38. [Introduction]
Two Selections by Brenda Laurel

The Six Elements and the Causal Relations Among Them

Star Raiders: Dramatic Interaction in a Small World

Brenda Laurel's approach to computing is a shock to many because of how classical it is. Certainly, it seemed radical in 1991 to envision interaction with computers in theatrical terms—but what Laurel proffers as the key to understanding computer interaction is a book more than 2300 years old: the *Poetics.*

Although Laurel's specific insights attained from Aristotle are useful (and are illustrated very well with regard to *Star Raiders,* in a section of her Ph.D. thesis that was not adapted for publication in *Computers as Theater* but is included here), the most powerful idea involved in her approach is that the computer can be studied from a rigorous humanistic perspective, using well-defined models established for other forms of art. As Donald Norman wrote in the foreword to *Computers as Theater,* the book from which the first selection below comes, Laurel asserts that "technologies offer new opportunities for creative, interactive experiences, and in particular, for new forms of drama. But these new opportunities will come to pass only if control of the technology is taken away from the technologist and given to those who understand human beings, human interaction, communication, pleasure, and pain" (xi). Rather than naming the conclusions Laurel drew from her analysis, the following excerpt gives insight into how the elements of drama were applied by her to enhance the understanding of computer interaction.

If computer interaction is considered as dramatic—a heightened, extra-daily experience which follows the shape of the experience of Attic drama—can it also be ordinary and everyday, fitting smoothly into our life? On the reverse side of the metaphorical coin there are certain features of a pre-established form which we may not particularly want to apply to new media. Using a well-developed system like Aristotle's in application to computer interaction can highlight undesirable features of interaction, unless the system we use to better understand computing is considered in complete appreciation for its original context and uses. This is part of the reason that Laurel recommends a thorough understanding of the principles being appropriated and applied, and names the *Poetics* an essential text for students of human-computer interaction.

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Aristotle's perspective on drama is not the only one in the history of theater, of course. An alternative formulation, of particular interest because of its possible application to interactivity in new media, is found in the theater and writings of Augusto Boal (◊22).

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In 1996 Brenda Laurel co-founded a company, Purple Moon, to create graphical adventure games for girls. The company was spun off from Interval Research; its games were designed with consideration for the media preferences of girls (studies determined sound was more important than had been previously thought, for instance) and based on social concerns that girls have. The first ones released were *Rockett's New School* and *Secret Paths in the Forest*. Laurel tells the story of her researches and work to develop a new type of computer game in her latest book: "Six and a half years and $40 million later, we had interviewed thousands of kids, invented a narrative world and a diverse set of characters, published eight CD-ROM games, produced a wildly successful Website, and built and lost a company" (4). Purple Moon's assets were acquired by Mattel in 1999.

Further Reading

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Original Publication

"The Six Elements and the Causal Relations Among Them" from *Computers as Theater*, 49–65. 2nd ed. Reading, Mass.: Addison-Wesley, 1993. (First edition, 1991.)

"Star Raiders: Dramatic Interaction in a Small World" from "Toward the Design of a Computer-Based Interactive Fantasy System," 81–86. Ph.D. Thesis, Ohio State University, 1986.

The Six Elements and the Causal Relations Among Them

Brenda Laurel

One of Aristotle's fundamental ideas about drama (as well as other forms of literature) is that a finished play is an *organic whole.* He used the term *organic* to evoke an analogy with living things. Insofar as a whole organism is more than the sum of its parts, all of the parts are necessary for life, and the parts have certain necessary relationships to one another. He identified six qualitative elements of drama and suggested the relationships among them in terms of formal and material causality.[1]

I present Aristotle's model here for two reasons. First, I am continually amazed by the elegance and robustness of the categories and their causal relations. Following the causal relations through as one creates or analyzes a drama seems to automagically reveal the ways in which things should work or exactly how they have gone awry. Second, Aristotle's model creates a disciplined way of thinking about the design of a play in both constructing and debugging activities. Because of its fundamental similarities to drama, human-computer activity can be described with a similar model, with equal utility in both design and analysis.

Table 38.1 lists the elements of qualitative structure in hierarchical order. Here is the trick to understanding the hierarchy: Each element is the formal cause of all those below it, and each element is the material cause of all those above it. As you move up the list of elements from the bottom, you can see how each level is a successive refinement—a *shaping*—of the materials offered by the previous level. The following sections expand upon the definitions of each of the elements in ascending order.

Enactment

Aristotle described the fundamental material element of drama as "spectacle"—all that is seen. In the *Poetics,* he also referred to this element as "performance," which provides some basis for expanding the definition to include other senses as well. Some scholars place the auditory sense in the second level because of its association with music and melody, but, as will be seen in the next section, it is more likely that the notion of melody pertains to the *patterning* of sound rather than to the auditory channel itself.

One difference, probably temporary, between drama and human-computer activity is the senses that are addressed in

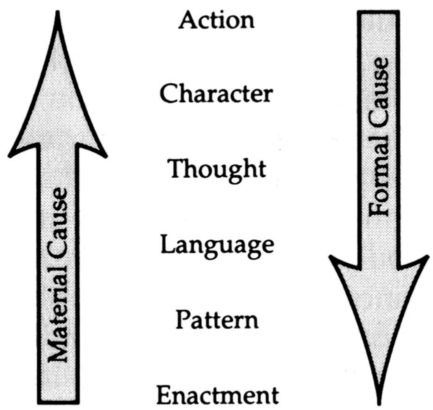

Figure 38.1. Causal relations among elements of quantitative structure.

the enactment.[2] Traditionally, plays are available only to the eyes and ears; we cannot touch, smell, or taste them. There are interesting exceptions. In the 1920s, for instance, director David Belasco experimented with using odors as part of the performance of realistic plays; it is said that he abandoned this approach when he observed that the smell of bacon frying utterly distracted the audience from the action on stage. In the mid-1960s, Morton Heilig invented a stand-

Element	In Drama	In Human-Computer Activity
Action	The whole action being represented. The action is theoretically the same in every performance.	The whole action, as it is collaboratively shaped by system and user. The action may vary in each interactive session.
Character	Bundles of predispositions and traits, inferred from agents' patterns of choice.	The same as in drama, but including agents of both human and computer origin.
Thought	Inferred internal processes leading to choice: cognition, emotion, and reason.	The same as in drama, but including processes of both human and computer origin.
Language	The selection and arrangement of words; the use of language.	The selection and arrangement of signs, including verbal, visual, auditory, and other nonverbal phenomena when used semiotically.
Melody (Pattern)	Everything that is heard, but especially the melody of speech.	The pleasurable perception of pattern in sensory phenomena.
Spectacle (Enactment)	Everything that is seen.	The sensory dimensions of the action being represented: visual, auditory, kinesthetic and tactile, and potentially all others.

Table 38.1. The six qualitative elements of structure in drama and in human-computer activity.

alone arcade machine called Sensorama, which provided stereoscopic filmic images, kinesthetic feedback, and environmental smells—for example, on a motorcycle ride through New York City, the audience could smell car exhaust fumes and pizza. Sensorama's problem was not that it addressed the wrong senses; it simply happened at a time when the business community couldn't figure out what to do with it—pinball parlors were monolithic, and it would be several years before *Pong* kicked off the arcade game industry.

At the same time that Heilig was thinking about multisensory arcade games and movie theatres, the development of new genres of participatory theatre accelerated. Such artists as Judith Melina and Julian Beck of the Living Theatre, Robert Wilson, Peter Brook, Jerzy Grotowski, and John Cage experimented with performances that began to dissolve the boundaries between actors and audience by placing both in the same space. Wilson, Cage, Josef Svoboda, and others produced works that integrated filmic and photographic images, musical instruments, and machines in novel ways.

In the 1980s, these trends toward increasing the sensory dimensions of audience participation gave rise to works where the audience could touch the actors and scenery and move about freely in the performance space. For example, in *Tina and Tony's Wedding*, a contemporary "interactive" play, the audience is invited to follow the actors around from room to room (kinesthetic), to touch props and sit on the furniture (tactile and kinesthetic), and to share in a wedding banquet (taste and smell). Another notable example is Chris Hardman's Antenna Theatre, where audience members move around a set prompted by taped dialogue and narration heard through personal headphones. A spate of site-specific interactive plays and "mystery weekends" in the late 1980s enjoyed a fair amount of commercial success. Contemporary performance art shares many of the same origins.

It is interesting that the development of this theatrical genre has been concurrent with the blossoming of computer games as a popular form of entertainment, and I speculate that computer games have in some ways served as a model for it. In fact, it is in the areas that dramatic entertainment and human-computer activity are beginning to converge that pan-sensory representation is being most actively explored. When we examine that convergence, we can see ways in which human-computer activity has evolved, at least in part, as drama's attempt to increase its sensory bandwidth, creating the technological siblings of the kind of participatory theatre described above.

The notion of "interactive movies," which has gained popularity in the late 1980s, has its roots in both cinema and computer games, two forms that combine theatre and technology. Earlier works were relatively isolated. These include the productions of Lanterna Magica in Czechoslovakia and an "interactive movie" that was shown in the Czech Pavilion at the 1967 World Expo in Montreal, Canada, in which the audience was allowed to influence the course of the action by selecting from among several alternatives at a few key points in the film (however, it is rumored that all roads led to Rome—that is, all paths through the movie led to the same ending). The idea of interactive movies has been rekindled and transformed into a bona fide trend by advances in multimedia technology. Likewise, there were early experiments in interactive television in the mid-1970s (such as the failed Warner QUBE system). Interactive TV had to await similar technological advances before finally becoming a 1990s buzz-word.

In drama, the use of technology to create representations goes at least as far back as the *mechane* of the ancient Greeks. Cinema as a distinct form diverged from drama as the result of the impact of a new performance technology on form, structure, and style. In complementary fashion, computer games can be seen to have evolved from the impact of dramatic ideas on the technology of interactive computing and graphical displays. Computer games incorporate notions about character and action, suspense and empathy, and other aspects of dramatic representation.[3] Almost from the beginning, they have involved the visual, auditory, and kinesthetic senses (you need only watch a game player with a joystick to see the extent to which movement is involved, both as a cause and effect of the representation).

At the blending point of cinema and computer games are such new forms as super-arcade games like *Battle Tech* and sensory-rich amusement park installations like *Star Tours.* These types of systems involve the tactile and kinesthetic senses; some are investigating the inclusion of the other senses as well through both performance technology and direct stimulation to the nervous system [Rosen and Gosser, 1987]. "Virtual reality" systems increase intensity through techniques described as *sensory immersion*—instead of looking at a screen, for instance, a person is surrounded by stereoscopic sounds and visual images delivered through earphones and "eyephones." Through the use of special input devices like specially instrumented gloves and suits, people may move about and interact directly with objects in a virtual world. Interestingly, the first virtual reality systems and applications were developed for nonentertainment purposes like computer-aided design, scientific visualization, and training. Home computers and home game systems are not far behind these expensive, special-purpose systems in their ability to deliver multisensory representations.

The element of enactment is composed of all of the sensory phenomena that are part of the representation. Because of the evolutionary processes described above, it seems appropriate to say that enactment can potentially involve all of the senses. These sensory phenomena are the basic material of both drama and human-computer activity; they are the clay that is progressively shaped by the creator, whether playwright or designer.

Pattern

The perception of patterns in sensory phenomena is a source of pleasure for humans. Aristotle described the second element of drama as "melody," a kind of pattern in the realm of sound. In the *Poetics* he says that "melody is the greatest of the pleasurable accessories of tragedy" [*Poetics,* 1450b, 15–17]. The orthodox view is that "spectacle" is the visual dimension and "melody" is the auditory one, but this view is problematic in the context of formal and material causality. If the material cause of all sounds (music) were things that could be perceived by the eye (spectacle), then things like the vibration of vocal cords and the melodies of off-stage musicians would be excluded. On the contrary, all that is seen in a play is not shaped solely by the criterion of producing sounds or music (although this may have been more strictly true in the performance style of the ancient Greeks than it is today). The formal-material relationship does not work within the context of these narrow definitions of music and spectacle.

In the previous section, we have already expanded spectacle into all sensory elements of the enactment. The notion of melody as the arrangement of sounds into a pleasing pattern can be extended analogically to the arrangement of visual images, tactile or kinesthetic sensations, and probably smells and tastes as well (as a good chef can demonstrate). In fact, the idea that a pleasurable pattern can be achieved through the arrangement of visual or other sensory materials can be derived from other aspects of the *Poetics,* so its absence here is something of a mystery. Looking "up" the hierarchy, it could be that Aristotle did not see the visual as a potentially semiotic or linguistic medium, and hence narrowed the causal channel to lead exclusively to spoken language. Whatever the explanation, the orthodox view of Aristotle's definitions of spectacle and melody leaves out too much material. As scholars are wont to do, I will blame the vagaries of translation, figurative language, and mutations introduced by centuries of interpretation for this apparent lapse and proceed to advocate my own view.

The element of pattern thus refers to patterns in the sensory phenomena of the enactment. These patterns exert a formal influence on the enactment, just as semiotic usage formally influences patterns. A key point that Aristotle made is that patterns are pleasurable to perceive in and of themselves, whether or not they are further formulated into semiotic devices or language; he spoke of them, not only as the material for language, but also as "pleasurable accessories." Hence the use of pattern as a source of pleasure is a characteristic of dramatic representations, and one which can comfortably be extended to the realm of human-computer experience.

Language

The element of *language* (usually translated as diction) in drama is defined by Aristotle as "the expression of their [the characters'] thought in words" [*Poetics,* 1450b, 12–15]. Hence the use of spoken language as a system of signs is distinguished from other theatrical signs like the use of gesture, color, scenic elements, or paralinguistic elements (patterns of inflection and other vocal qualities). In the orthodox view, diction refers only to words—their choice and arrangement. That definition presents some interesting problems in the world of human-computer activities, many of which involve no words at all (e.g., most skill-and-action computer games, as well as graphical adventure games and graphical simulations). Are there elements in such nonverbal works that can be defined as *language?*

When a play is performed for a deaf audience and signing is used, few would argue that those visual signs function as language. The element of language in this case is expressed in a way that takes into account the sensory modalities available to the audience.[4] A designer may choose, for whatever reason, to build a human-computer system that neither senses nor responds to words, and which uses no words in the representation. Hardware configurations without keyboards, speech recognition, or text display capabilities may be unable to work with words.

In human-computer activities, graphical signs and symbols, nonverbal sounds, or animation sequences may be used in the place of words as the means for explicit communication between computers and people. Such nonverbal signs may be said to function as language when they are the principal medium for the expression of thought. Accordingly, the selection and arrangement of those signs may be evaluated in terms of the same criteria as Aristotle specified for diction—for example, the effective expression of thought and appropriateness to character.

Thought

The element of *thought* in drama may be defined as the processes leading to a character's choices and actions—for example, to emotion, cognition, reason, and intention. Understood in this way, the element of thought "resides" within characters, although it can be described and analyzed in aggregate form (the element of *thought* in a given play may be described as concerned with certain specific ethical questions, for example). Although it may be explicitly expressed in the form of dialogue, thought is *inferred,* by both the audience and the other characters (agents), from a character's choices and actions. In his application of a theatrical analogy to the domain of artificial intelligence, Julian Hilton puts it this way: "What the audience does is supply the inferencing engine which drives the plot, obeying Shakespeare's injunction to eke out the imperfections of the play (its incompleteness) with its mind." [Hilton, 1991]

If we extend this definition of thought to include human-computer activities, it leads to a familiar conundrum: Can computers think? There is an easy answer. Computer-based agents, like dramatic characters, do not have to *think* (in fact, there are many ways in which they cannot); they simply have to *provide a representation from which thought may be inferred.*

When a folder on my Macintosh desktop opens to divulge its contents in response to my double-click, the representation succeeds in getting me to infer that that's exactly what happened—that is, the "system" understood my input, inferred *my* purpose, and did what I wanted. Was the system (or the folder) "thinking" about things this way? The answer, I think, is that it doesn't matter. The real issue is that the representation succeeded in getting me to make the right inferences about its "thoughts." It also succeeded in representing to me that it made the right inferences about mine!

Thought is the formal cause of language; it shapes what an agent communicates through the selection and arrangement of signs, and thus also has a formal influence on pattern and enactment. The traditional explanation of how language serves as material for thought is based on the overly limiting assumption that agents employ language, or the language-like manipulation of symbols, in the process of thinking. This assumption leads to the idea that characters in a play use the language of the play quite literally as the material for their thoughts.

I favor a somewhat broader interpretation of material causality: *The thought of a play can appropriately deal only with what is already manifest at the levels of enactment, pattern, and language.* Most of us have seen plays in which characters get ideas "out of the blue"—suddenly remembering the location of a long-lost will, for instance, or using a fact to solve a mystery that has been withheld from the audience thus far. The above theory would suggest that the interjection of such thoughts is unsatisfying (and mars the play) because they are not drawn from the proper material. Plays, like human-computer activities, are closed universes in the sense that they delimit the set of potential actions. As we will see in the discussion of action below, it is key to the success of a dramatic representation that all of the materials that are formulated into action are drawn from the circumscribed potential of the particular dramatic world. Whenever this principle is violated, the organic unity of the work is diminished, and the scheme of probability that holds the work together is disrupted.

This principle can be demonstrated to apply to the realm of human-computer activity as well. One example is the case in which the computer (a computer-based agent) introduces new materials at the level of thought—"out of the blue." Suppose a new word processor is programmed to be constantly checking for spelling errors and to automatically correct them as soon as they are identified. If the potential for this behavior is not represented to you in some way, it will be completely disruptive when it occurs, and it will probably cause you to make seriously erroneous inferences, to perhaps think "something is wrong with my fingers, my keyboard, or my computer." The computer "knows" why it did what it did ("thought" exists) but you do not; correct inferences cannot be made.[5] A text message, for instance, or an animation of a dictionary with its pages turning (language), could represent the action as it is occurring.

Other kinds of failures in human-computer activity can also be seen as failures on the level of thought. One of my favorite examples is a parser used in several text adventure games. This particular parser did not "know" all of the words that were used in the text representation of the story. So a person might read the sentence, "Hargax slashed the dragon with his broadsword." The person might then type, "take the broadsword," and the "game" might respond, "I DON'T KNOW THE WORD 'BROADSWORD'." The inference that one would make is that the game "agent" is severely brain-damaged, since the agent that produces language and the agent that comprehends it are assumed to be one in the same. This is the converse of the problem described in the last paragraph; rather than "knowing" more than it represented, the agent represented more than it "knew." Both kinds of errors are attributable to a glitch in the formal-material relationship between language and thought.

Character and Agency

Aristotle maintained that the *object* of (i.e., what is being imitated by) a drama is action, not persons: "We maintain that Tragedy is primarily an imitation of action, and that it is mainly for the sake of the action that it imitates the personal agents" (*Poetics,* 1450b, 1–5). In drama, *character* may be defined as bundles of traits, predispositions, and choices that, when taken together, form coherent entities. Those entities are the agents of the action represented in the plot. This definition emphasizes the primacy of action.

In order to apply the same definition to human-computer activities, we must demonstrate first that agents are in fact part of such representations, and second, that there are functional and structural similarities between such agents and dramatic characters.

In a purely Aristotelian sense, an agent is one who takes action. Interestingly, Aristotle admits of the possibility of a play without characters, but a play without action cannot exist [*Poetics,* 1450a, 22–25]. This suggests that agency as part of a representation need not be strictly embodied in "characters" as we normally think of them—that is, as representations of humans. Using the broadest definition, all computer programs that perform actions that are perceived by people can be said to exhibit agency in some form. The real argument is whether that agency is a "free-floating" aspect of what is going on, or whether it is captured in "entities"—coalesced notions of the sources of agency.

The answer, I believe, is that even when representations do not explicitly include such entities, their existence is implied. At the grossest level, people simply attribute agency to the computer itself ("I did this, and then the computer did that"). They also attribute agency to application programs ("My word processor trashed my file"). They often distinguish between the agency of system software and applications ("Multifinder crashed Excel"). They attribute agency to smaller program elements and/or their representations ("The spelling checker in my word processor found an error").

In social and legal terms, an agent is one who is empowered to act on behalf of another. This definition has been used as part of the definition of agents in the mimetic world. It implies that, beyond simply performing actions, computer-based agents perform a special kind of actions—namely, actions undertaken on behalf of people. It therefore also implies that some sort of implicit or explicit communication must occur between person and system in order for the person's needs and goals to be inferred. I think that this definition is both too narrow and too altruistic. There may be contexts in which it is useful to create a computer-based agent whose "goals" are orthogonal or even inimical to those of human agents—for instance, in simulations of combat or other situations that involve conflicting forces. Agents may also work in an utterly self-directed manner, offering the results of their work up to people after the fact.

For now, we will use the broader definition of agents to apply to human-computer activity: entities that can initiate and perform actions. Like dramatic characters, they consist of bundles of traits or predispositions to act in certain ways.

Traits circumscribe the actions (or kinds of actions) that an agent has the capability to perform, thereby defining the agent's potential. There are two kinds of traits: traits that determine how an agent can act (internal traits) and traits that represent those internal predispositions (external traits). People must be given cues by the external representation of an agent that allow them to infer its internal traits. Why? Because traits function as a kind of *cognitive shorthand* that allows people to predict and comprehend agents' actions [see Laurel, 1990]. Inferred internal traits are a component of both dramatic probability (an element of plot) and "ease of use" (especially in terms of the minimization of human errors) in human-computer systems. Part of the art of creating both dramatic characters and computer-based agents is the art of selecting and representing external traits that accurately reflect the agent's potential for action.

Aristotle outlined four criteria for dramatic characters that can also be applied to computer-based agents [*Poetics,* 1454a, 15–40]. The first criterion is that characters be "good" (sometimes translated as "virtuous"). Using the Aristotelian definition of "virtue," good characters are those who success-fully fulfill their function—that is, those who successfully formulate thought into action. Good characters *do* (action) what they *intend* to do (thought). They also do what their creator intends them to do in the context of the whole action. The second criterion is that characters be "appropriate" to the actions they perform; that is, that there is a good match between a character's traits and what they do. The third criterion is the idea that characters be "like" reality in the sense that there are causal connections between their thoughts, traits, and actions. This criterion is closely related to dramatic probability. The fourth criterion is that characters be "consistent" throughout the whole action; that is, that a character's traits should not change arbitrarily. The mapping of these criteria to computer-based agents is quite straightforward.

Finally, we need to summarize the formal and material relationships between character and the elements above and below it in the hierarchy. Formal causality suggests that it is action, and action alone, that *shapes* character; that is, a character's traits are dictated by the exigencies of the plot. To include traits in the representation that are not manifest in action violates this principle. Material causality suggests that the stuff of which a character is made must be present on the level of thought and, by implication, language and enactment as well. A good example is the interface agent, Phil, who appears in an Apple promotional video entitled "The Knowledge Navigator" (© 1988 by Apple Computer, Inc.). In the original version, Phil was portrayed by an actor in video format. He appeared to be human, alive, and responsive at all times. But because he behaved and spoke quite simply and performed relatively simple tasks, many viewers of the video complained that he was a stupid character. His physical traits (high-resolution, real-time human portrayal) did not match his language capabilities, his thoughts, or his actions (simple tasks performed in a rather unimaginative manner). In a later version, Phil's representation was changed to a simple line-drawn cartoon character with very limited animation. People seemed to find the new version of Phil much more likable. The simpler character was more consistent and more appropriate to the action.

The Whole Action

Representations are normally thought of as having objects, even though those objects need not be things that can or do exist in the real world. Likewise, plays are often said to represent their characters; that is, *Hamlet* is a representation of the king of Denmark, and so on. In the Aristotelian view, the object of a dramatic representation is not character but action; *Hamlet* represents the action of a man attempting to discover and punish his father's murderer. The characters are there because they are required in order to represent the action, and not the other way around. An action is made up of incidents that are causally and structurally related to one another. The individual incidents that make up *Hamlet*—Hamlet fights with Laertes, for instance—are only meaningful insofar as they are woven into the action of the mimetic whole. The form of a play is manifest in the pattern created by the arrangement of incidents within the whole action.

Another definitional property of plot is that the whole action must have a beginning, a middle, and an end. The value of beginnings and endings is most clearly demonstrated by the lack of them. The feeling produced by walking into the middle of a play or movie or being forced to leave the theatre before the end is generally unpleasant. Viewers are rarely happy when, at the end of a particularly suspenseful television program, "to be continued" appears on the screen. My favorite Macintosh example is an error message that I sometimes encounter while running Multifinder: "Excel (or some other application) has unexpectedly quit." "Well," I usually reply, "the capricious little bastard!" Providing graceful beginnings and endings for human-computer activities is most often a nontrivial problem—how to "jump-start" a database engine, for example, or how to complete a network communications session. Two rules of thumb for good beginnings is that the potential for action in that particular universe is effectively laid out, and that the first incidents in the action set up promising lines of probability for future actions. A good ending provides not only completion of the action being represented but also the kind of emotional closure that is implied by the notion of catharsis.

A final criterion that Aristotle applied to plot is the notion of magnitude:

> To be beautiful, a living creature, and every whole made up of parts, but also be of a certain definite magnitude. Beauty is a matter of size and order. . . . Just in the same way, then, as a beautiful whole made up of parts, or a beautiful living creature, must be of some size, but a size to be taken in by the eye, so a story or Plot must be of some length, but of a length to be taken in by the memory [*Poetics,* 1450b, 34–40].

The action must not be so long that you forget the beginning before you get to the end, since you must be able to perceive it as a whole in order to fully enjoy it. This criterion is most immediately observable in computer games, which may require you to be hunched over a keyboard for days on end if you are to perceive the whole at one sitting, a feat of which only teenagers are capable. Similar errors in magnitude are likely to occur in other forms, such as virtual reality systems, where the raw capabilities of a system to deliver material of seemingly infinite duration is not yet tempered by a sensitivity to the limits of human memory and attention span, or to the relationship of beauty and pleasure to duration in time-based arts.

Problems in magnitude can also plague other, more "practical" applications as well. If achievable actions with distinct beginnings and ends cannot occur within the limits of memory or attention, then the activity becomes an endless chore. On the contrary, if the granularity of actions is too small and those actions cannot be grouped into more meaningful, coherent units (such as a word processor that only lets you type or a spreadsheet that only lets you add up columns of numbers), then the activity becomes an endless stream of meaningless chores. These problems are related to the *shape* of the action as well as its magnitude.

The notion of beauty that drives Aristotle's criterion of magnitude is the idea that made things, like plays, can be organic wholes—that the beauty of their form and structure can approach that of natural organisms in the way the parts fit perfectly together. In this context, he expresses the criterion for inclusion of any given incident in the plot or whole action:

> An imitation of an action must represent one action, a complete whole, with its several incidents so closely connected that the transposal or withdrawal of any one of them will disjoin and dislocate the whole. For that which makes no perceptible difference by its presence or absence is no real part of the whole [*Poetics,* 1451a, 30–35].

If we aim to design human-computer activities that are—dare we say—*beautiful,* this criterion must be used in deciding, for instance, what a person should be required to do, or what a computer-based agent should be represented as doing, in the course of the action.

In this chapter, we have described the essential causes of human-computer activity—that is, the forces that shape it—and its qualitative elements. In the next chapter [of *Computers as Theatre*], we will consider the orchestration of action more closely, both in terms of its structure and its powers to evoke emotional and intellectual response.

Star Raiders

Dramatic Interaction in a Small World

Brenda Laurel

Star Raiders is an animated action game developed by Douglas Neubauer for the Atari computer in 1979. At that time, Neubauer was working as a hardware engineer and not a game designer, but felt that there should be a good video game for the new home computer. The dozens of awards that *Star Raiders* has won over the years, including "best video game" for three consecutive years in a popular computing magazine, are a testament to Neubauer's skill and dramatic insight.[1]

The game places the user in control of a starship, with the objective of cleaning pugnacious alien spacecraft out of several contiguous quadrants of the galaxy. To succeed completely, the user must be able to maneuver and fight, generate strategies for defending his starbases, and be able to dock with a starbase when necessary for refueling and repairs. The game's primary visual mode is a convincing first-person view from the bridge of the starship as the ship races through the starfield, dodges meteors and enemy fire, and fires photon torpedoes at Zylon ships. Besides forward or aft views from the bridge, the display includes status indicators for the ship's fuel and various functions. The computer keyboard, in the user's visual field directly below the display, becomes an extension of the imaginary ship's controls.

Other visual modes include the *galactic chart* and the *long range sector scan.* The galactic chart is a display to which the user may toggle at any time to view the location of friendly starbases and enemy ships, and to see the number of ships in each quadrant. The chart is used for strategic planning and navigation between quadrants. The user enters *hyperwarp,* the means of travel from one quadrant to another, by moving the game cursor to his destination on the galactic chart. The long range sector scan is a view of the user's own ship from "above" its current location (an impossible view which is often employed in science fiction movies—ever wonder how they get those cameras hanging out in space?), and shows the location of other targets as well. It is used for navigation within quadrants.

There are two distinct kinds of action in the game: combat, which requires maneuvering skill and eye-hand coordination; and the planning and execution of strategies to prevent friendly starbases from being surrounded and destroyed. The two activities blend well in the overall action, because fighting is part of the execution of strategic plans, and because the user is free to toggle to the galactic chart and review his plans at any time. The action is continuous regardless of visual mode: Zylons are on the move, and the ship is always running, depleting its fuel supply.

Star Raiders, unlike *Zork,* is *enacted,* with computer-generated spectacle and music. As in traditional drama, enactment in *Star Raiders* entails the illusion of real, continuous time. Unity of action is provided by the user's overall objective, and reinforced by a rating of the user's overall performance that is displayed at the end of every game session. The game's incidents are causally related—the order in which various Zylon-bearing quadrants are attacked, for example, affects the enemy's ability to surround a starbase, as well as the player's fuel consumption and hence the need to dock for refueling.

The plot of a game session exhibits a traditional dramatic structure, with exposition (initial scanning of the galactic chart), rising action (encounters with Zylon ships), crisis (threat to starbases posed by enemy ships), climax (moment at which the outcome is determined), falling action or denouement (action from climax to the moment of complete success, destruction, or running out of fuel), and conclusion (the starfleet rating message). Interestingly, the dramatic structure emerges more distinctly as the user becomes experienced and begins to generate long-term strategies for play. The user's strategic plan and its implementation is the central action of the plot, and the better it is formulated, the more the whole behaves dramatically.

Like *Zork, Star Raiders* casts the user as the central character; however, *Star Raiders* does so more completely and successfully. There is no "System's I" to muddy the issue of who the central agent actually is. While the user's identity is often lost in a fog of pronouns in *Zork,* the notion of user as character in *Star Raiders* is rendered completely unambiguous by the first-person treatment of spectacle.

The other characters in *Star Raiders* are represented as the Zylon vessels and friendly starbases, with their guiding intelligences assumed. There are three types of Zylon agents, distinguishable by their graphical images and one or two behavioral traits in battle. Starbases behave identically, and have a small repertoire of characteristic actions and communication protocols. All characters, including the user-character, are extremely simple due to the constraints of the game world: the kinds of things that can happen are few, and hence the agents of those few actions require correspondingly few traits. Despite the outer space setting, *Star Raiders* takes place in a very "small" world.

Contributions of the user on the levels of spectacle and music are materially constrained by the program's repertoire of images, animation sequences, and sound effects—again, the possibilities are few when compared to traditional drama. Likewise, the user's contributions on the level of diction are constrained by the set of commands that the system can recognize and act upon. The game creates the illusion of responding to a relatively greater range of contributions on the levels of thought and character because subtly different strategies, as well as emotions and motivations ("I'm going to kill those Zylon bastards" vs. "I keep a clean quadrant") are often not translated by the user into objectifiable plans and specific actions. The effects of chance and physical dexterity tend to be interpreted by the user as the results of his strategies and character traits. The game is successful in supporting such fantasies because the user is not generally aware of the material and formal constraints on his actions.

Unlike *Zork* (in which the single plot is discovered by the user in a series of sessions), the plot of *Star Raiders* is variable and collaboratively formulated by the system and the user. There is no single outcome that must be attained in order for the whole plot to be revealed and no single way to reach that end. The number of possible plots is constrained by the relatively few *kinds* of actions that can occur (a measure of the *potential* of the dramatic world). Because the user's strategies and actions influence the order and incidents and the outcome of each (e.g., how much damage is sustained in a battle), the plot can be seen to be collaboratively formulated.

The system's functioning as provider of constraints, protocols, and a finite set of materials is, in many game programs and to some degree in *Zork,* intrusive and destructive of the user's fantasy experience. In *Zork,* the user's relationship to the system, as represented by the "System's I," can be described as a "second-person" one (as demonstrated by the second-person pronouns in the dialogue between them), and is quite distinct from the first-person experience that is desired by the user and intended by the system's designers. The "System's I" stands outside the context of the fantasy, with no distinct character or role in the action—what computer folks would call a "kludge." The functioning of the "System's I" is taken over by the ship's computer in *Star Raiders,* and thus cleverly integrated into the fantasy world. The user employs the ships computer and the various "tools" it offers him (the galactic chart and attack computer, for instance) quite naturally in a first-person mode.

This chapter has employed dramatic theory to elucidate the structural characteristics of poetic interactive works. In creating a theory of interactive drama, emphasis has been placed on comprehending and integrating the contributions of the user-character as the co-creator of an interactive work. The form of such works is determined by the manner in which the system formulates materials—human-authored, computer-generated, and contributed by the user-character—into a dramatically satisfying whole. The form of an interactive drama must enable the user to participate in the fantasy world as an active character—a dramatic agent.

Notes—*The Six Elements*

1. The explicit notion of the workings of formal and material causality in the hierarchy of structural elements is, although not apocryphal, certainly neo-Aristotelian. See Smiley [1971].

2. Aristotle defined the enactment in terms of the audience rather than the actors. Although actors employ movement (kinesthetics) in their performance of the characters, that movement is perceived visually—the audience has no direct kinesthetic experience. Likewise, although things may move about on a computer screen, a human user may or may not be having a kinesthetic experience.

3. Within the art of computer games, there are various forms, including action games, strategy games, adventure games, and so on.

4. It is interesting to note in this context that American Sign Language (ASL) is in fact a "natural language" in its own right, and not a direct gestural map of English or any other spoken language. If a language can be constructed from gesture, then it follows that spoken words are not essential elements of language.

5. In human factors discourse, this type of failure is attributed to a failure to establish the correct conceptual model of a given system [see Rubinstein and Hersh, 1984, Chapter 5]. The dramatic perspective differs slightly from this view by suggesting that proper treatment of the element of thought can provide a good "conceptual model" for the entire medium. It also avoids the potential misuse of conceptual models as personal constructs that "explain" what is "behind" the representation—that is, how the computer or program actually "works."

Notes—*Star Raiders*

1. Atari's policy was never to connect the names of authors with their video games, thus Neubauer is known primarily through "in-house" legend. The awards won by his game were accepted by a succession of marketing vice-presidents who never heard of him.

References—*The Six Elements*

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