DIGITAL ASSEMBLAGES: EVIDENCE AND THEORIZING FROM THE COMPUTERIZATION OF THE U.S. RESIDENTIAL REAL ESTATE INDUSTRY [1]

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ABSTRACT

We theorize on industry-level computerization by drawing data from on-going empirical study of the United States' residential real estate industry begun in 1997. Real estate serves us here as a "living laboratory" for studying information-intensive economic activity. In lieu of standard economic analyses, we advance computerization as the analytic framework for this study because it focuses attention to the take up and uses of information and communication technologies (ICT) in conjunction with related socio-economic changes. We find, as might be expected, that with the increased use of ICT real estate agents are less involved as information intermediaries and yet are more deeply embedded into the processes of buying and selling of houses: they are more socially embedded. We find, as expected, that uses of ICT are now pervasive in this industry. However, the ways in which these ICT are used help agents to embed themselves more deeply into the transacting of real estate rather than serving as vehicles for disintermediation. Building from these findings we theorize on the ways in which social embedding supports economic transactions. And, we theorize the ways in which ICT are brought together and used can more coherently understood as a 'digital assemblage' than as some sort of formal information system or particular technology. Our conceptualization of a digital assemblage is characterized by distinct patterns of ICT collections that, in use, are functionally equivalent and structurally similar, relying on standardized and commodified ICT.

Keywords: real estate agents, industry analysis, economic transaction, digital assemblage, social embedding, multi-method study, longitudinal research.

INTRODUCTION

The focus of this paper is theorizing on the roles that information and communication technologies (ICT) play in industry-level changes. To support this theorizing we draw on a multi-year study of the United States (U.S.) residential real estate industry as it computerized. This work contributes to an ongoing debate about the impact of ICT, and digital forms of data and information, on the basic architecture of future industries and perhaps economies (e.g., Bar, 2001; Pinch and Swedberg, 2008). Most of the punditry, and much of the scholarly work, depicts the move towards a more digital infrastructure as primarily a function of economic rationality. These future digital infrastructures are seen as supporting rationalized and "frictionless" markets where ICT help reduce the costs of transactions (e.g., Bakos, Lucas, Oh, Simon, Viswanathan and Weber, 2005; Hahn, Litan and Gurman, 2005).

In contrast, our premise is these digital infrastructures rely on and must provide for the social activity through which economic activity arises. We see these infrastructures as neither frictionless nor rational (e.g., Hanseth, Montiero and Hatling, 1996; Hanseth, 2010). In this view social activities are what overcome the digital friction of incompatible systems, computing breakdowns and the common-place incompatibilities between action and understanding that define human and machine interaction (e.g., Suchman, 1987; 2008; Wigand, Steinfield and Markus, 2005). This is not a unique view: it is shared by scholars from a range of intellectual communities, (e.g., Baksky, Simmons, Huffaker, Teng & Adamic, 2010; Pinch and Swedberg, 2008; Agarwal, Gupta and Kraut, 2008; Kane and Alavi, 2008; MacKenzie, 1992; Swedberg & Granovetter, 2001; Runde, 2001; Lie, 1997).

The core principle of the socially-embedded view is that human activities are fully enmeshed in the conduct of economic life (e.g., Swedberg, 1994; White, 1981; Lindenberg, 1990). If economic activity is increasingly reliant on digital architectures, then these digital architectures must support (and must be designed to support) human interaction in order for markets to work (e.g., Pinch and Swedberg, 2008; Bar, 2001; Agarwal, Gupta and Kraut, 2008). This means computerization is as much about changing social arrangements as it is about taking on technologies like ICT (e.g., Burriss, 1998; Kling, 1995).

To advance this thinking, the paper continues in five sections. The remainder of section one contains an explanation for choosing the U.S. residential real estate industry as the empirical setting. This is needed because conceptualizing computerization is best developed by situating the concepts in the empirical domain —the focus of section two. In section two we also explain why computerization is the appropriate conceptual perspective for this work. In section three, we detail the research design and data collection methods. In section four, we present and discuss our findings. With the final section we extend current theorizing regarding computerization and advance our conceptualization of digital assemblages.

Why Real Estate?

We use data from a study of the U.S. residential real estate industry (begun in 1997):[2] it serves us as a "living laboratory" for studying information-intensive industries[3]. Real estate has always relied on using information about properties and potential clients to create sales. This has been enabled of late through the rapidly increasing uses of ICT. For example, in 1995 less than 2% of agents, home sellers, and buyers accessed the Internet for information about real estate and agents were just beginning to use mobile phones. But, by 2009, agents' mobile phone use was essentially ubiquitous; nearly 98% of agents were using other forms of ICT; and, more than 90% 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).

We know a real estate agent's[4] work is based almost exclusively on competition for, and value-adding uses of, data and information. And, we know much of this data and information is now digital. Success is based on an agent's expertise, experience and motivation. This is typically measured by the number and dollar amount of sales (for which the agent earns some percentage of the sale price). Agents work with a combination of other agents, brokers, buyers, sellers, lawyers, bankers, appraisers, title insurers, inspectors and other value-adding service providers to consummate the purchase and sale of a

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[2] In the U.S. residential and commercial real estate businesses operate under different rules of agency and brokerage. Here, we focus on residential real estate—or "real estate" for brevity's sake.

[3] It is the kind of revelatory setting of which Yin (1994) speaks.

[4] For brevity's sake, going forward we use 'agents' as a short-hand for real estate agents.

house.

Despite the social complexity suggested by this list of players, a too-common misunderstanding of their work is that agents serve primarily as information intermediaries[5]. This misunderstanding is rooted in a view that the agent is simply transferring information between the buyers and sellers. If all agents do is to transfer information, then shifting information transfer from human intermediaries to ICT-based intermediaries will reduce the cost of a transaction by lowering costs of information search and transfer for buyers and sellers (e.g., Nadel, 2006).

Such a thin understanding of agents' work also leads some scholars and many pundits to see the sharing of information about houses for sale through a federated set of data repositories—known collectively in the U.S. as the multiple listing services (MLS)—as a possibly monopolistic activity (e.g., Baen & Guttery, 1997; Hahn, Litan & Gurman, 2005; Kummerow & Lun, 2005; Muhanna & Wolf, 2002). The perception of monopolistic activity arises in part through the ability to add to these databases being restricted to those who belong to a local realtors association (generally affiliates of the National Association of Realtors (NAR))[6].

Claims based on an agent's work being primarily intermediation have not been empirically supported. We now know that homes-for-sale listings are accessible online via the Internet, meaning buyers and sellers have access to much of the listing data and, as noted, more than 90% of all purchases begin with prospective buyers searching online. Instead of disappearing with the advent of ICT-based access to home listings data, the number of real estate agents is (still) greater now than in 1995, even following several years of substantial declines in sales since the economic downturn of 2006[7]. Instead of rampant disintermediation (sales no longer being brokered by agents) the percentage of sales made directly between owners (known as "for sale by owner" or "FSBO") has not changed appreciably in this

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[5]   This is detailed at http://www.usdoj.gov/atr/public/real_estate/index.htm. Last accessed 21 September, 2011.

[6]   In September, 2005, the US Department of Justice brought suit against the NAR based on the first clause Sherman Anti-Trust Act regarding access to and uses of the MLS. In November, 2008, this case was settled out of court. As part of this settlement, the NAR altered its policies regarding sharing and listing house information.

[7]   See http://www.realtor.org/crtweb.nsf/pages/CRTsurvey. Last accessed 21 September, 2011.

time period[8]. Despite concerns about 'market friction' due in part to agents, residential real estate has appreciated since the mid-1990s[9]. And, the downturn in home prices since 2006 (more than 20% nationwide and more than 30% in most major cities) is seen as a result of speculative mortgage brokering, not the incremental costs of real estate agent's participation (Rugh and Massey, 2010).

This trail of evidence regarding real estate agents' roles suggests the effects from the presence and uses of ICT extend beyond disintermediation. Given the limited empirical support for the many techno-economic conceptualizations of the roles of ICT in real estate, prudent science demands (1) modifying transaction cost economics (the conceptual basis for most of these studies) or (2) pursuing an alternative conceptualization. We pursue an alternative conceptualization: computerization.

CONCEPTUALIZING COMPUTERIZATION

Our thesis is that agents are embedded in the transacting of real estate and ICTs are used in part to support this embedding. We conceptualize the presence and uses of ICTs in real estate as a socio-economic phenomenon enacted through socio-technical arrangements. Computerization focuses attention to the interplay of social activities (the efforts made to transact real estate), economic activities (the conduct of the transactions), and technologies[10] (the various ICTs used to support the listing, buying and selling of real estate), as these are interdependent and mutually constituted over time (e.g., Burris, 1998; Kling, 1996). This approach emphasizes that agents perform social activities such as bringing together the participants and providing value-added services regarding both the conduct of the transaction and the creating meaning from the available data that are of greater importance than transferring information (see Dimaggio & Louch, 1998; Sawyer, et al., 2003). That is, the work agents do are the means through which transactions are consummated: they are market makers (e.g., White, 1981).

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[8] Exact data on FSBO numbers remain scarce. The best evidence suggests that FSBO sales range from 11 to 14% of all sales over the period 1996-2005, with no appreciable change over this time (Hawker, 2006).

[9] Based on data made available at www.realtor.org/research, we note that in 2011, 4.67 million existing homes were sold, up from 1.8 million in 1996. Over this same time, the average house price is up 11%, to $177,00. This, in turn, is down from the 2005 average of $222,500. Last accessed 1 September, 2011.

[10] For this paper we focus specifically on ICT and digital technologies; not technology as a general conceptual construct.

The alternative advanced here builds on characterizations of 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 networks, and through this sharing meaning is co-constructed. An agent's value is defined by these relationships and embedded efforts. The social connections embodied in these networks are the means by which agents help buyers and sellers reach closing. Uses of ICT serve as vehicles for both access to information and to share and interpret it with those who come together to bring about a closing. Thus, ICT uses magnify, not replace, an agent's roles and their value-adding potential.

Computerization scholars have advanced a framework that consists of depicting multi-valent and multi-directional interactions among: 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 (Burris, 1998; Kling, 1991; Kling, 1996; Taylor, Groleau, Heaton & Van Every, 2001; Hara & Rosenbaum, 2009). Computerization begins with the premise that ICT-based systems are introduced to create change in the existing social order and focuses attention towards understanding changes how the ICT-based system is bound up in the nature of work and working arrangements. Relative to the nature of work and working arrangements, the interests of computerization are towards changes in workers' skills, the control of work and work arrangements, and to the restructuring of work tasks. Computerization's third component is situating these two in the broader social, temporal, economic, cultural and historical context in which these changes unfold.

Computerization viz. alternative socio-technical perspectives

We build on computerization as it elevates the roles and structures of the ICT to be more than either reflections of social action (such as the social construction of technology (SCOT)) or accomplices to social action (viz. the social shaping of technology (SST)). Computerization provides a conceptual

means to make a direct link to the ICT's presence and uses, which structuration and institutional[11] theories do not. While actor-network theory (ANT) also advances two conceptual elements central to our approach: relational arrangements and equality among human and non-human 'actants," it demands the epistemologically, empirically and conceptually problematic construction of focal, temporally-evolving, and scale-free networks. We seek to explicitly contextualize embedding and uses of ICT, making ANT a less-useful conceptual frame for our needs.

There are also emerging several socio-technical approaches to studying ICT such as information infrastructure (Hanseth, 2002), socio-materiality (Orlikowski, 2007; 2010), domestication (Haddon, 2006) and the biography of artifacts (BoA) (Pollock & Williams, 2008). While these are promising, at present only computerization provides us the means to conceptualize the roles of ICT with both work and the industrial context. Information infrastructure focuses on the negotiated arrangements of standards and larger-scale systems—and our focus here is on arrangements of data, work roles and ICT uses that both rely on these and that are situated in a particular domain. Socio-materiality and domestication are tied to practice, which is attractive for our research, but provide little conceptual guidance and value-added for the industrial-level goals of our analysis. Likewise the BoA approach focuses attention to the larger scale of ICT, but provides little guidance as yet on studying more micro-scale aspects of work.

We also note that computerization, like many socio-technical theories, has most often been used to study the processes of socio-technical change (e.g. Kling, 1996; Kraemer & Elliott, 2008; Hara and Rosenbaum, 2009). Here, given space constraints, we focus on depicting changes over a specific period of time, foregoing an analysis of the temporal processes of computerizing that undergird these changes.

Using computerization as our conceptual frames leads to three specific research questions:

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?

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[11] One reviewer suggested we adopt an institutional theoretic approach. We have, in previous work (see: Sawyer, Wigand and Crowston (2005)). It was through this work that we became aware of shortcomings with institutional theory relative to advancing the roles of ICT in industrial change. This led us to advance computerization as a more appropriate alternative.

RESEARCH DESIGN AND DATA COLLECTION

To understand computerization in real estate we have pursued a multi-level, multi-method, research effort (Leonardi & Barley, 2010; Agar, 2005; Brewer & Hunter, 1989; Jick, 1979; Miles & Huberman, 1994; Gallivan, 1997). As outlined above, the kind of data needed to gain insight into computerization demand both situated and detailed observations of agents' working contexts, working arrangements and their uses of ICT to be combined with larger-scale data regarding changes over time in the industry.

Data collection

As summarized in Table 1 and depicted in Figure 1 the basic research design focuses on gathering evidence of the work of real estate agents, looking specifically to the ways in which ICT are being taken up and used. Data collection efforts were premised on collecting multiple types of data, at different levels of analysis, iteratively, and to be used in ways that allow for analytic triangulation. Data were collected through field work efforts, surveys, and from secondary sources. Field-work efforts included semi-structured interviews, participant observation, and the collection of working documents and common work materials. Survey data collection involved pre-tests, pilot tests and a national, stratified, random sample of real estate agents and brokers, carefully following the guidance specified in Dillman (1978).

Secondary data were drawn from the U.S. Bureau of Economic Analysis (BEA), U.S. Department of Justice (DOJ), U.S. Department of Housing and Urban Development (HUD), NAR, Mortgage Bankers Association of America (MBAA), and several local MLS. Additional secondary data sources include reports from governmental and non-governmental organizations such as the U.S. Department of Justice, U.S. General Accountability Office (GAO), the U.S. Department of Commerce (DOC), the Brookings Institute, the American Anti-Trust Institute (AAI), and other relevant think-tanks and issue-advocacy organizations. We also used feedback from our informal interactions with a wide range and number of brokers, agents, vendors, MLS directors, association executives, journalists, industry pundits, and other scholars that arose from our many presentations of findings to industry participants and industry groups.

Insert Table 1 and Figure 1 about here

The iterative design and our focused attention to engaged in empirical work supported by multiple forms of data provided us exactly the kind of durable, but flexible, approach that can sustain a 15+-year research project. Our initial fieldwork activities were framed by computerization and our data collection built on semi-structured interview guides combined with both detailed field notes of our participant observations and working document and materials gathered from agents, brokers and others (e.g., Jackson, 1987).

We began with micro-level studies of work and working practices as suggested by Barley and Kunda (2001). This provided us guidance as we drew from the literature to develop a survey instrument to help us test specific hypothesis regarding the ways in which agents used ICT and to what effect. We were then able to pre-test and pilot-test this survey in one local real estate market.

Building from the field work we developed a nationwide survey to specifically investigate particular uses of ICT and effects. This was administered during the 2003-2004 academic year. Following the initial survey data analysis we returned to the field in from late 2004 through 2005 to do additional interviews to help us better understand findings. In 2006 we returned to the field to collect data to help us understand and theorize on institutional and policy arrangements that frame the more localized work of agents. To do this we interviewed members of the NAR, U.S. government agencies, banks and financial institutions, and relevant professional and trade associations. And, across this study we developed several key informants – practicing real estate agents, real estate brokers, local real estate association executives, and national real estate association staff – whom we contacted frequently.

In Table 2 we summarize the interview subjects. In Table 3 we list secondary documents that were instrumental in this work. In Table 4 we list presentations at local and national-level industry conferences, workshops, and specific interactions with others involved in real estate.

Insert Table 2, Table 3 and Table 4 about here

Longitudinal studies such as this do not easily condense to a single journal-length report of findings, implications and theoretical insights. For example, each of these stages of data collection could be considered a specific research effort, worthy of a distinct analysis and reporting. And, for several of these efforts, this is what we have done. We report the findings and analysis of our initial interviews and results of our analysis of pilot survey data in Crowston, Sawyer and Wigand (2001). We report on the analysis of our first three rounds of field data collection in Sawyer, Crowston, Wigand and Albritton (2003). Analysis of institutional-level data is reported in Sawyer, Wigand and Crowston (2005). Here, we pursue a broader-scale analysis. Our focus is to theorizing on computerization, drawing on data from our field work and secondary data (deferring more focused analyses such as specific hypothesis testing of survey data for future publications).

Analysis

Following Miles and Huberman (1994) we pursued a program of interim analyses from the outset, relying on explanatory event matrices. The interim analysis demanded we begin to systematically reflect on our data from the very beginning in order to guide future data collection. This led us to revamp some aspects of the data collection protocol by adding new elements, reshaping other elements, and reconfiguring data collection protocols to reflect what we were learning (e.g., Miles, 1979). Through this planned interim analysis effort both themes and issues emerged. These, in turn, framed the return to the field for additional data collection.

In an explanatory event matrix themes (or issues) form one axis and sources of evidence form the other axis. The thematic focus is to computerization's three elements and our research questions regarding the *work context*, *the nature and arrangements of agents' work*, and the *technical (ICT-based) system*. The cells made from this matrix contain pointers back to the source of evidence relative to the theme (or issue) to which it relates. The simplicity of the matrix structure belies the difficulty in classifying and coding multiple forms of data into coherence. This analytic effort is a lynchpin of multi-method research (e.g., Brewer & Hunter, 1989). The long-standing working relationships among the authors, and their

complementary but differing scholarly and multidisciplinary perspectives, served as the creative engine for the rounds of interim and final analysis[12].

FINDINGS REGARDING COMPUTERIZATION IN THE U.S. RESIDENTIAL REAL ESTATE INDUSTRY

We present evidence relative to the three research questions. For each of the questions we present two depictions: one focused on the arrangements when we began our work in the late 1990s, the second presenting contemporary arrangements. The changes are outlined below and summarized in Table 5. Given the focus on conceptualizing the social embedding of economic activity and the socio-technical nature of computerization, the detailed presentation provides the basis for the findings. The findings provide the basis for our discussion and theorizing that follows this presentation.

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

This question focuses attention to changes in the working context of real estate agents related to use of ICT. We begin by outlining the U.S. real estate context in the late 1990s; then presenting the contemporary context; lastly summarizing the changes.

The real estate context of the late 1990s

The real estate agents' role was to facilitate the sale of a property by helping the seller attract prospective buyers. In most cases two agents were involved in each real estate transaction. The listing (or seller's) agent (who gained exclusive rights to list the house) was expected to help the seller by marketing the property, helping to determine an asking price, guiding the seller to make the property attractive, advertising the property and screening potential buyers, in return for a commission (generally a percentage of the sale, typically ranging from three to six percent). When offers to buy the property were received, the listing agent helped the seller with the negotiations and details of the transaction.

The other agent (often called the buyer's agent) helped buyers find suitable properties among those offered for sale, again in return for a commission. This agent might advise a buyer regarding price and purchase details once a property was identified. However, the seller paid the commission for both

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[12] Triangulating across multiple forms of data is a collective effort and we have also benefitted from the insights and energy of the many students who have participated in this work (as noted in our acknowledgements)!

agents and both agents had a fiduciary duty to the seller—not to the buyer. Thus, while the typical house sale and purchase had the buyer and seller negotiating via the intermediation of the buyer's agent and the seller's agent, both were acting on behalf of the seller.

In most of the U.S., agents were required by law to associate with (contract to) one (licensed) broker. The organization a broker oversaw was (and is) called an agency. Agencies ranged in size from a single broker/agent (one person who performs both roles) to those with several brokers, dozens (or hundreds) of agents, and additional clerical and managerial staff. Some agencies were franchises of national corporations, others were regional institutions, and many were small/local businesses. Agents were not employees of the agency or a broker; rather, they were independent contractors. However, agents received a variety of services from the broker's firm. In return, they gave the broker and the firm a share of the commission earned from successfully completing the purchase or sale of a property.

While the two agents evenly divided the commission (into two "sides"), they were likely to have very different arrangement for dividing up their side of the commission between the broker/agency and their own earnings. Productive agents had the bargaining power to negotiate for additional services or a more favorable division ("split") of their side of the commission. Less experienced and less productive agents often saw 80% of their side go to the agency.

The purchase and sale of a home was structured in part by the information required to be provided on two forms: the purchase and sales agreement (P&S) and the 'HUD1' form[13]. The P&S details the provisions for the transaction (even though its form varies by state). The HUD1 form's use was mandated (via the Real Estate Settlement Protection Act (RESPA) of 1974) as the basis of all residential real estate transactions. The HUD serves as the overseer of 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 that is split into two columns, for the buyer and for the seller) of the expenses incurred for selling and buying a property.

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[13] For more on the HUD1form see: http://www.hud.gov/offices/adm/hudclips/forms/hud1.cfm or
http://www.alta.org/consumer/hud1.cfm. Last accessed on 21 September, 2011.

Contemporary arrangements

The basic role of the agent remains unchanged: to bring together the seller and buyer of a property. The legal mandate remains: an agent is required to contract to one (licensed) broker. The organization that a broker oversees is still called an agency. Real estate agencies still 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 still franchises of national corporations; others are local or regional institutions and sole proprietorships are as numerous as they were 15 years ago (National Association of Realtors, 2006). Agents continue to receive a variety of services from the broker's firm and, in return, give the broker and the firm a share of the commission from successfully completing the purchase or sale of a client's property. Agents remain independent contractors who must work solely through one broker. Independent broker-agents must still provide their own resources and develop their own professional networks.

Two agents are typically (still) involved in each residential real estate transaction. The work of seller's agent remains unchanged. However, the work of the buyer's agent has changed in many cases as 'buyer agency' rules are now common. A buyer's agent signs an agreement with the buyer to help them find suitable properties among those offered for sale. The buyer's agent advises the buyer on the price and purchase details once a property is identified. But in return for a promise to use the agent's service for some time period, the buyer's agent is bound to serve the buyer, not the seller as in traditional agency Thus, the typical house sale and purchase has the buyer and seller negotiating via the intermediation of the buyer's agent and the seller's agent. The P&S and HUD1 forms are still required. The two agents still share the two 'sides' of the commission when a house is sold and purchased.

There has, however, been some downward pressure on the percentage of the sale price that agents charge (particularly for high-cost houses and in particular markets). Productive agents still have the bargaining power to negotiate for additional services or a more favorable split of the commission. However, agents can now gain this market power by representing either the seller or the buyer.

Changes in the working context between 1995 and 2010:

We observe two changes in the working context over the period 1995 to 2010: buyer agency and stasis. The rise of buyer agency and the explicit attention to representing buyer's interests gives buyer's more equal representation in a transaction. Without this, agents were beholden to represent the seller's interests, leaving the buyer more exposed to risk than the seller. Buyer agency also delineates the agent's roles and their reward structure. There is also evidence that agents are choosing to specialize their efforts, focusing on either the buyer or seller side of the transaction.

The second observation is stasis. Other than the rise of buyer agency, the working arrangements have not changed. Buyer agency represents a codification of the work agents were doing for these consumers, legitimating an ongoing practice. This noted, there are no changes relative to who are central actors in consummating the transaction of a house that is for sale: they continue to be buyers, sellers, and real estate agents. Despite the rapid take-up of ICT, the working arrangements seem much the same.

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

We begin with a summary of the arrangements for work as of the late 1990s, then summarize contemporary work and arrangements, and finish by listing changes to work and working arrangements.

The working arrangement in the late 1990s

The work to transact a house consisted of four broad efforts: (1) listing homes for sale, (2) searching for homes to buy, (3) negotiating the purchase and sale of a home, and (4) resolving the contingencies leading to the consummation of the sale (or closing). Listing meant a prospective seller made their house available for sale. Listing was done through posting signs, placing ads in newspapers, and by contracting with a real estate agent to have the home's data entered into the local MLS.

Sellers could market the house themselves or they could contract with an agent to represent their interests (which most did). Whereas the contracts provided formal structures and standards, the efforts to list homes, search for homes, negotiate for purchase and sale, and resolve contingencies were more fluid and less standardized. There were dependencies (one could not resolve contingencies before having a

P&S agreement); but, the four parts of an agent's work: listing-finding-negotiating-closing was not a linear workflow. That is, an offer could be made on a house that was not listed. Likewise searching for and listing homes were (and are) independent.

Central to listing a property for sale were the MLS: the federated repository for houses-for-sale information. Broker-owners, agents and others (like lawyers, home inspectors and appraisers) participated in their local MLS, which provided them a means to share information on houses for sale (listings) with others who could access the MLS. When a listing (or seller's) agent signed a contract with the seller of a property, the agent entered a description of the property into an MLS database.

The MLS was a term encompassing more than 1200 local databases: each focused on serving a particular geographic region. Most MLS were owned by the local realtors' organization (the "Board") and operated by a separate MLS company. A few MLS were owned independent of the local realtor organization. Most of these MLS had, by 1995, shifted to being digital databases for information on houses for sale. These databases were developed, controlled and used by the local MLS company (though some of the larger and more innovative had begun pursuing data-sharing arrangements with other MLSs).

Access to MLS data was carefully controlled: typically it was shared solely among the agents and brokers of a particular geographic location—often as a printed "listings -- or MLS -- book." The listings book would be printed on a routine basis (monthly or perhaps bi-weekly in active areas) and a prospective buyer could only view the listings by having an agent show them. Some agents were quite willing to share, others controlled access to the MLS book. While agents cooperated with each other by sharing information on MLS listings by request, there was no common access to MLS data.

However, by 1997 agents were experimenting with online access. Some would offer clients informal access to the MLS data via the agent's personal computer. But, the MLS book and concepts of limited access to this data were dominant norms of conducting business. We expand on the MLS's role, below.

When an offer was accepted (when the P&S was signed by both parties) there were typically a set of contract contingencies that need to be addressed. These contingencies might include the buyer

successfully securing financing, inspection and appraisal of the property, etc. The agents helped the seller

by providing access to resources to redress the contingencies, though the buyer sometimes benefitted

because the agents did not get paid until the sale consummated. Once the contingencies specified in the

P&S agreement were satisfied, the deal could be consummated: it could "close." Closing was where the

title to the property and payment changed hands. The time between a P&S being signed and the house

closing was typically multiple weeks in duration and stressful. Resolving contingencies typically

demanded extensive, frequent, timely and often unexpected interactions among agents, buyers, sellers and

many other value-adding personnel such as lawyers, inspectors, banks, and perhaps contractors.

Contemporary work and work-related arrangements

Securing listings, finding buyers, negotiating a P&S, and getting to closing remain the focus of an

agent's work. There are subtle changes to each, however. For example, most prospective buyers now

search for properties online via various national and regional MLS access points, agents' web sites, and

through other online sources such as Zillow.[14] Listings are still secured by agents. Houses are still

advertised in newspapers and by posted signs. However, it is rare now for agents to be the ones to first

show a buyer a house. And, with the rise of buyer-agency, there is now a greater effort by agents to secure

potential buyers (in addition to or instead of working to secure listings). Likewise, there exist some fee-

for-service agents (who will put a house's listing in the MLS for a flat fee and price services *a la carte*).

Once a short list of possible houses is identified, the buyer (still) 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 listing agent still provides advice to the seller regarding both marketing the house and arranging for

its sale. The P&S remain central to a sale, as does removing contingencies. But, with the more open

access to house-for-sale information, both the listing and buyer agents are spending more of their time in

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[14]   See www.zillow.com. Last accessed 22 September, 2011.

the early stages of a transaction reviewing material and explaining options to buyers and sellers.

Changes in work and working arrangements between 1995 and 2010

We present three findings regarding changes to agents' work and working arrangements. First, and consistent with other detailed studies of agents' work behavior, we find that while agents serve three roles, information sharing, process consultation and providing value-adding services, increasingly they focus on process consultation and providing value-adding services (see also DiMaggio & Louch, 1988; Crowston, Sawyer & Wigand, 2001; Sawyer et. al., 2003). Process consultation is embodied in the efforts towards helping clients to list and/or identify houses for sale, negotiate offers, and bring the purchase and sale of a house to completion. The provision of value-adding services includes identifying useful others such as lawyers, architects, contractors; explaining confusing data; helping their clients sort out financing alternatives and implications: often serving as a mediator for couples to help with decision-making.

Second, the rise of buyer's agency has made it easier and more useful for buyers to retain an agent on their behalf. The fundamental structure of the transaction is unchanged, but the increased attention to serving the buyer's needs (and not just the sellers) provides agents with more ways to provide value-adding services.

Third, much of the intermediation work to share house data that was previously done by agents is now being done by buyers and sellers who directly access information via sites found on the Internet. Agents spend far less time driving prospective buyers from property to property: most buyers approach an agent having done much of this prospecting online (and if they have not, the agent has them begin there). Agents spend more of their time helping buyers prepare to purchase and helping sellers prepare their homes for sale. Moreover, it appears that the increased attention to process consultation and value-adding service provision is furthered by the ability to shift the house search activities to buyers.

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

We first outline the state of the ICT-based technical system in real estate as of the latter part of the 1990s, then detail the contemporary arrangements, and finish by summarizing the changes.

The ICT-based technical system in the late 1990s

The 1990s saw three waves of ICT-based changes in real estate. The first wave of change, done by 1995, was the transition of the MLS to being hosted on personal computers (PCs). Prior to this change most MLS companies relied on either mini-computer or mainframe-hosted systems (and some had remained a paper-based system). Shifting to PCs reduced operating expenses and often freed the MLS company from costly third-party hosting arrangements. Many of the MLS companies also shifted to some sort of third-party (and often packaged) software or had local programming talent develop the data structures and reporting functions for use by their MLS subscribers. This back-office automation meant that (1) the MLS data was now digital and (2) the local MLS gained more control over its data.

The second wave of ICT change came about as buyers, sellers and agents rapidly took up personal computing. Agents began to do so because they could, via direct modem connection, access the MLS from their home computer. Recognizing this, software vendors began offering specialized data query and reporting packages for real estate agents. Others began to offer special MLS database query and reporting services (supplanting home-grown systems with their software packages). Still others began to provide services more directly to buyers and sellers. No matter the intent or form of these offerings, direct access to MLS databases via modem connection allowed agents (and increasingly their clients) to bypass the printed MLS book and its constraints on access.

The third wave of ICT take-up during the late 1990s was the rapid growth in mobile phone use. Agent's reliance on mobile phones was nearly universal by early 2000 (and most buyers and sellers were also deeply involved with mobile phones by 2003). The mobile phone allowed agents to accept calls while on the move. This reduced the need to constantly check in with an office receptionist or to scan one's answering machine.

This mobility leveraged the uses of fax machines. Through the 1990s fax machines were critical ICT as they were the primary means for sharing documents among buyers, sellers, other agents and stakeholders (like the banks and lawyers). Fax machines were central to agent's home offices, brokerage

and all value-adding participants. Receptionists played a key role in document management – collecting, sorting and forwarding faxes to other fax machines

Building on the growth of PC ownership, the late 1990s witnessed an increased interest in web-based access to an MLS's listing for both agents and clients (paralleling the rise in residential broadband Internet access)[15]. Web-based access allowed the prospective house buyers, sellers and agents to more easily search this collection. Agents who were members of an MLS were provided additional search capability to scan the MLS databases for properties that fit their clients' needs. And, as this more direct access grew, the printed MLS book ceased to be a useful information source and most MLS had ceased publishing these by 2000. Innovative agents began experimenting with putting up web sites showcasing their house listings, and real estate firms followed soon. The NAR contracted with a sole-source provider to create a national point-of-entry on the Internet for accessing MLS data; and, by the late 1990's, agents were rushing to get house data online. It became clear the MLS system developed through 100 years of cooperation provided the industry with a unique platform (e.g., Crowston and Wigand, 1999).

Contemporary arrangements of the ICT-based technical system

The ICT-based technical system supporting the listing, buying and selling of real estate remains centered on the MLS, though alternatives have emerged. By early 2011, the number of MLSs had dropped to 942[16], with 900 operated by companies chartered by the local Realtors' Board. The others are privately held companies independent of the local Realtor organization.

The MLS remains federated. However, there is now broad-scale sharing of local MLS data with Move (the company that owns www.realtor.com). This is governed by the specific agreements which stipulate what MLS data are to be shared and used[17]. Somewhat unexpectedly, there have been several

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[15]   Some might count this a fourth ICT-enabled change. We see this as an outgrowth of personal computer access.

[16]   The exact number of local/regional MLS continues to change as these merge or devolve. The trend is, however, toward fewer and more regional MLS. Real estate agents and others must pay an annual fee to participate in an MLS. Typically, membership in the local realtor association is required to join an MLS. This membership also covers dues for the NAR (see www.realtor.org). As an aside, real estate agents who are members of the NAR are called 'Realtors,' a trademarked term.

[17]   The technical and governance agreement to share MLS data are detailed in the NAR's IDX agreement. See http://www.realtor.org/realtorae.nsf/pages/memberIDX?OpenDocument for more details. Last accessed 10 November, 2010.

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.

The set of digital services and specialty software applications surrounding the MLS has grown from essentially nothing to being a multi-million dollar industry niche. Agents now have access to specific software applications which allow for sophisticated use of the MLS. 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. Most agents take advantage of digital forms (for the P&S, HUD1 and other contractual documents) software that the local realtor association provides (and this is emerging as a de facto requirement in some areas of the U.S.). These digital forms can range from simple PDF to more sophisticated dynamic data entry and tracking applications that can work on both smart phones and personal computers.

Smart phones have replaced cell phones and PDAs. This adds texting, email and web capabilities to the mobile devices. These mobility-enhancing devices are ubiquitous and central to agents' work. Data make clear agents cannot conceive of carrying out their work without their smart phone. As one of our long-time confederates texted: "…if you don't have a smart phone, you're not a serious agent."

Digital pictures and video have become standard (if not expected) when one lists a house and agents have either invested in high-quality digital video cameras or are sub-contracting the photo and video shoots to third parties. Agents are keen to have the homes they are listing be seen on multiple websites: their own professional site, the agency site with whom they are affiliated, the local MLS site, www.realtor.com, and others.

Over the past 15 years, the traditional lock box had been replaced with electronic lock boxes. These require a digital entry code to access the house key (often via an application on the agent's smart phone) and record all accesses to that house's key. This provides the selling agent a digital record of who has viewed the property. And, while fax machines can still be found in every office, their use is now

(distantly) secondary to the nearly ubiquitous email sharing of documents (making the smart phone with email access an even more critical device for agents).

For those working for larger agencies there is typically agency-level software for tracking leads, transaction status and market activity (in essence a customer relationship management (CRM) system). 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 personal devices (e.g., a smart phone) or personal computer. Agents often spread their work among personal computers and personal devices (phones), with the latter always with them.

Contact lists are a core resource of the agent, and they are loath to share this data and store it centrally. Newer agents, and particularly those working for large agencies and franchises, are often required to agree to keep these contact lists stored in the agency-provided CRM-like applications. This makes it more difficult for the agent to retain the privacy of their contact list and raises the barrier to changing agencies.

Beyond these devices and applications, there are a number of web sites providing additional data on mortgage and finance calculators, neighborhoods, schools, comparisons of economic indices, community data, commuting times and other possibly relevant data. Some of these web sites draw data from the MLS to provide a value-adding service[18]. In the course of their work, agents build up a collection of preferred sites, often linking to them from their own professional sites. This set of individualized professional resources serves, in part, as a representation of their ability to provide the 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.

Changes in the Technical (ICT-based) System

Relative to the technical (ICT-based) systems of real estate, we present three findings. First, and despite the ongoing changes to its federated structure and data-sharing practices, and the rise of viable

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[18] For example, the previously noted www.zillow.com combines some data on houses for sale with detailed of other house's selling prices and property tax data and presents this information together on maps.

alternatives, the MLS remains a core, common, informational infrastructure (e.g., Hanseth, Montiero, & Hatling, 1996). By informational infrastructure we emphasize the importance of having shared access. The shared access via the MLS also provides standards for data access so that vendors can provide additional services and software applications that are neither owned nor governed by the MLS's owners, but which provide additional value to agents.

Second, we observe the shift towards more uses of digital forms of data sharing, reflected in the movement from facsimile sharing to PDF documents sharing. This increased digitization 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 the voice mail, texting and data access from smart phones, agents are more connected to their customers and partners while mobile. The digital lock box access (and tracking of visits that this allows) is a third example of the shift to digital forms of data[19].

Third, we observe the substantial increased in the uses of and reliance on ICT. The forms of ICT vary; but, ICT are embedded in most all elements of the agent's practice. The ICT an agent uses now include personal software for querying the MLS and engaged in contact management; professional websites for sharing out house data and a set of links to other useful professional sites; digital cameras, videos and lockboxes; and perhaps agency-provided CRM software. Beyond this growth of individualized use, we also observe the growth in work and contact management systems being 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 organizational asset. The value of this effort to the agencies are clear, the implications of this effort relative to attracting and retaining agents is not. And, we note that while there are a stunning variety of devices, software packages, web-based applications, and ways in using these, any one agent's collection of ICT seems to be functionally similar to others.

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[19] 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 network of contacts to communicate with buyers, sellers, and others. This is not, however, a focus of the findings to date.

DISCUSSION

We discuss the findings relative to their implications regarding the findings relative to each of three research questions: (1) changes in the working context of real estate agents; (2) changes in the nature of real estate agents' work and working arrangements; and, (3) changes to the technical (ICT-based) system that is used in real estate.

Changes in the working context

Relative to changes in the working context we note that the set of players involved in a real estate transaction, and the relationships among these players, is structured by contracts. Evidence makes clear the structure and form of these contractual arrangements frames the residential real estate industry. And, there seems to be no indication of a movement away from relying on contractual arrangements (see also Sawyer, Wigand and Crowston, 2005). If anything, there is some evidence of a move towards increased contractual specification (such as the growth of rules regarding the roles of buyer agents). The trajectory and pace of change in contractual arrangements seems constrained, suggesting that the working context is evolving along a conservative trajectory that is shaped by the current regulatory regimes. And, there is no evidence to support large-scale changes in the working context due to the rapid and pervasive take up on a range of ICTs.

This conservative trajectory of working context change noted, we observe that the details of these contractual arrangements are continually renegotiated: it is a dynamic equilibrium. For example, agents and brokers continually negotiate commissions and duties (the scope and pay for work). From state to state, the roles of the participants and their contractual requirements are always being discussed. At a national level the structure and contents of the HUD1 form are constantly negotiation 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 characterized as "dynamic stability." By calling this dynamic stability we seek to emphasize that the policy and regulatory context in which real estate is transacted is far from fixed or unchanging. The evidence makes clear the changes in access to

data about real estate, the shift towards this 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 incredible level of resources being spent to change it. One reason for this is that there are substantial financial gains for any group that is able to tilt the regulatory regime towards their specific interests.

Changes in agents' work and working arrangements

We observe that the structure of agencies and brokerage remain remarkably unchanged over the 15 years of this work. Likewise, the numbers of large and small agencies, of franchise and local operations, and even the number of agents, remains relatively unchanged. Set against this organizational stability, however, is that the agent's work practices have changed in two ways. First, agents have increased their attention to buyers, through the rise in buyer agency. Second, agents have shifted their work practices toward process consultation and provision of value-adding services and away from information intermediation. Both changes to agent's work lead them to being more embedded into the transacting of real estate, bringing them closer to their clients, and altering their working practices (see also Perkins, Thorns and Newton, 2008).

Changes to the technical (ICT-based) system

We summarize the changes to the technical (ICT-based) system in three parts. First, and despite the rise of alternatives, the MLS and federated access to shared data on homes for sale remains a core element. The MLS and its *de facto* standards for sharing data, the basic data structures, and the legacy of practices and social norms around MLS data use provide a platform – an informational infrastructure – for agents, consumers, and value-adding service providers. Second, more of the data being used to support the transacting of real estate is digital. And, more kinds of data are available. This combination is shifting the attention of consumers and agents from information brokerage to information explanation: agents are being asked to help consumers sort out the mounds of data they can now access. Third, and perhaps most obvious, is the growth in the number of forms and uses of ICT. This growth is seen in the individually

selected, but collectively common uses of smart phones and data plans, digital camera/videos, digital lock boxes, personal professional websites, personal computers and software, internet access, increased agency fees to cover the costs of agency-level software, etc. We further note that this growth means that agents are facing a rapid growth in the cost of computing and also a growth in the number of people involved in supplying and supporting computing elements.

Unsatisfactory alternative explanations for changes to the ICT-based technical system

One counter-argument regarding agents' uses of ICT to further embed them into the transactions is collusion: agents are working nefariously and collectively to remain in the transaction. Building from assumptions central to the techno-economic perspective, this seems a logical alternative (e.g., Nadel, 2006). There are four reasons why collusion is a dubious argument. First, evidence shows that the agents have choices about how they embed themselves into transacting real estate, which ICT they opt to use, and how they choose to use ICT. Second, there is no over-riding economic pressure that overcomes this embedding: buyers, sellers (and agents) all benefit from the presence of agents. So, it is not necessarily that embedding is only what agents want. Third, changes in the nature of the transaction means agents have to spend even more time contending with buyers and sellers involved in negotiations: they have more work due to the easier access of consumers to data. Fourth, as noted at the outset, despite constant attention by those holding to the assumptions of the techno-economic perspective, there has been no evidence to support large-scale collusive behavior. Evidence presented here indicates that focusing on the social activities of real estate agents and their uses of ICT provides insights into the transacting of real estate that current techno-economic perspectives cannot.

THEORIZING ON COMPUTERIZATION

The findings illustrate how the services agents provide are enacted via a network of relationships. This enactment is supported by agents' personalized collections of commodified ICT. These collections rely on digital access to housing data and other relevant information in the MLS and other online sites. Agents rely on a combination of mobile devices, computers, and a range of software and other web-based

services. While these collections are personalized, there are remarkably common patterns across agents, leading us to articulate these common patterns of devices, applications and uses as 'digital assemblages.' We observe that the ways in which agents gather together and use various ICT display a high level of functional similarity and remarkable resiliency. The agents rely on commodity ICT products/services and also common access to shared data sources. We theorize below on both the nature of social embedding and the concept of digital assemblages

Social embedding

The focus on creating and using networks of professional relationships helps to define the behavior of the agents, buyers, sellers, and others involved in transacting real estate. These socially-based forms of coordination—such as networks of professional relations—are uniquely different from the de-socialized forms of organizing such as markets and hierarchies that capture most economists', and many real estate industry pundits', interests (c.f. Lie, 1997). As Powell (1990) makes 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 that support economic exchange (e.g., Jones, Hesterly & Borgatti, 1997).

A socially-embedded perspective on computerization focuses attention to the social connections among value-adding players and the resulting network-like social structures that embody these links (White, 1981; DiMaggio & Louch, 1988). The set of concepts that underlie current understanding of social networks are, for the transacting of real estate, more instrumental and focused social ties that are specific to actions, which support a process or particular activity (Wigand, 1988; Burt, 2000).

Evidence indicates that computerization activities to support economic transactions such as buying and selling real estate are about both increasing direct access to data and providing a means to support the social interactions required to transform data into information. The first part, direct access to data, seems to draw far more attention in both the scholarly literature and professional press, to the detriment of the insight derived from understanding the second. The detailed, situated and careful analytic approach that a computerization perspective demands helps to make clear that the sale and purchase of a

house (the fundamental economic transaction that defines the real estate industry) arises 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. Absent this insight, changes in economic action would be difficult to understand or predict.

Digital Assemblages

We introduce the term 'digital assemblages[20]' to as a means to conceptualize the presence and uses of collections of ICT in and for work. Digital assemblage is defined as a recurring pattern of individual choices of ICT artifacts, uses, and purposes. The specific collection of ICT may differ from one person to the next relative to data structures, particular applications, devices and norms of use. However, and despite these differences, the basic form and effect are functionally equivalent and the collections are structurally similar across many individuals. This stands in contrast to the concept of an 'information system (IS),' in that a digital assemblage is not a pre-defined set of functions, features or technologies. Nor is a digital assemblage owned, developed, deployed or governed by some institutional or organizational function. A digital assemblage is personal, and information system is institutional.

Conceiving the collections of ICT used by real estate agents as a digital assemblage, and not as an IS, emphasizes that digitally-enabled work is done by drawing on a number of different computing elements and software-based systems that are neither selected by individuals and may not be well-integrated or formally planned. The design of a digital assemblage is ad-hoc and is only governed to the extent that the individual doing the assembling is making choices. This conceptualization of digital assemblages emphasizes the *ad hoc* but patterned nature of collections.

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[20] We build here on the broader concept of an *assemblage* that has been advanced through contemporary French social philosophy as seen in the work of Foucault, Latour, Callon and others. Our use of digital assemblage draws from this broader view and is not tied to its interpretation and enrollment into actor-network theory. There are at least two other, and equally nascent, uses of the term "digital assemblage." One usage, and closer to the meaning we develop, is that of sociologist Saskia Sassen's (2005) conceptualization. She also draws from the Foucaultian conceptualization of assemblage and uses it to articulate the meso-scale arrangements and institutional inter-connections of global finance. Her view of a digital assemblage emphasizes 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, (2006) and their conceptualization of 'digital formations'). A second meaning for digital assemblages, and more distant from ours, is to represent particular forms of artistic effort that combine traditional and digital media in one piece or showing.

We emphasize four characteristics of a digital assemblage: shared access, structural similarity, functional equivalence, and standardization via commodification. By shared access we emphasize the importance of common access to data critical to the transacting of houses. The MLS, even in the face of nascent competition, serves this role – creating a *de facto* standard data structure and means for common data access. Absent this informational infrastructure, it would be more difficult to advance the digital assemblage concept.

Structural similarity arises from the dual forces of common data and the regulatory framing of the work being done. For example, while evidence shows each of the four elements of a real estate agent's work are changing (and some faster than others), the regulatory stability regarding the process of transacting a house sale/purchase means that agents have clarity as to what they will need to support: the uses of digital forms, constant communication with clients and value-adding others, digital access to important data sources, and support for managing digital data flows. Given these common needs, it is not surprising each agent's collections of ICT are similar.

Functional equivalence is seen in the common patterns of use across individuals' collections of ICT, software and collections of data. 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 ICT, assembled and used in deeply personalized ways, supports the selling and buying of houses without any over-arching design required.

To support assembling this together, one needs standardization. Standardization is achieved partly *de facto* through the structuring of MLS and other data. Standardization is also achieved through commodification that is 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 the uses of commercial software. Standardized products reduce the 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 similar

functionalities, and to tinker 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 conceptualizations of IS, digital assemblages are not based on some set of formal functions and features, they are not subject to overt governance and there is no expectation of collective ownership. Moreover, a digital assemblage is more than a single technological element, making it unwise to focus on specific aspects such as the MLS, or digital lockboxes, or particular software. The digital assemblage conceptualization emphasizes the importance of the relational and collective presence of many ICT, work practices and processes, and the centrality of many types of digitized data. What binds together the digital assemblage in real estate is the regulatory structuring of the industry's core process magnified by the centrality of the communicative practices of agents working with buyers, sellers and value-adding service providers. The digital assemblage is coherent only when seen as a pattern of digital technologies and a bundle of policies and practices.

The digital assemblages in real estate are further distinguished by differences in what is available to agents relative to what is available to buyers and sellers. This creates what are essentially two different arrangements of these digital assemblages: one which agents put together and one which buyers and sellers put together. While these two differing arrangements share common features, in practice these are distinct as they serve different purposes in supporting and shaping the transacting of real estate and are assembled by people pursuing different goals. In the rest of this section we articulate the common elements and then the different components of the agent and consumer digital assemblages.

Like the agent's generic digital assemblage, buyers and sellers focus their digital assemblage primarily on the MLS, to which most also seek other web sites to get data and advice regarding the nature and characteristics of the homes for sale relative to the house's characteristics, the neighborhoods and other aspects of cost and life. The market space of digital information and services provides consumer with the several possibly relevant informational sources which they, in turn, arrange into some sort of assemblage. This suggests that the components and value of a consumer's digital assemblage varies quite a bit, with a core element being MLS access and a functional focus on the search part of the process of

transacting houses. The consumer's digital assemblage is more ephemeral (since buyers and sellers do not engage in this assembling as part of their work). This puts pressure on buyers and sellers to seek clarity and insight from others. A key source for this guidance and clarity is their agent. The agent often serves to disambiguate the information which buyers and sellers are finding—reversing the agent's intermediary role from acting as a gatekeeper to information to being a tutor and guide for making sense of the information and further embedding them into the transacting of real estate.

Contributions and Implications

We advance two contributions: (1) computerization emphasizes the social embeddedness of economic activity – here evidenced by the roles that agents play in transacting real estate. (2) The concept of digital assemblages as a means to conceptualize the patterns of shared and collective uses of commodified ICT – here evidenced by the ways in which agents have taken up a range of digital technologies.

Relative to social embedding, we see contemporary computerization efforts as focused on both providing more access to data and increasing people's ability to comment on, communicate about, and interact with others to co-construct meaning and add new information from what they access. This line of reasoning is reflected in Agarwal, Gupta and Kraut's (2008) admonition regarding the need for more research on the communicative and social nature of online and digital networks. We further note that this insight is consistent with findings from work in related areas such as mortgage brokering (e.g., Markus, Dutta, Steinfield, & Wigand, 2008). Moreover, in our own study of real estate agents' work, we have seen no computerization activities focused to developing workflow systems, increasing production control or automating tasks. More broadly, the enormous popularity of what has been called social software and embodied in iconic contemporary examples such as LinkedIn and Facebook reflect computerization activities directed towards social efforts for finding, sharing and meaning-making efforts around data and information (Ellison, Lampe & Steinfield, 2007).

It seems the increasing degree of access to sources of potentially useful data, combined with the increasing ability to engage others who will (and can) comment on this data, are at the core of

computerization. This is what Schmiede (2006) calls "informatization:" using information can add value; and, in doing so, re-shapes one's understanding of the problem and the ways in which people organize for and work on such problems. Similarly, Dutton (2005) argues that re-configured access to information leads one to rethink the ways in which problems (and work) are engaged. Evidence from our work on the changes to real estate agents' work supports this concept of reconfigured access, re-framed problems, and reshaped working arrangements.

The evidence from changes in real estate over the past 15 years makes clear the computerization of informational work leads to a reconfigured access to data and information. In turn, this reconfigured access changes the nature of, and the approach to resolving, the problem. More than 20 years ago Zuboff (1988) made this point relative to the automation of organizational work, focusing on the increasing access to information for both workers and managers in large and formal organizations. All participants could benefit from increasing access to information, but this benefit is manifested in their ability to use it to advantage: to re-shape fitting the way they do their work. It appears this re-shaping is not an organizational phenomena, it is an informational effect.

Building from the conceptual contribution regarding digital assemblages is the centrality of indeterminacy (e.g., Sproull & Kiesler, 1991; Kling, 1996). That is, many of the specific technological elements of a digital assemblage are (always) in play. For example, the various component ICT being used by agents are evolving, the material resources available online continue to change, the access to data as well as the type and volume of digital forms of this data continues to grow, and there continues to be little integration among these elements. This means that any one agent's digital assemblage relies on both standardized and personalized aspects, and the ways in which these are assembled is quite flexible (Hanseth, et al., 1996).

The functional stability of digital assemblages is a central concept known as stabilization in the literature on SST (see Russell & Williams, 2002). Stabilization is, in practice, an ongoing—a dynamic— process of changes in the socio-technical arrangements (of the digital assemblage in this case) in order to retain functional equivalency. These changes often yield small and path-dependent shifts over time. But,

these changes rarely alter the basic arrangements or functionality of the technical system. A stabilized sociotechnical arrangement is able to absorb changes: it is enduring even as it is evolving. A stabilized arrangement most often has the simple appearance of being settled or static. Sometimes it has the appearance of rapid change. However, more detailed analysis reveal stabilization as both dynamic and evolving and that which may seem to be fixed in design evolves through use (e.g., Hanseth, et al, 1996).

One example of stabilization in real estate is the role and structure of the MLS. A simple observation is that the MLS serves a static role of an information repository. However, closer inspection reveals that the data available via the public MLS sites are changing (mostly with more data becoming available) even as the set of 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 like the MLS is remarkably dynamic given empirical observation.

A second example of stabilization 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 of these communication technologies provides for different levels of access and increases the collective ability of an agent to develop and us their network of clients and professional contacts.

Other forms of ICT currently being used in real estate are not, yet, showing signs of stabilization. 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 geo-location data regarding properties, and increased uses of call-tracking, contact management and other sales/marketing systems. What these examples suggest is that even as some of the more visible and common elements of real estate show stabilization, others are changing in ways that we cannot yet fully understand, much less predict.

CONCLUSIONS

Our work suggests that insights into industry-level computerization activities can be fruitfully developed by focusing on the social activities of that industry's workers. It appears that, increasingly, these activities are emphasizing both access to and making sense of data for others. This attention to accessing and making sense of data is, in turn, leading to changes in both agents' work (the workers in the real estate industry) and its organization. All this is situated in a larger policy and regulatory framework in which practices and norms play important roles. Some elements of these changes are, after 15 years, showing signs of stabilizing, but the effects and implications of much of the ICT uses remain indeterminate.

We also see that computerization's attention to the interdependent roles of the working context, working arrangements and technical system provides analytic and conceptual insight into the social structures and activities that under-gird economic effort. This focus provides an alternative and socially-rich explanation for how ICT, conceptualized here as digital assemblages, are being taken up and used in information-intensive industries. We advance our socially-embedded view as a complement, and sometimes as a contrast, to more techno-economic perspectives.

We expect others might seek to take on similarly detailed studies of other information-intensive industries that are, or continue to be, computerizing such as finance, education, law, education, and national security. Doing so will advance the conceptual structures of computerization and our collective understanding of these complex domains and their activities. Each of these industries have characteristics similar to real estate such as information-intensivity, core work practices that rely on social connections, evolving work contexts and working arrangements, some set of formal regulation, and increasing uses of information and ICT.

In order to better characterize the combinations of work practices, work structures and the uses of ICT, we advanced the concept of digital assemblages. We theorize that digital assemblages are

characterized by common access to shared data/resources, reliance on commodification and standards, structural similarity in terms of components, and functional equivalence relative to practices and norms.

Digital assemblages in real estate rely on the MLS. However, it is the data and information sharing activity surrounding the MLS encompassing email, reporting, phone calls, texting, face-to-face interaction, forms sharing and the extensive interpersonal dialog, which provides the agents the means to use their digital assets to connect with consumers. The social activity of interacting, sharing data, and having meaning-making discussions regarding this sharing of data, reflects the embedding of agents into economic act of transacting real estate and makes clear the agent's digital assemblage is centered on creating mechanisms to support human-to-human interactions.

We anticipate future work will advance the current conceptualization and characterizations of digital assemblages. We expect to see studies expand on, explore and contest our conceptualization of digital assemblage. Likewise, studies that explore digital assemblages at different levels of analysis and in different domains will be valuable. For example, we noted that Sassen (2005) advanced a conceptualization of a global, financial, digital assemblage to characterize the interdependent, global, financial system. Likewise, scholars of policing are beginning to conceptualize the collection of systems, ICT and processes in which police participate as ecologies to make more clear the implications of the substantial complexity inherent to this work (Manning, 2008).

Using digital assemblage as a conceptual frame to better understand the collections of organizational technologies is likely to reveal their coherence for managers and the difficulties faced by front-line workers and serve as an alternative to the techno-economic rationality of enterprise architecture. More broadly, advancing digital assemblages as an alternative to current conceptualization of IS may also encourage debate and conceptual updates to a core concept that is both central to the IS intellectual community and in need of more development.

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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 organizations, 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 organization 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.

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*	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 assoc. 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 organizations	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**	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	

Notes: * Typically, journalists contacted one of the authors to discuss the research.
** 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.

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 assoc. 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 agents and their agencies.
National trade conference	2	
State-level assoc. meetings	4	To discuss licensing and policy issues due to web access and uses of MLS by agents from other associations.
National assoc. 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	

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.

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TABLE 6: SUMMARY OF FINDINGS REGARDING COMPUTERIZATION

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 ICT 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.