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It's not how old the contact is, it's how old the contact feels! - This discussion will explain how the initial design force in a contact can be significantly different by its end-of-life.

- **Design Force**
- **Dimensional Tolerances**
- **End-of-Life Contact Force**
- **Permanent Set**
- **Stress Relaxation**
- **Fatigue**

The next issue of Technical Tidbits will include an informative discussion about the importance of contact force.

Reliability and End-of-Life Contact Force

An electrical connector is designed to pass an electric signal from one component of a device to another component of the same or different device. In order for the signal to pass through with minimal alteration, the contacts within the connector must maintain good contact force and resist corrosion over the life of the contact. Connectors must be designed to meet all performance requirements at the end of the useful life of the component. Since performance will degrade over time, this means that the designer must carefully consider how long the component is expected to last and how many cycles the contact is expected to see.

Every electrical contact is designed to provide a certain amount of normal force at the contact interface. This **design force** is usually calculated under the assumption that all part dimensions fall exactly at the midpoint of the allowed **dimensional tolerances**. In reality, the actual force experienced by the contact will probably be different than the design force, because of the allowed variations in part dimensions. With luck, these variations may serve to provide a contact force greater than the designed value. However, it is equally likely that the actual contact force may be lower than what the designer anticipated.

To further complicate matters, the normal force generated by the contact will change over time due to several factors. The **end-of-life contact force** will almost certainly be lower than the force generated by the first contact cycle. The force will probably never increase over time (to this day, nobody has ever designed a contact that violates the laws of thermodynamics). Therefore, the design force must be increased to ensure that the end-of-life force is adequate to maintain good electrical contact.

Permanent set is one method by which the contact force decreases over time. If a contact has yielded during the initial deflection, it will not return to its original shape when the load is removed. This means that any subsequent deflection of the contact by a smaller mating component will be reduced, and the corresponding contact force will be lower as well. Materials with higher yield strengths will thus allow for greater contact forces to be generated, no matter the size of the mating component.

Stress relaxation is another phenomenon which results in loss of contact force. When a contact is under deflection, a certain amount of stress will be generated in the metal. Under a steady deflection, this stress will relax (decrease) over time. Since the stress is what generates the contact force, the force will decrease as well. Additionally, the reduction in stress will mean that the contact will not return to its original configuration when disconnected. Therefore, stress relaxation can also be thought of as a delayed permanent set.

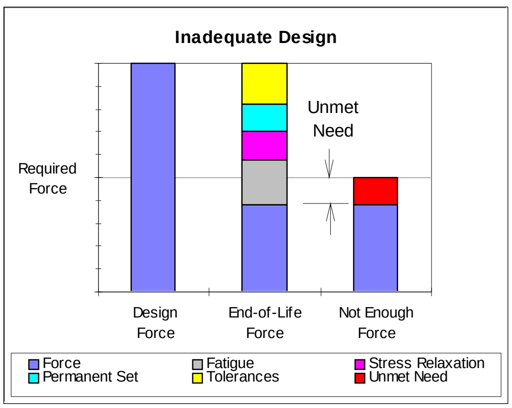
Stress relaxation is depended upon time, temperature, the initial stress level, and material. The longer a contact is deflected, the more the stress will relax. In addition, the relaxation rate increases with temperature. The rate is also dependent on the initial stress level. As the stress exceeds the yield strength, the rate increases. This is where materials with higher yield strengths

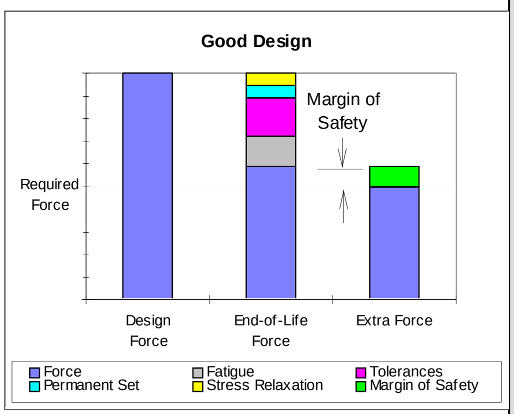
Reliability and End-of-Life Contact Force (continued)

have an advantage. Additionally, some materials will relax much more easily than others. Materials that have greater stress relaxation resistance will work better than others.

Fatigue also affects end-of-life contact force but in an indirect manner. The number of deflection cycles a contact can be expected to experience without breaking depends on the initial stress level. As the stress increases, the expected number of cycles decreases. Therefore, as the contact needs to see more and more deflection cycles, the stress level must be reduced to allow this to happen. However, if the stress level is reduced, the contact force is reduced as well. Therefore, materials with greater fatigue strength can generate greater force at the same amount of cycles or can last longer at the same force level.

In order to maintain adequate end-of-life contact force, the contact must be designed to give an initial force greater than the minimum required for electrical signal integrity. The length of service time, number of cycles, and the temperature levels experienced must all be carefully considered when choosing a material. In this age of decreasing part size, there is less room to increase the contact dimensions in an effort to increase the force. Indeed, miniaturization often results in lower forces and higher stresses. Therefore, the best material for the job will be the one that most effectively retains greatest percentage of the initial contact force over the life of the contact.





Written by Mike Gedeon of Brush Wellman's Alloy Customer Technical Service Department. Mr. Gedeon's primary focus is on electronic strip for the telecommunications and computer markets with emphasis on Finite Element Analysis (FEA) and material selection.

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Brush Wellman Inc.
6070 Parkland Blvd.
Mayfield Heights, OH 44124
(216) 486-4200
(216) 383-4005 Fax
(800) 375-4205 Technical Service

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