During development of the Optiframe chassis, the team had considered assembly without tools. One idea was to design components—the internal drives and so forth—with rails that could snap into bays on the chassis.

At that time, the idea was impractical because it would require discarding tools that had several years of life left. When it came to the new Transformer frames, however, Dell had already committed to new tooling.

Dell developed a patented design using shock-absorbing material for the rails. Suppliers agreed to fasten the rails onto the components, so the screws for those parts were moved to an earlier stage of manufacture.

There was one more screw that the team could eliminate. The motherboard in the Optiframe had fitted into a number of built-in hooks, with a single screw to keep it secure. The software targeted that screw and guided the search for alternatives. “Actually, we had a number of challenges to overcome,” Keup said. “Motherboards face damage in shipping, installation, and use. They are awkward to handle. It’s very common for an operator to damage the EMI shielding just by picking up a motherboard. The board must be kept rigid for shipping and when it is placed in the PC.”

**One-Piece Solution**

The mechanical engineers and the DFX team devised a one-piece solution that eliminated a screw while reducing the potential for damage. Dubbed a “tempan,” it is an L-shaped metal plate that the supplier screws to the underside of the board. The tempan protects the board and its EMI shielding during shipping and handling. It latches into holes on the motherboard base of the chassis, holding the board both secure and rigid. A single motherboard/tempan design fits all three chassis sizes.

Another targeted task involved routing the integrated drive electronics cables inside the chassis and plugging them into the appropriate components. “Once you start combining features, it’s hard to stop,” Stimson said. “The Transformer design included the cable routing and allowed us to receive the cables preinstalled by the supplier. Plus, we color-coded the cables to make plugging them in even easier for both the factories and service.”

Shipping experts contributed to analyses that reduced the risk of damage in handling. The team modified PC features that were likely to break on impact, then selected a thin, compressible packing foam that could absorb impacts from either dropping or bumping.

The new design decreased overall packaging size. According to Keup, “If we shrink the packing box by a half-inch in height or width, we can save hundreds of thousands of dollars in outbound freight costs.”

The different sizes of the final design share parts, reducing inventory and tooling expenses. The integrated cabling in the chassis offers a similar drop in purchasing, storing, and kitting, or outside assembly. It also augments the freight savings from the reduced packing box size. Additionally, the parts integration saves labor and floor space. Because features are common across all three desktop product lines, Dell has been able to standardize its assembly training.

Overall service time for PCs has been reduced 20 to 30 percent. Replacement motherboards are delivered from suppliers with tempan already installed. The other components arrive with rails in place. A service call involves toolless entry and part installation.

Dell still uses four screws in one area of in-plant assembly. Because hard drives become obsolete rapidly, it was not practical for Dell to purchase a large inventory of hard drives with the rails pre-installed. Operators in the build cell of the Dell factories use torque-driven nut drivers to fasten rails onto the hard drives, using two screws per rail. The minimum time for fitting hard drives with rails is 32 seconds.

Cutting those 32 seconds may be a place to start when the time comes to design the next generation of chassis. “We are exploring an automated system for rail installation,” Stimson said.