Methodology:

The appropriate input to an intent-based illustration system is a specified communicative intent and access to an object knowledge-base. To begin with, we consider the process of illustration as goal driven. Simply stated, the illustration system is provided with a specific communicative intent to achieve, which refers to a particular world modeled in a separate knowledge-base. This scenario is analogous to a work order sent to a human illustrator who is, for example, required to illustrate how roomy a car interior is. The person placing the work order is not responsible for determining all the objects that are necessary for the illustrator to complete his or her task; instead the illustrator is given access to a wide variety of sources, and from these eventually determines what and how the task will be completed. For example, a human illustrator could have access to the objects themselves, photograph and films of the objects, geometric models of the objects, texts describing the objects, different representations of the objects, and other manuals. The illustrator may already be familiar with the objects. It may be that the illustrator does not require access to all these sources of information for each or any of the illustrations he or she creates. For example, the illustrator may be illustrating only the exterior of the car and therefore does not need to refer to what is under the hood. On the other hand, if the illustrator decides to depict the car with the hood open, then that information is necessary. The illustrator may opt to communicate the roominess of the car using completely different objects. Again, what information is needed is determined during the design process, not beforehand.

This separation of the communicative intent from the knowledge-base also enables greater flexibility. The communicative intent does not specify either what particular objects will be included in the illustration or how each will be depicted; instead the communicative intent specifies what about the objects in the known world should be conveyed through the illustration. The way an illustration conveys these concepts is to depict them, or show them. In pictorial representations, the content is a function of the form. Given a world to depict, by choosing a view of that world and rendering styles, both the form and content are determined. Communicative goals specify what aspects of the world to convey, but the stylistic choices determine what objects are used to depict those aspects. Thus, semantics are prioritized during the decision process. No decision is made for any other reason than to achieve the desired semantic value.

We apply a generate-and-test approach to the design of illustrations. Although, in the long run, this is an implementation issue, it serves to emphasize a point made earlier. All constraints in an illustration are global. Every new decision threatens to violate the success of previously satisfied goals. Each time a new decision is made and the current state of the illustration is modified, tests must be performed in order to determine which, if any, goals are now violated. This is analogous to the human illustrator imagining or viewing the result of some modification to the illustration in order to evaluate its success. The human illustrator replans, erases, increases or decreases contrast of objects, changes perspective and so on, continuously modifying and adjusting the illustration. In all cases, the end result is evaluated to determine the consequences of a decision. This can be accomplished using analytic procedures or by examining partial results in a framebuffer. How this is accomplished is purely a question of implementation. What is important is that the result of a decision is evaluated to detect goal conflicts.

Various aspects of an illustration cannot be determined until the illustration has been fully specified. Since our system depends on the success of visual effects and cues, it also depends on the ability to

judge each of these visual effects. For example, consider the case in which it is important that an object appear red. Until the illustration is fully specified, it cannot be determined whether or not that object appears red in the illustration. First, it has to be determine if the object appears at all. It may be occluded by other objects or it may reside outside the view volume. Second, the object may take up so little space in the illustration that its color is illegible. Third, the lighting may be defined so that the object is so dark that it is difficult to determine its hue. These conditions can only be tested for when the view specification and viewport sizing are determined, the lighting is set, and the set of objects appearing in the scene is determined and a rendering style is assigned to each.

The separation of design and style provides a clear delineation between content and rendering. The design of an illustration specifies how to achieve communicative intent, the overall plan for an illustration, and what visual effects are needed. The style of an illustration specifies how to achieve visual effects, the individual style choices, and what illustration procedures are called. We again draw upon our characterization of illustration by a human illustrator to determine that there are two main types of decisions made during the illustration task. First, the illustration is designed. This is analogous to the human illustrator determining what sets of visual cues or style strategies are necessary to convey the communicative intent. The simplest case entails that a certain object should be depicted. However, the list of goals can be large: the object has to be seen from a certain angle, the text on that object must be legible, some part of the object must be clearly highlighted, and another object must also appear in the scene and so on. Each of these goals can be accomplished in a number of different ways. The decision to use one method rather than another to achieve each goal should therefore be based on the interaction of the various elements in the illustration itself and not determined beforehand.

For example, suppose we need to show where a building is located. There are several designs we can adopt to achieve this goal. We can draw some kind of map, or we can draw a picture of the house with a street sign clearly in view, or we can show the building with a label displaying its address. These different solutions differ in design because the visual cues used to depict location are different. In the first solution we have chosen to depict part of the city, in the second part of a block and sidewalk, in the third just the building. In each design, though, the building itself is depicted, but how? It may be depicted photorealistically, as a simple line drawing, or iconically. These solutions all differ in style, and each design could be achieved using any one of these styles. Thus, there is a clear distinction between the high-level design goals as opposed to the lower-level style goals. Design decisions should not involve issues such as in what particular shade of gray the building should be drawn; since drawing the building in that particular shade of gray will not necessarily convey its location. Thus, the separation of design from style is enforced by a division of labor between two components: illustrators select design rules while drafters select style rules.