

A Management Strategy for Implementing Snap-fit Technology

a report by

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This article discusses issues associated with moving from a threaded fastener culture to one that can make an informed choice between threaded fastener and snap-fit attachments and then successfully implement snap-fits when they are appropriate. The key phrase here is 'informed choice'. Both attachment methods have a place in product design; the important issue from a product cost/quality/reliability standpoint is to make the correct fastening technology choice and then properly execute the attachment.

For an organisation with a design tradition based on loose fasteners, using snap-fits can be difficult. The transition can involve multiple design iterations, attachment failures during development testing and assembly problems as product engineers learn by trial-and-error. At the very least, these problems increase engineering costs and use valuable development time. At worst, they may increase warranty costs and reduce customer satisfaction. With too many bad experiences involving snap-fits, a company may conclude that snap-fit technology is unreliable and return to the exclusive use of loose fasteners, thus removing a viable attachment method from their engineer's design alternatives.

Threaded Fasteners and Snap-fits

The author does not take a stand in favour of one fastening method over the other. Some proponents of design for assembly argue that threaded fasteners have inherent quality risks not shared with other mechanical fastening methods. The author's position is that fastening-related quality problems are the result of selecting the wrong fastening method or poor execution of fastening, not an inherent inferiority in a particular fastening technology. Quality improvements associated with design for assembly are the result of paying more attention to the assembly process and eliminating part-to-part interfaces, regardless of how those interfaces are held together.

The most important thing to understand when choosing to use snap-fit attachments is that threaded fastener knowledge does not transfer to snap-fits. A common management mistake is to instruct product engineers to start 'doing' snap-fits and assume that

they will naturally apply their experience to the new fastening method. The most common result in this scenario is that snap-fit features (often the ever-popular cantilever hook) are substituted at threaded fastener sites and the design is considered complete. While this approach may sometimes work, it more often results in attachments with poor assembly characteristics, improperly loaded features and looseness, with these shortcomings sometimes leading to outright attachment failure.

It is also important to understand that, while threaded fastener knowledge does not transfer well to snap-fits, the reverse is not true. A thorough understanding of snap-fit principles, when applied to a threaded fastener attachment, can result in a more robust joint that is also optimised for design for assembly. Thus, a strong case can be made for learning about snap-fits, although actual application of the technology to a particular product may be limited.

Snap-fits as a System

Product engineers must understand that a snap-fit attachment is a system. This is quite different from the threaded fastener applications, where the systemic aspects of the attachment can be largely ignored or minimised due to the independent nature of the fasteners and the clamped parts. A definition of a snap-fit attachment is:

"... a system of compatible locators, locks and enhancement features, acting together to form a mechanical attachment between components."

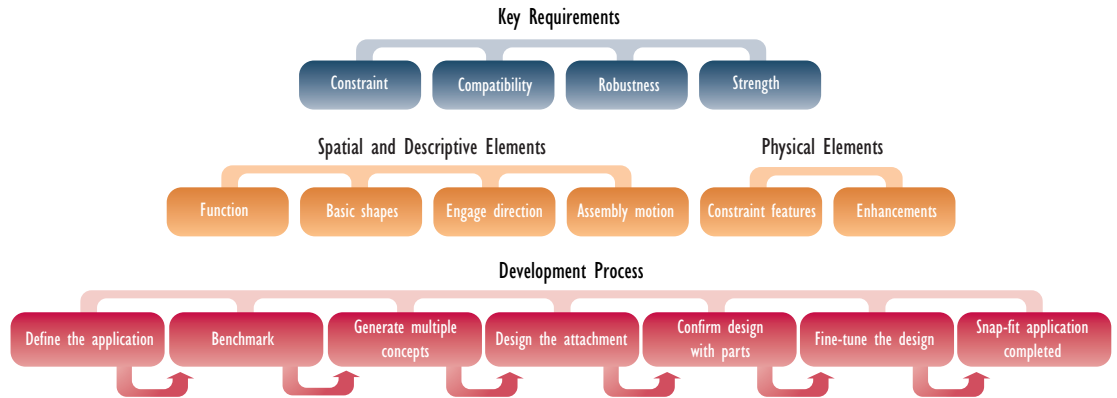
The systemic aspects of snap-fits must be considered during both attachment development and problem diagnosis. Not recognising the systemic nature of a snap-fit can result in improper diagnosis of a problem's root cause and failure to fix what might otherwise be a minor design flaw.

Traditional snap-fit knowledge consists of equations describing the assembly behaviour and retention performance of various kinds of locking features. The equations represent the feature level of snap-fit technology. However, analysis and properly designed



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Figure 1: An 'Attachment Level' Model of Snap-fit Technology



features do not ensure a reliable attachment if the systemic aspects of snap-fits are ignored. The systemic requirements are more basic and fundamental than feature design and are called 'attachment level requirements'. An understanding of snap-fits at the attachment level is critical to good snap-fit design. Feature-specific calculations are important only after the interface features are properly arranged in the attachment interface.

Figure 1 depicts a model that reflects the system's (attachment level) aspects of snap-fit technology. This model is the basis for understanding and applying snap-fit design knowledge. The 'key requirements' define the high-level requirements of a snap-fit. Traditional feature level requirements are captured in the key requirement of 'strength'. The first four 'elements' are spatial and descriptive and are used to define and describe the application. The last two elements are the physical features of the interface. The 'development process' guides the engineer through the tasks of applying the elements to create a fundamentally sound attachment that satisfies the key requirements.

The Design Decision – Snap or Screw

Threaded fastener attachments use clamp load to hold parts together. Clamp load is created when the fasteners are tightened and draw the parts together. These attachments not only enjoy the benefits of clamp load, but the fasteners' strength is independent of the joined parts' material strength. In a sense, threaded fastener attachments are a 'brute force' method of attachment.

Snap-fits, on the other hand, do not and cannot use clamp load for joint integrity. They must rely on a line-to-line fit between features in the interface and on latching mechanisms limited to the strength of the parent material. Proper execution of the design to satisfy fit and latching requirements requires an understanding of part-to-part constraint. Proper constraint is the most fundamental requirement of a

snap-fit and is quantified in terms of degrees of motion for a body in space. A working understanding of constraint principles and failure to apply them is the major shortcoming when making the transition from threaded fastener to snap-fit technology.

If clamp load is required in the application, a snap-fit is probably not the correct attachment. However, caution should be used when making judgements about the need for clamp load. In many applications where only shear and/or compression forces exist on an attaching interface, clamp load-based fastening methods may be in use, but may not be necessary.

In many applications, the snap-fit or screw decision does not have to be made immediately. The recommended snap-fit development process (shown in Figure 1) does not require a snap-fit/threaded fastener decision until the second phase of the 'select constraint features' step. At that point, regardless of the chosen attachment method, the interface concept has been optimised for assembly, robustness and minimum attachments. (Recall the earlier statement that snap-fit principles translate well into threaded fastener attachment design.) Getting the attachment concept right is critical because studies have shown that decisions made during concept have a significant impact on the final product cost.

Managing Snap-fit Knowledge

How does a company begin to 'bootstrap' itself into snap-fit expertise? In the short term, the goal is to learn about snap-fits and begin to apply the learning to relatively simple applications. In the long term, the goal should be to build a learning organisation with the expertise and confidence to apply the technology to increasingly sophisticated designs and applications.

In the Short Term

- Have a model of the snap-fit technical domain. Develop your own or use the model shown in Figure 1.

- Fit the known needs and requirements of the particular product(s) into that model.
- Benchmark own products and other applications. Use the attachment-level key requirements and elements to guide understanding of what is 'right' and what is 'wrong' with the applications studied. Many applications can be studied, including toys, small appliances, electronics, cameras, electronic devices and automobiles. It is desirable to find products that are similar to yours, but not critical.
- Use the model as a tool to capture and organise knowledge gathered during benchmarking.
- Apply the new knowledge to simple attachments and follow the suggested development process.
- Continue to fill the attachment level model with new knowledge gained as snap-fit attachments are developed for new products.

In the Longer Term

As organisational expertise grows, two things will occur. First, a comprehensive 'library' of snap-fit knowledge will be available as a design reference tool for both experienced and new product engineers. Second, the organisation will find that some (maybe many) product applications can be classified into a limited number of basic shape combinations. This is an opportunity to standardise the most common (i.e. highest leverage) interface concepts.

'Standardised' means that a particular arrangement of constraint features and certain enhancements is recognised as 'preferred'. As new applications are identified that can use the standard (proven) interface concept, feature-level calculations are used to develop application-specific feature dimensions. The fundamentally sound attachment concept, however, is 'off-the-shelf'. This saves design time and it ensures against creating new attaching concepts that may not work as well as the standard concept.

A Minimum Requirements Strategy

Three key requirements (proper constraint, compatibility and strength) that must be met and four enhancements (assembly guides, clearance, process-friendliness and operator feedback) that should appear in every snap-fit application have been identified. Additional enhancements may be required to meet specific application needs, but these four should appear in every snap-fit.

Companies designing their own products or seeking bids on products should require that these minimum requirements be addressed in all product

designs submitted for consideration. When the minimum requirements and other application-specific enhancements are ignored early in the product development process, it is usually just a matter of time before they become issues that will need to be addressed.

Conclusions

The following points should be remembered:

- snap-fits are a true paradigm shift from threaded fastening methods;
- there will be a learning curve for the new technology;
- threaded fastener knowledge does not transfer to snap-fits;
- snap-fit principles transfer very readily to threaded fastener attachments;
- snap-fits generally take longer to design than threaded fastener attachments;
- piece cost will be higher with snap-fits – the savings are in ease of assembly and part reduction;
- snap-fit development is iterative, especially when the attachment is complex – very few attachments will be perfect the first time around and the goal is to minimise the number of design iterations; and
- snap-fit expertise can be managed to ensure good snap-fit designs and the growth of organisational expertise.

Do Not

- use snap-fits if clamp load is required;
- leap into snap-fit technology on complex or critical attachments;
- ignore the material and manufacturing (plastic moulding) issues associated with snap-fit features; or
- rely on threaded fastener experience to do snap-fits.

Do

- allow more time for snap-fit development;
- include materials and processing experts in the development process;
- include the minimum snap-fit requirements on a list of product requirements;
- benchmark and study other snap-fit applications;
- think in terms of basic shapes during benchmarking; and
- group the most common applications and shape combinations to support a catalogue of standard interface concepts. ■

This article has been abridged from a longer article containing tables and additional information. The full version of this article can be found in the Reference Section of the CD-ROM accompanying this business briefing.