

# Pedagogical Soap

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## Abstract

Interactive Pedagogical Dramas (IPD) are compelling interactive stories that have didactic purpose. Autonomous agents realize the characters in these dramas. Their roles may be to portray humans facing overwhelming, emotionally-charged difficulties. This challenges the agents to interact with a depth and subtlety that is consistent with human behavior in difficult, stressful situations. To address this challenge, we have adopted an approach that deconstructs a professionally written script in order to inform the design of the agents that realize the interactive drama. This deconstruction is based on psychological research on human emotion and personality. This approach is realized in *Carmen's Bright IDEAS*, an interactive drama designed to improve the social problem solving skills of mothers of pediatric cancer patients.

## Introduction

Carmen is the mother of a seriously ill nine-year-old boy, Jimmy. Jimmy's illness is a significant physical and emotional drain on Carmen and her family. Carmen is often at the hospital with Jimmy. As a result, Carmen's six-year-old daughter, Diana, is having temper tantrums because she feels scared and neglected. Carmen's boss is also upset about her absences from work. Unable to effectively deal with these problems, Carmen is experiencing high levels of psychological distress, including anxiety and depression. To help her address these problems, a clinical counselor, Gina, is going to train Carmen in a problem-solving technique called Bright IDEAS.

The above is the background story of *Carmen's Bright IDEAS*, an *interactive pedagogical drama* (IPD) realized by socially intelligent agents. *Carmen's Bright IDEAS* is

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designed to improve the problem solving skills of mothers of pediatric patients, mothers that face difficulties similar to Carmen's. The pedagogical goal of the title is to teach a specific approach to social decision-making and problem solving called Bright IDEAS. Each letter of IDEAS refers to a separate step in the problem solving method (*Identify* a solvable problem, *Develop* possible solutions, *Evaluate* your options, *Act* on your plan and *See* if it worked).

In an interactive pedagogical drama, a learner (human user) interacts with believable characters in a believable story that the learner empathizes with. In particular, the characters may be facing and resolving overwhelming, emotionally charged difficulties *similar* to the learner's. The learner's identification with the characters and the believability of their problems are central to the goals of having the learner fully interact with the drama, believe in the efficacy of the skills being employed in it and subsequently apply those skills in her own life.

The design of IPDs poses many challenges. The improvisational agents who answer the casting call for characters like Carmen and Gina must provide convincing portrayals of humans facing and discussing difficult personal and social problems. They must have ways of modeling goals, personality and emotion, as well as ways of portraying those models via communicative and evocative gestures. And this portrayal must be done for a "tough audience", a learner who is facing similar problems.

Most critically, an IPD is a social drama. Thus, the agents in the drama must behave like socially interacting humans. An agent has to be concerned with how other agents view their behavior. They may emotionally react if they believe others view them in an way that is inconsistent with how they see themselves (their ego identity). Also, to achieve its goals, an agent may need to motivate, or manipulate, another agent to act (or not to act).

Because of the highly emotional, stressful events being dramatized, the design of the agent's models was a key concern. The design was heavily inspired by emotional and personality models coming out of work on human stress and coping (Lazarus 1991), in contrast to the more commonly used models in agent design coming out of a

cognitive or linguistic view (e.g., Frijda 1986; Moffat 1997; Oatley and Johnson-Laird 1987). Our overall approach to the agent design process is to start with a professionally written script and deconstruct it in order to derive the agent models. Models of human emotion and personality play a critical role in providing a basis of analysis for the deconstruction process.

Of course, because IPDs are animated dramas, the design of an IPD faces a wide range of additional issues and draws on a range of research to address those issues. Although these issues will not be discussed in great detail here, it is nevertheless important to note them. The agent architecture uses a model of gesture heavily influenced not only by work on communicative use of gesture (Cassell and Stone 1999; McNeil 1992) but also work on non-communicative but emotionally revealing nonverbal behavior (Ekman and Friesen 1969), including work coming out of clinical studies (Freedman 1972). Further, since these agents are acting out in a drama, there must be ways to dynamically manage the drama's structure and impact even while the characters in it are self-motivated, improvisational agents (e.g., Kelso, Weyhrauch and Bates 1993; Blumberg and Galyean 1995). Because IPDs are animated dramas that are dynamically unfolding, there must be ways of managing its presentation (e.g., Bares and Lester 1999; Tomlinson, Blumberg and Nain 2000). Additional details on many of the issues discussed here, can be found in (Marsella, Johnson and Labore 2000), available at <http://www.isi.edu/~marsella/ipd.doc>

The discussion that follows provides a brief overview of the IPD design. Then the relation of the agents' emotional modeling to their social interactions is discussed in greater detail using examples drawn from Carmen's Bright IDEAS.

## IPD Background

In our basic design for interactive pedagogical drama, there are five main components: a cast of autonomous character agents, the 2D or 3D puppets which are the physical manifestations of those agents, a director agent, a cinematographer agent, and finally the learner/user who impacts the behavior of the characters. Animated agents in the drama choose their actions autonomously following directions from the learner and/or a director agent. Director and cinematographer agents manage the interactive drama's onscreen action and its presentation so as to maintain story structure, achieve pedagogical goals, and present the dynamic story so as to achieve best dramatic effect. The design of these agents requires both general capabilities as well as knowledge specific to the interactive drama that is being created.

As mentioned earlier, our current approach to the design

of IPDs is to start with a professionally written script and systematically deconstruct it. The deconstruction serves several ends. It provides a model of the story and how variability can enter that story. In particular, the deconstruction provides the knowledge to dynamically direct the agents in the drama. It also guides the modeling of the improvisational agents in the drama, their personalities, their goals, their dialog, as well as how they interact to achieve their goals. Finally, it serves to constrain the complexity of these models. Detailed discussion of this script deconstruction approach and the overall IPD architecture is beyond the scope of this document but more details can be found in (Marsella, Johnson and LaBore 2000).



Figure 1. A distraught Carmen in Gina's office.

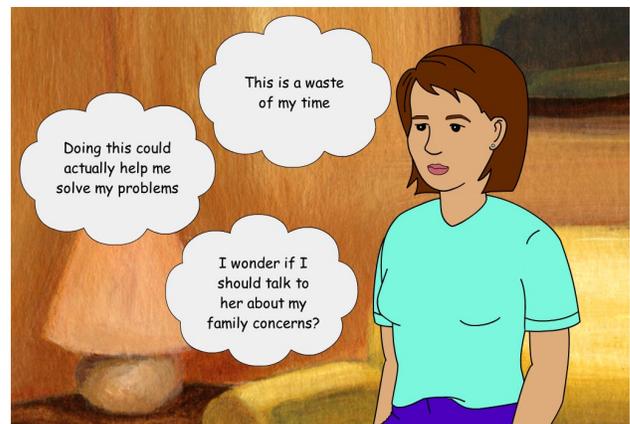


Figure 2. User's choice of thoughts for Carmen.

## Carmen's Bright IDEAS

The story for Carmen's Bright IDEAS is organized into three acts. The first act reveals the back story. The second, main, act takes place in Gina's office. Carmen discusses her problems with Gina, who suggests she use Bright IDEAS to help her find solutions. With Gina's help,

Carmen goes through the initial steps of Bright IDEAS, applying the steps to one of her problems and then completes the remaining steps on her own. During this discussion the action may flash back as Carmen recalls events that occurred in the past, or flash forward as she imagines possible outcomes of her actions. Figure 1 depicts a scene in Gina's office, showing a distraught Carmen soothing herself by rubbing her arm. The final act reveals the outcomes of Carmen's application of Bright IDEAS to her problems.

The human mother interacts with the drama by making choices for Carmen such as what problem to work on, what Carmen's inner thoughts are at critical junctures, etc. Figure 2 depicts how interactions are displayed. The mother's selection of inner thoughts for Carmen impacts her emotional state, which in turn impacts her thinking, as well as her behavior. It is Gina's task to keep the social problem solving on track by effectively responding to Carmen's state, and motivating her through dialog. Meanwhile, a bodiless cinematographer, Alain, is dynamically manipulating the camera views, flashbacks, and flash-forwards.

Gina and Carmen interact through spoken dialog. In order to add realism and maximize the expressive effect of this dialog, recorded dialog of voice actors is used instead of speech synthesis. A significant amount of variability in the generated dialog is supported by breaking the recordings into meaningful individual phrases and fragments. Additionally variability is achieved by recording multiple variations of the dialog (in content and emotional expression). The agents compose their dialog on the fly. The dialog is also annotated with its meaning and intent so that the agents can reason about what to say, understand each other and more generally interact via dialog. In Carmen's Bright IDEAS, the events processed by the agents are mainly these annotations attached to the recorded dialog fragments. For the agents, the annotations, along with problem-solving context, reveal the meaning of what is being said. The agents experience the annotations in order, so their internal state and appearance can be in flux over the dialog segment.

### Agent Architecture

The agent architecture used for the characters in CBI is depicted in Figure 3. There are distinct modules for problem solving, dialog, physical focus, emotional appraisal and affective appearance. The problem solving models the agent's cognitive layer, specifically its goals, planning and deliberative reaction to world events. The dialog model models how to use dialog to achieve goals. It is closely tied to the problem solving and is shown as part

of the same component. The output of this combined component is the agent's deliberative acts, such as spoken dialog. Emotional appraisal is how the agent emotionally evaluates the events. This module is a rule-based system that encodes the agent's concerns as well as rules for emotionally appraising world events (e.g., dialog annotations). Note this appraisal can be mediated by how the problem-solving model plans to cope with those events. For example, having a plan in place to deal with an event will suppress the magnitude of the emotional reaction. Conversely, strong emotional states such as depression can suppress the execution of a plan. Affective appearance simply drives facial expression (the eyes and brows). Finally, physical focus manages the agent's other nonverbal behavior.

There are several pathways in the model worth noting. The agent's acts feed back to the input. Thus it is possible for the agent to say something and then react to the fact that it has said it. There is also feedback from affective appearance and physical focus so that the model allows expression of a gesture to modulate affective state. There are also some paths that are arguably missing. For example, there is no direct link from the problem solving to affective appearance. So the agent is currently not able to deceptively move its brows so it looks angry when in fact it is not angry. Finally, there are multiple inputs to physical focus, from emotional appraisal and problem solving. Essentially, physical focus must mediate between alternative demands on the agent's physical resources (arms, legs, mouth, head, etc.). The agent's dialog may be suggestive of a specific gesture for the agent's arms and hands while the emotional state is suggestive of another. It is up to physical focus to decide on the appropriate gesture.

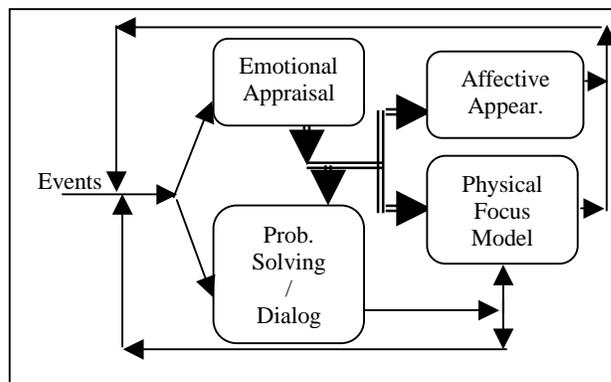


Figure 3. Agent Architecture

A simple example serves to elucidate how some of these pathways work. Assume Carmen is feeling anxious about being judged a bad mother by Gina. An external event occurs: Gina asks Carmen why her daughter Diana is

having temper tantrums. Carmen copes (problem solving) with her anxiety by dismissing the significance of the tantrums. She answers (dialog model): “She is just being babyish, she wants attention.” Based on this dialog and Carmen’s emotional state, physical focus selects relevant behaviors (e.g., fidgeting with her hands). The dialog also leads to emotional re-appraisal. She may now feel guilty for “de-humanizing” her child (emotional appraisal) and may physically display that feeling (physical focus). She will then go on to openly blame herself in front of Gina. Note that Carmen may go through this sequence of interactions with Gina based on the flux in Carmen’s emotional reaction to her own behavior, while Gina is simply passively listening.

## Emotions & Social Interactions

The nature of agent interactions in this IPD design arise in large part from four sources: the overall architecture of the agents, their goals, the knowledge contained in their emotional appraisal model and finally how appraisal impacts their behavior (their coping strategies). As noted in the daughter Diana example above, the architecture, specifically the reactivity and feedback built into the architecture can lead to interactions based on the flux in emotions caused by an agent’s re-appraisal of, and reaction to, its own behavior. This feedback is critical to the Carmen agent’s realization of a subtle, convincing performance. Clearly, an agent’s goals also impact the nature of the interaction. This is particularly true in the case of Gina who has the specific goal of teaching Carmen the IDEAS technique, which we discuss below.

Emotional appraisal plays the key role in shaping how the agents interact and how the user interacts with Carmen. The appraisal model being used here draws on the research of Richard Lazarus (Lazarus 1991; Smith and Lazarus 1990). In the Lazarus model, emotions flow out of cognitive appraisal, and management, of the person-environment relationship. In general, appraisal of events in terms of their significance to the individual leads to emotions and tendencies to cope in certain ways. The work structures this appraisal into two classes. Primary appraisal establishes whether an event is relevant to a person’s well-being. Specifically, it determines whether an event is relevant to an agent’s goals, whether it is congruent or incongruent to those goals and the type of ego-involvement. If an event is relevant to an agent’s goals then some form of emotional response is possible. If the event is incongruent with respect to an agent’s goals (in conflict with them) then a negative emotional response is possible, such as fear or anger. If it is goal congruent then a positive emotion is possible, such as happiness. Ego-involvement concerns how an event impacts the agent’s collection of individual commitments, goals, concerns or values that comprise its

ego-identity. This collection includes concerns for self and social-esteem, social roles, moral values, concern for other people and their well-being and ego-ideals.

The knowledge represented by the agent’s ego identity comprises a key element of how it interacts with other characters and its response to events. For example, it is Carmen’s concern for her son’s well-being that induces sadness. And it is her ideal of being a good mother, and desire to be perceived as one (social esteem), that leads to anxiety about discussing Diana’s tantrums with Gina.

Secondary appraisal addresses the options available to the agent for coping with the event and how the options will impact the agent. It evaluates 4 factors: accountability, expectancy, problem-directed coping potential and emotion-directed coping potential. Accountability establishes who, if anyone, is to blame for a motivationally incongruent event. If the agent is to blame, there may be self-directed anger, or guilt if another also suffers. Expectancy establishes whether there is hope that matters will get better. Coping potentials are an assessment of how effectively the agent will be able to cope. Could the agent effectively change the world to make it more congruent (problem-directed coping) or adjust psychologically (emotion-directed coping)?

The pattern of results that arise from evaluating these primary and secondary appraisal factors establish the emotional state which in turn leads to certain coping strategies dependent on the particular strategies available to the agent. For example, if an external event is relevant to the agent’s goals, is incongruent to those goals, threatens its self-esteem (part of ego-identity) and can be blamed on some external agency then an increase in anger results in the agent (in humans, the story here would necessarily be more complex).

This emotional model provides rich potential for capturing the emotional nature and individual differences of characters. This potential is critical for creating the social interactions necessary for a drama like Carmen’s Bright IDEAS. However, pragmatically, the detail of an agent’s model must be limited. Here, the script plays a critical role in identifying the essential nature of the character and where detailed modeling is required.

## Interactions from 3 Perspectives

To exemplify how the agents in this drama socially interact, it is useful to view it from three perspectives, Gina’s, Carmen’s and the learner. Gina is trying to guide Carmen through the application of Bright IDEAS to her problems. From Gina’s perspective, the social interaction revolves around motivating Carmen. Carmen is quite distraught and Gina must apply gentle persuasion to keep Carmen positively engaged. Gina’s only tool is her use of dialog. However, the conversation is actually a potential

source of considerable anxiety for Carmen. From her perspective, there is concern that Gina will perceive her to be a bad mother because she is unable to control her daughter. Carmen view of herself as a good mother is a critical part of her ego identity. Adding complexity to this dynamics, the learner (the user) interacts with the drama by selecting Carmen's inner thoughts which in turn impacts her emotional state and behavior.

From Gina's perspective, the social interaction is centered around a persistent goal to motivate Carmen to apply the steps of the IDEAS approach to her own problems. This goal is part of the knowledge stored in her problem solving module (and is also part of her ego identity). But there is no way for Gina to force Carmen to apply the IDEAS steps. Dialog is Gina's main tool in this struggle and she has a variety of dialog strategies and individual dialog moves she employs to motivate. An example of a strategy is that she may ask Carmen to answer a series of questions about her problems that will help guide Carmen through identifying the causes of the problems. At a finer-grain, she may reassure Carmen that this will help her, prompt her for information or praise her. Gina selects between tactics based on a model of Carmen's emotional state.

These tactics work because Gina's dialog (the annotations) will impact Carmen. Because of her depression, the Carmen agent may initially require prompting, but as she is reassured, or the various subproblems in the strategy are addressed, her secondary appraisal of *expectancy* that her problems can be addressed increases. This will, in turn, be a positive impact on Carmen's emotional state. She will begin to feel more hopeful that the problem solving will work. This may cause her to engage the problem solving without the need for explicit prompting at each step. Similarly, the learner's interaction with Carmen impacts her emotional state and thus impacts how much prompting, praise or reassurance is necessary.

Carmen has a different perspective on the interaction. Unlike Gina, she does not have explicit goals or plans to achieve in the interaction. She is far more reactive and far more involved emotionally. Her reactions stem from her ego-involvement which is part of the knowledge encoded in her emotional appraisal module. Among this knowledge is her concerns about being a good mother, as well as inference rules such as good mothers can control their children and treat them with respect.

Finally, the learner is also part of this interaction. The learner impacts Carmen at the intentional level, choosing among possible thoughts and feelings that Carmen might have in the current situation. Those thoughts and feelings are incorporated into Carmen's mental model, causing Carmen to act in character in response to them. This design allows the learner to assume different relationships to story

and characters. She may identify with Carmen and have Carmen feel as she would. She may "act out" in ways she would not in front of her counselor. She may flip-flop in choices for Carmen.

This combination of Gina's motivation through dialog and the learner's impact on Carmen has an interesting impact on the drama. While Gina is using dialog to motivate Carmen, the learner's interaction is influencing Carmen's thoughts and emotions. That creates a tension in the drama, a tug-of-war between Gina's attempts to motivate Carmen and the initial, possibly less positive, attitudes of the Carmen/learner pair. As the learner plays a role in determining Carmen's attitudes, she assumes a relationship to this tug-of-war, including, ideally, an empathy for Carmen and her difficulties, a responsibility for the onscreen action and perhaps even an empathy for Gina. If Gina gets Carmen to actively engage in applying the Bright IDEAS technique with a positive attitude, then she potentially wins over the learner, giving her a positive attitude. In either case, the learner gets a vivid demonstration of how to apply the technique.

## Extensions

*Carmen's Bright IDEAS* is currently being extended so that the user can choose between controlling Carmen or Gina. Thus the user will be able to assume a relation with either the student or the teacher in this pedagogical drama. Also, the design of a new IPD title is underway that goes beyond the dyadic conversation explored in CBI. This new title has more characters onscreen involved in more complex social interactions.

## Concluding Comments

The social interactions in *Carmen's Bright IDEAS* are played out in front of a demanding audience - mothers who are undergoing problems similar to the main protagonist. This challenges the agents to socially interact with a depth and subtlety that is consistent with human behavior in difficult, stressful situations. To address this challenge, we have adopted an approach that takes as a starting point an engaging linear script and deconstructs it in order to inform the design of the agents that realize the interactive drama. This deconstruction is informed by psychological research on emotion and personality.

The *Carmen's Bright IDEAS* prototype will enter clinical trials in the Fall of 2000, where it will face it's demanding audience. At that time, we will have clear evaluation of how well the challenge has been addressed.

## Acknowledgements & Credits

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