

# Let's work together: supporting two-party collaborations with new forms of shared interactive representations

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**Abstract.** Collaboration generally refers to people working together as a team towards a common goal. Here we discuss a different kind of collaboration: sales-based transactions which occur between two parties who have different goals, which are nevertheless mutually interdependent. Findings from an ethnographic field study of the way travel agents and customers build up complex products (e.g. round-the-world trips) showed the collaboration to be asymmetrical, affecting the success of its outcome. We discuss how we developed a collaborative technology, aimed at reducing the cognitive load involved during planning. We designed an interactive trip planner, that dynamically links a number of information resources and visualisations, co-displayed on three adjacent screens embedded in a shared worktable. Preliminary findings showed that using these kinds of graphical constraining enabled the two parties to quickly build up a shared reference and mutual understanding, which in turn facilitated more effective collaboration.

**Keywords.** CSCW, two-party collaboration, sales-based transactions, information visualisations, external cognition, cognitive offloading, dynalinking, shared representations, planning, multiple representations, travel agents

## 1. Introduction

The term collaboration is generally used in CSCW to refer to people working together as part of a team, for a common purpose [3], [5], [6]. Teams may work physically together in the same office or virtually, by being geographically co-located. They may be ‘close-knit’, where much of the collaboration depends on constant monitoring of what each other is doing when and where [5], [11]; or more distributed, where members come together for meetings and work separately at other times. Whatever the make-up of a team and how they might work, an overriding characteristic is having a common goal.

Another form of collaboration, often overlooked in CSCW, is where people work together not as teams but as ‘parties’, who belong to different groups, but who need to collaborate to achieve different goals that are mutually interdependent. An example of this form of two-party based collaboration is between an agent and a customer<sup>2</sup> in a sales transaction, where the agent wants to sell something to the customer and give them a satisfactory service, and the customer wants to get the best product that suits their needs. Each needs to provide information for the other, and to cooperate to enable the transaction to progress. While both parties may try to help each other out to achieve their respective goals, it is often the case that ‘obstacles’, such as misunderstandings and mistrust, can get

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<sup>1</sup> Mike Scaife died suddenly and unexpectedly while we were writing this paper. He was the instigator of, and inspiration behind, the research.

<sup>2</sup> We use the term customer in the singular but it can refer to more than one person, such as a couple or family.

in the way, making the collaboration difficult to manage. Furthermore, the collaboration can often end up being one-sided, where one party takes over the work needed to achieve both party's goals (usually the agent), leaving the other party highly dependent on him/her. Such asymmetry in the sharing of the work can have undesirable effects on the success of the collaboration.

There are other differences compared with team-based collaboration. For example, the collaborators are usually complete strangers beforehand. This means that they have to build up a shared understanding of what each other wants and is trying to do for the other in a relatively short period of time. In so doing, they need to establish mutual trust, whereby each needs to find out the other's intentions and to believe what the other is saying is true. Much stumbling in the dark can happen at the beginning of a transaction where sensitive topics (e.g. the customer's age, how much money they want to spend) are often skirted around.

In this paper we begin by exploring the problems that can arise in two-party collaborations. On the basis of our analysis we consider how we might overcome some of these through designing collaborative technologies. We then describe how we went about designing a more enriched physical and socio-technical environment intended to support more equitable collaboration and work. The particular domain we are concerned with here is the travel industry, where an agent and customer have to work together to specify a round-the-world trip, typically starting out with a vague and hazy plan.

Sales-based transactions involve the creation of complex products. Developing an insurance portfolio, configuring a digital TV package, or booking a round-the-world trip, typically take a long time and much work to develop [14]. This is especially so where neither the customer nor the agent have a clear idea of what the customer really wants, and hence what the outcome of the transaction might be. To determine the nature of the product, much discussion, negotiation and 'fleshing out' needs to be carried out early on, and various alternatives have to be weighed up, together with the trade-offs involved in including certain options and not others. Achieving this state requires much accessing and interpretation of a diversity of information sources, e.g., online booking systems, brochures, websites and promotional materials, as well as the knowledge of the agent and the expectations of the customer. In addition, various kinds of representations need to be created, e.g., booking forms and schematic plans. Hence, much distributed and external cognition [12] is involved, where the socio-cognitive processes of planning, remembering, problem solving, conveying knowledge, constraint-matching and decision-making are central [7]. The disparate nature of having to deal with so many different kinds of information and representations at the same time, can cause high cognitive load, sometimes resulting in confusion and misunderstanding (see also [2]).

A main goal of our research, therefore, is to design new forms of collaborative technologies that can support two-party collaboration. Specifically, our objective is to provide shared representations and interactive computational tools that can offload some of the cognitive work required to develop complex products during a transaction. They should enable both parties to be able to integrate more effectively the disparate kinds of information and representations needed during planning. The combined effect of providing such computational support should also allow both parties the opportunity to explore more alternatives given what is available, and what the consequences of making certain decisions are at a given point during their planning activities. In so doing, it could lead to a more equitable sharing of the 'work' involved when developing a product, better product specification and enhanced social aspects of the transaction (e.g. more enjoyment, better trust).

## 2. The problem space: asymmetrical collaboration

A general observation about two-party collaboration is the extent of the asymmetry that occurs between the two parties. To begin with, the customer makes all the running, starting by reading the literature, searching the web, visiting agencies, and writing out a plan. When they decide they have reached a point of ‘readiness’ (i.e. they need to turn their ideas into a product) they will approach an agent. It is at this stage that the customer is obliged to hand over responsibility for their planning to the agent, rather like handing over a baton in a race. Having taken over the customer’s plan, the agent then takes control of the research and development work. In so doing, the customer’s role is significantly reduced to being essentially that of a respondent, answering questions which the agent poses during their interactions.

One of the main reasons why the customer becomes essentially excluded at this stage is that the information necessary for progressing the plan into a product is typically not designed to be used or accessed by them. Whereas the literature about a product, in the form of brochures, websites, pamphlets, posters, etc., is designed specifically for the customer (see Figure 1a), much of the information needed to actually build a product is represented in arcane formats, which are a legacy of the way database and software systems have been designed. While there are also good reasons why some information should only be available to agents (e.g. the amount of commission they are earning), other information remains inaccessible to customers not because it needs to be, but as a result of esoteric information representations. These frequently appear in the form of tables and codes which can only be understood and used by agents, who need to be highly trained to do this (see Figure 1b). Thus, the way the information is presented and accessed in sales-based transactions means it can only be interacted with by agents, with the customer depending on an agent to translate the information into a verbal form they can understand.

**QUEENSLAND**  
Lizard ISLANDS

**BEDARRA ISLAND**

Secluded in the warm waters of Queensland's tropical north off the coast from Cairns, Bedarra offers the ultimate romantic island getaway. With just 15 luxurious freestanding villas, each with its own private balcony, Bedarra is a club so exclusive you often can't find the other members! Bedarra invariably has more beaches than guests and there's no need to worry about cash as everything is included in the tariff, from Australia's finest wines to some of the continent's most exquisite cuisine. One of the most popular activities is to jump in your own motorised dinghy in search of a secluded bay where you can celebrate your discovery with a glass of chilled champagne and a gourmet picnic hamper. On Bedarra, the entire emphasis is on romance, peace and relaxation. Prices are inclusive of all meals, all beverages and the return launch from Beak.

Access: Fly to Dunk Island and board a private launch.

Prices per person	Twin	Single
01 Apr 01 - 31 Mar 02	£322	£390

**Special Offers**

3 Night Romantic Moments - Stay 3 nights and as well as enjoying an overall saving of £90 per person twin share, you will also receive a complimentary one hour massage.

Beau Offer - Stay 6 nights and receive a 7th night FREE! (Valid up to 31 Mar 02).

**LIZARD ISLAND**

Private and exclusive, Lizard Island is Australia's northernmost island resort, situated right on the Great Barrier Reef. The luxurious accommodations include Anchor Bay Suites which nestle just above the beach or Sunset Point Villas which boast stunning views from their elevated hillside location. You can relax and rejuvenate at the island's Pavilion Spa or the more romantic can enjoy a champagne picnic on a secluded beach. A variety of waterports including snorkelling, catamaran sailing and scuba diving are all available and with its close proximity to the world famous 'Cut Hole' dive site, it's no surprise that Lizard is internationally renowned for its fishing and diving. The menu on Liza showcases the finest local produce and all meals (including drinks) are included in your stay... and for that special romantic occasion, you can dine 'sand-between-us' style on the beach - only on Lizard!

Access: Via direct flight from Cairns.

Prices per person	Twin	Single	Triple
01 Apr 01 - 31 Mar 02	£306	£382	£249

**Special Offers**

3 Night Romantic Interlude - Stay 3 nights and as well as enjoying an overall saving of £90 per person twin share, you will also receive a Pavilion Spa treatment to the value of \$80.

Beau Offer - Stay 6 nights and receive a 7th night FREE! (Valid up to 31 Mar 02).

Figure 1a Information designed for the customer

Figure 1b Information designed for the agent

Figure 1 Differences in information resources used by customer and agent

The asymmetrical relationship between the agent and the customer is exacerbated by the particular arrangement of the technology and information displays used. The technology is usually set up in such a way that it makes it difficult for the customer to become engaged in the collaboration, even if both parties are willing (see Figure 2).



**Figure 2** Arrangement of information and technology at a travel agency

The agent and the customer will often sit on opposite sides of a desk, in the canonical ‘office’ set-up. The PC is positioned in front of the agent, who uses it to do a variety of tasks, like looking up flight availability or special offers, and filling in forms. Sometimes, the customer will surreptitiously try to peer at the screen (similar to reading someone else’s newspaper on the train) and very occasionally the agent will swivel their monitor towards the customer to show them something. This often happens when the agent needs to convince the customer that a choice is not available, e.g. that there are no seats left for the days they want, and where the customer does not want to believe it because these are the only days they can go on. During these kinds of interactions, the customer will provide answers to questions like destinations, dates and budget, while waiting for the agent to tap this into a database and try to come up with suggestions. This means there is much time spent when the customer is waiting doing nothing, and is not being communicated with by the agent. The agent may also need to break away from the interaction with the customer, and leave their desk to access other resources like handbooks or to query other agents [8].

Clearly, these kinds of asymmetries affect the nature of the collaboration, and can result in the customer feeling disempowered and the agent overstretched. Hence, we wanted to find ways of improving two-party collaborations such that they might proceed more efficiently, more equitably and more enjoyably. Before deciding on what collaborative technologies to design, however, we needed to get a better idea of what is actually involved in two-party transactions and how existing resources are used. Thus, we began by carrying out a six month ethnographic study at a London-based travel agency specializing in round-the-world and intra-continental tours. In particular, we wanted to find out how the arrangement of technologies, and the displays of information available, impact the way the transaction is introduced, followed through and completed.

### **3. Analysing the intricacies of the planning involved in two-party transactions using the external cognition framework**

We observed and video-recorded a number of different transactions that took place at the travel company, following through all the different stages involved in building a round-the-world trip. We also interviewed customers and agents about their strategies and the problems they encountered. We spent considerable time observing how various information

resources, such as brochures, are used by the customers and agents, alone and when together.

To analyse the findings from the study, we used our external cognition framework [9], [12]. Briefly, the framework provides a means of analyzing how different representations are used during collaborative activities such as planning, deciding and problem-solving. The framework also allows us to examine the level of cognitive offloading that takes place. This refers to how different external representations offload the cognition, such that they reduce the mental effort needed to perform a given task. We were interested in initially discovering what kinds of activity required a heavy cognitive load and how the different parties coped with them. In particular, we wanted to see how they re-represented information in order to constrain the problem space to progress with their tasks. We also wanted to see what bottlenecks arose during the transaction process and what role the available external representations played in this.

We were also interested in the social and affective aspects that cognitive offloading might produce. For example, shared displays that both customer and agent can understand and operate might mean solutions are arrived at more effectively, and with a different character: more cooperative, and more satisfying for the customer.

### **3.1 Key components of a typical transaction that takes place between a customer and agent**

When a customer first approaches an agent about planning a round-the-world trip, the agent will usually give the customer a set of brochures and ask them to return once they have worked out an itinerary showing where they want to go and what they would like to do. The agent needs to get the customer to do this initial ‘pre-planning’ work, because the degrees of freedom in what it is possible to do are immense. Hence, the customer needs to constrain this before the agent can start to progress with building the product. One of the agent’s worst nightmares is when a customer comes in and says ‘I’d like to go somewhere hot and sunny for a month’.

#### ***3.1.1 Using external representations***

Brochures are the main resource used by agents to help customers start making their first choices. They are designed to be attractive and pleasant to browse, and importantly provide suggested itineraries. However, when customers are initially given a set of brochures to look at, this can create high cognitive workload for them. This is because the different brochures are not usually cross-referenced, requiring the customer to have to do a lot of switching between them. For example, one brochure might feature only tour and travel information, and another hotels. If the customer wants to develop an itinerary involving a tour and then a week by themselves staying in hotels, they have to move between the two brochures and coordinate the information together, remembering where they last were in each. When deciding on a particular hotel, customers have to think, ‘what does this cost’; ‘how does it add to existing costs’; ‘how long should I stay there’; ‘what are the effects on my timescale’; and so on. Carrying all this in the head is difficult, so customers tend to compensate by creating their own plans, using pen and paper. These are usually timeline-based, with annotations, involving the times, destinations and cost of their planned trip. Creating these representations while going through the various brochures is also time-consuming when trying to find something specific. Moreover, brochure material is difficult to reference without adding post-it notes or other indicators, otherwise the place one previously was will be forgotten. On top of this, once annotations have been made, items are difficult to move about without erasing and starting again. Also, it is difficult to

represent different possible alternatives at the same time. Creating itineraries in this manner, therefore, requires a lot of cognitive effort. Added to the cognitive work is manual work: for example, annotations are often re-represented by writing up or wordprocessing for the agent.

Having done all this work, a typical plan a customer might bring to an agent for their follow-up visit is as follows: the customer wants to spend six weeks travelling around Australia, arriving and staying in Sydney for one week; then travelling up to Cairns by air. They then wish to do a one week tour of the Great Barrier Reef taking in some of the islands, afterward returning to Cairns and travelling by train to Alice Springs, where they need three nights' accommodation. From there they will join another tour around the Red Centre, seeing Ayers Rock, and eventually returning to Alice Springs. They then wish to fly to Perth, staying for a week. Finally they wish to take a deluxe train journey from Perth back to Sydney via Melbourne. On the return flight out of Sydney they want to stay in Singapore.

### 3.1.2 Re-representing the itinerary

When the customer has developed their initial itinerary, they present it to an agent. For the customer itinerary to be useful to the agent, it has to be formatted according to a particular structure, with dates, times, sequenced destinations, and budget. This requirement is always implicit, so customers may, despite writing down a detailed itinerary, produce something that is not easy for the agent to work with. At the same time, the customer's effort in organising their itinerary chronologically is only part of what is needed to quote on it.

Date	Destination	Description
15/10/01	London	Depart London to Sydney
22/10/01	Sydney	Arrive Sydney
29/10/01	Sydney	Depart Sydney to Cairns
05/11/01	Cairns	Arrive Cairns
12/11/01	Cairns	Depart Cairns to Alice Springs
19/11/01	Alice Springs	Arrive Alice Springs
26/11/01	Alice Springs	Depart Alice Springs to Perth
03/12/01	Perth	Arrive Perth
10/12/01	Perth	Depart Perth to Sydney
17/12/01	Sydney	Arrive Sydney

Figure 3a Customer itinerary

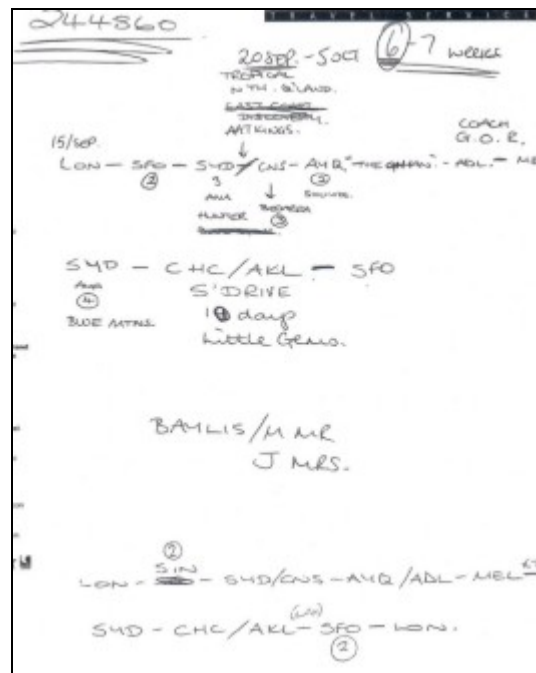


Figure 3b Agent itinerary

Figure 3 Differences in customer- and agent-produced itineraries

Figure 3a shows a chronologically-ordered customer itinerary – an Excel spreadsheet produced after searching through brochures, and involving a lot of work. In contrast, Figure 3b shows an agent's itinerary made in response to a phone enquiry. This is organised quite differently. In order for the agent to produce a quote for the customer, the agent has to re-represent the customer's chronologically-organised itinerary according to the different 'products' involved. This involves pulling out and ordering the different product types (a product can be a flight, a hotel, car hire, a tour, etc.). The horizontal lists shown in Figure

3b, e.g. SYD–CHC/AKL–SFO, are abbreviations for sets of flights which the agent has to sort out before anything else can be done. So, using our example, the agent has to work out what flights are available into and out of Sydney, whether these fit with the customer's requirements, and how the internal flights (Sydney to Cairns; Ayers Rock to Perth) fit in. Following this, the agent moves onto accommodation and other 'land sales' products like tours. At this point the agent needs to see what hotels fit in with the itinerary, whether these are those specifically requested by the customer, and whether they are available. The same happens for tours (for example, the guided tour around the Red Centre; the deluxe train from Perth to Sydney). Thus product order follows booking order, where flights frequently have to be booked early to get savings, while the other products can come later.

A lot of the booking work is done by the agent when the customer is not there, as it is time-consuming and requires considerable work to completely specify. Once a quote form has been completed by the agent, it is then sent out to the customer as a letter or email. The customer examines this and if satisfied confirms by sending in the required deposit. However, what often happens is the customer wants to make changes or query certain components of the product, or add detail (for example, requesting a room with a view at a hotel) before the deposit is given. The customer translates the quote form into another communication, sending this back to the agency via email, fax or phone. Thus, changes to the itinerary can come from two sources for two different reasons: from the customer for reasons of preference; and from the agent because of booking issues, non-availability of deals, replacement deals, and so on.

Hence, the retranslation of chronological itineraries sketched out by the customer into product-ordered ones needed by the agent to make the booking, reflects different customer and agent models of how a product can be specified, as well as different expectations and requirements. Itineraries submitted by customers are often highly specified, with every component having equal priority in the sense that the customer wants simultaneous confirmation of all of them. However, working with booking orders, and issues like not knowing the exact price of a tour until closer to the time of the proposed trip, the agent cannot guarantee this. It may be that the whole product cannot be finalized for several months, and may even have to be changed. Thus, mismatches can arise between customer and agent expectations and priorities.

### ***3.1.3 Media translation overheads and the linear planning effect***

To progress a provisional itinerary written by the customer into a firm booking developed by the agent, usually requires several interactions between the customer and the agent. These interactions can vary in the way they are conducted: face-to-face, via phone, e-mail, letter, or fax. The different modes of communication mean there are different media involved, and this creates *media translation overheads*, e.g., phonecalls translated into itineraries translated into booking forms translated into emails. In many cases the new medium requires a retranslation of the itinerary, sometimes from scratch. While this has the benefit of both parties being able to overview and recapitulate the itinerary every time it is looked at, the lack of a shared representation which clearly shows its current status creates extra workload for both parties as they do this updating. There are also update issues in that a new quote form has to be done from scratch; and any changed itinerary does not show where or how it has changed. At the same time, itineraries have to change because of issues to do with the booking; again, this involves a lot of redevelopment work where the impact of a change on the whole product has to be recomputed.

Media translation overheads, agent workload, and the lack of shared representations, all create what we call a *linear planning effect*. By this we mean two things: first, before the product is actioned, only one possibility is decided (as we saw in our example), in order to constrain the work that needs to be done, given all the possibilities for a round-the-world

trip. Second, the agent limits the space of parameters worked with to major ones like costs, dates, and destinations, which enables him/her to manage the cognitive overload of dealing with multiple concerns in the development of the product. If the agent is able to confirm the itinerary as requested by the customer, linear planning is effective. However, as we saw, the customer may want confirmation of a specific, detailed itinerary. Because of the booking order, this may not be possible; and if not, the agent has to find alternative components like different hotels or flights. These changes can be difficult to integrate into itineraries because of knock-on effects such that other parts also have to be reorganized. To facilitate this, the agent has to concentrate on the major parameters mentioned rather than considering other parameters such as their knowledge of the customer's interests, or what type of person they are. Here, concentration on a single itinerary, plus limitation of the parameters worked with, can create problems: the customer's rejection of changes, and the need to do more development work. The linear planning effect, then, can create a paradox: the agent's requirement for a single itinerary specified in terms of a limited number of parameters, while it appears to save time and work, may in fact do the opposite. These kinds of product development problems can be exacerbated by the 'ping-pong' nature of the transaction. Communications going to-and-fro, often at a distance, mean it can take a long time for queries to be resolved. Products can sometimes take months to put together in this way.

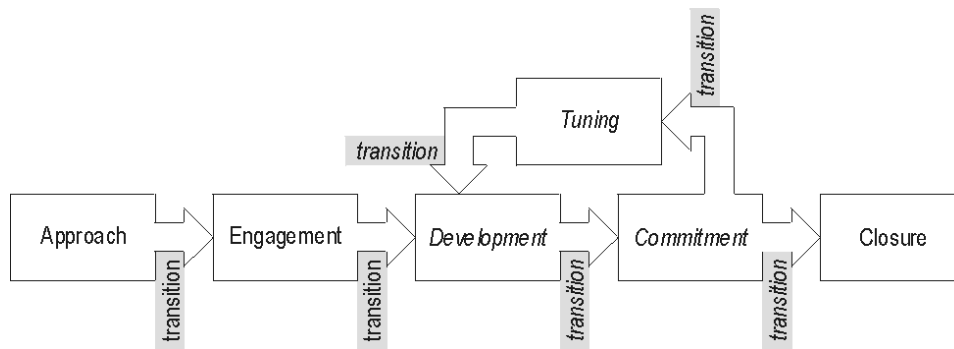
Here, we see how the sorts of information representation used by agents, and the one-sided, linear form of transaction they give rise to, can create problems in sales-based transactions. Ways in which such bottlenecks might be reduced include developing different itineraries in parallel; the two parties getting to know each other; and through cooperative rather than serial ('ping-pong') practices. For example, the agent may be able to show a customer difficulties with the itinerary such that the customer chooses to leave certain things open, reducing the linear planning effect. However, agents have to work out the cost of how much time they are spending with a customer and the effort required to work up their product, ensuring that the total amount of time spent is profitable. Spending, say, ten hours with a customer to book a trip costing only five hundred pounds is a very inefficient and loss-earning use of their time. Thus the amount of time agents (and also customers) spend on developing a product is a critical factor that we needed to take into account: one that explains the linear planning effect despite potential difficulties.

### **3.2 Modelling the transaction process**

A key finding from our study, therefore, is that mismatches can arise between the information the agent uses to create a product, and the information the customer has and understands. In an attempt to bridge this gap, we decided to explore ways of providing new forms of information visualisations and interactive planning that would provide shared resources that both agent and customer could refer to during the planning and creation of an itinerary. Before building our prototype, however, we needed to consider which stage of the transaction process to focus on; one that would be most beneficial to the agent and the customer. Below is a simplified model of how a transaction, of the kind we have just described, develops, showing the roles of external representations used and created during the process (see Figure 4, below).

The model depicts the transaction as a set of phases (as shown by the boxes). At the *approach* phase, the customer approaches the agency. If this is successful, an *engagement* phase follows, where the agent is able to act on the approach. This is followed by *development* and *commitment* phases, which may go through several iterations as the product is revised and finalized. At *closure*, the complete sale occurs. For one phase to flow





**Figure 4** Transactional model

into another, the model proposes that a *transition* has to occur involving an interaction between (1) external representations used (e.g. brochures); (2) customer knowledge - the current plan of the trip, the budget, etc.; and (3) agent knowledge - of products, the current plan of the itinerary, how the product can be further developed. For transitions (and hence the whole transaction) to go smoothly, the cognitive work at each phase needs to be supported by appropriate external representations. The model identifies a critical transition between the approach and engagement phases. Here, the customer must have a workable itinerary already developed, in a form the agent can act on. Engagement can only occur once this transition has been achieved. We decided to look to support the transaction at the beginning which impacts the transition from approach to engagement. Here, as identified in our study, is where there is asymmetry in the distributed work done and where the external representations place high cognitive load on agents and/or customers.

#### 4. Designing ‘The Trip’: a prototype to support better collaboration

We decided to focus on how to better support the joint planning that goes on between customer and agent – especially in terms of shared representations used and created when making an itinerary in the early phase of planning. Our analysis generated a set of requirements, including:

- reduce stages where there is an exceptionally heavy cognitive load on the customer and agent
- provide shared external representations to allow shared planning and decision making
- allow ways of exploring and discussing different product possibilities and alternatives, especially where there are awkward issues to be raised (e.g. how much a person is prepared to spend)
- provide better links between different external representations to allow for more effective coordination of information

Based on these, we decided to design a prototype that would provide:

- a new physical set-up of technologies, changing the way the customer and agent sit together and hence collaborate
- a way of dynamically linking existing external representations (e.g. brochures, notes)
- new information visualisations and an interactive planning tool enabling easy comparison of alternatives and weighing up multiple parameters during the creation of an itinerary

The prototype, called ‘The Trip’, consists of three interlinked components:

- the eTable
- the interactive planner
- the shared visualisations

#### 4.1 The eTable (Mark II)

We propose that one way of improving collaboration, especially the ability for shared referencing, is to change the ways of displaying and sharing information and its accessibility, particularly for the customer. To do this we have been developing and combining different arrangements of displays and devices. Here we describe one such ‘device and display’ configuration, known as eTable (Mark II), that essentially provides three integrated large flat 21-inch displays set at 1280 x 1024 resolution, embedded in an oval table 1.5m long and 1m wide (see Figure 5b). The customer (this can be one or two) and agent sit (or stand) in front of the eTable, where they can see each other and make eye contact, without the table acting as a barrier between them. Sufficient surface space is also provided as part of the table for a wireless mouse and keyboard together with room for placing other materials.



Figure 5a eTable Mark I



Figure 5b eTable Mark II in use at a travel trade show

Figure 5 eTable Marks 1 and II

eTable Mark II evolved from an earlier version, Mark I [13] shown in Figure 5a. This was originally designed as a horizontal display surface, using back-projection from an xga data projector with a mirror arrangement under the table. The size of the table, 1m x 1.5m and the embedded screen was designed to give a space that allowed two or three people to view and work with the display in relative comfort. People could sit or lean on/stand at it, and the asymmetric display location allowed an area for placing and working on things such as paper/brochures. Interaction with the display surface was pen-based, using an inexpensive mimio unit.

Studies using eTable Mark I showed it improved collaboration between groups of three markedly, compared with the same groups trying to collaborate when huddling around a single workstation [10]. However, it only allowed for one screen of information to be displayed at any one time. To meet our core requirement for ‘The Trip’, of allowing the customer and agent to integrate different representations readily and understand the connections, we decided that it was imperative to have multiple interconnected displays. The use of multiple monitors has also been found to be an effective strategy by users for coordinating information [4]. Hence, we designed eTable Mark II to have two embedded horizontal flat screen displays that are adjacent to each other, together with a third vertical screen behind them. This gave us considerable flexibility to experiment with partitioning of information, visualisations and plans that both parties had shared access to.

## 4.2 The interactive planner component

One of the ways we propose to reduce cognitive overload for both the agent and customer is to provide shared interactive representations that supported both chronological and product-ordered models, allowing for more effective searching and integration of information found from brochures. The interactive planner was designed to present information on the different screens of the eTable, that are contextually ‘dynalinked’ [9] with each other (see figure 6, over). For example, an itinerary selector is presented on one screen and the effects of making certain choices in this are shown on another screen. The agent and customer can refer to both and make changes to one which will cause further changes in the other.

The interactive route component of ‘The Trip’ provides a palette of ‘product’ icons (planes, trains, hotels) which can be dragged onto an interactive map (such as Australia) which is then iteratively built up. For example, a hotel can be placed on Ayers Rock, which is where the customer is at that stage of planning their itinerary. A pop-up box appears, allowing them to interactively put in the number of days they would like to stay there. This triggers a relevant page from the brochure to pop up on the back screen showing them various options, which they can select. The hotel icon remains fixed at Ayers Rock as a reminder that this part of the planning has been done (it can equally be undone by removing it from the map). Dragging a plane icon next from the palette onto Ayers Rock and then moving it (for example) to Perth, produces an externalization of an internal flight. Hence, the itinerary can be built in terms of product order (e.g. flight, hotel, tour) or chronologically, by adding a hotel, then a flight, then another hotel, and so on. Any of the components of the itinerary can be removed and new ones tried out. Other flights can be added in the same way, and then hotels can be added.

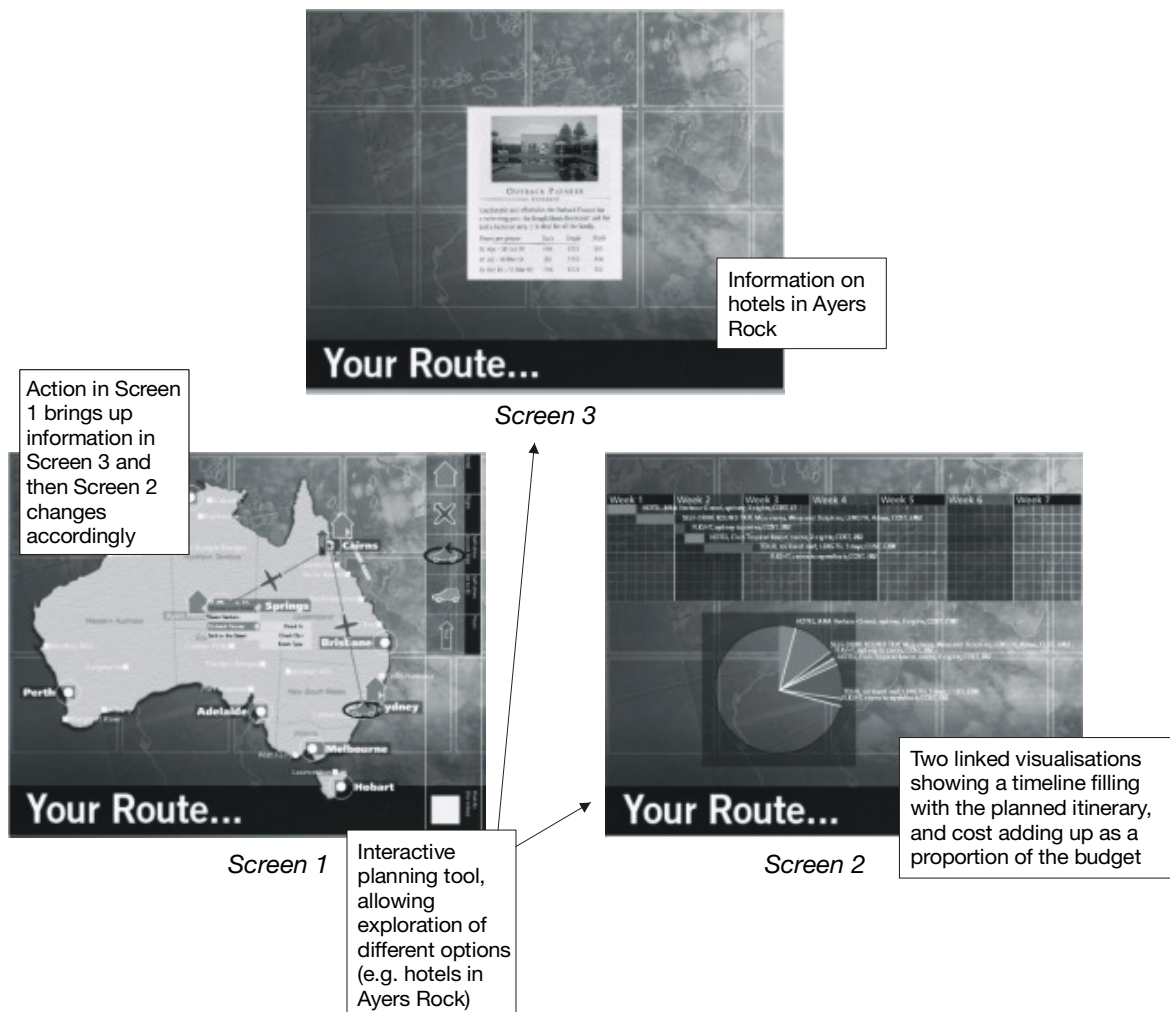
The interactive planner is linked to a brochure database and itself represents an itinerary. The itinerary can be downloaded as text to form a quote. The configured planner can also then be saved and printed as another form of externalization that the customer can take away with them.

Thus the interactive planner was designed to provide new forms of externalization, making it easy for the customer and agent to try out alternative plans, by adding and removing components, without needing to start from scratch. In turn this supports experimenting with alternatives, something that is much harder to do using existing means. For example, a hotel configured at a certain cost and number of nights, if it is not available can be removed and another inserted, with the effects on the rest of the itinerary immediately shown in the shared visualisations (see next section).

## 4.3 The shared visualisations

Interlinked to the interactive planner are two visualisations, that show dynamically-updated graphical representations of the amount of budget spent so far and the segments of the itinerary being built up, using a time-line. They appear together on the adjacent display to the interactive planner. Both are updated in relation to the way the itinerary is being developed. For example, the cost of the flight from Sydney to Cairns plus four nights in a hotel selected from the online brochure are shown as a proportion of the budget, using a ‘piechart’ visualisation, which moves clockwise and anticlockwise depending on what the different selected products cost. At a glance the agent and customer can see how much is being spent, without ever having to explicitly refer to it. The time-line visualises the various segments of the itinerary using colour coding (e.g. a mauve block for a week on a tour) and weekly segments. Again it provides the customer with a way of seeing how parts fit

together and also how they might change them, for example so that they spend two weeks in Cairns and one less in Sydney. It is also relatively easy for the agent to show the consequences of making such changes.



**Figure 6** Screen shots of the three displays from 'The Trip' showing the itinerary unfolding

Post-it notes are also provided to allow for annotation to the itinerary as another form of external cognition. For example, if the customer is not certain whether they should go for a particular hotel, they can add a post-it to this component with a note to that effect. This can be dragged to one side while other possibilities are tried, and reinserted in the itinerary if required.

#### 4.4 The shared experience

The combination of the eTable, the interactive planner and the shared visualisations provide a new experience for the agents and customers. The way it is envisioned to be used in a travel shop is that when a customer is first thinking about going on a round-the-world trip, they would be encouraged to sit down and explore possibilities with an agent. Within a 5-10 minute time frame, it would be possible for the two to have reached a shared understanding of what the other expects and wants, to allow the transaction to progress to the next phase. Working together like this, which they cannot do at the moment, means that there is less need for translation in the initial phases of building up a product: both parties can work with the same representations.

## 5. Preliminary evaluation of ‘The Trip’

To evaluate our prototype, we carried out a preliminary experiment in which joint planning tasks were set up. We also placed ‘The Trip’ in a large travel trade show in London, where customers explored its potential with the aid of a sales agent from the travel company we are working with.

### 5.1 Findings from the experiment

The aim of the experiment was to determine whether the new forms of shared interactive visualisation allowed participants to more effectively plan an itinerary. There were two conditions. In the first set-up, two participants acted as customers and were asked to plan a trip with budget, time and destinations constraints. Specifically, the participants were asked to plan a holiday around Australia starting and finishing at Sydney, and taking in Cairns and Ayers Rock. It should also include a tour around the Great Barrier Reef. The ‘customers’ were given £2,200, and asked to limit their trip to three weeks maximum. The set-up was designed to be sufficiently complex, to enable us to evaluate the extent to which the visualisations and the integrated representations facilitates customer planning, where many parameters have to be taken into account. In the other set-up, two participants interacted with each other: one acting as a customer who had already made their plan; and the other acting as an agent. This second participant had been ‘trained’ on what they needed in order to progress the transaction. One of the participant customers from condition one used their saved planner visualisation to ‘approach’ the agent. The agent had to be able to interpret it in terms of booking orders and to be satisfied that they could progress the plan into a product. Hence, the aim here was to see how well ‘The Trip’ supports joint planning between customer and agent. In both conditions, sets of brochures were provided as well as pen-and-paper. A control condition was also carried out where the participants carried out the same tasks, but using only paper-based brochures and pen and paper.

Briefly, the main findings from the preliminary experiment were:

- Planning was found to be much quicker for the conditions when the participants were using ‘The Trip’ compared with the condition where brochures only were used. Participants were able to put together an itinerary in about ten minutes using ‘The Trip’, compared to over thirty minutes in the brochure-only condition. This was because they did not need to search and coordinate the brochures. Also, there was no need to make and revise a pen-and-paper plan because the computation was being done for them by the planner.
- Although they were not instructed, participants spontaneously tried out and saved different possibilities using ‘The Trip’. The post-it notes and the ability to save configured components appear to have contributed to this. Another reason is that the time and cost scales, which update automatically, made it easy for participants to see immediately what the effect of changes were on the whole itinerary.
- The agent participant was able to see clearly what the product order was, when provided with the saved itinerary.
- The customer drew attention to two alternative itineraries involving how to do a tour, either by starting and finishing at the same point, or by finishing at a different point, and what the timing/cost implications were. The agent was able to demonstrate these alternatives easily and to save these.

These findings suggest therefore that ‘The Trip’ was effective in reducing cognitive load at different stages of the planning of the itinerary. Information, as it unfolds during the planning, is externalized and coordinated such that computations and representations do not

need to be made and kept by the customers in their heads or on scraps of paper. The findings also showed the benefit of having shared planning, in terms of speed, efficiency and ease of communication when using 'The Trip'. The participants were able to develop alternative plans relatively easily and the linkage of information between different representations also appears to have been effective.

## **5.2 Preliminary findings from the situated use of 'The Trip' at the travel trade show**

At the trade show, 'The Trip' was set up as shown (above) in Figure 5b. Three types of video data were gathered: demos to agents by ourselves; demos to customers by ourselves; and use of the system by agents and customers together to support a transaction. Feedback from the demos on the customer side was positive, with many customers interested in, and spontaneously trying out, the prototype. Agents were also enthusiastic, but under time/commission pressure needed to be able to integrate the results more seamlessly with their standard practice of using DOS-based applications on other PCs. This meant that the consultation, after the engagement phase, was continued in a separate area using these other systems. However, despite this issue, successful consultations were held using 'The Trip' to support approach and engagement phases, leading to potential bookings (due to the technical restrictions of the trade show setting, actual bookings were not possible). These consultations differed markedly in character to those taking place simultaneously with the agents' standard systems, with shared use of the display, a more informal interaction without any table/PC 'barrier', much more direct customer input, and exploration of different options. In terms of time, customers and agents working together were able to put together reasonably full itineraries in around 20 minutes – faster than the typical consultation, with customers more engaged and active.

## **6. Discussion**

The focus of our paper has been on supporting collaboration between two parties that have different goals, but which are mutually dependent. In particular, we looked at how multiple representations are produced, translated and coordinated between different parties when carrying out a complex sales transaction. We found that existing ways of building up a shared product can be hindered by the problems associated with using disparate resources. Our ethnographic study showed, for example, how the information represented in brochures and databases is quite different, sometimes leading to misunderstandings and divergent planning strategies between the agent and customer. Equally, we saw how the discrepancies between the way such representations are structured can constrain the collaboration between the agent and customer to one of linear planning where there may be more optimal means: for example, exploring alternative plans before making a commitment.

A key concern arising out of our research was how to provide a collaborative environment that could more effectively support the coordination of the multiple representations that are generated and accessed by the two parties. Currently, customers carry out their planning in a largely *ad hoc* fashion, not knowing fully what the parameters are that they must specify, the level of detail, or the order the itinerary should be built in. They can also be overwhelmed by the information overload when consulting numerous brochures, the web, etc. The agent, on the other hand, has the knowledge of how to use brochures and what form to write an itinerary in (in order that it can be progressed into a product), but cannot dictate or suggest to the customer how to proceed at the outset. They

must instead spend considerable effort re-translating the idiosyncratic plans and ideas that the customer has generated, by themselves, into a workable form.

Such a problem space is ripe for being better supported. However, there is little design guidance on what kinds of collaborative tools might be developed to more effectively support the use and generation of multiple representations, that would enable reduction of the current level of cognitive effort and work needed. While there has been some work on how to design effective multi-representational learning environments, the focus has been on supporting the learning process *per se* (e.g. linking multiple representations to provide deeper understanding of the way abstractions work). One design principle that has proven to be generalisable to other contexts and we used extensively here is dynalinking [9], which proposes co-varying context-relevant information in co-located displays to show the relationships between them more explicitly.

Cognitive offloading was also reduced for both parties, and in so doing, supported better collaboration between agent and customer in terms of allowing them to work on the same product using the same set of tools. It also provides them with a shared reference that both can refer to and have a mutual understanding of, allowing them both to talk on more equal terms. More specifically, it was shown to reduce the media translation overheads, divergent planning strategies, and repair work which come from having disparate information representations; and representations which are not accessible by both parties. 'The Trip' goes some way to showing how better coordination across external representations can be achieved, and how this impacts a two-party collaboration not only cognitively but also in terms of its social character to create a transaction which is more effective as well as more congenial.

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## References

- [1] S.E. Ainsworth (1999) Designing effective multi-representational learning environments. *Technical Report No. 58*, School of Psychology, University of Nottingham.
- [2] S.E. Ainsworth, P. Bibby and D.J. Wood (1997) Information technology and multiple representation: new opportunities new problems. *Journal of Information Technology for Teacher Education*, 6, 93-104.
- [3] C.A. Ellis, S.J. Gibbs, and G.L. Rein (1991) Groupware: some issues and experiences. *Proceedings of CSCW'88*, 250-256.
- [4] J. Grudin (2001) Partitioning digital worlds: focal and peripheral awareness in multiple monitor use. *Proceedings of CHI'2001*, 458-465.
- [5] C. Heath and P. Luff (1992) Collaboration and control: crisis management and multimedia technology in London Underground line control rooms. *Journal of Computer Supported Cooperative Work* 1(1), 24-48.
- [6] E. Hutchins and T. Klausen (1996) Distributed cognition in an airline cockpit. In Y. Engstrom and D. Middleton, Eds. *Cognition and Communication at Work*. NY, Cambridge University Press, 15-24.
- [7] B. Raskutti and I. Zukerman (1997) Generating queries and replies during information-seeking interactions, *International Journal of Human-Computer Studies*, 47, 689-734.

- [8] Y. Rogers (1994) Exploring obstacles: Integrating CSCW in evolving organizations. In *CSCW'94 Proceedings*, ACM, NY. 67-78.
- [9] Y. Rogers and M. Scaife (1999) How can interactive multimedia facilitate learning? In: *CDROM/WWW Proceedings on Multimedia Interfaces*, AAAI. Menlo Park, CA.
- [10] Y. Rogers, M. Scaife, and S. Lindley (2002) The affordances of vertical and horizontal displays: their effects on group collaboration. (in prep).
- [11] Y. Rogers, H. Sharp, and J. Preece (2002) *Interaction Design: Beyond Human-Computer Interaction*. Wiley.
- [12] M. Scaife and Y. Rogers (1996) External cognition: how do graphical representations work? *International Journal of Human-Computer Studies*, 45, 185-213.
- [13] M. Scaife, Y. Rogers and J. Halloran (2001) eSpace: integrating novel displays and devices for augmenting collaborative transactions. [www.cogs.ac.uk/users/yvonner](http://www.cogs.ac.uk/users/yvonner)
- [14] A. Zalatan, (1996) The determinants of time planning in vacation travel, *Tourism Management*, 17, 123-131.