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Digital assemblages: evidence and theorising from the computerisation of the US residential real estate industry

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We develop the concept of digital assemblages in order to advance current theorising on the ways in which information and communication technologies (ICTs) are helping to reshape work. The empirical setting is the US residential real estate industry—a 'living laboratory' for studying information-intensive work and the adoption and uses of ICT. We find that real estate agents' uses of ICT are pervasive and suggest that agents now embed themselves more deeply into the transacting of real estate by actively supporting buyers and sellers, rather than acting primarily as information intermediaries. Building from this, we theorise that this ICT use can more coherently be understood as a 'digital assemblage' rather than a formal information system. Digital assemblages are characterised as distinct patterns of ICT collections that, in use, are functionally equivalent and structurally similar, relying on standardised and commodified ICT and are neither formally designed nor collectively governed.

Keywords: work, computerisation, ICT, field study, digital assemblages, real estate.

Introduction

The contribution of this paper is to theorise on the roles information and communication technologies (ICT) play in reshaping work arrangements and, specifically, to advance the concept of a *digital assemblage* as a lens for this analysis. Most punditry and much scholarship characterise the use of ICT for work as a function of economic

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rationality. For example, digital infrastructures are often portrayed as supporting rationalised and 'frictionless' markets in which ICT reduce the costs of transactions (e.g. Bakos *et al*., 2005; Hahn *et al*., 2005). In contrast, like many other scholars of work, we see digital infrastructures as neither frictionless nor entirely rational (e.g. MacKenzie, 1992; Hanseth *et al*., 1996; Lie, 1997; Swedberg and Granovetter, 2001; Dawson and Gunson, 2002; Miozzo and Ramirez, 2003; Kane and Alavi, 2008; Pinch and Swedberg, 2008; Baksky *et al*., 2010; Hanseth, 2010; Baldry, 2011). Rather, digital infrastructures rely on and must provide for the social activity through which economic activity arises (e.g. Bar, 2001; Dutton, 2005; Pinch and Swedberg, 2008). Social activities are needed to overcome the friction of incompatible systems, computing breakdowns and contrasts between action and understanding that define human and machine interaction (e.g. Wigand *et al*., 2005; Suchman, 2007).

To advance current theorising about ICT's roles in reshaping work arrangements, this work draws on data from a study of the US residential real estate industry—which serves here as a 'living laboratory' for studying information-intensive industries. Real estate has always relied on information about properties and potential clients to create sales. Real estate agents' work is based almost exclusively on competition for, and value-adding uses of data and information, much of which is now digital (National Association of Realtors, 2009). And ICT's roles and uses have expanded over time. For example, in 1995, when the study began, less than 2 per cent of agents, home sellers, and buyers accessed the Internet for information about real estate and agents were just beginning to use mobile phones. By 2009, agents' smart phone use was essentially ubiquitous; nearly 98 per cent of agents were using additional forms of ICT; and more than 90 per cent of all purchases began with prospective buyers looking for available houses by using one of the many house-listing sites available via the Internet (National Association of Realtors, 2009).

Given the centrality of information to the industry and work of agents, a common assumption is that agents serve primarily as information intermediaries (Benjamin and Wigand, 1995; U.S. Department of Justice, 2009). Based on this assumption, an economic analysis of the role of ICT in reshaping work arrangements concludes that ICT will enable a shift from human intermediaries to ICT-based intermediaries, reducing the cost of a transaction by lowering costs of information search for buyers and sellers (e.g. Nadel, 2006). As an aside, such a thin understanding of agents' work has lead many pundits and some scholars to see the sharing of information about houses for sale as a possibly monopolistic activity (e.g. Baen and Guttery, 1997; Muhanna and Wolf, 2002; Hahn *et al*., 2005; Kummerow and Lun, 2005).

Evidence of the hypothesised monopoly is hard to find, but evidence about the hypothesised shift in sources of information abounds. Homes-for-sale listings are now accessible online via the Internet from a number of sites, and buyers and sellers have far greater access to the listing data. As noted, more than 90 per cent of all purchases begin with online searches.

Moreover, the predicted changes to the work arrangements have not been observed empirically. Instead of disappearing, the number of US real estate agents is greater today than in 1995, even following several years of substantial sales declines since the 2006 economic downturn (National Association of Realtors, 2009). The percentage of sales made directly by owners without the use of agents (known as 'for sale by owner' or 'FSBO') has not changed appreciably in this time period (ranging from 11 to 14 per cent of all transactions, Hawker, 2006). Despite concerns about the 'market friction' of agents, residential real estate has appreciated overall since the mid-1990s: In 2013, 4.90 million existing homes were sold, up from 1.8 million in 1996. Over this same time, the average house price is up 23 per cent, from $160,000 to $196,000 [but down from the 2005 average of $222,500 (National Association of Realtors, 2013a)]. The downturn in US home prices from 2006 through 2013 is being attributed to speculative mortgage brokering, not the costs of real estate agents (Rugh and Massey, 2010). This evidence suggests the reshaping of work arrangements due to the presence and uses of ICT cannot be analysed simply as economic disintermediation.

Conceptualising computerisation

Given the failure of the prediction of disintermediation, we pursue an alternative conceptualisation of the role of ICT: computerisation. The fundamental premise of computerisation is that agents are embedded in transactions and that ICTs are taken up and used to support this embedding rather than for purposes of strict economic rationality.

Computerisation scholars advance a general framework comprised of three interdependent aspects: (1) the working context, (2) the nature of work and working arrangements and (3) the technical (here, ICT-focused) system through which work is done (Kling, 1991; 1996; Burris, 1998; Lloyd and Newell, 1998; Taylor *et al*., 2001; Hara and Rosenbaum, 2008). Like most sociotechnical theories, computerisation focuses analytic attention to mutual interdependencies among social aspects of technological elements and technological arrangements shaping social activities and structures.

Computerisation frames real estate work as embedded in sets of social relations and interactions arising from webs of social ties among a range of stakeholders. Information needed to complete the closing is shared across these social relations, and through this sharing meaning is co-constructed. An agent's value is defined by these relationships and embedded efforts. Social connections embodied in these networks are the means by which agents help buyers and sellers reach closing. ICT use is a vehicle for both access to information and for sharing and interpreting it with those coming together to bring about a closing. Building from this, to advance our understanding of the role of ICT in reshaping work arrangements, the work presented here is done in pursuit of three research questions relative to the computerisation of real estate:

RQ1: What are the changes in the working context of real estate agents?

RQ2: What are the changes to real estate agents' work and working arrangements?

RQ3: What are the changes to the ICT-based systems used in real estate?

Research design, data collection and analysis

To describe computerisation in real estate, the work reported here is based on a multi-level, multi-method, longitudinal research program (Jick, 1979; Brewer and Hunter, 1989; Miles and Huberman, 1994; Agar, 2005; Leonardi and Barley, 2008). As summarised in Table 1, data collection efforts were premised on the need to collect multiple types of data at different levels of analysis iteratively over time, to allow for analytic triangulation. The iterative design supported by multiple forms of data provided a durable, but flexible, approach to sustain a 15+-year research project.

Data collection encompassed fieldwork and secondary sources. Initial fieldwork activities were framed by computerisation. Data collection relied on semi-structured interview guides, detailed field notes from participant observations and the collecting of various working documents and materials from agents, brokers and others (e.g. Jackson, 1987). This began with micro-level studies of work and working practices as suggested by Barley and Kunda (2001), returning to the field to collect data to help us understand and theorise on institutional and policy arrangements framing the work of agents. Interviewees included members of the National Association of Realtors (NAR), other relevant banking, financial, professional and trade associations, and US government agencies.

Several key interviewees—practicing real estate agents, real estate brokers, local real estate association executives and national real estate association staff—were involved across the course of this. Table 2 includes a list of these interview subjects. Table 3 contains a list secondary of documents instrumental in this work. Table 4 provides a list of presentations at local- and national-level industry conferences, workshops and events with others involved in real estate.

Finally, secondary data needed to understand the industry and its evolution came from the U.S. Bureau of Economic Analysis, U.S. Department of Justice, U.S. Depart-

Table 1: Data collection/activity timeline

Year	Activity
1997–1998	Initial literature review begun. Initial contacts for field work begun.
1998–1999	First round of 14 interviews and observations conducted (real estate agent focus).
1999–2000	Pre-pilot survey distributed to 868 agents in single metropolitan area.
2000–2001	Second round of 11 interviews and observations (real estate agent focus).
2001–2002	Pilot survey tested with national sample of 350 real estate agents.
2002–2003	Round of 13 interviews focused on national organisations, law and regulation.
2003–2004	Full survey distributed to national sample of 9000 real estate agents.
2004–2005	Third round of 13 interviews and additional observations (real estate agent focus).
2005–2006	Analysis of 14 local markets (secondary data and phone-based interviews).
2005–2006	Fourth round of 21 interviews (local organisation focus).
2007–2008	Fifth round of four interviews (focus on local changes viz. national markets).
2008–2009	Interviews with NAR staff and local agents regarding economic downturn and effects.
2009	Summative analysis begun.

NAR, National Association of Realtors.

ment of Housing and Urban Development (HUD), NAR, Mortgage Bankers Association of America and several realtor associations. Additional secondary data came from governmental and non-governmental organisations such as the U.S. Department of Justice, U.S. General Accountability Office, U.S. Department of Commerce, the Brookings Institute and the American Anti-Trust Institute (AAI). Additional data came from feedback from informal interactions with brokers, agents, vendors, various real estate association executives, journalists, industry pundits and other scholars arising from several presentations of findings to industry participants and groups.

Longitudinal studies such as this do not easily condense to a single journal-length report. For example, each of these stages of data collection could be considered a specific research effort, worthy of its own distinct analysis and report (and indeed, different pieces of the study have been published separately). The work reported here is a broader-scale analysis: theorising on computerisation. This analysis draws primarily on data from the fieldwork and secondary data, but the focus is to look beyond the specific and situated experiences of real estate agents and other professionals towards a broader-scale understanding. This summative approach to analysis, while diminishing the ethnographic voice of the fieldwork, privileges trend presentations.

Data analysis followed Miles and Huberman (1994) guidance for interim analyses, relying on explanatory event matrices framing the efforts. In an explanatory event matrix, themes (or issues) from one axis and sources of evidence form the other. The thematic focus was computerisation's three elements and the research questions regarding the *working context*, *the nature and arrangements of agents' work*, and the *technical (ICT-based) system*. The cells of this matrix contain pointers to the source of evidence relative to the theme to which it relates. The simplicity of the matrix belies the difficulty in classifying and coding multiple forms of data into coherence. This analytic effort is the lynchpin of this multi-method research (e.g. Brewer and Hunter, 1989).

Table 2: Summary of interviews

Role	*n*	Focus
Broker/owner	4	Brokerage, local trends, ICT uses, agent recruiting and performance
Broker/manager	3	Brokerage, local trends, ICT uses, agent recruiting and performance
Agent	17	Work, incentives, uses of ICT
Lawyer	3	Information sharing, uses of ICT, connections to agents
Mortgage brokers	2	Information sharing, uses of ICT, connections to agents
Journalists[a]	7	Industry trends and issues, alternative sources of data, their experiences and perceptions
Appraiser	3	Information sharing, uses of ICT, connections to agents
Home inspector	2	Information sharing, uses of ICT, connections to agents
Local association of realtors directors	5	Local and national trends, information sharing, uses of ICT
MLS director	5	Information sharing, roles of MLS, relationship to agents
NAR senior staff members	12	Industry trends and issues, uses of ICT, policy activity, information sharing, alternative sources of data, their experiences and perceptions.
Directors and senior staff of national organisations	7	Industry trends and issues, uses of ICT, policy activity, information sharing, alternative sources of data, their experiences and perceptions.
Entrepreneurs	4	Industry trends and issues, uses of ICT, their intentions.
Vendors	3	Industry trends and issues, uses of ICT, their experiences and perceptions.
Others[b]	3	Industry trends and issues, uses of ICT, policy activity, information sharing, alternative sources of data, their experiences and perceptions.
Seller (using agent)	3	Activities in listing and selling their house.
Buyer (using agent)	3	Activities in searching for and purchasing a house.
Seller (FSBO)	2	Activities in listing and selling their house.
Buyer (of FSBO)	1	Activities in searching for and purchasing a house.
Total	83	

ICT, information and communication technology; FSBO, for sale by owner.
[a]Typically, journalists contacted one of the authors to discuss the research.
[b]Others include owners/managers of software companies selling to real estate agencies, or sales staff for companies offering various value-adding services or education to real estate agents or brokers.

Findings regarding computerisation in the US residential real estate industry

The evidence is presented relative to the three research questions regarding changes from the beginning of the data collection, when agents' ICT use was relatively sparse, to the end, when it becomes ubiquitous. The changes are to be outlined later and summarized in Table 5. These findings regarding the restructuring of work arrangements provide the basis for the discussion and theorising that follows.

RQ1: what are the changes in the working context of real estate agents?

A real estate agent's role was and is to bring together the seller and buyer of a property. A typical house purchase and sale has the buyer and seller negotiating via the intermediation of a buyer's agent and a seller's agent. Purchase and sale agreements

Table 3: Summary of observations and participation

Activity	*n*	Focus
Planning meeting of local association	2	Developing strategies for using the web and internet resources to benefit association members.
Local MLS board meeting	2	To discuss agent's uses of MLS access software.
Local realtor board leadership meeting	4	To discuss agent's uses of digital lockboxes, digital forms, and agency management software packages.
Local realtor board association meeting	2	To engage attendees in discussion of their uses of MLS and web applications/data sources.
Local trade conference	2	To learn more about software products available to
National trade conference	2	agents and their agencies.
State-level association meetings	4	To discuss licensing and policy issues due to web access and uses of MLS by agents from other associations.
National association meetings	3	To discuss with brokers and agents changes to the real estate process due to the take up and uses of various ICT.
NAR meetings	11	To discuss with analysts and research group changes to the real estate process due to the take up and uses of various ICT.
Total	32	

ICT, information and communication technology; MLS, multiple listing service; NAR, National Association of Realtors.

Table 4: Important secondary sources for data

Federal Trade Commission website on Competition in Real Estate (see materials online at http://www.ftc.gov/bc/realestate/index.htm).

Government Accountability Office. 2005. *Real Estate Brokerage: Factors that May Affect Price Competition*, August, Washington, DC.

National Association of Realtors annual surveys of home buyers, sellers and realtors (see materials available online at http://www.realtor.org/crtweb.nsf/pages/CRTsurvey).

Yun, L. 2005. Real Estate Brokerage Industry: Structure-Conduct-Performance, Oct. 25, Federal Trade Commission Workshop on Competition in Real Estate, Washington, DC. Available online at http://www.ftc.gov/opp/workshops/comprealestate/yun.pdf.

(P&S) and Housing and Urban Development (HUD) forms (known as the HUD1) are required (Housing and Urban Development, no date). In the United States, the HUD oversees the commercial transaction of real estate in the same way the U.S. Securities and Exchange Commission provides oversight to financial transactions. The HUD1 form contains detailed information (in a line-by-line format in two columns, for the buyer and for the seller) of the expenses incurred for selling and buying a property (Housing and Urban Development, no date).

Two agents share the two 'sides' of the commission paid by the seller when a house is sold and purchased. With increasing house prices, there has been downward pressure on the percentage of the sale price that agents charge, particularly for highly priced houses and in particular markets.

Table 5: Summary of findings regarding computerisation

Working context	1. Framed by legal regulations and contractual arrangements regarding (a) the transacting of houses and (b) the relationships among buyers, sellers, agents and brokers. 2. The legal regulations and contractual arrangements are constantly negotiated (context is dynamically stable).
Work and working arrangements	1. Agents use various ICTs to support their roles as intermediaries, process consultants and value-adding service providers. 2. Growth of buyer agency and opportunities to provide value-adding services for buyers 3. Focus of agent's work shifting away from information brokerage and towards process consultation and providing value-added services. Remaining information intermediation work shifting towards information explanation and away from brokerage.
Technical (ICT-based) system	1. Importance of access to data (via MLS and other sources) 2. Shift towards more uses of digital forms of data 3. Substantial increased in the uses of and reliance on ICT

ICT, information and communication technology; MLS, multiple listing service.

Organisationally, agents are independent contractors required by law to contract with one (licensed) broker. Real estate agencies range in size from a single broker–agent to those with several brokers, dozens (or even hundreds) of agents, and additional clerical and managerial staff. Some of these agencies are franchises of national corporations; others are local or regional institutions. Sole proprietorships are as numerous as they were 15 years ago (National Association of Realtors, 2006). Agents receive a variety of services from the broker's firm and, in return, give the broker and the firm a share of the commission they receive for successfully completing the purchase or sale of a client's property. Productive agents have the bargaining power to negotiate for additional services or a more favorable commission split. Independent broker–agents provide their own resources and develop their own professional networks.

The most substantive change in the working context between 1995 and 2010 is buyer agency, which changes the relationships among the seller, the buyer and this agent. Buyer's agency means the buyer signs an exclusive agreement with an agent who helps them find suitable properties among those offered for sale, giving the buyer more equal representation in the transaction. Without buyer's agency, agents are beholden to represent the seller's interests, leaving the buyer more exposed to risk than the seller. The fundamental structure of the transaction is unchanged, but increased attention to serving the buyer's needs (and not just the seller's) provides agents with more ways to provide value-adding services and to gain market power.

RQ2: what are the changes in real estate agents' work and working arrangements?

Securing listings, finding buyers, negotiating P&S agreements and getting to closing are the focuses of an agent's work. Agents still secure listings of a house for sale. In return, the agents provide advice to sellers regarding both marketing the house and arranging for its sale. Houses are still advertised in local multiple listing services (MLSs, a database of for-sale properties originally accessible only to other agents, but now visible to all via the Web), and in newspapers, posted signs and a wide range of more digital media. Over the past 15 years, fee-for-service agents have sprung up,

who will put a house's listing in the MLS for a flat fee (and perhaps price other services *a la carte*), either to lower the cost of the house or increase the amount retained by the seller.

Most prospective buyers now search for properties online via various national and regional MLS websites, agents' websites and through other online sources such as Zillow (Zillow, 2013). Rarely now do agents identify houses for buyers. Once a short list of possible houses is identified, the buyer physically inspects a few potential properties (the 'finalists') before deciding which to buy, with the buyer's agent making the arrangements for these visits and accompanying the buyer. Once a property is selected, the buyer's agent provides advice (to the buyer) on making an offer to purchase the property and helps with negotiations.

The P&S remains central to a sale, as is removing contract contingencies to enable the closing. But with more open access to house-for-sale information, both the listing and buyer agents are spending more of their time in the early stages of a transaction reviewing material and explaining options to buyers and sellers.

The data suggest two changes to agents' work and working arrangements define this transition. First, and consistent with other detailed studies of agents' work, data make clear that agents serve three roles: information sharing, process consultation and providing value-adding services (e.g. DiMaggio and Louch, 1998; Crowston *et al*., 2001; Sawyer *et al*., 2003). However, information sharing is now far less a part of the agent's job because buyers and sellers have access to the homes for sale via the Internet, obviating the need to work through an agent to see the listings book. Agents spend far less time driving prospective buyers from property to property as most buyers approach an agent having done much of this prospecting online.

The second change is agent specialisation, as can be seen in the rise of buyer's agency and fee-only agents. The rise in buyer agency means that agents can now gain market power representing either the seller or the buyer. There is now a greater effort by agents to secure potential buyers, in addition to or instead of working to secure listings. Some agents now focus solely on supporting one side of the purchase and sale of a house. In contrast, a few have opted simply to be conduits for access to the MLS, providing a modest fee to list a house, providing no other services.

RQ3: what are the changes to the technical (ICT-based) system?

Agents' individual work is supported by a wide array of hardware and applications, both generic and industry specific. Agents often spread their work among personal computers and personal devices with their phone always with them. Smart phones have replaced cell phones, adding contact management, texting, email and web capabilities to ubiquitous mobile devices. The data make clear agents cannot conceive of carrying out their work without their phone. As one of the study's long-time confederates texted: '. . . if you don't have a smart phone, you're not a serious agent.'

The primary information source supporting the business of real estate is the MLS, a federated system of systems storing basic information about available properties. The exact number of local/regional MLS continues to change. The trend is, however, towards fewer and more regional MLS. By late 2012, the number of MLS instances in the United States had dropped to 942, 900 operated by companies chartered by the local realtors' board, the others, by privately held companies independent of the local realtor organisation (to which licensed agents must affiliate). However, there is now greater sharing of local MLS data with Move, the company owning http://www.realtor.com, a site that provides unified public access to MLS data. This sharing is governed by specific agreements (the Internet Data Exchange or IDX) stipulating what MLS data are to be shared and used (National Association of Realtors, 2013b). Somewhat unexpectedly, there have been several efforts to provide an alternative to MLS data via public sites such as Zillow and others that focus on serving regions or specific sellers/buyers. None of the current competitors have usurped the MLS's

centrality, but these expand the options for consumers and agents to share and find house information (National Association of Realtors and Google, 2013).

The suite of digital services and specialty software applications surrounding the MLS has grown from essentially nothing to a multi-million dollar industry niche. These third-party software packages provide agents with the means to automate routine queries, support customized analysis of sales and transactions, and allow special reporting functions. The traditional lockbox[1] has been replaced with digital lockboxes that record each access to that house's key, providing the selling agent a digital record of who has visited the property. Digital pictures and video are standard components of a house listing. Agents have either invested in high-quality digital video cameras or subcontract the photo and video shoots to third parties. Most agents take advantage of digital forms software for the P&S, HUD1 and other contractual documents. These digital forms range from simple PDF to more sophisticated dynamic data entry and tracking applications that work on smart phones and PCs. And, while fax machines can still be found in every office, their minimal use is now secondary to the nearly ubiquitous email sharing of digital documents.

Contact lists remain a core resource for agents. For agents working for larger agencies, there is typically agency-level software for tracking leads, transaction status and market activity (in essence, a customer relationship management system). Newer agents, and particularly those working for large agencies and franchises, are often required to keep these contact lists stored in the agency-provided applications, which makes it more difficult for the agent to retain the privacy of their contact list and raises the barrier to changing agencies. Independent of (and often in addition to) this agency-provided software, most agents develop some sort of personal contact list and some means to keep track of these contacts, relying on applications for their mobile devices or personal computer.

Agents are keen to have their listed homes be visible on multiple websites: their own professional site, their agency site, the local MLS site, http://www.realtor.com, and others. Beyond these devices and applications, many websites now provide additional data on mortgage and financing, neighborhoods and schools, economic index comparisons, community characteristics, commuting times and other possibly relevant data. Some of these websites leverage data from the MLS to provide value-adding services. For example, the previously noted http://www.zillow.com combines some data on houses for sale with details of other houses' selling prices and property tax data and presents this information together on maps. In the course of their work, agents build up a collection of preferred sites, often linking to them from their own professional websites. This set of individualised professional resources serves, in part, as a representation of their ability to provide process support and value-adding services: the suite of ICT an agent can bring to bear is embedded into their approach to supporting their client.

From this come three findings regarding changes to the technical (ICT-based) systems of real estate. First, and despite the ongoing changes to its federated structure, data-sharing practices and the threat of alternatives, the MLS remains a core, common, informational infrastructure. Such a core informational infrastructures make clear the importance of having shared access and institutional arrangements facilitating its care and use (e.g. Hanseth *et al*., 1996). Shared access via the MLS also leads to standards for data access and vendors can provide additional services and software applications that are neither owned nor governed by the MLS's owners, but provide additional value to agents.

Second, there is a shift towards widespread sharing of digital data, reflected in the movement away from faxing to sending PDF documents. Increased digitisation is further amplified by the mobility allowed by smart phones and email on the go. This, in turn, reduces the need for agents to be tethered to a physical location or rely on others to help them move information. Combined with voice mail, texting and data access from smart phones, agents are more connected to their customers and partners while mobile. The rise of digital lock box access (and tracking that this allows) is a third example of the shift to digital forms of data. As an aside, the growth of social media

uses by agents reflects an interesting convergence of the value-adding services to extend MLS data use and the increased digital reach of agents who use their contact network to communicate with buyers, sellers and others. This is not, however, part of the findings reported here.

Third, the uses of and reliance on ICT are pervasive. The forms vary; but a host of ICT are now embedded in most all elements of the agent's practice: personal software for querying the MLS, contact management software, professional websites for sharing house data and links to useful sites, digital cameras, smart phones, digital lockboxes, and so on. Beyond this growth of individualised use is the growth in work and contact management systems put in place by brokers and agents. The implication of these work and customer management systems are to increase the options available to agents while also trying to retain some of the agent's intellectual capital as an organisational asset. And, finally, while there exist a stunning variety of devices, software packages, web-based applications and ways of using these, any one agent's collection of ICT seems to be functionally similar to others.

Discussion

These findings are discussed relative to each of three research questions before proposing assemblages as an alternative conceptualisation of ICT for understanding their role in reshaping work arrangements.

Relative to changes in the working context, the set of players involved in a real estate transaction and the relationships among these players are formally structured by contracts. The structure and form of these contractual arrangements frame the residential real estate industry (see also Sawyer *et al*., 2005). There is no evidence that these relations are changing with increased use of ICT. If anything, there is some evidence of a move *towards* increased contractual specification (such as the new rules formalising the roles of buyer agents).

The minimal changes in working context noted, it is worth noting that contractual arrangements are continually renegotiated: the system is in dynamic equilibrium. For example, agents and brokers continually negotiate commissions and duties (the scope and pay for work). At the state level, the structure of the P&S is constantly discussed. At the national level, the structure and contents of the HUD1 form are constantly negotiated as particular players such as realtors, mortgage bankers, home inspectors and others advocate for their particular interests to be represented on the form.

This continual renegotiation can be best seen as 'dynamic stability'. This emphasizes that the policy and regulatory context in which real estate is transacted are far from static. The evidence makes clear that the changes in access to data about real estate, the shift towards these data being digitalized and the desires by many of the key players and new entrants to connect themselves to the transacting of real estate (and control of, or access to, data) both shape and reflect the types of software offerings and their uses. That is, the seeming stability of the regulatory regime and contractual framing of real estate belies the astonishing level of resources being spent to attempt change, as there could be substantial financial gains for any group that is enabled to tilt the regulatory regime towards their specific interests.

Set against the institutionalized stability of the working context, agents have shifted their work practices towards (1) process consultation and (2) provision of value-adding services and away from information intermediation. These changes to work lead agents to being more embedded into the transacting of real estate, bringing them closer to their clients and altering their working practices (see also Perkins *et al*., 2008). Many of these changes are accomplished through or with various ICT that have been taken up and used over this period of computerisation. The shift in agent's work towards process consultation and providing value-adding services focuses them on creating and using networks of relationships. This social coordination through networks of professional relations stands in sharp contrast to the de-socialised forms of organising such as markets and hierarchies that capture most economists' and many real estate industry pundits' interests (c.f. Lie, 1997). As Powell (1990) made clear, too often the relative lack

of attention towards networks of relations has led to historical inaccuracies, overly static models and an inability to explain forms of collaboration supporting economic exchange (e.g. Jones *et al*., 1997).

Detailed and situated analysis that the computerisation perspective demands helps to make clear that the sale and purchase of a house (the fundamental economic transaction defining the real estate industry) stem in part due to (and through) a series of social negotiations that arise out of, and are structured by, interpersonal ties among participants in these networks.

Finally, three aspects of the technical (ICT-based) system of real estate agents' work serve to frame the discussion of changes to the ICT in real estate. First, and despite the rise of alternatives, the MLS and its standards for sharing data, the basic data structures and the legacy of practices and social norms around MLS data use provide an informational infrastructure serving as a common platform for agents, consumers and value-adding service providers. Second, more of the data supporting the transacting of real estate is digital and more kinds of data are available. Third, and perhaps most obvious, is the growth in the forms and uses of ICT, seen in the uses of smart phones and data plans, digital camera/videos, digital lock boxes, personal professional websites, personal digital devices and software, and Internet access. Moreover, agents are facing a rapid growth in the cost of computing, both personally and in increased agency fees to cover the costs of agency-level software, and also a growth in the number of people involved in supplying and supporting computing elements.

While these collections of ICT are highly personalised and individual, they are also remarkably similar: there are common patterns of ICT collections that agents assemble. That is, the ways in which agents gather together and use various ICTs display a high level of functional similarity and remarkable resiliency. This observation leads to re-conceptualising the role of ICT in reshaping work arrangements.

Conceptualising ICT as digital assemblages

The term 'digital assemblages' is conceptualised here as the presence and uses of collections of ICT in and for work. A digital assemblage is defined to be a recurring pattern of ICT artefacts, uses and arrangements. The specific details of the collections of ICT may differ from one person to the next: the particular applications or specific devices. However, and despite these differences, the basic form and effect are functionally equivalent and the collections are structurally similar across many individuals doing the same job.

This builds from the broader concept of *assemblage* that has been advanced through contemporary French social philosophy as seen in the work of Foucault, Latour, Callon and others. However, our conceptualisation of digital assemblage is not tied to its interpretation and use in actor–network theory. There are at least two other relevant, and equally nascent, uses of the term digital assemblage.[2] One usage, and closer to the meaning develop here, is that of sociologist Sassen (2005). She also draws from Foucault's conceptualisation of assemblage and uses it to articulate the mesoscale arrangements and institutional interconnections of global finance and emphasises the institutional flows of information and cross-institutional nature of the digital technologies used to support and model these arrangements [see also Latham and Sassen (2005) and their conceptualisation of 'digital formations'].

A second meaning of assemblage builds from the work of De Landa (2006), who conceives of assemblages as sets of possible arrangements among entities. Unlike systems or 'organic' approaches, De Landa's argues that assemblages have very few boundaries or constraints, allowing for new relations, arrangements and options to form among the entities of any collection. This non-organic perspective has been taken up by scholars of infrastructure to emphasise the potential for unplanned growth (e.g. Henningsson and Hanseth, 2011).

Conceiving the collections of ICT used by real estate agents as a digital assemblage, and not as an information system (IS), emphasises that digitally enabled work is done

by drawing on many different computing elements and software-based systems selected by individuals that may not be well integrated or formally planned. The design of a digital assemblage is thus *ad hoc* and is only governed to the extent that the individual doing the assembling is making choices.

From this work come four characteristics of a digital assemblage: shared access, structural similarity, functional equivalence and standardisation via commodification. Shared access to an important common resource creates the reason to assemble the collection of systems. In real estate, this is the MLS data: a *de facto* standard data structure and means for common data access. This shared information resource provides the basic foundation for the common functionality of the assemblages.

Structural similarity reflects the dual forces of common access to a shared resource and the institutional framing of the work being done. For example, the institutional stability regarding the process of transacting a house sale/purchase means agents have clarity as to what work they need to support: the uses of digital forms, continuous communication with clients and value-adding vendors, digital access to important data sources and managing digital data flows. Given these common needs, it is not surprising that each agent's collections of ICT are similar.

Functional equivalence arises from the common usage patterns across individuals' collections of ICT, software and data resources. In real estate, these collections include an agent's personal contact lists and agency or agent-specific data sources combined with their uses of the MLS and house data. Collections of different ICTs, even used in deeply personalized ways, supports the selling and buying of houses without any over-arching design required.

Finally, standardisation facilitates assembling the individual systems. Standardisation is achieved partly *de facto* through the structuring of MLS and other data. Standardisation is also achieved through the commodification embodied in the use of Internet-based applications and services, the reliance on third-party smart phones, mobile data service providers, personal computers, Internet protocols and commercial software use. Standardised products reduce pressure on any one agent to have all the know-how to connect these elements together. Moreover, the modularity inherent to commodification allows agents to upgrade each element, to overcome the failure of one part by reaching out for others with similar functionalities, and to tinker with new components at their rate of comfort. Finally, by collectively relying on standards, each agent's personal digital assemblages can interact and interface with others.

In contrast to common conceptualisations of IS, digital assemblages are not based on sets of formally defined functions and features. Nor are digital assemblages centrally or coherently governed: these are personal efforts. Finally, there is no expectation of collective ownership. Digital assemblages may draw on communal services, but each individual is responsible for his/her own collection. A digital assemblage is personal: an IS is institutional.

Moreover, a digital assemblage comprises multiple technological elements, in contrast to many analyses of the impacts of technology that focus on only single systems, such as the MLS, digital lockboxes or some particular software package. This digital assemblage conceptualisation emphasizes the importance of the relational and collective presence of many ICT, work practices and processes, and the centrality of many types of digitised data. What binds together the digital assemblage in real estate is the regulatory structuring of the industry magnified by the centrality of the communicative practices of agents working with buyers, sellers and value-adding service providers. A digital assemblage is coherent only when seen as a pattern of digital technologies and a requisite bundle of policies and practices.

Finally, in a single industry, there may be several overlapping digital assemblages. In real estate, there are assemblages assembled by agents, buyers and sellers. While these differing arrangements share common features, in practice, they are distinct as they serve different purposes in supporting and shaping the transacting of real estate and are assembled by people pursuing different goals.

Contributions and implications

We have proposed the concept of computerisation as a lens to better illuminate and conceptualize the roles of ICT in reshaping work practices. Digital assemblages are a means to conceptualize the patterns of shared and collective uses of commodified ICT to support work—here evidenced by the ways in which agents have taken up a range of digital technologies to support their work.

One important feature of digital assemblages is the role of informational access. Dutton (2005) argued that reconfigured access to information leads people to rethink the ways in which they engage with problems (and work). Evidence from this work illustrates this concept of reconfigured access leading to re-framed problems, and reshaped working arrangements. Such expanded access to sources of potentially useful data is at the core of computerisation—what Schmiede (2006) called 'informatization'. Over 25 years ago, Zuboff (1988) made this point relative to the automation of factory work, focusing on the increasing access to information for both workers and managers. All participants benefited, differentially, from increasing access to information, as manifested in their ability to use the information to their advantage, to reshape the way they do their work.

A second feature of digital assemblages is the centrality of indeterminacy (e.g. Kling, 1996; Orlikowski, 2007; Baldry, 2011). That is, specific technological elements of a digital assemblage are always in play. The various ICTs used by agents are continually evolving, the material resources available online change constantly, the access to data—as well as the type and volume of digital forms of these data—both evolve and grow, and there continues to be little formal integration. This means that any one agent's digital assemblage relies on both standardised and personalised aspects, and the ways in which these are assembled are quite flexible (Hanseth *et al*., 1996).

Finally, in combination with this constant change, assemblages show a paradoxical degree of functional stability. The process of achieving this functional stability—referred to as stabilisation by social studies of technology scholars (see Russell and Williams, 2002)—is an ongoing dynamic process of change in the socio-technical arrangements. These changes yield small and path-dependent shifts over time, while rarely altering the basic arrangements or functionality of the technical system. A stabilised socio-technical arrangement is able to absorb change—it endures even as it evolves. A stabilised arrangement most often has the simple appearance of being settled or static. However, more careful analysis reveals stabilisation as both dynamic and evolving and that which may seem to be fixed in design evolves through use (e.g. Hanseth *et al*., 1996; Lloyd and Newell, 1998).

One example of stabilisation in real estate is the MLS. As noted earlier, the role and function of the MLS have not changed during the course of this study. However, closer inspection reveals that the data available via the public MLS sites are changing (mostly with more data becoming available) and the arrangements about which data are shared are constantly renegotiated. Moreover, challenges to the MLS's centrality continue even as other players rely on its presence and structure as a *de facto* standard. A seemingly static resource such as the MLS is remarkably dynamic given empirical observation.

A second example of stabilisation from real estate is the uses of ICT to reach buyers and sellers. The telephone, long the most common means of reaching buyers and sellers, is now both mobile and but one means of conveyance that also includes an array of new media such as email, texting and social computing conveyances such as Twitter and Skype. Each provides different functionalities and increases the collective ability of an agent to develop and use their professional social networks.

However, other forms of ICT currently in use are not yet showing signs of stabilisation. For example, there is substantial growth in the uses of web-based applications for evaluating real estate costs, for sharing images, using geographic data and geolocation data regarding properties and increased uses of call tracking, contact management and other sales/marketing systems (see also Dawson and Gunson, 2002; Miozzo and Ramirez, 2003). What these examples suggest is that even as some of the more

visible and common elements of real estate show stabilisation, others are changing in ways not yet fully understood, much less predicted.

More broadly, computerisation focuses attention on the interdependent roles of the working context, working arrangements and technical system and provides for both analytic and conceptual insight into the social structures and activities that under-gird work. Doing so leads to a socially rich explanation for how ICTs, conceptualised as digital assemblages, are being taken up and used in information-intensive work such as real estate. Digital assemblages are theorised as being characterised by shared access to data resources, reliant on commodification and standards, structurally similar relative to components and functionally equivalent in use. Much needs to be done to advance the current conceptualisation and characterisations of digital assemblages. For example, much can be gained from studies that expand on, explore and contest this conceptualisation (e.g. Henningsson and Hanseth, 2011). More broadly, advancing digital assemblages as an alternative to current conceptualisations of IS will also encourage debate and conceptual updates to a core concept that is both central to the study of work and organisation and in need of more development.

Going forward, others might pursue similarly detailed studies of other information-intensive industries that are, or continue to be, computerising such as finance, education, law and national security (see also Baldry, 2011). Each of these industries have characteristics similar to real estate such as information intensity, work practices that rely on social connections, evolving work contexts and arrangements, strong institutional norms or regulations and increasing uses of ICT. Such studies will advance the conceptual structures of computerisation and add to our understanding of these domains and their work practices.

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Notes

1. A lockbox is a secure container attached to the door of a home for sale. It contains the key to open that house. Traditional lockboxes were opened using a key provided to agents who belonged to the local realtor's association. Digital versions replace key access with a smart phone reader.
2. A third and non-relevant meaning for digital assemblages is of an artistic effort that combines traditional and digital media in one piece or showing.

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