TEN BOLTS
THE DESIGN ENGINEER'S PRE-BUILD CHECKLIST
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REV C, GENERAL USE. UPDATED: 6/5/2019
INSPIRED BY 'TEN BULLETS'

- Utility
  - The component accomplishes high-level goals either directly or indirectly. Addition/revision of the component can be thoroughly justified.
  - All use cases of the component have been carefully considered. Additional features of a component are not simply thrown on.
  - A component is cool because it does this, and not for any other reason.
- Elegance
  - Efforts were made to streamline and simplify the design.
  - The design and execution is aesthetically pleasing on its own and flows with the rest of the system.
  - The beauty of the component is derived from its utility.
- Weight
  - Efforts to reduce component mass have been undertook to balance survivability and performance.
- Strength and Rigidity
  - Load paths have been thought out thoroughly and designed, not just accepted at face value.
  - If applicable to performance, stiffness of the component has been analyzed.
  - If applicable to meshing or alignment, deformation of the component has been analyzed.
  - Analysis has been conducted that matches physical reality as closely as possible (choosing correct boundary conditions and loads) or uses empirically derived formulations.
  - Fatigue has been analyzed if the component undergoes cyclical loading.
  - Buckling has been analyzed if there are long portions in compression.
  - Yield has been considered for catastrophic load cases.
- Survivability

  - Entry of rocks and conductive objects has been taken into consideration.
  - Entry of dirt and dust has been taken into consideration.
  - Entry of water and oil, both low and high temperature, has been taken into consideration.
  - Inertial loads have been taken into consideration.
  - If all bolted joints become like ball-and-socket joints, a structure is properly constrained.
  - The effects of component wear (eg. egging and abrasion) have been considered.
  - Effects of vibration have been considered and locking fasteners appropriately selected.
  - Overheating has been considered.

- Economy
  - All commercial over the shelf (COTS) have been considered.
  - Modifying COTS options or using bespoke options has been considered.
  - Part count is minimized. Every single fastener, adhesive, or weld is justified.
  - Parts are sized to readily available components rather than bespoke ones. Bespoke components are avoided.

- Manufacturability
  - In manually machined parts, complicated contours are removed, and radii are sized for available tooling.
  - The limitations of fabrication processes are considered.
  - A âĂŸmental machiningâĂŹ process has been gone through.
  - The part can be held rigidly and securely in every set-up, with minimal machine calibration.
  - The part can be indicated reliably in every set-up.
  - Tooling can reach everywhere it needs to, while being held rigidly and securely.
  - Effects of warping during welding are considered and mitigated.
  - The effects of fabrication on material properties (strain hardening, heat treatment) are taken into account.
  - Reasonable materials and post treatment are considered and justified.

- Integration

  - All of the following are considered and communicated:
    * Tolerance stackup
    * Loads the component receives and creates.
    * Vibrations the component receives and creates, along with generated noise and modes.
    * Thermal conditions around the component, and created by the component.
    * Required tolerances between components to line up and function properly.
    * Airflow around the component and the resulting wake.
    * Driver/user comfort and feedback

- Serviceability
  - Maintenance required for the component is easy to perform, practiced, and well-documented.
  - The time/cost of removing/reinstalling the component has been considered. Appropriate fasteners have been selected.
  - Ample clearance and access has been allotted for inserting fasteners, wrenches, sockets, and hands. Conveniences like âĂŸwrench slotsâĂŹ are integrated.

- Rules Compliance
  - All rules possibly pertaining to this component and the systems it interacts with have been searched for and complied with well in advance.
  - Discrepancies in rules are sorted out with the Q and A promptly.