Team id : PNT2022TMID46283
Date : 15 November 2022

Functional Features

1. Introduction In the Engineering community there have been many published definitions of the term "feature" [Salomons 1995] [Shah & Mantyla 1995). This has produced ambiguity and has allowed the introduction of many different types of features. A confusing proliferation of types of features have been identified, including:

- Form Features: related to the geometric form.
- Precision Features: concerning deviations from nominal dimensions.
- Technological Features: related to performance and operation.
- Material Features: material composition, treatment, conditions.
- Assembly Features: concerning the assembly process.
- Pattern Features: patterns of similar

entities.

- Connection Features: geometric constraints.
- Property Features: properties not explicitly related to geometry.
- Application Features: related to process planning requirements.
- Manufacturing features: related to particular processes, such as machining.

However, faced with such variety, and in order to provide a generic definition, writers have gradually been moving towards very general definitions that are in fact only minor variations of "anything about the thing being designed that's of interest" [Dixon 1991]. For example, Vandenbrande & Requicha [1993] define features as regions of an object that are meaningful for a specific activity or application.

2. Functional Features In addition to the types of features mentioned above, another type has been identified-Functional features: concerning function, purpose or behaviors. Functional features have been increasingly mentioned in the literature. This has happened as CAD has been influenced by Concurrent Engineering, by theories about the design process, and has moved away from being purely geometric. McGinnis & Ullman [1992] write that:

> "Functional features include both the purpose of the design object such as support, stability, or strength and the behavior that the design object performs like lifting, gripping, or rotating. The form features embody the physical characteristics of design objects in a design while the functional features explain what purpose the design objects achieve individually and what behaviors they exhibit in the

overall design." This suggests that while a functional feature will have implications for structure/form it is not necessarily about the form.

FUNCTIONS

buzz: TOMAKE buzzing
(buzzer)

IF pressed (manual-switch) * PROVIDED
assumption1 BY behavior1
stop-buzz: ... END FUNCTIONS
STRUCTURE COMPONENTS

manual-switch(tl. t 2), battery (t3,
4).

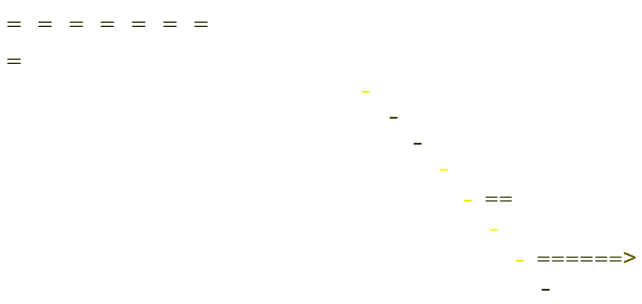
RELATIONS

serially-connected(manual-switch, battery. coil,
clapper) AND includes (space1, space2)
ABSTRACTIONS-OF-COMPONENTS COMPONENT
clapper(ti, t2, space) FUNCTIONS magnetic,
acoustic, mechanical STATES
elect-connected(ti, t2), repeated hit(clapper)
ASSUMPTIONS assumption2, assumption3 END
COMPONENT

END STRUCTURE

BEHAVIOR

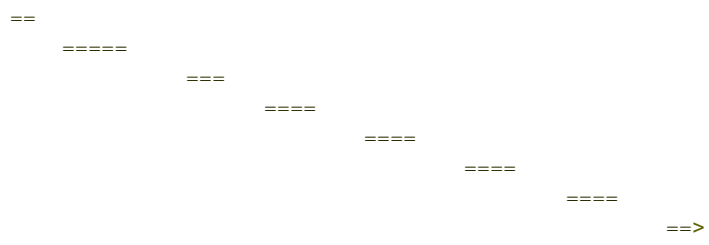
behavior1: pressed
(manual-switch)*



by behavior2

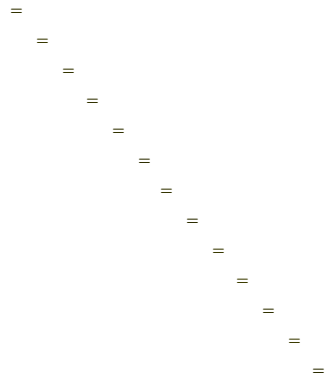
(elect-connected(t7, t8); connected
(t7. t 8))*

elect



USING FUNCTION mechanical OF
clapper(t7, t8, space 2)

repeated-hit(clapper)



```
    USING FUNCTION acoustic
    OF clapper(t7. t8. space2)
    buzzing (clapper)
----equivalent to-----
    buzzing (buzzer)

    END BEHAVIOR
```

Figure 1: Extracts of SBF representation, for a buzzer, from [Sembugamoorthy & Chandrasekaran 1986).

In most functional reasoning research the description of structure is not the main focus of the work, and so the representation normally bottoms out at an abstract description of the types of components and the way they are connected, with no geometric detail. However,

nothing would prevent this configuration-oriented level of detail from referring to a geometric level. The structural description, S, is considered to include what's needed to describe the physical design, including geometry, spatial relationships, components, and properties. Structural properties, Ps, include material, surface area, surface finish, color, mass, etc. As far as the author knows, no SBF representation considers the possibility of Behavioral properties, PB, or Functional properties, PF. Behavioral properties might include the presence of state-to-state loops, for example, while Functional properties might include whether or not the design has a human user.

4. **Function** Function is best thought of in terms of the way that the designed object interacts with an environment when placed in it. Chandrasekaran & Josephson [1996] define a function of an object in terms of the effect it has on its environment. The environment can use behaviors, structure or structural properties, and can provide inputs' or stimuli that trigger the

function to enable, prevent or maintain the interaction [Keuneke 1991). For example, a clock functions when placed in an environment that provides it with power and allows the time display to be visible. Note that in this example a subset of the object's behaviors is being used for a function: the 'ticking' sound is normally not used. A chair functions, when placed in an environment that places a load on it, by resisting that load. Here the key behavior involves no gross movements and is completely in response to external stimuli. A knife functions when placed in an environment which applies a force on the knife causing a particular portion of the structure (the 'sharp edge) to be in contact with another material. In this last case, the function is provided by a very specific piece of geometry, and by the material properties of the knife that prevent it from bending, breaking or changing its shape. In the clock case, the function is provided by a combination of behaviors and the structure that supports
them.