Modeling Permanent vs Temporary Components

## Scenario Objective

This pattern illustrates how to model the different ways a component can be part of an assembly, focusing on the temporal aspect of the relationship. It explains the critical difference between:

* A component that is an *essential, permanent* part of an assembly for its entire existence.
* A component that is a *temporary or replaceable* part of an assembly.

This distinction is vital for accurately modeling manufacturing, maintenance, repair, and asset lifecycle management.

## General Pattern Description

An assembly is composed of parts. BFO provides two distinct properties to describe the nature of this parthood relationship over time:

1. **bfo:hasContinuantPartAtAllTimes**: This property is used when the part is **essential** to the identity of the whole. If this part is removed, the whole ceases to be the same kind of thing or is fundamentally incomplete. This relationship is permanent for the lifetime of the whole.
   * **Example:** A car chassis is a permanent part of the car. You cannot have the car without its chassis. A welded joint is a permanent part of the welded structure.
2. **bfo:hasContinuantPartAtSomeTime**: This property is used when the part is **temporary, replaceable, or non-essential** to the identity of the whole. The part may be attached for only a portion of the whole's lifetime.
   * **Example:** A tire is part of a car, but it can be replaced. The specific tire ns:tire-A is part of ns:my-car *at some time*, and later, ns:tire-B is part of it *at some time*.

By using these two different properties, we can make precise statements about how components relate to their assemblies, which has major implications for reasoning and querying.

## Use Case: A Car and its Engine

A car is an excellent example to illustrate this difference. Some parts are integral and permanent, while others are designed to be replaced.

* **Scenario:** We have a specific car, ns:car-123.
  + It has a chassis (ns:chassis-ABC) that was installed when the car was manufactured. The chassis is a permanent part.
  + It currently has an engine (ns:engine-XYZ) installed. However, this engine could be replaced during a major repair. Therefore, the engine is a temporary part.

## Use-Case Pattern Description:

* ns:car-123 is the assembly (an instance of bfo:Object).
* The chassis ns:chassis-ABC is linked to the car using bfo:hasContinuantPartAtAllTimes. This tells us that for ns:car-123 to be considered this specific car, it must have this specific chassis.
* The engine ns:engine-XYZ is linked to the car using bfo:hasContinuantPartAtSomeTime. This tells us that ns:engine-XYZ is currently a part of the car, but it doesn't have to be. The car could exist with a different engine in the future.

A diagram of a flowchart

AI-generated content may be incorrect.

Diagram: A Car's Permanent and Temporary Parts

## Nuanced Semantics and Transitivity

**Why are has...Part and is...PartOf not always simple inverses?**

* For bfo:hasContinuantPartAtSomeTime and bfo:isContinuantPartOfAtSomeTime, they **are** simple inverses. If A has part B at some time, then B is part of A at that same time.
* For bfo:hasContinuantPartAtAllTimes, the situation is more complex. Let's say:
  + "A car (ns:car-123) has a chassis (ns:chassis-ABC) as a part *at all times* it exists."
  + The inverse statement is: "The chassis (ns:chassis-ABC) is a part of the car (ns:car-123) *at all times*..." At all times *what* exists? The chassis could be manufactured and exist for a year before it's installed in the car. It is only part of the car during the car's existence. So, the inverse is not symmetric. The AtAllTimes qualifier applies to the lifetime of the **whole**, not the part.

**Transitivity: The "Part of a Part" Problem**

* **Transitivity** means: If A has part B, and B has part C, does A have part C?
* bfo:hasContinuantPartAtSomeTime **is transitive**. If a car has an engine as a part, and the engine has a piston as a part, then the car has the piston as a part. This works for temporary parts.
* bfo:hasContinuantPartAtAllTimes **is also transitive**. If a car has a chassis as a permanent part, and the chassis has a specific welded cross-member as a permanent part, then the car has that cross-member as a permanent part.

By correctly choosing between these two properties, your ontology can support powerful queries, such as:

* "Show me all current components of car-123." (This would query for both ...AtAllTimes and ...AtSomeTime parts).
* "Show me the original, non-replaceable parts of car-123." (This would query *only* for ...AtAllTimes parts).