

**TechniCom
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*Detailed analysis of the
CAD/CAM/CAE/PDM
marketplace*

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SensAble Technologies moves haptic technology into surface modeling

A few weeks ago, we had the chance to meet with SensAble Technologies. Bruce Boes, Vice President of business strategy, Kate Allgood, media relations manager, and Michael Rockwood, industrial designer and chief demonstrator came to our offices to preview their recently announced FreeForm Version 4, software for touch-based modeling. Several years ago, in Issue 13 (August, 1999) we reviewed FreeForm and commented that "we have seen nothing like their new FreeForm software coupled with 3D touch hardware for developing a virtual clay model."

With this version of the software coupled with the dramatic improvements in hardware speeds, the new version moves beyond free form clay modeling into constraint based modeling. New tools in this version provide greater control over models, allowing users to comply with design criteria.

The original technology, remains approximately the same - computer based sculpting, allowing the creation of shapes that would be extremely difficult to create using surface or solid modeling. Can you imagine Michelangelo designing his David sculpture using surface modeling?. The PHANTOM haptic interface hardware, a kind of kind of positioning pen with touch based feedback, makes it possible for users to "touch" and manipulate virtual objects. The FreeForm modeling system, an end-user application based on touch-technology, allows the creation of 3D models using modeling techniques such as sculpting, wire cutting, shaping and deforming. Designers can create highly aesthetic models not possible with surface or solid modelers, and new in this version -- achieve compliance with design criteria.

When we last reviewed the system, it required advanced PC hardware. Since then the technology has caught up with the requirements and the system can be operated a system with Windows Professional 2000, connection of the haptic device using a parallel port, dual Pentium III processors, and a minimum of 512 MB RAM. The end user applications are Freeform and FreeForm Plus, differing in that FreeForm Plus includes new capabilities in 3D curves, 3D surfaces, and shape deformation.

Version 4.0 includes: an enhanced sketching capability, the addition of 3D curves with precise control over more sophisticated shapes, an offset function for creating "shell" models, new modeling tools for interactively modifying designs, and the capability to deform shapes and perform global changes on a model without losing detail. With this release, the FreeForm system is now available in two distinct products: FreeForm - an aesthetic styling tool and FreeForm Plus - which adds shape creation and deformation techniques.

FreeForm uses a voxel representation of a 3D solid model. Similar in 2D to a pixel, A voxel can be visualized as a pixel with depth. During modeling, the number of voxels can be either up-sampled or down-sampled, which in effect, either decreases or increases the number of voxels used in the model. Voxel technology allows operations that are quite different than those normally associated with surface modeling. For instance, using sandpaper to remove irregularities (called smoothing) similar to actual sandpaper.

The demo and resulting models

We looked at and actually sculpted on a pre-designed model of a gecko to illustrate the pure sculpting capabilities of FreeForm V4. We found that using the haptic device was quite easy to learn. Within minutes we were sculpting ourselves, although we better keep our day jobs after looking at the results. We were able to easily add and subtract material from the model. As you move the sculpting tools over the model, the haptic hardware provides feedback that allows you to sense the contact with the model. The tool and the depression force cause the amount of material removed to change, much as in real life. However, working in virtual space, allows actions that are not physically possible. For instance, we were able to pull material out or sculpt the inside of the model. *Such sculpting is of limited use to CAD designers, but definitely should enhance the ease with which industrial designers design free form, organic shapes.* See the images posted here for samples.
www.cad-portal.com/eWeekly/issues/Issue95/Sensablegallery/index.htm

In the second part of the demonstration, we looked at capabilities of Freeform Plus, which allows the use of constraints. Initially, the demonstration used a series of planar curves to develop the binoculars seen here. The steps that we went through to build the 3D version of the binoculars can be seen here. As we looked at his type of modeling, it became more complex, and more CAD-like to build the solid models. We were able, however, to proceed very rapidly without ever using specific spatial coordinates, as would be required in a CAD system. We were also able to easily to use the sculpting capabilities of the software to clean up the model. One interesting capability demonstrated was the ability to apply realistic textures to the model. We developed a series of grips, using alternative textures, a most useful capability for generating a series of alternatives for industrial design models. Some of the alternatives can be seen in the images.

Getting data from FreeForm

The system outputs STL or IGES formatted surface files. STL turns out to be handy for producing rapid prototype models. To export to a CAD system users need to perform an extra step to generate a NURBS surfaced model. Using the inherent surface software, the user draws four boundary curves on the model to signify an appropriate surface patch. The system then calculates the NURBS surface for the patch. The patches will need to envelop the entire model. If not too complex, users

can wrap the entire model in a single NURBS surface and then export it. SensAble's software developers expended substantial effort to export closed solid models that need little or no additional work once inside the CAD system.

Pricing

The software and hardware is sold direct by SensAble Technology. Contact them at the web address below. Freeform costs \$15,000 USD and also includes PHANTOM hardware and driver software. FreeForm Plus is \$24,150 USD, and includes the capabilities in FreeForm as well as new capabilities in 3D curves, 3D surfaces, and shape deformation. FreeForm plus is targeted mainly at industrial engineers who need to assure design criteria compliance.

About the company

Founded approximately 6 years ago, SensAble Technology, a private venture funded company, raised \$23 million last year to expand its market share. The company has approximately 60 people and has somewhat less than 10 million dollars in revenue.

Conclusions

Who would use it? Boes claims "this is a must see for all industrial designers seeking the perfect blend of form and function, desiring to capture the true intent of their designs digitally." We agree!

www.sensable.com

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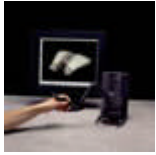
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Sensable

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1) Overview of the Sensable System



2) Scanned images are used as reference.



3) In Sketch, draw curves on image.



4) Sections are created for lofting.



5) Create Loft.



6) Using a wire cut, remove half the model. (User will mirror later)



7) Sketch a profile to define the hinge section of the binoculars.



8) Revolve the profile to create the hinge section.



9) Curves are used to define the blend surface between the hinge and main body.



10) Replicating a real world process which uses putty or bondo to blend between these two shapes. First material is first added in the gap and then shaped using the boundary curves.



11) The resulting blend.



12) Through carving and smoothing, excess clay is removed and blended to capture designer's exact intent.



13) Sharp edges are softened with the Smooth tool.



14) Entire model is selected and mirrored, creating 2nd half of model.



15) The two halves of the model intersect in the hinge section. To build a correctly functioning hinge, we select areas of each piece to delete.



16) Result.



17) Close up of hinge section.



18) More detail is added to the model and the grip area is created.



19) To create a texture, the grip area is deformed using a 2D image. Physically modeling the texture rather than using a visual texture map allows production via any rapid prototyping process.



20) Resulting grip.



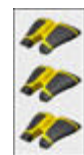
21) To communicate the design downstream to engineering/analysis and manufacturing applications we use IGES surfaces. The first step to do this is to define the boundary of the area to be communicated.



22) The underlying complex surface texture is easily captured.



23) The resulting surface is ready to be exported. FreeForm also supports STL and OBJ.



24) Montage of various grip textures for design evaluation.



25) Finished model from different views.