Enhancing Remote Participation in Live Auctions: an 'intelligent' gavel

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ABSTRACT

Auctions, both traditional and electronic, are a pervasive social organisation for the valuation and exchange of goods and services. Despite the long-standing interest in integrating internet contributions into the more traditional auction such initiatives have remained problematic. We consider the organization of interaction of sales of fine art and antiques and develop a prototype 'intelligent' gavel system that is designed to enhance remote participation and ease the flexible ways in which internet contributions are legitimately integrated into live auctions. We present the findings of a quasi-naturalistic experiment involving the use of the system by auctioneers and its consequences for the general development of technologies to support internet participation in live co-located events.

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Auctions, social interaction, trust, mundane artefacts

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INTRODUCTION

One of the more surprising developments over the past few decades has been the extraordinary success of the auction. A seemingly simple mechanism that evolved during the Roman times, if not earlier, has survived and continues to be used to enable the exchange of a wide range of goods and services, from livestock to government contracts, from art and antiques to mobile phone licenses. In this regard, the rise and rise of the internet auction, in particular eBay, has had a significant impact on the continuing importance of the auction. In 2007 eBay reported listing 650 million items to the total value of $16bn dollars a quarter. The traditional live auction however remains of some economic importance. For example if we consider art and antiques in 2007, ignoring the significant number of other national and international auction houses, Christie's alone, sold over $6 billion of goods in around only 600 sales. Surprisingly however the Internet and the traditional auction remain largely distinct. Indeed, despite numerous initiatives to introduce on-line bidding into the live auction, there is relatively few contributions from internet buyers and attempts to develop 'prestige' internet auctions, such as eBay's 'Great Collections' have met with little success [6].

The relative absence of internet bidding in live auctions, in particular in auctions of fine art and antiques, cannot simply be attributed to the relative conservatism of either the auctions houses or their clients. Indeed, as early as 1999 Sotheby's collaborated with eBay, Amazon and others to introduce on-line bidding, and whilst there were initial teething problems, over the past decade we have witnessed the wide-spread deployment of systems to enable internet contributions to the live auction. Moreover, with the flourishing of contemporary art, the emergence of the new 'international' buyer, and the widespread availability of a range of mobile technologies and novel types of electronic auction systems, one might expect a significant increase in internet participation in sales of art and antiques. This has not been the case; the commission bid and the telephone remain, by far, the most prevalent way in which those that do not attend a sale, participate remotely.

In this paper we discuss the development of a system that is designed to address a number of the issues or problems that arise with the integration of internet contributions into the conventional auction. Drawing on wide-ranging studies of the organisation of social interaction at sales of fine art and antiques, in the UK and abroad, including North America, we focus on two critical issues that underpin auctions: firstly the selective ordering of bids and the rapid escalation of values, and secondly, the visibility, transparency, and legitimacy of bids and bidding. In developing the system, we were keen to preserve the ecology of the saleroom and exploit the conventional objects and artefacts that are used by auctioneers to interact with participants and establish the

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sale of goods. The hammer or gavel is critical in this regard, and our system is designed to enhance the gavel and the actions it is naturally used to perform. Before presenting our system and its evaluation in a naturalistic experiment, we discuss some of the key issues that arise in the organisation of conventional auctions and the introduction of internet bidding.

BACKGROUND

Auctions and auction mechanisms have been topics of long-standing interest in the social sciences, in particular in economics and econometrics (for overviews see [10, 11, 14]). Despite the substantial contribution of this research, the ways in which auctioneers, in collaboration with buyers, deploy particular mechanisms and thereby enable legitimate exchange of goods remains neglected. There is a small, but important, corpus of ethnographic studies of auctions. These studies in various ways demonstrate that auction mechanisms rely upon a social organization: common assumptions and beliefs, occupational cultures and communities of practice [4, 5, 12, 19]. However, these studies pay little attention to the ways in which auctioneers in concert and collaboration with buyers, elicit, juxtapose, arrange and legitimize bids. And yet, in seeking to explore how we can create affinities between the internet and live auctions, the ways in which bids and bidding are contingently managed within the practicalities of a sale would seem critical to understanding the problems that arise with regard to current systems and the design and deployment of appropriate solutions.

In this regard, it is worthwhile mentioning the substantial corpus of research, once again primarily within economics and econometrics, that addresses online auctions and the design of auction mechanisms (for an overview see [15]). This research points to some of the significant issues and problems that pervade online auctions, some of which arise by virtue of the design of particular auction mechanisms. Take for example shill bids, bids made by 'confederates' of the vendor to inflate prices, and how they are facilitated through the use of multiple identities. Or, consider the ways in which the 'hard close' favoured by many online auction houses such as eBay, has an important impact on the timing of bids and the opportunity to 'snipe', strategically submitting a 'last second' final bid to secure the goods [8, 9, 16, 17]. As these and more sociological studies suggest a major issue for online auctions, like conventional sales, is trust in the integrity of the process: that bids are actual bids on behalf of genuine interested parties. Online auctions have progressively introduced various mechanisms and rules in efforts to establish trust in vendors, the integrity of bids and the legitimacy of the process. When, attempting to integrate internet contributions within live auctions, issues of trust and legitimacy once again emerge.

In identifying the gavel as a critical artefact that might be enhanced to resolve issues that arise when internet bidding is integrated into traditional auctions, we draw on recent developments in ubiquitous computing [20]. Here everyday objects as diverse as badges, chairs, desks, pens or pieces of paper have been enhanced with computational capabilities to support particular activities. There has been recent interest in how such developments might support collaborative activities, particularly public performances and events [2, 3]. Auctions offer distinctive challenges, not only are they fast paced, involving intense activity, with the sale of each lot lasting little more than thirty seconds, but they can have significant financial consequences for the participants. They have to be managed, and have to be seen to be managed, in a transparent and legitimate manner. In this and other respects auctions pose significant demands on new technologies and the ways in which they enhance participation and engagement both local and remote.

This paper draws from a substantial corpus of video-recordings of auctions of fine art and antiques gathered in the UK, mainland Europe and the United States, both in large international and regional auction houses. We have augmented these by fieldwork and interviews with participants. The analytic approach we adopt draws on ethnomethodology and conversation analysis and the growing corpus of 'workplace studies', where we consider the situated, interactional and multi-modal accomplishment of activities.

ORDERING BIDS

At sales of fine art and antiques, an auction may include more than 800 lots in two days, and it is not unusual for auctioneers to sell more than 100 lots an hour. At any one time there may be up to a hundred people at an auction, many who are potential bidders for the goods that come up for sale. There may also be a number of people who have booked telephone lines with the auction house to bid through sales assistants on particular lots, and others who have registered to bid through the Internet. The auctioneer, in cooperation with bidders, has to deploy an organisational arrangement whereby the potential contributions of multiple participants, who may have very different ideas of the value of the object, are organised through an orderly sequence of turns, where those turns, to corrupt Sacks, Schegloff and Jefferson [18] are 'valued'. literally in this case. We have simplified the transcripts and represented bidding by numbering particular bidders in the order they enter the bidding for example [B.1] for bidders based in the room or [SA.1] for the sales assistants representing those bidding over the telephone. Times are shown in brackets in seconds, with micro-pauses of a tenth of a second less given as '(.)'. The following is a fragment of an auction from a recent sale of Old Masters.

Fragment 1 (abbreviated)

A: Lot Twenty Two (2.1) Argh:: Lot Twenty Two (1.0) The studio of Anthony van Dyck (2.1) a:::n::d (2.1) <fifteen thousand to open it (0.3) At fifteen thousand

pounds. (0.3) [B.1] At sixteen thousand I see, already. At sixteen thou:sand in the room. At sixteen thousand pounds: (0.2) At sixteen, standing. [B.2] Seventeen thousand (.) [B.1] Eighteen thousand (0.2) [B.2] Bidding? Nineteen thousand [B.1] Twenty thousand (0.2) [B.2] Twenty two thousand……

A: Forty two thousand (0.2) [B.2] Forty five thousand (0.2) [B.1] Forty eight thousand (0.4) [B.2] Fifty thousand (0.2) [B.1] Fifty five thousand (0.4) [B.2 withdraws] At fifty five: thousand. Standing at fifty five thousand [B.3] Sixty thousand (0.2) [B.1] <Sixty five thousand (0.3) [B.3] Seventy thousand (0.2) [B.1] Seventy five thousand…….

A: At ninety thousand pounds (0.5) Coming in lots of places. (0.2) [SA.1] Ninety five thousand (.) with Susan (0.5) [B.3] One hundred thousand (2.3) [SA.1 withdraws] >At one hundred thousand pounds (0.3) [B.4] <One hundred an ten thousand (1.2) [B.3] One hundred and twenty thousand (4.2) [B.4] One hundred and thirty thousand (2.3) [B.3] *One hundred an forty thousand (4.2) [B.4 withdraws] At one hundred an forty thousand…[SA.2] One hundred an fifty thousand. (13.5) [B.3 withdraws] To Jane now … At one (.) hundred (.) an fifty (0.2) >thousand pounds (0.2) {**Knock**}

Irrespective of the values that potential buyers may have in mind, following the introduction of the lot and its description, the auctioneer structures bidding in terms of a series of increments that remain stable through certain values, in this case increments of £1000, of £2000 and £3000, £5000 and then £10,000. With only one bidder remaining, the painting is sold, on the fall of the gavel or hammer, at £150,000, ten times its opening price. Once the incremental structure is established, it projects the series of values that enables the price of goods to be rapidly and transparently escalated; participants bidding at the projected next value that is announced by the auctioneer.

In Fragment 1 a total of six different participants successfully bid. There are other potential buyers who attempt to bid but are excluded from contributing. At any point the serial escalation of price does not involve numerous bidders, but rather the successive contributions of two participants. In receiving a first bid, the auctioneer identifies a second potential buyer, takes a bid at the projected next increment, and returns to the original bidder to invite the next bid. The escalation of price is based on a procedure known as the 'run'. The auctioneer establishes, or seeks to establish, *two bidders and no more than two bidders at any one time*. The run provides the auctioneer with a way of establishing direct competition between two principal protagonists. It also provides a resource for disregarding the potential or actual contributions of others that if acknowledged, would disrupt the flow and rapid escalation of the price. As the first fragment reveals, the participation of further bidders is postponed until one bidder withdraws. At that place, the auctioneer undertakes a search to identify a new bidder to replace the participant who has withdrawn. When the auctioneer fails to find a new bidder then the goods are sold, if they have reached the reserve; that is, the lowest price that the vendor is prepared to accept for the goods in question.

In establishing a run, the auctioneer not only projects a series of increments and distributes those increments between two specific bidders, but also establishes the pace, a rhythm at which bids are elicited and voiced. The pace and rhythm varies between bidders, different types of auction and the auctioneer's ability to encourage potential buyers to respond to projected increments with dispatch. It is not unusual for bids to be elicited and voiced, especially if they are taken from participants in the room, in less than half a second and that pace may be sustained over a run involving more than ten bids. In this regard, bids via the telephone represented by sales assistants can be particularly problematic. They can significantly extend the time it takes to elicit a bid and undermine the ability of the auctioneer to pressure the bidder to bid and bid with dispatch.

The pace, rhythm and the evenness of bidding therefore is of some importance, not only to sustain the involvement and commitment of potential buyers and the audience as a whole, but also for the inferences that auctioneers and potential buyers can draw concerning the commitment of others to remain in the bidding for a lot.

REVEALING THE SOURCE AND INTEGRITY OF BIDS

It has long been recognised that sales by auction are subject to the possibility of corruption and in particular that the price of goods can be unfairly increased by the placement of fictitious bids. It is in the interest of both the auction house and the vendor that the highest possible price for goods is achieved since it maximises both the number of goods that are sold, that is reach their reserve and the revenue that is received (for instance up to 25% of the sale value from both the vendor and buyer). With auctions commonly acknowledged as one of the purest forms of market activity where immediate demand constitutes the price and value of goods, and enables their exchange, then it is critical that bids are, and are seen to be, genuine bids on behalf of actual potential buyers or their representatives.

Auctioneers go to some trouble to reveal the source and integrity of bids. In some cases for example, in particular when a new bidder enters the bidding the auctioneer will explicitly describe the location of the participant (e.g. 'at the 'back of the room') or name the sales assistant handling a remote bid. More commonly however, and in particular as a run develops, the auctioneer's bodily and visual orientation, coupled with his or her gestures, display both to the bidders themselves and all those gathered in the saleroom, the location and source of the bid and reproduce the procedure, 'two and no more than two bidders at any one time'. In this regard, auctioneers not infrequently point

with the gavel towards the particular participant when announcing the bid. Indeed, pointing is critical to the ways in which auctioneers reveal the source and integrity of the bid.

Bids from those in the saleroom, via the telephone or over the Internet, are not the only source of bids received by the auctioneer. Buyers who are unable to attend the sale may leave bids on commission with the auction house. Commission bids are the highest price that the buyer is prepared to pay for a particular lot. At his or her discretion, the auctioneer then bids on behalf of the potential buyer until the lot is secured or the commission is beaten by a bid in the room or on the telephone. Less commonly known, at least outside the trade, auctioneers may also bid on behalf of the vendor up until 'one increment below the reserve'. Commission bids and the reserve prices are documented on the sales sheet or auctioneer's book that lies on the podium accessible only to the auctioneer.

Commission bids, and the possibility of bidding on behalf of the vendor, are important resources for auctioneers. They provide the auctioneer with the opportunity to establish a run and escalate the price where there is only one bidder, or in some cases, where there is no bidder at all. However, the 'invisibility' of the source of the bid, a bid that is neither apparent in the room nor on the telephone, coupled with the fact that the auctioneer has an interest in maximizing the value of the goods, can raise doubts concerning the legitimacy, even existence, of particular bids and whether the final price and sale of goods reflects genuine demand.

1.1 1.2 1.3

Figure 1: Auctioneers taking bids from the room (1.1 and 1.2) and taking a commission bid from the book (1.3)

Auctioneers attempt to ameliorate the questions of legitimacy and trust that are posed by bidding on behalf of sellers and absentee buyers in a number of ways. Firstly, a price left on commission, or the reserve price, is ordinarily decomposed into a number of increments and only serves to escalate the price where a second bidder, for example, in the room or via the telephone, is found. Secondly, bids on behalf of sellers or absentee buyers, are routinely taken at the beginning of the sale of a particular lot; they are not idiosyncratically introduced wherever the auctioneer appears in need of a second 'bidder' to establish a run. Thirdly, auctioneers display to all those present that bids are being placed on behalf of an absentee buyer, for example by explicitly announcing the source of the bid 'on commission', 'with me', 'my buyer', and/or pointing to the book or sales sheet when the bid is taken. Indeed, visibly pointing to the sales sheets when announcing a bid from commission is a pervasive way in which auctioneers reveal the source and legitimacy of the contribution.

INTERNET BIDDING AT AUCTIONS

Over the last five years or so we have witnessed the introduction of internet bidding to live auctions of fine arts and antiques. The most common form of system, with variants used in the Europe, North America and the Far East, enables a buyer to register with the auction house and as the sale proceeds bid on any lot. For example, in the UK many auction houses use the system known as 'the-saleroom.com' provided by the trade journal, the Antique Trade Gazette. The remote participant is able to gain information concerning lots, listen to the live auction, and bid if they so desire. In the saleroom, the system is operated by an administrator, who is responsible for entering data (including the current price) and when appropriate inform the auctioneer of internet bids. The administrator is normally positioned alongside or close to the podium.

Even with the widespread introduction of these systems, the number of internet bids received by auction houses during a sale in the UK remains relatively small. In our data rarely more than 10% of the overall number of lots. It should be added that demand to bid by telephone, via a sales assistant, has, if anything, increased over the same period; an anomaly also recognised by the auction houses and that is seen to deserve some explanation. The current systems are quite simple to operate, they provide relevant information to bidders concerning both current price and when to bid, and pass bids to the auctioneer through the administrator. However their operation is not entirely unproblematic.

Internet bidders can be slow in issuing bids and this can undermine the auctioneer's ability to establish a run, maintain a rhythm or pace of bidding and in some cases the final valuation and sale of the goods. For example, we find that if runs are established between a room and am internet bidder, they rarely involve more than four or five bids. Secondly, the average time it takes to issue internet bids in our data using 'the-sale-room.com' is approximately four seconds but in some cases it can take up to ten seconds to secure the bid. Moreover, even with the same buyer within the run, there is significant variation in the time it takes to secure bids. Thirdly, the sale of a lot that involves internet contributions routinely takes significantly longer than those involving the room and telephone.

In consequence, we find that auctioneers tend to postpone taking internet bids until they have exhausted interest (except for say one potential buyer within the room) and it is rare to find successive runs that involve participants both from the room (or telephone) and the Internet. Moreover, delays in the issuing of bids and the ways in which this undermines the pace of the sale, can cause significant frustration amongst participants within the saleroom. It also

leads to some suspicion when bids appear to arise 'out of the blue' without any previous indication that there is a potentially interested party waiting in the wings. For the remote bidder, their limited access to action in the saleroom can make it difficult to anticipate when they should bid and whether they are being 'run up' by the auctioneer taking fictitious bids.

The following fragment exemplifies one or two these problems. On bringing down the gavel, the Internet Administrator (IA) indicates to the auctioneer that there may be a bid on the Internet. He reopens the sale of the lot, accepts the internet bid and attempts to elicit a further bid from the room. The goods are finally sold to an internet bidder at £180.

Fragment 2 (abbreviated)

A: at one sixty is all that I'm bid one eighty now one eighty now then sixty all ( ) and done now at a hundred and sixty, {**Knock**}

IA: ((Gestures at screen))

A: Oh (.) I can do one eighty is that a one eighty bid yes? (.) on the Internet one eighty and I'm waiting↓ one eighty yes or no? on the Internet one one sixty I cannot sell

IA: Yes

A: one eighty is the bid one eighty is on the Internet one eighty one eighty one eighty one eighty (.) with the Internet now (.) at a hundred and eighty pound the next bid is two hundred (.) if anyone is interested (.) at one eighty on the Internet **{knock}**

There is an interesting development that may help ameliorate one or two of these problems; the introduction of video that enables the remote participant to see as well as hear the auctioneer. Christie's have progressively introduced the system over the past couple of years and 'the-saleroom.com' plan related developments in the next few months. Our initial observations of the operation of these systems suggest that the remote bidder is more able to produce timely and relevant contributions to the sale, and we have reports that they experience a stronger sense of presence. However, whilst enabling bids to be elicited and issued with more dispatch, the participation of remote bidders remains less than transparent to those within the room. Bids that are inaccessible and invisible to those gathered within the room are taken by the auctioneer and serve to escalate the price of goods. Delays do continue to arise and internet bids thereby undermine the pace of the sale and frustrate those that have taken the trouble to attend the auction. It should be added that despite the sophistication of the systems that provide video as well as audible and textual access, the telephone, coupled with leaving commissions, remain the most pervasive ways in which buyers participate remotely.

In general therefore, despite the widespread deployment of systems to enable remote bidding at traditional auctions, a number of significant problems and issues remain. These, in part. explain why relatively few lots in auctions of fine art and antiques involve contributions from (or sales to) internet bidders. Our technical developments are aimed at addressing one or two of these difficulties and exploring ways in which we can enhance the sense of presence and participation of remote bidders in the live auction.

ENHANCING REMOTE PARTICIPATION: A NATURALISTIC EXPERIMENT

Drawing from our field studies and discussions with auctioneers and buyers, there were a number of key considerations that informed the design of the system. These include: (i) enabling the flexible integration of internet bids into the sale at any point, (ii) enhancing the pace and rhythm with which internet bids could be elicited and acknowledged, (iii) providing both remote and local participants with a stronger sense of the presence and the actions of each other, (iv) enhancing the visibility and transparency of remote and local contributions, and (v) preserving the anonymity that is associated with remote contributions, be it via the telephone or Internet. Alongside these, we were keen to preserve the conventional ecology of salerooms and enable participants to use the familiar objects and artefacts that pervade auctions.

In this regard, here are three key elements to the system; (i) an 'intelligent' gavel that enables auctioneers to point to and take bids from remote participants, allowing direct, interaction with people bidding through the Internet, (ii) an 'intelligent' paddle that enables remote participants to bid at the current price and (iii) two large screens placed within the 'saleroom' to one side of, and visible to, the co-located buyers, each screen displaying an avatar, a simple graphical figure representing the internet buyer and the movement of the intelligent paddle. In many cases in the real auction, remote participants are eager to remain anonymous. Consequently, in this experiment, we employed an avatar instead of showing the video image of the remote buyer.

The gavel is augmented with a small magnetic Polhemus 120Hz FASTRAK sensor. This allows us to track the position (X, Y, and Z Cartesian coordinates) and orientation (azimuth, elevation, and roll) of the gavel. A magnetic emitter placed on the rostrum in front of the auctioneer allows us to detect the orientation of the gavel and we developed software that computes this even if the auctioneer holds the gavel by its head and points with its base (as in fig 1.2). When the bid is accepted, by pressing a button, the background to the avatar turns from green to red. The button is required so that the acceptance of a bid by the auctioneer can be displayed to all the potential buyers, both remote and in the saleroom.

Remote participants use an 'intelligent paddle' to bid at the current price, which they do by raising the paddle. The

paddle is equipped with a one-axis accelerometer to detect this movement. A unidirectional video and audio connection from the saleroom to the remote site allows the remote buyers to observe and hear the auctioneer, the cameras are placed close to the avatar display to present the appropriate view for the remote participant. When the remote bidder raises the paddle, the avatar also raises its hand. If the auctioneer uses the gavel to point to the remote bidder the background colour turns green, and if he accepts the bid it changes to red. We also provide the remote bidders with software that gives about the lot and the current price, similar to that displayed in the saleroom.

In this experiment, we used two displays (of different sizes), one for each avatar, the size of each projected avatar being adjusted so that it was almost life size. These screens were on the right side of the auctioneer, along the wall. Participants in the auction room sat on the left of the auctioneer so that they could observe both auctioneer and avatars.

Figure 2: An image from the experiment when both internet bidders (IB.1, left and IB.2, right) were bidding, and when IB.2 has been selected. The Intelligent Gavel is being held in the right hand of the auctioneer.

Figure 3. The Intelligent Gavel

We decided it would be premature to attempt to introduce the system into an actual live auction. However, we were keen to test the technology in a challenging situation that was as close as possible to a conventional sale. We secured the agreement of two professional auctioneers to participate in an experimental auction within our own premises and recruited about 30 potential buyers: members of staff, postgraduate and undergraduate students. We prepared the appropriate materials for the auction: a detailed catalogue listing lots of various types and their estimates (based on recent sales of art and antiques) and sales sheets for the auctioneers documenting lot numbers, estimates and commission bids. We gave each bidder a fixed sum of £1500 to spend on lots of their choosing.

We decided to provide two methods of bidding. In the first the remote bidders bid at each increment. In the second, they enter their maximum price and the system bids automatically on their behalf, similar to proxy bidding in eBay. In the latter case, the hand of the avatar, remains raised until it reaches the participant's maximum price.

We video-recorded the event using several cameras and microphones, enabling us to analyse the conduct of both bidders and the auctioneers. Immediately after the event we also undertook a series of open-ended interviews and debriefings with the bidders (room and on-line) and the auctioneers, to explore their immediate reactions to the experiment and the system. For the analysis we transcribed a proportion of the data and also quantified a series of actions and events

We were pleased that both auctioneers and the potential buyers found the experiment realistic. Indeed, the auctioneers went to some trouble to structure and pace the event to establish the sense of urgency and competition of a conventional auction and our buyers entered into the spirit and intensity of the event. We will consider some of the more important findings, the contributions and shortcomings of the system.

Ordering Bids

The system appears to enable the auctioneer to efficiently and flexibly take remote bids at any stage within the sale of particular lots. The auctioneers establish runs among participants in the room, between participants in the room and on the Internet and also between the two internet bidders. We find that 32 of the 40 lots involve an internet bidder; and 11 of those involve runs between the two internet bidders. In the following fragments B.1 represents a room bidder (in the order of first entry) and IB.1 or IB.2 and internet bidder (sometimes referred to by the auctioneers as 'Screen A' or 'Screen B'). In Fragment 3 after a late contribution from the Internet (IB.1) the auctioneer re-establishes a run between IB.1 and the room.

Fragment 3

A: …Seven hundred are you bidding that, sir? (B.1) seven fifty (B.2) eight hundred is there in the room? Yes or no? Eight hundred (B.1) Eight fifty eight hundred your bid at eight hundred pounds at the back its eight hundred pounds the bids the:re at eight hundred pounds (.) last chance (.) at eight hundred pounds being sold then at eight oh God hh… eight hundred Eight fifty is now? eight hundred, eight hundred and fifty pounds (IB.1) its eight fifty on the internet eight nine hundred pounds (B.1)...

Just as the auctioneer is about to bring the gavel down (on 'at' in 'being sold then at eight') and end a run between two room bidders, he notices a change in the avatar indicating a

bid from the Internet. He turns to the screen, uttering 'oh God…". and accepts the new bidder, establishing a new run between the internet bidder and a participant in the room. The bidding then continues for more than half a minute. Bidding therefore that had reached near completion after 30 seconds is expanded and eventually brought to completion after 73 seconds following a lengthy and rapid series of runs involving both room and Internet bidders. In the following fragment a brief run emerges between two internet bidders.

Fragment 4

A: Seven fifty (IB.1) Eight hundred (B.2) (.3) Eight fifty (IB.1) Nine hundred (IB.2) (.5) nine hundred on screen B Nine fifty (IB.1) nine fifty on screen A, at nine fifty (.3) one thousand one thousand on screen B. (IB.2) at one thousand pounds on screen B. one thousand and fifty (B.3) one thousand and fifty Eleven hundred (IB.2) thank you (.3) eleven hundred pound eleven fifty (B.3) eleven fifty's the lady's bid in the room…

When one internet bidder (IB.1) withdraws, it is followed by a run between the other (IB.2) and a new bidder in the room (B3).

The ability for internet bidders to participate at different places within the auction generates extensive bidding involving a range of participants within successive runs. We find therefore that the auctioneers were able to use the system to seamlessly alternate between internet bidders and bids from the saleroom and that the ease with which they could recognize and select internet bids allowed remote contributions to be juxtaposed with co-located contributions at any stage within the proceedings. It was not, for example, unusual for the auctioneer to return to take bids from the room following a run involving the remote bidders.

The findings suggest that with regard to the integration of remote internet bids into the co-located auction the Intelligent Gavel compares favourably with systems currently used by auction houses. In conventional auctions, auctioneers largely postpone taking internet bids until they have exhausted competition in the room and only one bidder remains. The sale is then brought to conclusion when one of the participants withdraws. With the Intelligent Gavel the auctioneers are more able to establish runs involving bids from the Internet at any stage of the proceedings. Indeed, the auctioneers managed 13 transitions from a run between a bidder in the room and a bidder on the Internet, to a run between participants who were both in the room. There is no significant difference whether remote bidders use proxy bidding or not, we find 6 transitions from the Internet back to the room when they use proxy bidding, and 7 transitions when they bid at the next increment.

The timing of transitions between runs does, however, differ according to whether the bidder is located in the room or on the Internet. Transitions between runs in the room are conducted within 1 second and transitions from the room to the Internet take approximately 2 seconds, with the exception of four very long delays in the selection of the next internet bidder. These long delays largely arose during the sale of the first few lots when the auctioneers were becoming familiar with the use of the system and in particular registering the bid when they used the gavel to point at the screen.

Pace and Rhythm

Auctioneers are able, with the Intelligent Gavel, to establish runs that have a pace and evenness of bidding equivalent to that found in the sale of lots in conventional auctions where there are no contributions from the telephone or the Internet. These include runs that consist of bidders in the room and on the Internet as well as runs that solely involve the two internet bidders. For example, we find runs involving remote participants that include a series of bids that are issued and accepted in less than one second and maintain an evenness of bidding. For example in the following fragment, the auctioneer establishes a run at 'four eighty' and rapidly increases the increments with the time between bids approximately equivalent to bids taken from the room.

Fragment 5

A: Four forty is here, four forty, four twenty, four forty, four sixty now do I hear? Four sixty (B.2) four sixty four eighty is it now? (1.6) Four eighty (IB.2), four eighty there four eighty? four eighty (B.2) (.5) Five hundred (IB.2) Five twenty? (.5) five twenty (B.2) (.5) five forty? (IB.2) Five forty (.8) Five sixty now, (B.2) five sixty …

Overall however, we do find that contributions from the Internet take longer than those from participants within the room. Indeed, if we take the overall average time of taking individual bids from the room and the Internet in the two conditions, we find that internet bids take on average between 2.0 and 2.8 seconds, as opposed to those from the room between 1.0 and 1.4 seconds. Even if we exclude the lots at the beginning of the sale, we find that on average internet bids take longer than bids from the room. There are a number of reasons for these delays. First and foremost, auctioneers did continue to have occasional difficulties registering the internet bids with the gavel, in particular when they moved away from the podium. The extent of these movements had not been anticipated in the calibration of the gavel. Secondly, despite their visual and audible access to the auction, Internet bidders could be slow in producing the next bid, particularly when they did not use the proxy bid mechanism. The auctioneer would then have to repeat the request to elicit the bid. In some cases auctioneers considered the internet bidder to have withdrawn and would go on to find a new bidder, only then to find the remote participant issuing another bid.

Proxy bids did appear to ameliorate some of these difficulties and delays. The auctioneer is able see in

advance of taking the bid whether the remote bidder remains an active participant, and can turn and take the bid often with dispatch. The following fragment exemplifies the smoothness with which transitions between runs are managed with proxy bidding. The avatar raises its hand at five hundred pounds and the auctioneer takes the first bid from the Internet bidder at eight hundred following the withdrawal of B.2. There is a split second delay in announcing the first bid from the Internet, but from then the pace and evenness of bidding is rapid and involves no delays or perturbations; indeed there is no noticeable gap between the announcement of each successive bid.

Fragment 6

A: Seven sixty (B.2) seven eighty (B.1) seven eighty (B.2 withdraws) I'm bid eight hundred (.) (IB.1) eight twenty (B1) eight forty (IB.1) eight sixty (B.1) eight eighty (IB.1) nine hundred (B.1) nine twenty (IB.1) nine forty (B.1) nine sixty (IB.1) nine eighty (IB.1) one thousand (B.1.) ….

Whilst the auctioneers largely managed transitions between runs smoothly and evenly, especially where proxy bidding was used by the remote participant, the sale of each lot took on average 78.3 seconds, significantly longer than the average time it takes to sell lots in conventional auctions (that do not involve internet contributions). The excessive time it took to sell each lot was due to two main factors: (i) the initial difficulties in using the gavel to register the bids, and (ii) having to set a fixed incremental scale in the system for the sale of all lots. This meant that prices rose by small increments and extended the time it took to sell the each lot. However, the flexibility, pace and evenness of integrating internet bids into the sale of each lot compares favourably with current systems used in conventional auctions.

Visibility and Witnessability

The way in which the gavel requires the auctioneer to point to, and register bids, coupled with screens that show the presence of an internet buyer and their bids, appear to make an important contribution to both the coordination and integrity of remote participation within the live auction. Unlike all current systems, as far as we are aware, all participants in the room including the auctioneers, assistants and potential buyers, have the same access to the remote participants and their actions in bidding or not bidding. In consequence, not only is the auctioneer able to directly assess the contributions of the remote participants, but potential bidders in the room can also see the conduct of the remote participants and act accordingly. So for example, in seeing an avatar indicating a bid, a buyer in the room might withhold their attempt to bid until after the completion of the next run. Or, seeing the auctioneer have difficulties registering the internet bid, a bidder in the room might persist with an attempt to enter a run, believing, in some cases correctly, that the auctioneer will take the more immediately accessible contribution. In other words, the mutual, but limited accessibility, within the saleroom to the conduct of the remote participants, provides an important resource for the timely production and coordination of actions, in particular bidding.

The visibility of the gavel's use to those within the saleroom, in pointing to and acknowledging bids, coupled with the participants' access to the different states of the avatar, namely the presence of a remote participant, an attempt to bid and a successful bid, also perhaps, contributes to revealing the legitimacy of internet contributions. The participants within the room, are not only able to witness the remote participant bidding, but to see whether the auctioneer accepts that bid. The transparency of Internet contributions and the ways in which they form part of the run, the escalation of the price and the final of sale of goods enables those within the room to believe that they were genuine contributions on behalf of actual buyers.

The system, however, only provides the auctioneers with partial access to the participation of the internet bidders. They can see the avatar, a bid, and the registration of that bid, but cannot see the remote buyer and draw more subtle inferences concerning their behaviour. For example, whereas an auctioneer can look at a participant within the room and tell whether they have definitely withdrawn or are hesitating in bidding, with remote buyers this information is not available. In consequence, for example, the auctioneer on occasions will repeatedly attempt to elicit a next bid from a remote bidder, not knowing whether he or she has definitely withdrawn or is hesitating. With proxy bidding these difficulties do not arise, since the 'arm' remains active throughout a series of increments and once dropped it clearly displays the withdrawal of the participant.

The scale and position of the screens also raises certain issues. We found that at times, the auctioneers are distracted by persistent internet bidders attempting, for example, to enter an existing run and that on occasions at a transition, auctioneers would inadvertently select an internet bidder over a buyer in the room, since the bidding action was so highly visible. We also notice that participants in the room are drawn to watch the internet bidders and at times appeared to withhold their attempted entry into a run if they saw a remote buyer attempt to bid.

For the remote participants however, the situation is rather different. In the current configuration they have restricted access to the event, distinct from the auctioneer and participants within the saleroom. They have access to the escalating price of the lot and bidding opportunities, can hear the auction and see the auctioneer, however they cannot see the participants within the saleroom. In consequence, they remarked that they were sometimes unsure whether their attempts to bid had not been noticed or were being ignored. On occasions, for example, remote participants would repeatedly attempt to bid when a first

attempt had been ignored and lacking visual access to what was happening in the room could be slow in making a bid and thereby securing their entry into a run. The problems that arise for remote bidders, that can serve to undermine their participation in the sale and in some cases lead to question the legitimacy of the process, require further attention. Indeed, it is widely argued that current systems in use, even those that provide visual access to the auctioneer, can inadvertently serve to disadvantage the remote participant.

DISCUSSION AND FUTURE DEVELOPMENTS

The auction whether it is a traditional event or on the Internet, remains an important mechanism for the valuation and exchange of a broad range of goods and markets. The Intelligent Gavel aims to address the issues that have emerged when auction houses have attempted to integrate internet bidding within the traditional live event.

The response to the Intelligent Gavel and the system as a whole from the auctioneers and 'buyers' was positive. The system goes some way to enable the flexible and efficient introduction of internet contributions into the live auction and provides the auctioneer with a way of integrating remote and local contributions moving seamlessly between the room and the Internet. The avatar displays provided buyers with a sense of the presence and participation of the remote bidders and, coupled with the gestured use of the gavel, renders visible, witnessable, the auctioneer's conduct. The results compare favourably with the current systems in use in the auction houses. However, there are shortcomings to the system including: difficulties that arise in registering bids with the gavel; inflexible increment scales; limited access to the sale-room for remote participants; and the scale and position of the avatar displays over-emphasizing the presence and demands of remote bidders. Despite these shortcomings, the system is useable, relatively robust and provides a environment that enhances the sense of presence and participation of remote and co-located buyers in the auction process.

A number of these difficulties we believe can be addressed and resolved, not least of which is the calibration of the remote gavel. We also believe that it is relatively straightforward to provide remote participants with enhanced visual access to the saleroom and visible actions of bidders. Some interesting question arise as to how to display internet bidders and their actions, during the sale. Avatars enable the anonymity of remote participants to be preserved, and monitors displaying two different participants allow the contributions of the two principal protagonists during a run to be shown. However, it may the case that in scaling the system for a real application it may be helpful to show, in some graphical or iconic form, all internet bidders that are registered to bid at the sale, as avatars, indicating only the active, bidding participants at any one time. Interestingly, we gather informally that one of the current leading auction system providers is exploring a similar possibility. We are in discussions with an auction house to deploy and evaluate the more sophisticated system we will develop at a live auction of fine art and antiques.

Auctions present distinctive challenges for the deployment of advanced technologies. Auctioneers have to rapidly establish the valuation and exchange of numerous goods at any sale - up to 400 or 500 in one day. They have to efficiently elicit bids from a broad range of possible sources, from commission, the room, the telephone and the Internet, and deploy an arrangement that orders these contributions and enables the efficient escalation of price; an arrangement that is transparent, visible and witnessable. We focussed on developing a technology that would be sensitive to these demands whilst enhancing the involvement of remote participants. In common with developments in ubiquitous computing [20], we chose to augment an everyday object that is familiar to participants in the setting and critical to the organisation of the event. In particular, whilst the gavel is known for the way in which it finalises bidding and in many cases marks a sale at auction, our studies revealed its importance, with gesture, in eliciting and ascribing bids during the sale. The gavel, in concert with talk and bodily conduct, serves to render visible and structure the specific contributions of particular participants amongst many both present and remote. We sought to draw on these observations to enhance the gavel, to enable this small wooden hammer to elicit, acknowledge and reveal bids from remote participants as well as those gathered in the same space, Although successful in the ways that it enabled auctioneers to naturally accept and reveal bids, we can begin to see the complexities that arise in attempting to enhance even the most simple of mundane objects. For example, seemingly small variations in the ways in which the auctioneer holds and points with a gavel, his position and movement at the podium, and the scale and position of screens, all had a significant impact on the efficiency of the device. Despite extensive analysis of auctions and even the use of the gavel, we can begin to see how much (more) we need to know about the activity's accomplishment to enable us to design and deploy a robust and useable system.

In recent years, there has been a growing interest in developing technologies that support and enhance participation in activities that involve numerous participants. These include for example theatre, multi-user game, even art installations and in some cases are designed to encompass contributions from both remote and co-present participants [1-3, 13]. An important challenge in these developments is supporting and enabling the highly variable and contingent participation that arises within these forms of event. Auctions are interesting in this regard and perhaps provide more general lessons as to one way in which we can begin to find 'solution' to seemingly intractable socio-technical problems. Within auctions, and

one suspects other forms of multiparty event, a highly efficient and seemingly robust social and interactional organisation has emerged over some centuries that enables the concerted and accountable production of the activity. This organisation provides a mechanism that orders and structures participation, contingently allocates and attributes 'turns' to particular individuals, enables anyone to contribute at some point, and renders those contributions visible and witness-able to others. Matters such as 'awareness' that have been a long-standing issue within CSCW are resolved within this organisation and provide the resources for participants to contribute to the activity in a timely and appropriate fashion [cf. 7]. In other words, the challenges to developing systems to support and enhance participation in large-scale, multi-party events may not primarily consist of what kinds of technologies we develop, but rather in delineating an organisation, and social and interactional arrangement, that enables the forms of participation that is required, if not desired. It may well be the case, that the analysis of ordinary events, their social organisation, might provide just the insights and resources to enable us to enhance, and in some cases create, the complex forms engagement that arise within large-scale events, and to resolve the problems of order and participation that pervade multi-party interaction.

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