key position in design decision making processes and the realisation of their individual and collective housing environments. It is also notable in this mapping that use value, insignificant in the previous mapping, holds a more significant role than market value.

One attribute all alternative Australian examples being studied have in common is that they exist within the established management sub-system. They seek alternative outcomes within boundaries which have evolved to meet the needs of developer led provision. Hence, each project has been required to negotiate challenges created by existent boundaries, effectively generating for itself a reconfiguration of the relationships/intermediary flows between the existing actors resident within the previously described 'black box.' This can be seen by the fact that the role of the main actors in the management system has not significantly altered. These projects are reconfiguring the existing network relationships over time to achieve more desirable housing outcomes and will provide guidance both for similar future projects and for an understanding of how the management sub-system might evolve to facilitate ongoing MDH innovation in urban consolidation. Further study of the four examples will be undertaken as they mature to identify how they can assist in facilitating an industry and community shift from a predictable risk-adverse (market led) future to a culture of active occupant participation in the generation of desirable future urban environments.

These cases demonstrate individual processes of emergence; the modification and reshaping of an existing, stabilised network via either subtle changes or revolutionary developments in response to a perceived need or possibility. "Networks are put into place by actors. However, since there is no actor without a network, new networks emerge out of already existing ones" (May and Powel 2008, p147). In this process of emergence the focal actor, initiating alternative connections and aligning

other actors through recruitment and translation, is confronted with the (possible) irreversibility and cumulative resistance of the existing network (Callon 1991). The ANT mapping proposed here provides a means of viewing both the existing and the desirable networks. The commonalities and difference between these network structures enables a visualisation of opportunities and barriers to change. That is, ANT mapping can facilitate transition between the two states, either via a reconfiguring of the existing 'black box' network (which becomes restabilised over time in an alternative form) or the emergence of an alternative which does not replace the existing 'black-box' but reduces its power in the network. With regard to MDH design innovation, the emergence of alternatives which encourage occupant engagement with design should not aim to replace the existing network, but offer alternatives to those households who seek it.

Facilitating Transition: moving from what we have to what we want……

Numerous scholars have described techniques for mapping networks based on an ANT methodology across a variety of disciplines[12]. Bengtsson and Lundstrom (2013) provide a comprehensive overview of ANT visualisation in the field of Information Systems which sets out three mutually exclusive categories of ANT mapping (visualisation).

> *a) Frameworks that visualise the relations of the actor-network, necessary translations, (obligatory) passage points, etc. that build up the domain*
>
> *b) Models that visualise the actor-network at some stage of the narrative*
>
> *c) Supportive visualisations that act as an aid for the user to better understand certain key concepts or stages in the narrative (often do not depict the entire network and their relations) (Bengtsson and Lundstrom 2013, p4)*

They go on to express concern that many of the mappings/visualisations observed do not explicitly map the ANT concepts. "Hence, comprehensive, precise and well-defined relations between the graphical representation and the concepts in ANT are not captured in the vocabularies of the visualisations, making the accumulation of best practice as well as theoretical synthesis difficult." (p6)

The mapping approach presented here aimed to represent and provide a means of analyzing the contents of the long-stabilised 'black box' of Australian MDH provision and as such is located in category b). The approach is used to both 'unlock the black box' and describe alternative, innovative actor-networks capable of producing more desirable outcomes (outputs). It is intended that this description of alternatives will provide an insight into future best practice states. However, future stages of this research will need to address another of Bengtsson and Lundstrom's criticisms as it progresses: that most visualisations they observed "depict the before and after state of the actor-network, lacking a representation of the transformation trajectory between different formations of the network." (2013, p.6) Hence, to be effective in guiding a reconfiguring of the 'black box' of MDH

[12] For example: Gartner and Wagner 2009 (Information Systems), Comber et al. 2002 (project management), Yaneva 2012 (Architectural design), Lyytinen and King 2002 (telecommunications), Thapa 2011 (Information and Communication Technology)

provision, this approach will seek support from additional category a) mappings to visualize the translations required to move the actor-network from the existing state to the proposed future best practice state. Furthermore, category c) mappings could assist with public communication of housing options.

Other [non MDH] 'black boxes':

The mapping approach presented here "offers an opportunity to carve out some space for action." (Gartner and Wagner 2009, p210) It proposes a means of analysing existing actor-networks which have been stabilised and 'black boxed' over time, and subsequently describing alternative network configurations. However, stable networks "not only resist competing translations but also restrict the number of possible future translations" (Callon 1992, p92). Comber et al note that for a new theory/network translation to be successful "it needs to gain allies and evidence of its own. It also needs to try to convert the allies of competitor theories for its own use." (2003, p303)

In this challenging context it is important to examine how systems change or not. Lovell and Smith (2010) propose innovation occurs through instability and differentiation (sites of failure, absence or mutation). Arguably the Australian MDH system is a site of failure as it is shown not to meet the needs of occupants or to facilitate the urban evolution proposed by strategic urban plans. At sites of failure actors begin to experience alterations in network associations, alternative networks composed of the same constituent actors evolve, changing the individual actor's 'way of acting' and enabling "inventive ways of thinking and doing and configuring and reconfiguring relations with other actors." (Barry 2001,p211) Whilst the ANT mapping approach presented here is yet to be effectively combined with a representation of the transformation trajectory between the existing and desired formations of the network, it none-the-less is in progress toward describing alternatives to the status-quo; more desirable reconfigurations of the actor-network which can inform new 'ways of acting' and new ways of designing more sustainable future living environments.

Given sites of failure are likely sites of network emergence, employing this 'static' ANT mapping approach to map stabilised networks ('black boxes') nearing failure will provide "an ANT-informed understanding (which) can enable practitioners to better anticipate and cope with emergent complexities" (Sarker et al 2006 cited in Bengtsson and Lundstrom 2013, p5). That is, to assist designers to understand and respond effectively to the complex network of opportunities which become mobilized at times of translation.

Conclusion

Through the identification of actors and their associations in the network/assembly of a 'black box' the designer both builds an understanding of how an existing stabilised network produces the outputs it does and how it might be reconfigured to produce alternative outputs - creating space for design innovation. The combination of ANT network mapping and social network analysis tools employed here offers an approach to identifying opportunities for systemic intervention for change which are of value not only to MDH design, but to other design arenas also. In fact, to any design challenge which requires the un-locking of a stabilised 'black box.'

Ongoing Research

This working paper presents PhD research in progress and as such acts to open further questions for discussion and investigation. The project aims to continue analysis of the alternative Australian MDH cases identified through actor-network analysis. One of these having been discussed above in a preliminary stage. The cases are is to be expanded with further interviews and will provide data for comparison.

Additionally, international MDH projects from Germany and the UK are to be observed. These examples also aim for greater occupier involvement with design decisions and focus on demand rather than supply led markets. Both the German and UK cases exist within proactive jurisdictions where planning, financing and other management sub-system modifications have been implemented to provide support and comparison of the network models from these are expected to provide insight into alternative approaches for Australia; to reassemble existing knowledge, and to generate the required controversies for innovation.

Final project outcomes aim to elucidate alternative(s) to the existing systems of medium-density housing provision in Australia, facilitating an industry and community shift from a predictable risk-adverse (developer and investor designed) future to a culture of active participation in the generation of desirable urban environments to meet current and future needs.

As noted in the paper, the mapping approach proposed here provides a starting point for this process and will require the development of additional mapping tools at a later stage to represent the transformation between different formations of the network.

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