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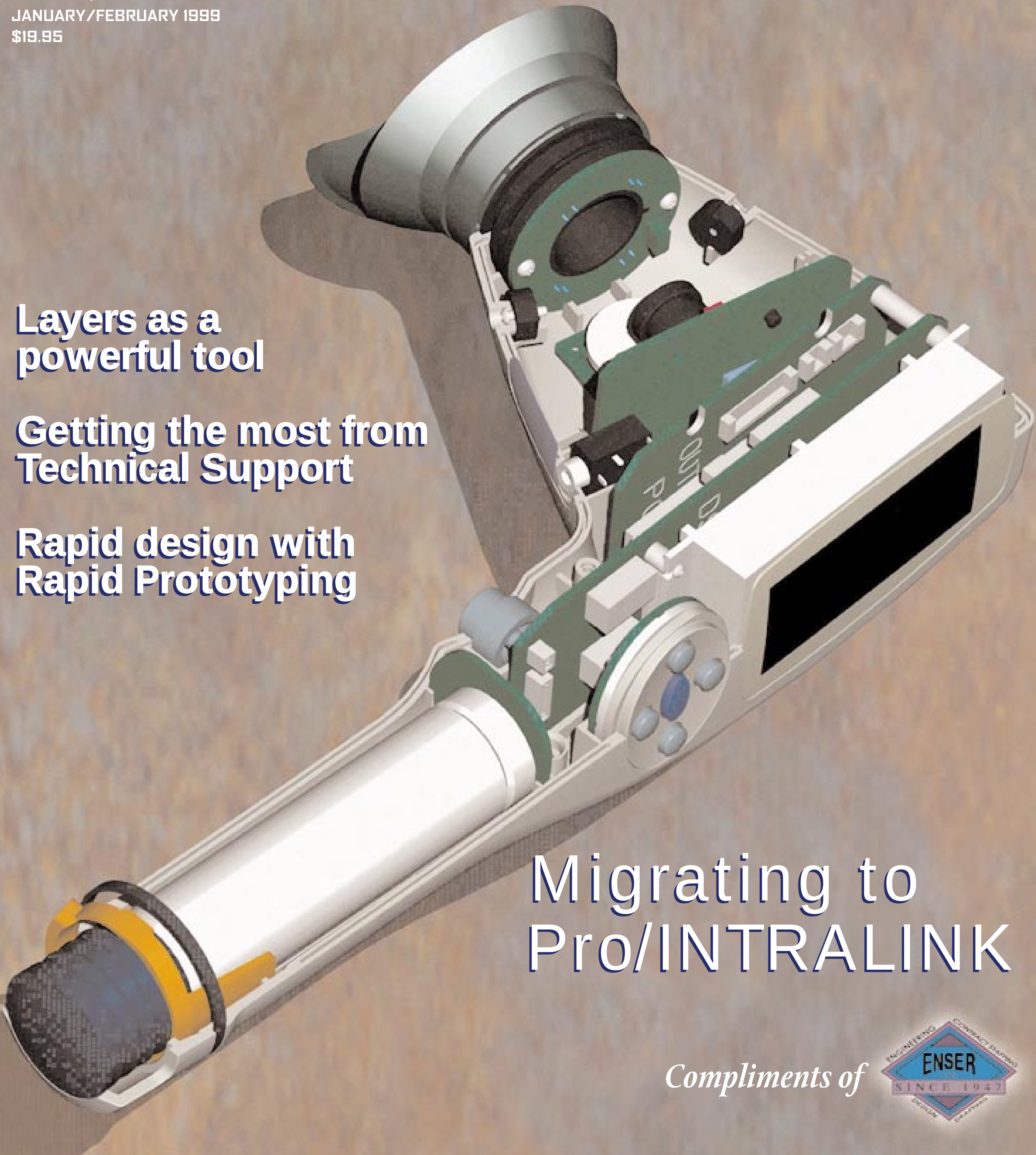

Layers as a powerful tool

Getting the most from Technical Support

Rapid design with Rapid Prototyping

Migrating to Pro/INTRALINK

Concept to prototype in 120 days

Marco Arnone

It happens all the time. There is an idea for a great invention or innovation, but no proven physical evidence that it will work.

Pupilometer–side view.

Case in point: an Original Equipment Manufacturer (OEM) in the medical arena had, for a number of years, been designing and manufacturing a pupilometer, a hand-held instrument using infrared technology that digitally measures the size of a dark-adapted pupil. The company tried numerous times to sell the idea of mass producing this instrument, but it found no company willing to invest.

Until this time, all of the OEM's instruments were rather utilitarian, without much concern for appearance and ergonomics. The company was at a crossroads. If it wanted to broaden its consumer base, the OEM needed a modern, more ergonomic design. Potential manufacturers were unwilling to assume the initial design costs, and they required that the OEM return when it was ready to manufacture.

What was the next step? The OEM, a small company with no in-house design capabilities, was faced with a daunting task for which it did not have the resources. It needed a company to create the design of the pupilometer, and the OEM engaged the support of a respected Industrial Design (ID) consulting firm. The ID firm was given the task of developing some concept sketches and appearance models of a more friendly and ergonomic housing for the pupilometer. After a few iterations, which are very common in the conceptual design process, the OEM and the ID firm agreed to the basic shape on which the new and improved design would be based.

The initial step had been taken. But a foam-core appearance model was still a long way from the working prototype that the manufacturer demanded. Not only would a new housing have to be designed, but all of its components had to be packaged as well—battery, digital camera, mini-computer, LCD display and serial port.

Needing assistance in this endeavor, the ID firm approached Enser Corp. of Cinnaminson, N.J., to make its dream a reality. Enser Corp. is an engineering and design firm that began the implementation of Pro/ENGINEER in 1992. Under the direction of one of Enser's project managers, Russ Mitchell, along with the assistance of one of its senior designers, Adam Friedrich, a master plan was implemented. As Mitchell explained, "The project was a multi-faceted endeavor that necessitated complete cooperation on the part of everyone involved, due to the time constraints for delivery."

The plan consisted of using the conceptual design to produce a working prototype in 120 days. *Table 1* breaks down the stages and the time frame for each. The goal was to deliver a fully functional prototype in 120 days, in time for a medical trade show.

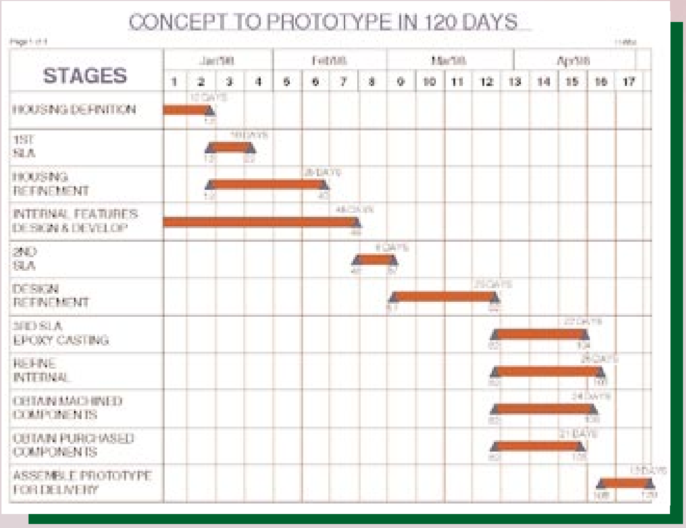

Table 1.

The initial task was to create a Pro/ENGINEER database that would incorporate the ergonomic design developed by the ID firm. Enser quickly accomplished this by using a foam-core model and conceptual design sketches, supplied by the ID firm as reference for the outside shape of the unit. At this point, it was discovered that the LCD display unit initially configured for the design was not available.

If this design had not been parametrically created in Pro/ENGINEER, the necessary changes caused by this discovery would have been reason enough to start the process over, thereby increasing the cost. But, since the model was created with Pro/ENGINEER, it was possible to make some dimensional modifications without starting over and rework the shape of the pupilometer, meeting the new requirements. A major obstacle in the design process was avoided, due, in large part, to the functionality of Pro/ENGINEER.

With the external shape determined, a stereolithography (SLA) of the model was processed to evaluate the ergonomic aspects of the design. Upon evaluating the SLA model, minor surface irregularities that were difficult to notice in the solid model were uncovered and, again, quickly remedied. A 3D concept modeler, Actua 2100 is currently being used instead of making SLAs in the initial conceptual stages of the design, which fully convey the subtleties of complex designs. This allows for ambiguities and errors to be corrected at the earliest possible stage and provides everyone the opportunity to evaluate the model at the initial design stages.

Concurrent with the housing development, internal components and a variety of other parts were being designed and modeled in Pro/ENGINEER. To determine the shape of the required printed circuit board, the housing was packed full of all the necessary hardware. Enser accomplished this using the shell functionality in Pro/ENGINEER, an invaluable tool in the creation of molded parts. One of the major criteria for producing a molded part is the need for a uniform wall thickness. With the shell function, complex surface geometry can be offset to an input value, and at the same time, the model is cut out or shelled to create a uniform thickness. This function is a tremendous timesaver.

Without the shell function, a designer is faced with the daunting task of recreating the interior surface and using a series of merges and cuts to obtain a wall thickness. It should be noted, however, that the shell function is useful only for uniform wall thickness, and if there is a need for various thicknesses the surfacing functionality has proven to be the best solution. The shell information was passed onto the designers of printed circuit boards to ensure that enough space was available for the required components. Upon reviewing this information, the PC board designers calculated that they would require more space than what was set aside for them. Again, we were asked to expeditiously make the necessary changes to the housing without disturbing the ergonomic aspects.

Once the external shape was ultimately determined, knowing that all the components would fit into the housing, the final design phase was the next step. This process involved refining the housing and other components to reduce manufacturing costs. At this point, internal ribbing was also added to strengthen the housing and retain the printed circuit boards.

Concept to prototype

Pupilometer–working unit.

In addition to the housing, Enser was challenged to incorporate an elastometric keypad and its mounting bezel onto the exterior of the housing. A major requirement with this task was to seamlessly incorporate the keypad without interfering with the integrity of the housing.

At this stage, another SLA model was produced to evaluate the fit and finish of the design. These SLA models also served as the test bed for the electronics, allowing the engineer to assess the temperature specifications of the housing. This was accomplished by completely assembling all of the SLA components to create an actual working prototype. The pupilometer was then functionally tested at its highest temperatures for 48 hours, and monitored with a thermostat probe to ensure it could withstand the heat created by the PC boards.

The next step was to refine the housing for moldability. This was achieved by using the draft feature and the surface evaluation draftcheck function of Pro/ENGINEER. In the production of tooling for injection-molded parts, the No. 1 consideration is the ability to remove the parts from the molds. The proper draft angle of the part is the driving factor that will make this happen. In the past, this feature was often relegated to the toolmaker's discretion. However, problems in the functionality of the part did arise with this method, if the toolmaker neglected to consider certain factors or was not made aware of specific design requirements.

Today, the designer is able to reflect the necessary draft angles in the solid model, eliminating any interpretation on the part of the toolmaker. With a Pro/ENGINEER model that reflects every aspect of the finished part, designers can better document, analyze and prototype their products. Also, the surface evaluation function of draftcheck allows the designer to check the model for the existence of adequate draft. By specifying the pull direction and the minimum required draft angle, a designer can check for inadequate draft and also for the existence of undercuts, which would cause problems in the tooling.

Enser was able to design a working unit that met all the client's requirements and, at the same time, evaluate the unit for form, fit and function. This assured all the involved parties that they could proceed with the next step, because all the parts were designed with the intent to manufacture by injection molding. But two factors interfered with producing hard tooling: time constraints and budget estimates. To overcome this obstacle, it was decided that a combination approach would be the best solution. First, silicone rubber molds were created from the SLA master models, and 12 sets of parts were produced. Then, the remaining parts were produced by conventional machining methods. Using Pro/ENGINEER, these parts were simplified by suppressing features that were required for molding, but were unnecessary for machining.

In just a few weeks, 12 working prototypes were produced in time for the much-anticipated medical trade show. These units had the fit and finish of injected molded parts and received an enthusiastic response at the show.

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