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Understanding socially-oriented roles and goals through motivational modelling

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Abstract—Technology has the potential to transform our home life, but only if it addresses the needs of its users. Understanding and modelling social needs is a challenge. For example, how do we understand, model, and then evaluate a system that must support needs such as “being fun”? In this paper, we define a systematic and repeatable process and method for understanding the roles and goals within a social domain for the purpose of informing technology design. We use the case study of building technology that supports meaningful interactions between grandparents and grandchildren separated by distance. Rather than attempt to define the roles of grandparents and grandchildren, and their associated goals, we study the roles and goals of activities in which grandparents and grandchildren typically engage, such as story telling and gifting, and define role and goals models from the resulting data. The data obtained from the study of these activities provides a form of validation of the models. From these, we gain a better understanding of this complex social relationship, and how software systems can be built to support it. The models that emerge during the process are useful boundary objects, allowing knowledge to be shared across and between the disparate stakeholder communities, including end users, software engineers, and field researchers, and serve as inputs to the design process.

Keywords: requirements engineering; socially-oriented requirements; ethnography.

1 INTRODUCTION

To build technological systems that support people in their everyday lives, we must understand the needs of the users. However, everyday needs are often ambiguous, subtle, and non-measurable. As an example, consider building systems that encourage fun and engagement between grandparents and grandchildren who are separated by distance, and want to maintain a presence in each other’s lives. The needs of such systems are that they must be “fun” and must support “engagement”. Such concepts are reasonable human expectations of the technology, yet difficult to model and measure.

We can start by identifying the *goals* of the system (being fun), and the *roles* that will achieve

them (grandparents and grandchildren). Role and goal modelling, or *motivation modelling*, has been applied successfully to socio-technical systems as analysis tools in the business domain (Guizzardi and Perini, 2005; Sterling and Taveter, 2009; Yu, 1997, 2002). However, these tools and techniques are not suited to the social domain (Baxter and Sommerville, 2010). By social domain, we mean those practices that are not primarily concerned with the production of economic output, but rather of engaging in cultural activities and embracing cultural values. The reason for this inadequacy is related to the nature of socially-oriented requirements. The success of a business system depends on its ability to fulfil its functional goals, possibly under some quality constraints. On the other hand, the success of a socially-oriented system depends on its ability to fulfil its *quality goals*. For example, the main goal of reading a story to a child (one of our applications) is not necessarily to complete the story — it is to entertain and engage with the child, and ultimately to strengthen social bonds.

To create technologies that support flexible and meaningful social interactions, it is important that we understand the roles and motivations of the users that will use this technology. Ethnographic studies can be used to provide data on how interaction occurs within social domains (Randall et al., 2007), however, this data is so rich, unstructured, and nuanced, that using it as a basis for building software is difficult. We assert that motivation models are well suited to abstracting rich data and providing a tool for analysis and understanding of the social domain. However, constructing such models is a non-trivial challenge (Baxter and Sommerville, 2010).

In this paper, we present a systematic and repeatable process and method for eliciting, analysing, and modelling *socially-oriented requirements*. By repeatable, we mean that the same steps can be

applied with the aim of producing reliable results across multiple projects. As part of the process, we select a set of activities related to the domain under analysis, and study the motivations of the people performing those tasks. Data on these tasks is gathered in two ways. First, using *technology probes* (Hutchinson et al., 2003): technologies that support both the evaluation of technological ideas in their domain, and the study of the needs and desires of their users. Second, via interviews with participants at multiple periods throughout the study. These interviews are used to further improve our understanding. From the probe and interview data, we derive role and goals models, which are used to express our understanding of the domain, and to facilitate meaningful discussions between stakeholders. This approach allows us not only to extend our understanding the domain, but provides us with evidence that can be used to validate the models. The resulting models are used to inform the system design.

A case study is used to illustrate our ideas. In the case study, we aim to understand the roles of grandparents and grandchildren, and the necessary goals that technology must support to facilitate meaningful interaction between the two. Rather than attempt to specify these motivations directly, we instead identify activities in which grandparents and grandchildren typically engage, such as story telling and gifting, and define roles and goals related to these activities. The specifications for these are drawn from ethnographic studies, and motivation models are used to abstract the rich ethnographic data for each activity. The roles of the grandparents and grandchildren are then approximated from the roles and goals of the identified activities.

2 SOCIALLY-ORIENTED REQUIREMENTS MODELLING

2.1 Bridging the gap between ethnography and software engineering

Using ethnography to inform technology design is not a new concept. However, despite some excellent work in the area (Hughes et al., 1995b, 1997; Walenstein, 2003; Rahwan et al., 2006; Randall et al., 2007; Paay et al., 2009), bridging the gap between ethnographers and software engineers is still in its infancy, especially for systems in the social domain (Baxter and Sommerville, 2010).

Several existing methods have been successful in combining ethnography with software engineering modelling to produce requirements specifications. Hughes et al. (1995a) were among the first to recognise the value of ethnography in software design, and among the first to recognise the importance using boundary objects to allow ethnographers and software engineers to share their understanding (Hughes et al., 1995b, 1997). Viller and Sommerville (1999, 2000) prescribe a method for documenting the results using UML use cases and domain models. Millen (2000) presents *rapid ethnography*, which is a collection of fields methods to help understand a socio-technical system for which technology is being designed. Ethnographers observe users in the field, and answer a structured questionnaire upon their return, which is used to derive a causal model that informs the system design. Diggins and Tolmie (2003) model the shared understanding of terminology between ethnographers and other field workers using *Grounded Innovation Maps*, which is a boundary object that organises ethnographic data in a manner that is palatable to both system designers and the field workers.

Many of these methods have been successfully applied to socio-technical systems, however, they are not particularly tailored to socially-oriented systems. This is due to the focus on the functionality of systems, which is not suitable for modelling and evaluated socially-oriented systems, in which the quality attributes are more important than functionality.

Our work builds on earlier work by Paay et al. (2009), in which motivation models are used as shared artifacts between ethnographers and software engineers. In that work, *cultural probes* (Gaver et al., 1999), collections of material are left in the field to generate insights of domestic situations, and are used to obtain data on the relationships between grandparents and grandchildren. Paay et al. found that agent-based motivation models served as useful boundary objects between ethnographers and software engineers for sharing understanding of the social domain. Our work extends this by using technology probes to study these relationships, and by providing a systematic, repeatable process and method for doing so.

Davis et al. (2011) present a study in which they observe playful activity between grandparents and grandchildren for the purpose of understanding intergenerational play. They define the roles of grandparent and grandchildren by specifying

which role they play in specific activities. It is this work that motivated our idea to explicitly study related activities to help understand roles in inter-generational fun. The work by Davis et al. differs to ours significantly in the way they collect and analyse data. First, Davis et al. use ethnographic observation to collect data on short, episodic interactions between grandparents and grandchildren at play groups, rather than using technology probes and interviews for data collection. Second, they do not present abstract interpretations of the data, such as our motivation models, thus do not contribute to software engineering. In our work, we use the agent paradigm to record and model our understanding of the roles and motivations of study participants.

2.2 Agent-oriented modelling

With the agent paradigm increasingly becoming a popular and successful way for modelling complex systems (Munroe et al., 2006), methodologies for agent-oriented software engineering have become an important research field. Several such methodologies have been proposed, such as Tropos (Bresciani et al., 2004), Prometheus (Padgham and Winikoff, 2004), Gaia (Zambonelli et al., 2003), INGENIAS (Pavón and Gómez-Sanz, 2003), and ROADMAP (Juan et al., 2002).

To model requirements, we use the notation of Sterling and Taveter (2009). Their work has focused on how to make high-level agent-oriented models palatable to non-technical stakeholders. This is achieved by using models with a straightforward and minimal syntax and semantics. The early requirements-phase models, which Sterling and Taveter call *motivation models*, are particularly lightweight.

Goal models are useful at early stages of requirements analysis to arrive at a shared understanding (Jureta and Faulkner, 2007; Guizzardi and Perini, 2005); and the agent metaphor is useful as it is able to represent human behaviour. Agents can take on roles associated with goals. These goals include quality attributes that are represented in a high-level pictorial view used to inform and gather input from stakeholders. For example, a role may contribute to achieving the goal “Release pressure” in a industrial system, with the quality goal “Safely”. We include such quality goals as part of the design discussion and maintain them as high-level concepts while eliciting the requirements for a system. For this purpose, the goal models have to

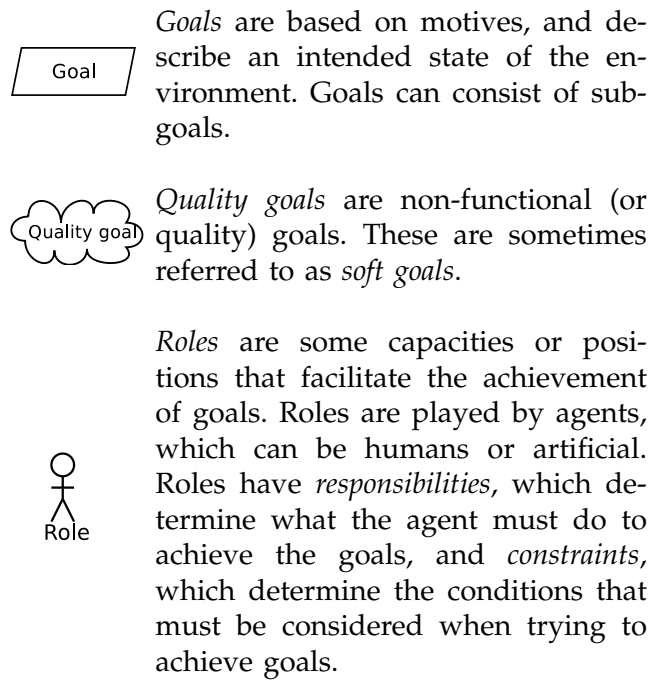


Figure 1: Sterling and Taveter’s notation for motivation modelling.

be simple yet meaningful enough to represent the goals of social interactions.

In this work, quality goals represent quality attributes of the sort that are found in social environments. Quality goals, such as fun and play, are less amenable to decomposition than hierarchical functional goals. These socially-oriented quality goals are often subjective, context-specific, and imprecise. Importantly, goal models provide an account for the often ambiguous nature of social concepts.

Figure 1 defines the notation employed by Sterling and Taveter in their motivation models, which we have used in our work. Goals are represented as parallelograms, quality goals are clouds, and roles are stick figures. These constructs can be connected using arcs, which indicate relationships between them. Goals and quality goals can be hierarchically decomposed into sub-goals. This relationship indicates that the sub-goal is an aspect of the higher-level goal.

Figure 2 shows a partial motivation model of one person giving a gift to another. The model consists of two roles: one of the gift giver, and one of the gift receiver. The goals of the giver are to choose a gift that makes the receiver feel special, and to present the gift in a creative way. The goal of the receiver is not just to receive the gift as one would during a commercial exchange, but to acknowledge

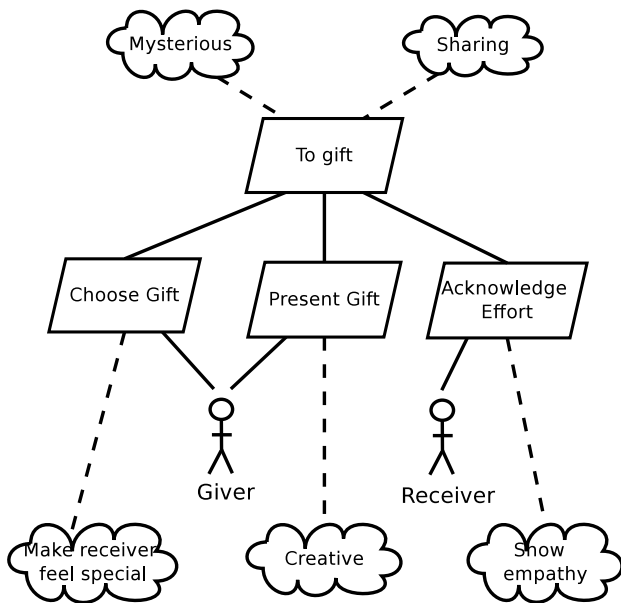


Figure 2: A partial motivation model for giving gifts.

the receipt of the gift and show that they appreciate the feelings that the giver is conveying. The quality goals play an important part in the description of gift giving here. Simply choosing a gift is not the primary motivation of the person giving the gift. Instead, they want to choose a gift such that the receiver is made to feel special in the eyes of the giver.

Gift giving is a good example to illustrate the complexities of social interaction. There are many attributes typically found in gift giving that are not (and perhaps cannot) be captured in a single model. For example, as described by Otnes and Beltramini (1996), one of the properties common in giving gifts is that the giver of the gift obtains more satisfaction from the interaction than the receiver. This is not captured by our model in Figure 2, which instead models some characteristic and crucial qualities that gift giving situations have in common.

Otnes and Beltramini also point out that all gift-giving occasions have different characteristics. Representing all of these in a single set of models is not possible, and methods for defining complete socially-oriented models is not the aim of our work. Instead, we aim to improve our understanding of social interaction using agent-oriented models as a documentation and communication tool between stakeholders.

In this paper, our focus is on roles and goals, however, we have successfully employed other agent-oriented concepts to understand social inter-

action, including scenarios and interaction models.

3 PROCESS

In this section, we present a process for deriving role and goal models for social domains. The process is method-independent — that is, we do not constrain how to perform the activities to fulfil the goals of the process. In Section 4, we present our specific method for implementing the process.

3.1 Reader exercise

Before we discuss the process, the reader may wish to briefly attempt the problem of modelling social roles and goals. As a start, we ask the reader to define the role and motivations of a grandparent. What responsibilities does a grandparent have towards their grandchildren? What goals do they have when interacting with their grandchildren? What constraints do they have when interacting with their grandchildren?

Any person attempting this is likely to use anecdotes from interacting with their own grandparents or grandchildren, or watching their own children interact with the children’s grandparents. From here, the anecdotes can be generalised. However, the motivations of grandparents are highly dependent on factors such as culture, proximity to the grandchildren, and the context of the interaction.

If one is to engineer a system that will be deployed in a social setting, anecdotal evidence from one’s own social experiences is likely to result in systems that suit personal circumstances. To engineer a system that has more widespread appeal, we require a systematic and repeatable process and method that captures some general characteristics of roles and goals in the domain.

3.2 Process Model

The process model we follow is shown in Figure 3. The model is a blend of top-down and bottom-up approaches. First, we take a top-down approach to identify the set of activities that we want to investigate. At this point, we know the domain that we want to investigate, and can loosely identify the important roles in this domain. Identifying which activities to investigate must therefore be performed with some knowledge of the common types of activities that particular roles play. For example, storytelling is an example of an activity within which grandparents and grandchildren interact. This can be based on personal experience, or

a more rigorous approach can be used (discussed further in Section 4.2.1).

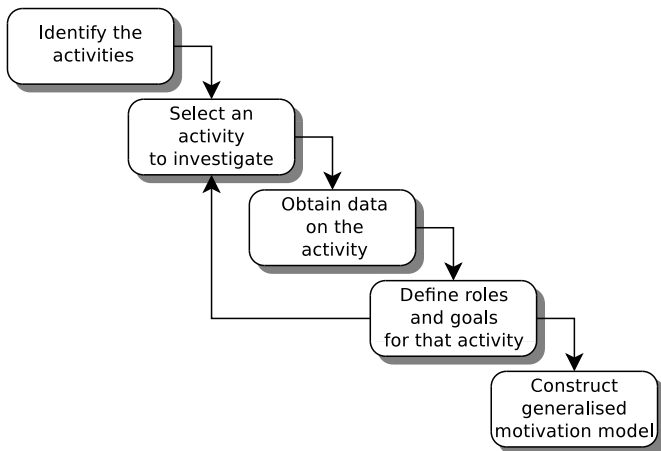


Figure 3: Process model for deriving socially-oriented models.

Once the activities have been defined, a bottom-up investigation is conducted for each individual activity¹. In this phase, one should focus on the motivations of the people involved in the activities, and how they go about fulfilling these motivations.

From the data derived for an activity, we define the role and goal model for the activity, constructing a top-down view of the domain. In this phase, we take the detail of the investigation, and abstract the most important motivations into a model — that is, the most important goals and roles. At this point, any data that may be relative to specific instances of this activity, for example, anecdotes or observational studies, is generalised in the motivation model.

Once each investigation and its corresponding motivation models are complete, we take the roles and goal defined for the activities and put these together in a single, meaningful goal hierarchy, including the roles that help to fulfil the goals. This includes identifying which concepts (roles and goals) in the models are equivalent, which concepts are similar enough to be merged, identify which goals can be considered sub-goals of others, and identifying *unifying* goals — that is, general goals that can be used to link related goals.

3.3 Interpreting the model

Using the role and goal models, we get an overview of a set of activities, and the roles and goals that

1. In our case study, we investigate several concurrently, but the activities are investigated in isolation.

comprise these. From this, we can extract meaningful, albeit partial, role and goal definitions within the domain.

Given a role that is not explicitly represented in the model, we can identify a set of activities in which that role may participate, and extract the parts of the motivation model that are relevant to the role. From this, we (partially) define the new role as the set of roles that it will take on as part of the activities, and the motivations (goals) that this role typically takes on.

4 METHOD AND CASE STUDY

In this section, we outline the method that we use to derive socially-oriented role and goal models. This method follows the process defined in Section 3. The method is presented using a running case study of the motivations of grandparents and grandchildren when they are having fun together.

4.1 Case study

We investigate a rather ill-defined yet common goal of social interaction: *fun*. Clearly, fun can occur in many different ways as part of many different activities, so a complete model of fun is not possible. Instead, a partial, high-level understanding that is based on real activities between grandparents and grandchildren must suffice.

In our current research project, we are aiming to understand how grandparents and grandchildren can utilise technology to interact in a fun and meaningful way, especially when the two parties are geographically separated. This is a particularly challenging problem, because we must account for two groups who are from different generations, and who have experienced technology in different ways. Furthermore, young children are generally unable to read and write, so standard communication technologies such as email do not facilitate such interaction; nor are they particularly fun!

To support the parallel investigation, we enlisted five different extended families in a total of ten households — that is, five sets of grandparents and their respective grandchildren — in which the grandparents and grandchildren had an existing strong and loving relationship, but are not part of the same household.

Family one consisted of an 8 year old girl living with her mother, about 12 kilometres from her grandmother (all in Melbourne, Australia). Family two consisted of three grandchildren of the age of

18 months, 6 years and 8 years, living with their parents about 8 kilometres from their grandparents (all in Melbourne). Family three consisted of two grandchildren aged 5 and 6 living with their parents about 16 kilometres from their grandparents (all in Melbourne). All grandparents had regular contact with their grandchildren (at least once a week) and all of them described having a strong and loving relationship.

Family four consists of two grandchildren aged 5 and 6 years living in Melbourne with the parents. Their grandparents live in Esbjerg, Denmark, approximately 15,000 kilometres away. Family five consists of three grandchildren aged 7, 11, and 14 living with their parents. Their grandmother lives in Vejle, Denmark approximately 15,000 kilometres away. Common to both Danish-Australian families is that the grandchildren and grandparents have met previously, and thus have some form of relationship and knowledge of each other even though they now live in different time zones.

Family	Collage	Magic Box	Story-telling	Distance
1	6 wks	6 wks	-	12 kms
2	3 wks	3 wks	6 wks	8 kms
3	3 wks	-	3 wks	16 kms
4	3 wks	-	3 wks	15,000 kms
5	3 wks	-	3 wks	15,000 kms

TABLE 1: Durations each probe was deployed in each family, and approximate distance between families.

In our case study, we employed three lightweight prototypes (discussed in Section 4.2.2): *collage*, *magic box*, and *storytelling*. Table 1 shows the durations that each probe was deployed in each family, and the distance between the grandparents and grandchildren. Durations were dictated by the availability of the family members and research team. Each technology probe collected data about the interactions that they facilitated, including factors such as the type of interaction, the duration, and the items involved. In addition, at intervals throughout the trials, the families were interviewed by the research team to gain a better understanding of how the technologies were being used to promote fun.

4.2 Instantiating the process model

Successfully applying the process model defined in Section 3 requires us to instantiate it. That is, to

identify methods and other processes for achieving the five steps in Figure 3.

4.2.1 Identify the activities

Identifying the activities to study is a domain-specific problem, and one for which there can be no general software engineering solution. Instead, domain-aware people must select a suitable set of activities to study. In our experience, stakeholders do not start with a blank slate; instead, there is some shared idea of the scenario that is being developed before the project starts. Identifying this scenario and the activities it comprises can be done using personal experience; for example, experience of one’s interaction with their own grandparents; using some informal observation, such as watching example users; or using existing knowledge in the area. However, the step of identifying the activities is important because the activities heavily influence the data that is collected, and therefore the results. As such, a more rigorous approach is preferred whenever possible.

The activities that we identified for the intergenerational fun case study are based on a previous field study in the area. In this previous study, *cultural probes* (Gaver et al., 1999) were used to elicit high-level motivations of interaction between grandparents and grandchildren. A cultural probe (Vetere et al., 2006) is a collection of material that is left in the field of study (in this case, the houses of grandparents and grandchildren). The material is used and modified by participants to give researchers a way to understand how the participants behave in their everyday lives without having to use direct observation. In the previous study, the cultural probe was a *magic box* (Vetere et al., 2006), and two households participated; the grandparents’ household and the grandchildren’s household. The magic box, provided by researchers, was initially given to one household, and contained a variety of colourful stationary such as scissors, stickers, cards containing catchphrases, etc. The participants were asked to use these to create something that reflected their feelings about the people in the other household. At night, the magic box was placed on the doorstep, and a magic fairy (a member of the research team), would collect the box and deliver it to the second household, who would repeat the exercise.

Figure 4 shows the high-level motivation model from this previous work. In our study, we use this model to select three different activities commonly

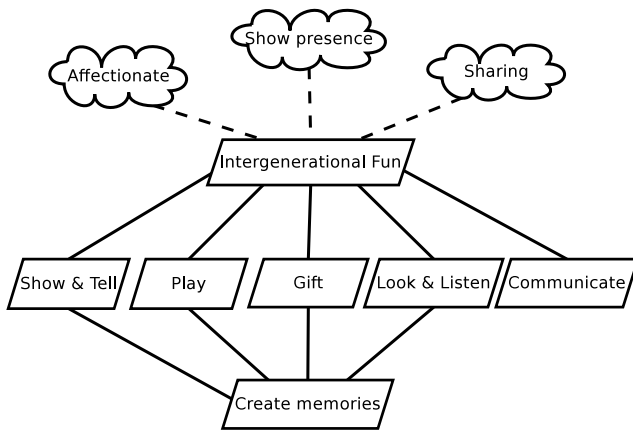


Figure 4: High-level motivation model for intergenerational fun.

performed between grandparents and grandchildren:

- 1) **Gifting.** Grandparents and grandchildren like to gift items to each other to demonstrate their feelings towards them. Children especially like to provide gifts that they have made themselves, and grandparents enjoy receiving these.
- 2) **Storytelling.** A common shared activity is for one party to tell a story to another. When the grandparent is the storyteller, they typically either read a storybook to the grandchildren, or tell stories about their earlier lives. When the grandchild is the storyteller, the stories tend to be about activities that occurred since they last spoke.
- 3) **Play.** Grandparents and grandchildren typically engage playfully over a physical object, which is explored and used as the basis of playful jokes.

4.2.2 Select and obtain data for an activity

The three activities that we identified were explored in parallel, although not all using the same investigation.

To obtain data about the activities, and how the grandparents and grandchildren interact, we use technology probes: technologies that support both the evaluation of technological ideas in their domain, and the study of the needs and desires of their users. We used the motivational model from Figure 4 to build three lightweight technology probes to investigate intergenerational fun over a distance:

- 1) **Electronic Magic Box.** The Electronic Magic Box system is a technological version of the original magic box. The system provides a way for the users to send messages and images to each other in an asynchronous manner. Images can be sent to the users' system by taking a photo with a mobile phone, and sending a multimedia message, thus allowing them to record their daily lives. When a user logs in, the magic box will display whether or not there is new content in the box, waiting to be opened. To look inside the box, users must first play a small game; for example, solving a maze. A broken seal on the magic box indicates that a message they have sent has been opened by the other household. All images and messages are collected into a "photo album", which can be viewed at any time.

This technology probe was introduced to mainly explore gifting, but it is clear that stories could be told, especially over a number of box exchanges.

- 2) **Collage.** The Collage system allows users to share photos taken throughout the day via touch screens with shared displays. A typical scenario involves a user (grandparent or grandchild) taking a photo of something interesting that happened during their day using a mobile phone. The mobile phone is then used to send this picture to Collage. Each household has a touch screen displayed in a prominent area of the house, and the pictures that are sent to Collage are shown on both touch screens simultaneously. Pictures scroll down the screen in a waterfall-like pattern at random intervals, with more recent photos being displayed more often. Either household can interact with the display by moving, resizing, hiding, or deleting pictures, and this interaction can be seen simultaneously in the other household. Users can also send text messages to the screen, which is fun for older children that can write. The random interleaving of text and pictures results in some strange and funny combinations.

The technology probe supports mainly play and storytelling, although again, gifting is also possible.

- 3) **Storytelling.** The Storytelling system allows users to interact over a shared story that is displayed on touch screens with shared dis-

plays, while communicating over an audio channel. As well as reading pre-loaded story books, users can create their own stories using pictures that have been sent to the system via a mobile phone. In addition, users can draw on the story books and pictures using the touch screen capabilities.

Clearly, this technology probe supports storytelling, but also play because users can interact over virtual objects using the touch screen capabilities. Asynchronous messaging was not included in the Storytelling system (for example, to schedule story times) for two reasons. First, asynchronous messaging is available in Magic Box, and we wanted Storytelling to give us different insights to Magic Box. Second, as Cao et al. (Cao et al., 2010) note in their study of family communication, family members “would often [...] wait to make a [synchronous] call, rather than opting to send an asynchronous message”.

The technology probes themselves are key to the data collection. The data obtained from the study will be influenced by the probes, therefore the probes need to be flexible in the way they allow the participants to interact with the probe itself, as well as with each other. Importantly, the probes must represent the main activities that the users perform in the domain, which is why identifying the activities is important. For example, grandparents and grandchildren often interact over shared objects (*look & listen*) or share stories (*show & tell*) (Davis et al., 2011). These concepts were translated in technology use over distance for the prototypes. As such, the probes instantiate the model in Figure 4, and the data collected aims to be consistent with this, and the data should be viewed through the model.

4.2.3 Define the roles and goals for that activity

Using the data derived from the technology probes, we derived motivation models, as described by Sterling and Taveter (Sterling and Taveter, 2009), which define the roles involved in the activities, the goals that they wish to achieve, and which roles help to fulfil those goals. The transcribed interviews and the data collected from the probes were analysed using ethnographic content analysis according to Patton (Patton, 2002). Further details of the methods for studying the data and deriving the models are discussed in earlier work (Pedell et al., 2009). In this paper, we focus on how the

resulting models improve our understanding of socially-oriented roles and goals specifically.

Figure 5 shows the motivation model that was derived from the data analysis on the storytelling activity.

Storytelling is primarily the telling of a pre-scripted, fictional story, but can also involve telling non-fictional, personal stories or improvised stories.

Definitions of the roles themselves are expanded to include the responsibilities and constraints that are associated with the role. Figure 6 shows the role model for the *Teller* and *Listener* roles from Figure 5.

Role Name	<i>Teller</i>
Description	The role of the teller of a story.
Responsibilities	Tell the story to the listener in fun and funny ways. Offer stories for the listener to choose. Respond to listener’s actions. Act the role of the characters in the story.
Constraints	Be lighthearted. Allow the listener to partially control the story.

(a) Role model for *Teller*.

Role Name	<i>Listener</i>
Description	The role of the listener of a story.
Responsibilities	Be visibly active to teller. Respond promptly. Playfully disrupt the teller.
Constraints	Be lighthearted.

(b) Role model for *Listener*.

Figure 6: Role models for the *Teller* and *Listener* roles shown in Figure 5.

To derive these models we employed a two-step process. First, an individual team member would analyse the data received as part of the study. This data was collected from two sources: the technology probes, and from interviews with the family members that used the probes. Most of this data is in the form of episodic interactions that are generally only a few minutes long. The individual team member would then construct a preliminary motivation model from their interpretation of the

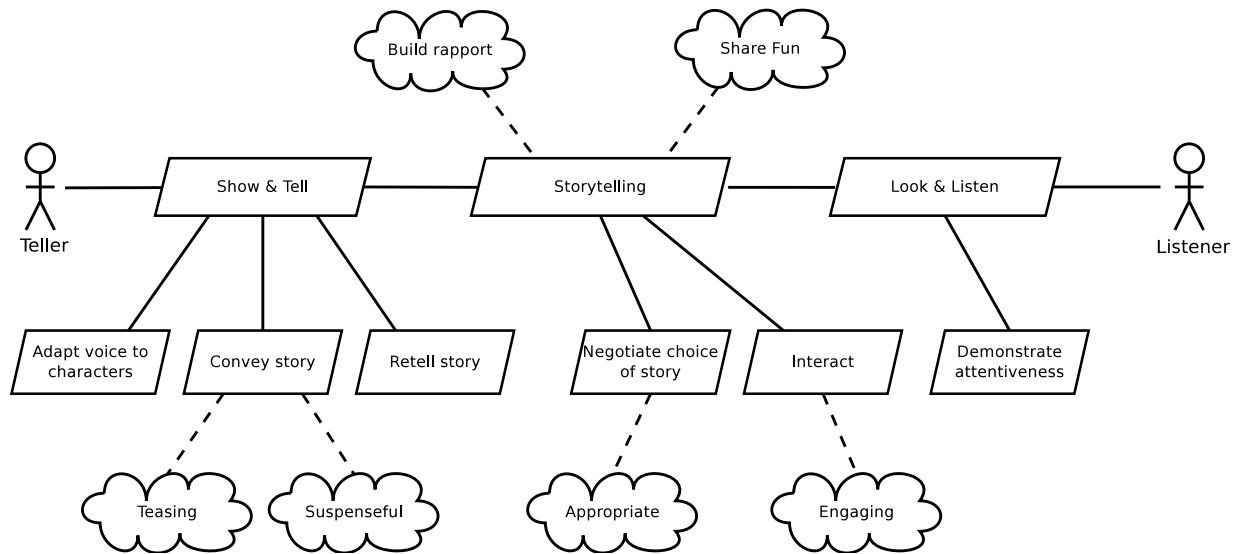


Figure 5: Motivation model for the storytelling activity.

data. Second, the team members would hold a round-table meeting, in which they were presented with summaries of the data, and the preliminary models. Some of the team members would have been present in the interviews with the families, so this discussion served to improve the models based on the summary data and the team members' individual experiences with the families.

In our study, the models derived were used to share our understanding of the domain, but also to interpret the data obtained during the study. The motivation models were constructed while the investigations ran, rather than after all investigations were complete. As a result, when new data was obtained, we used the models as a lens through which we could view the data; that is, did a particular interaction fit within a particular goal, role, or quality goal.

As new stories about the families emerged from the interviews and data analysis, the team would attempt to explain the stories with respect to the models — that is, we would use these as examples that fitted the model. If this could not be done, a conversation would be triggered that attempted to modify or extend the model to consider this. Alternatively, a particular story may not be considered or important enough to be generalised and added to the model. For example, if new data conflicted with the existing understanding of the domain, a conversation would result that would decide whether the new data was: 1) an anomaly that is out of scope, and could be omitted in the model; 2) the model needed modification to generalise the

conflicting information; or 3) the model needed to represent this conflict. We found that new data was rarely incompatible with the existing model, but new additions to the model did occur (discussed in the results, Section 5).

4.2.4 Construct the generalised motivation model

The other activities investigated as part of the case study produced similar motivation models to that of the storytelling model in Figure 5. From these three models, we construct a generalised motivation model that represents the shared aspects of the different activities. The high-level model itself was constructed using the same two-step process that was used to construct the low-level models: one member of the research team constructing a model and then presenting it along with the data to the entire team at a round-table meeting.

Figure 7 shows the updated high-level generalised motivation model for our intergenerational fun study, which is an extension of Figure 4. Note that two of the goals from the Storytelling motivation model in Figure 5, *Show & Tell* and *Look & Listen*, are also present in the generalised model. As part of the generalisation, these goals, along with the other goals in Figure 7, were considered general enough that they were related to all activities seen in the technology probes.

We note that there is no hierarchical relationship between the generalised motivation model (Figure 7), and the lower-level model (Figure 5). That is, the goals in the generalised model do not expand directly into goals in the lower-level models. In

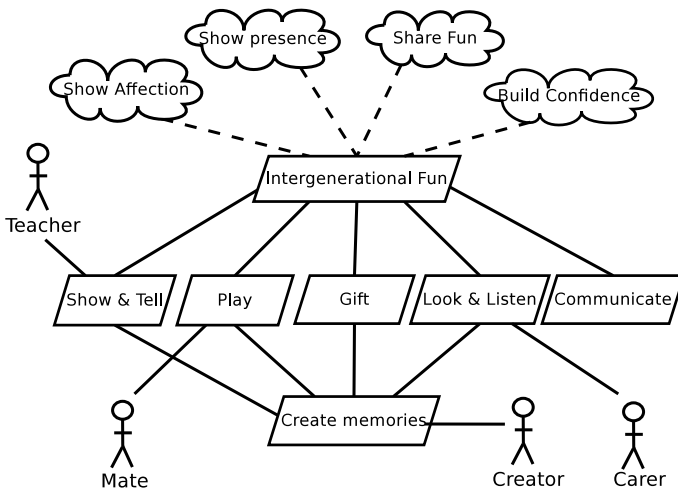


Figure 7: Updated high-level motivation model for intergenerational fun.

the case of the storytelling model, one can see that *Show & Tell* and *Look & Listen* are both goals that make up the goal of *Storytelling*, but the *Storytelling* goal is not present in the generalised model. Our experience suggests that this is a reasonable way to link to the different motivation models, as there are some roles and goals that are interpreted differently depending on their context and level of abstraction. For example, the goal *Show & Tell* in Figure 5 has three sub-goals that do not make sense when doing show and tell outside of story telling — adapting one’s voice to characters is non-sensical in the collage system, as it does not have an audio channel.

4.3 Using the models

Once a thorough-enough understanding of the motivations in the domain has been discovered, the new models are used to inform the design of the system.

Sterling and Taveter (2009) present the *viewpoint* framework for studying the types of models within agent-oriented software engineering. The framework is consistent with model-driven engineering, and describes three different abstraction layers, and the models that correspond to the three different viewpoints at each of these layers.

The three abstraction layers in the viewpoint framework are:

- 1) **conceptual domain modelling** — describes the motivations within the system;
- 2) **platform-independent computational design** — describes the system design; and

- 3) **platform-specific design and implementation** — describes the deployment of the system.

The three viewpoints are:

- 1) **behaviour** — the behaviour of the agents performing roles within the system;
- 2) **information** — the knowledge and data contained within the system; and
- 3) **interaction** — the interaction between the agents performing roles in the system.

Each of the three layers contains each of these three viewpoints, resulting in a total of nine viewpoints. The higher-level models are refined progressively into lower-level models, serving as input into the design and implementation process, as well as models against which to validate lower-level models.

In Sterling and Taveter’s work, motivation models, including roles, goals, and domains, serve as models at the conceptual layer. The models produced using our approach provide software engineers with the role and goal models at the conceptual domain modelling layer. The nature of social systems means that mapping these models to unambiguous requirements will be non-trivial compared with, for example, a business system; however, a more accurate understanding of the domain at this level will allow better customisation of the system with respect to the users’ motivations, and therefore an improvement in quality. The simple nature of the motivational models leaves scope for designers to add information later when a better understanding of the system has been obtained, but also may omit some information. For example, Sterling and Taveter (2009, Chapter 3) make a special point that relationships between goals, such as *AND* and *OR* relationships are avoided in their models for the sake of retaining simplicity. Like them, we have found that the simpler models are more palatable for non-technical stakeholders, and serve as better boundary objects. For this reason, attaching quality goals to functional goals is important. It is difficult to disambiguate socially-oriented quality goals before development starts. Just stating them as non-functional requirements may result in them being ignored. We connect qualities to functional goals so that we carry them through to development without (necessarily) resolving them completely. Social concepts can not be decomposed into functional requirements as the responsibility of success lays partly — as in every socio-technical

system — with the human actors.

We note that the models need not stand alone: any detail regarding the relationship between goals that is important can be added as either a text addendum, can be annotated directly on the models, or can be included in additional models. Even in our experience in non-social systems, we have found that the split between requirements and software design is not so clear, and that often different levels of detail are useful for different stakeholders. For example, in another project, we have used these models as boundary objects in the domain of air traffic control. In that project, our industry partner welcomed the different levels that the models offer, as they find that some of their clients are more comfortable with high-level requirements, but others like to see more detail. In our experience on the intergenerational fun project and previous projects, we have found that flexibility and simplicity are ultimately more important than completeness for understanding socially-oriented roles and goals because completeness cannot be attained. We have not found a need for such addendums in any of our experiences using using agent-oriented models to capture social-oriented requirements.

5 RESULTS

In this section, we present what we learnt from the case study. Some results are about our process and method in general, while others are about the grandparent-grandchild relationship, which helps to validate our process and method.

5.1 Lessons earned about the method

The most important result of this case study was that the the overall roles cannot be defined as simply a set of sub-roles, as we had initially anticipated. For example, given the resulting intergenerational fun motivation models, we initially envisaged that we could approximate the grandparent role as something like:

$$\textit{Grandparent} \approx \textit{Teller} + \textit{Teacher} + \textit{Giver}.$$

That is, the role of a grandparent is approximately defined as someone who takes on the role of story teller, teacher, and gift giver. An actor that takes on this role (in our case, presumably a human agent) would be expected to play some of these roles.

However, the results of the study indicate that such a definition is not sufficiently nuanced to represent the complex and subtle relationships found

in social domains. We saw that the grandchildren were eager to give gifts to the grandparents, and that they were also happy to fulfil the role of a story teller, especially to tell a story about their day. As such, the role of a grandparent depends on the role of the grandchild, and vice-versa. Furthermore, both depend on the context of the interaction.

The second result relating to our method is regarding the responsibilities of roles. Adhering to Sterling and Taveter’s models (Sterling and Taveter, 2009), each role has a set of “responsibilities” outlining what the agent must do to achieve its goals. In the context of socially-oriented systems, these responsibilities must be interpreted lightly. That is, a role can achieve its goals without fulfilling all of its responsibilities. For example, one responsibility of the *Listener* role defined in Figure 6 is to be disruptive. It is not necessary to do this as a story listener, but it often contributes to the interaction being fun. We expand further on the “disruptive” them in Section 5.2. In such cases, distinguishing optional responsibilities from mandatory responsibilities may prove useful, similar to the approach employed by Liaskos et al. (2010) to distinguish optional goals from mandatory goals.

An interesting extension of this is related to the link between responsibilities and goals. The responsibilities are often not linked directly with functional goals, but are instead linked to the quality goals. For example, one responsibility of the *Teller* is to tell the story “in fun and funny ways”. Completing the story is not necessary and it is irrelevant to the quality goals such as *showing affection* and *sharing fun*.

5.2 The grandparent-grandchild relationship

We discuss what we learnt about the grandparent-grandchild roles and goals overall, and also specifically from the story telling activity, as this is the part of the case study we have focused on the most.

The case study uncovered several interesting new aspects of the relationship that were both undiscovered in the original Magic Box case study (Vetere et al., 2006), and unexpected by us.

The *Teacher* role: As expected, there is the sense of a role of *Teacher* in the relationship, with the grandparent teaching things to the grandchild. However, the responsibilities and constraints of this role were different from our expectations. While wanting to teach new things to their grandchildren, grandparents do not want to be seen as a teacher

in the traditional sense. Instead, they want to feel close and have fun, and have the learning as a side effect.

One grandmother expressed the following in an interview:

I have brought up my children. I love to simply enjoy spending time with my grandchildren — I do not see it as my task anymore to educate them — I have done my bit.

This result indicates that technology support in this setting should not be set up around teaching, but should be flexible enough to allow objects to be shared so that the child can learn from the interactions.

The Mate role: While it was expected that the relationship would be friendly, it was also evident that there was no controlling role in the activities. Sterling and Taveter define three major types of relationships between roles: *control*, *benevolence*, and *peer*. It was assumed that the grandparent-grandchild relationship would be a *control* relationship, however, this was not the case. While the grandparents felt a sense of responsibility towards their grandchildren, they did not want to be controlling, and considered their playful relationship as a *peer* relationship — they were “mates” with their grandchildren.

Disruptive play: An important aspect of intergenerational fun over a distance is the ability to be disruptively playful. This was particularly evident in the storytelling application, in which grandchildren would playfully disrupt the telling of the story by doing such things as turning the pages before the grandparent had finished reading it, or wiping writing off the screen as soon as the grandparent wrote something. Early in the study, the grandparents would initially react with annoyance, but this would quickly be followed by laughter.

One grandfather responded to the early turning of pages as if nothing had happened — he continued to read the story as he knew it off by heart. He explained that initially he “*tried to do some teaching about ‘if you want me to read the story you don’t flip the pages around!’*, but in the end for me the objective really was having fun.”

The reason that disruptive play was so popular for the grandchildren was because it shifted the balance of power, which was facilitated by the distance and interaction possibilities. This is somewhat related to the peer relationship for which the grandparents aimed. One particularly shy granddaughter

became progressively “cheekier”, which the grandparents viewed as a positive development.

We believe that this disruptive possibility is one of the reasons that storytelling was fun compared to storytelling over the phone. A grandparent telling a story over the phone offers much less scope for disruptive play.

This result, as well as the result regarding the *Mate* role, indicates that, if possible, technology supporting intergenerational fun should not be designed in a way that gives one role power over the other.

Showing weakness: We learnt that, as part of showing affection to their grandchildren, grandparents do not mind displaying their weaknesses. This was particularly evident in the Electronic Magic Box application, in which messages were sent in an asynchronous manner, separate from the often loud and chaotic manner of the storytelling application.

Grandparents were open regarding their inability to easily use the applications that we provided to them, and discussed their failures with their grandchildren. They were also willing to share parts of their everyday life that demonstrated that they were somewhat disorganised, and did “wrong” things even though they “should know better”, such as not tidying up after themselves.

People only tend to show failures to people that they trust and love, and such messages were seen as something special by the grandchildren.

This result indicates that offering an asynchronous and possibly personal method of communication is desirable in technology for supporting intergenerational fun.

Building up confidence: As part of the study, we identified a new quality goal called *Build up confidence*, which is seen in motivational model Figure 7, but not the initial model in Figure 4. The data obtained around this theme did not fit in with any part of our motivational model, so was included as a new quality goal.

Both grandparents and grandchildren enjoyed the applications that built up their confidence; especially those that built up their confidence in technology itself. The Electronic Magic Box application encouraged one of the grandparents to start using email, which they had previously seen as an uninteresting and unmanageable way to communicate.

The Electronic Magic Box had an interesting feature, in which, if an empty magic box (no message or photo) was sent, the person opening the box would see a kangaroo jump out of the

box and across the screen. The grandparents were informed of this, but not the grandchildren. One grandmother was proud that she was able to do something unexpected with the technology that excited her granddaughter, which again increased her confidence.

Both grandparents and grandchildren took pride in showing off their new-found confidence to friends. One mother commented that her daughter particularly loved showing off to her friends:

Showing them something cool: "this is what I've got. This is mine — this is my phone and I can send pictures."

Grandparents took pride in playing the role of technology advocate among their peers. They had never anticipated that the applications would prompt them to become advocates of new technologies.

This result indicates that technologies supporting intergenerational fun must allow the users to slowly build up their confidence by starting with straightforward and perhaps familiar tasks, and building up from there.

5.3 Building new technology

Using the results of this study, we have produced a new system for intergenerational fun called "Family Fun", which is based on Collage and Storytelling. To build this improved system, we studied the goals that describe the high-level goals from our models, and specified sub-goals that describe concrete functionality of the software application, while focusing on the related quality goals. A step like this requires us to make decisions about the system design, and these decisions are based on the understanding contained in the motivational models.

As an example, consider two sub-goals of the goal *Storytelling* from Figure 5: *Negotiate choice of story* and *Interact*. To support these goals and their related quality goals, specific functionality is required. Figure 8 shows a breakdown of these two sub-goals into further sub-goals that specify the design of the system.

These sub-goals describe functional goals to achieve their parent goal. To negotiate a story, two functional goals are included: one that specifies the goal of searching a library of stories, which specifies further that a library of stories is required; and one that specifies the goal of adding/removing new/existing stories. Together, these two sub-goals

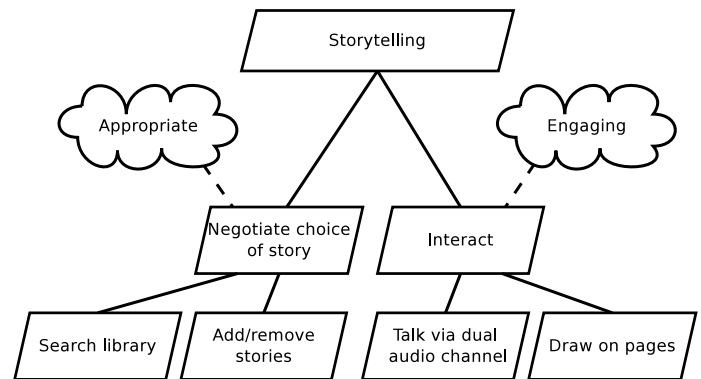


Figure 8: An extension of the storytelling model from Figure 5.

allow stories to be negotiated, and allow the quality goal *Appropriate* to be fulfilled because new stories can be added to suit the age of the children, and inappropriate stories can be removed. These sub-goals can be broken into further sub-goals as desired.

To interact in a fun and engaging manner, the stories must not simply be told in a way that leaves the listener as a passive participant. To achieve the *Interact* goal, we include some functionality from the original storytelling application, in which the stories are told over a two-way audio channel, and either the teller or listener can draw on the pages or turn the pages. These support playful interaction far better than simple one-way communication.

The decision to produce a new system that combines parts of both Collage and Storytelling was made to achieve the new quality goal of *Build Confidence*. Less confident users can start with the simpler Collage part of the application. The new system supported new functionality such as drawing on photos in the collage waterfall. However, this functionality does not have to be used, and therefore does not destroy the aesthetics of the simple waterfall, which was preferred by the less confident grandparents. More experienced computer users, especially those familiar with applications such as telephony software, were comfortable with the storytelling application. Some of the children, in particular the younger ones, preferred the storytelling application while some enjoyed the sending and moving of photographs.

A screen shot from the Family Fun system is shown in Figure 9. Here, the story is displayed while the waterfall continues in the background. Photos from the waterfall can be dragged via the touch screen onto the story book, to allow stories to

be created in real time from the family's everyday experiences.



Figure 9: The “Family Fun” system.

The new system preserves the idea of flexible interaction, which was important with the technology probes. We believe it is important to allow new forms of interaction between the users, and the experience in this case study highlights that leaving the users' actions unconstrained can help to achieve this aim.

6 CONCLUSIONS

In this paper, we presented a systematic and repeatable process and method for improving our understanding of roles and goals in the social domain. The social domain provides many challenges for modellers that they would not encounter in the business domain, where the roles and goals of actors are often clearly defined, and where the quality of the system can be somewhat measured via its ability to achieve functionality or measurable quality attributes. In contrast, users of systems in the social domain tend to judge the quality of a system relative to ambiguous, subtle, and non-measurable goals, such as “having fun”.

Our understanding of a particular social domain is modelled using motivation models. Rather than attempt to define the roles and goals seen in this domain, we advocate defining these relative to a set of activities that are typically performed in that domain. The conglomeration of the roles and goals in these activities can then be used to provide an approximation of the high-level roles and goals. As part of our method, these activities are studied using technology probes, and the resulting ethnographic data is abstracted into motivation models,

which can be used to inform technology design. The data that results from the technology probes are used as a form of validation of the role and goal models. These models are useful boundary objects, allowing knowledge to be shared across and between the disparate stakeholder communities, including end users, software engineers and field researchers.

To validate our process and method, we performed a detailed case study that investigated how grandparents and grandchild who are geographically separated can use technology to have fun. From our studies, we have obtained a much better understanding of how grandparents and grandchildren can interact in a fun and meaningful way using domestic technology. Importantly, we challenged some of the early assumptions about the domain as part of the design discourse. For example, we learned that grandparents want to be viewed as friends, rather than an authority figure, and that they do not want to play the traditional role of a teacher. We also learned that disruptive play is an important part of fostering fun in intergenerational interactions. We have evaluated the intergenerational fun models further by having a student team develop a prototype system based on these models.

Using such an approach has some downsides. First, there is a need for multidisciplinary skill sets in any team that would use our approach. Second, the approach blends a top-down approach (modelling) with a bottom-up approach (ethnography), and managing these two approaches may prove challenging in many domains. Third, different viewpoints on how the top-down and bottom-up viewpoints should merge may present unique problems, and there is no authority to decide which viewpoint is “right”.

In future work, we will investigate the use of scenarios and personas to create ethnographically derived context data role and goal models. This can supplement our current round-table discussions with a more formalised recording of episodes and individual characters, and provides a more structured, systematic, and repeatable technique for deriving role and goal models than we currently employ.

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