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EXCLUSIVE ARTICLE

## Lattice Technology's Ultra Lightweight XVL Format and Software

By Ralph Grabowski, February 7, 2013

Lattice Technology was founded in 1997 by university professors in Japan who figured out a solution to the problem of 3D models having large file sizes. Over the years, Lattice Technology has become known as the "ultra lightweight 3D file" company.

The company's software resurfaces 3D models using Gregory patches, which turns them into the smallest file size possible. For instance, the 3D CAD model of a satellite is 1.6GB in SolidWorks, but only 5.5MB in Lattice Technology's XVL format. Being nearly 300 times smaller equates to fast loading and browsing times -- yet all the necessary data is found in the XVL file, and so users can browse all 8,000 parts and associated product data in the satellite assembly.

The important thing to remember is that lightweight does not mean inaccurate. For instance, the XVL technology is important enough to Toyota's car manufacturing business that the automotive company purchased a significant ownership of Lattice Technology, and is its biggest customer. ECAD vendor Zuken owns another share, and uses the software to bring printed circuit board designs into XVL Studio Z for checking design aspects, such as interferences between boards and cases, static electricity jumps, and short circuits.

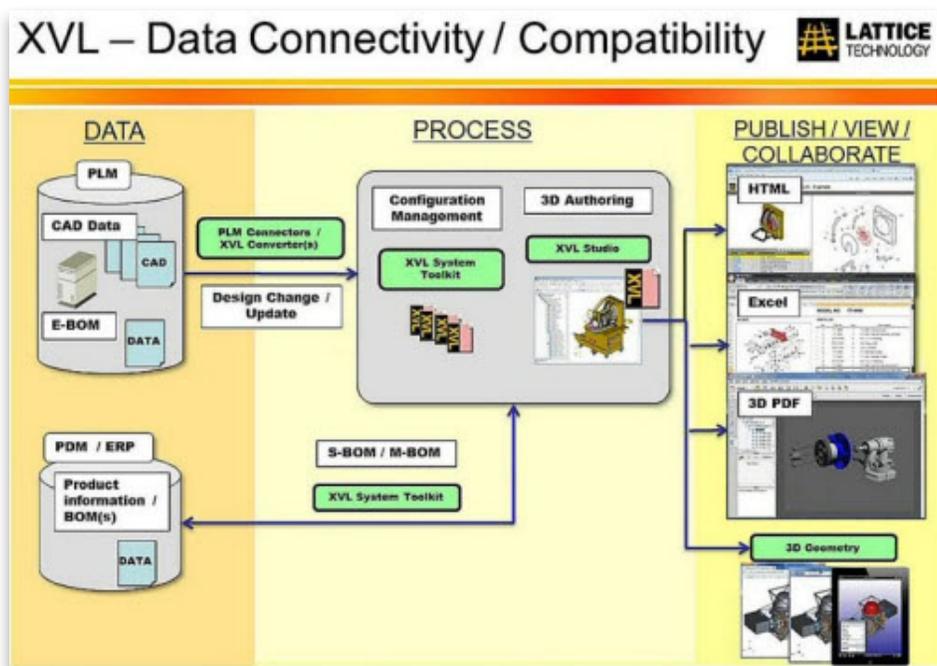
Today, XVL is popular with automobile, aircraft, and other huge design projects, as well as ones as small as medical devices.

### About XVL

The file format developed by Lattice Technology is called "XVL," and over the years it has evolved to compress 3D models even further and to encompass more product data. XVL sits between data creation and data consumption (see figure 1).

**Data Creation.** Data is created as 3D models by CAD programs like SolidWorks and Inventor. While XVL can be translated from MCAD software, it can also interface using XML through PLM software, such as TeamCenter (from Siemens PLM Software) or ENOVIA from Dassault Systemes. It can read non-CAD data from PDM/PLM/ERP systems, and then attach them to the 3D model (details at <http://www.lattice3d.com/our-products/xvl-integration-toolkit>).

**Data Consumption.** Data is consumed by those who need to work with the data, but not necessarily in its original MCAD format; this includes employees who produce technical documentation



or digital mockups. Creating the digital mockup of an entire automobile is much easier when the thousands of parts consist of files that have a very small size.

All of the viewers from Lattice Technology are free, and so XVL Player software lets anyone view the files. Other software from Lattice Technology publish XVL files to formats, such as HTML (for XVL-embedded Web pages), XLS for embedding 3D models in spreadsheets, 3D PDF for technical documentation, and even outputting to iOS devices like iPad, iPhone, and iPod Touch.

Another advantage to XVL is that it is multi-CAD, so that parts can be imported from multiple CAD systems, and then checked against each other. Toyota, for instance, designs car bodies in CATIA but designs drive trains in Pro/Engineer, and so they put together the design at the PLM level: they build an XVL model of the completed vehicle. (Toyota formerly employed Delmia.)

Another example is when a parts supplier needs to make sure his parts fit the larger product. Its clash analysis and tolerance checking lets engineers check the design, and send back reports as spreadsheets; this is the reason a Lexus doesn't rattle doing down the street.

To create and consume XVL data, Lattice Technology produces the following programs that handle ultra lightweight data in a variety of ways:

### **Authoring and Publishing**

- XVL Converters translates all major CAD formats to XVL; available in standalone or server versions
- XVL Studio views, checks, and animates models and assemblies; available in Basic, Standard, and Pro versions
- Webmaster publishes XVL files as 3D Web pages
- iXVL Publisher publishes XVL files to iOS devices
- XVL Signer keeps XVL files secure.

### **Consumption**

- XVL Player views XVL files; available in a free version and a Pro version
- Lattice 3D Reporter embeds XVL files in Excel spreadsheets

### **Utilities**

- System Toolkit integrates XVL data into ERP and PLM systems

See <http://www.lattice3d.com/our-products/product-list/> for details on each product. The central software is XVL Studio Pro, so let's take a look at its capabilities.

## **XVL Studio Pro**

XVL Studio Pro is a 3D viewer, model checker, publisher, and translator. For viewing and checking 3D XVL files, Studio Pro can take measurements, apply annotations, and make cross-sections. It even can edit things like materials and textures.

For model checking, it does manual and automated interference detection of even very large assemblies.

For 3D publishing and downstream reuse of XVL data, Studio Pro generates animations with keyframes and process definitions. An optional Illustration add-on is available.

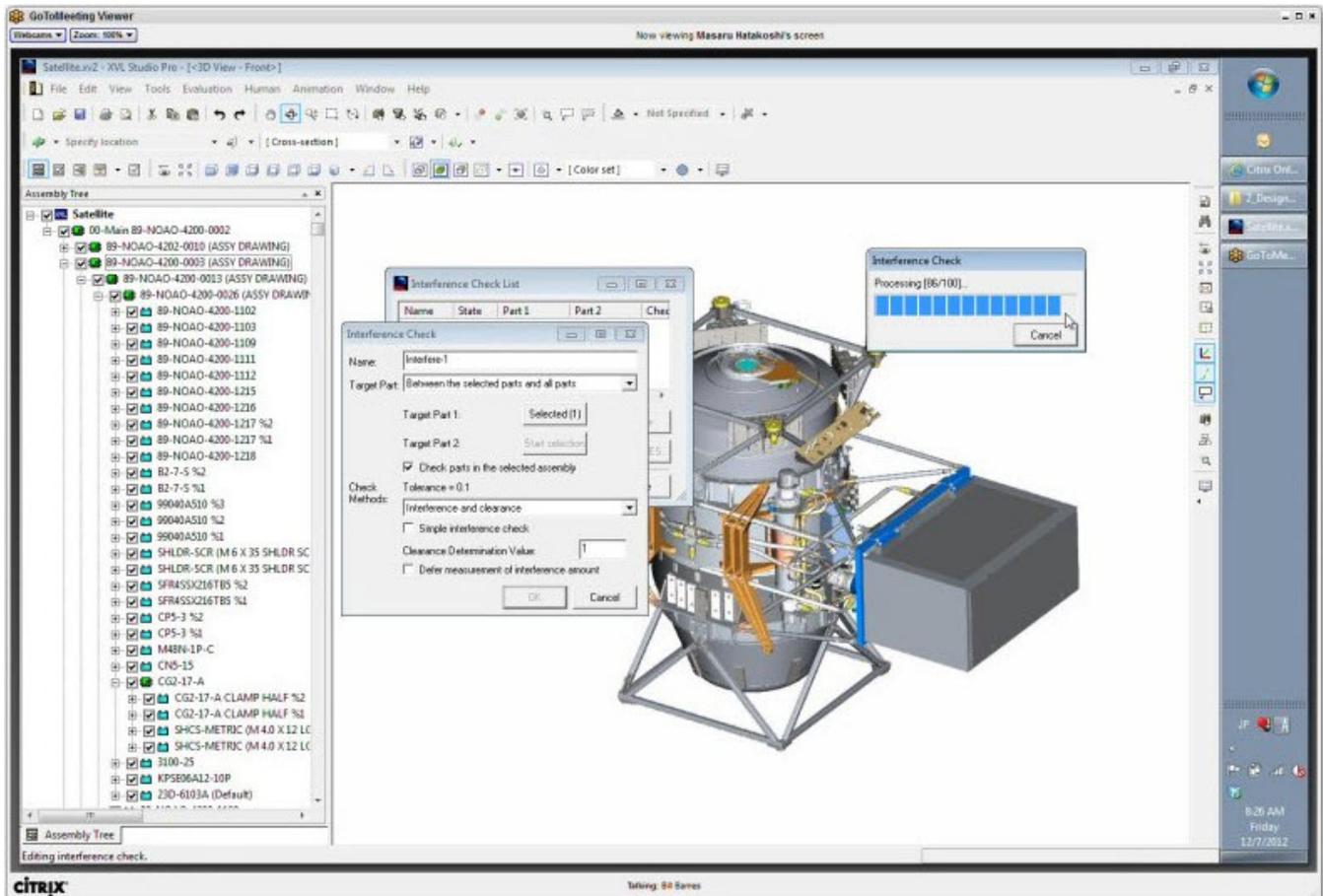
Studio Pro only works with XVL files, and so the software itself imports and converts almost any CAD or 3D format. In companies with PLM, however, XVL conversions can be made automatically every time a file is checked in. It can work with parts or assemblies versions of XVL, mirroring the assembly structure of the original CAD model exactly. (XV0 is an assembly of XVL part files.)

Let's dive a bit deeper into the model checking and downstream publishing capabilities of XVL Studio Pro.

## Model Checking

Studio Pro does static and dynamic interference checks. During static checking, you can move a part and the software uses color coding to highlight tight clearance distances, such as those less than 1mm. You can switch to a 2D cross-section view to see the interference error more clearly.

In dynamic collision detection, Studio Pro generates animations along the path of parts that might hit each other (see [figure 2](#)). To speed up things, Studio Pro internally replaces all parts with rectangular bounding boxes; if the boxes don't collide, then the parts can be safely ignored.



*Figure 2: Interference is checked by comparing pairs of candidates throughout the model*

Dynamic measurement shows the distance between a part and the collision point; you can see how the distance narrows interactively. At the collision point, you can generate a 2D cross-sectional view, which can make it clearer to see the contact point (see [figure 3](#)). Again, you can generate reports about the collisions.

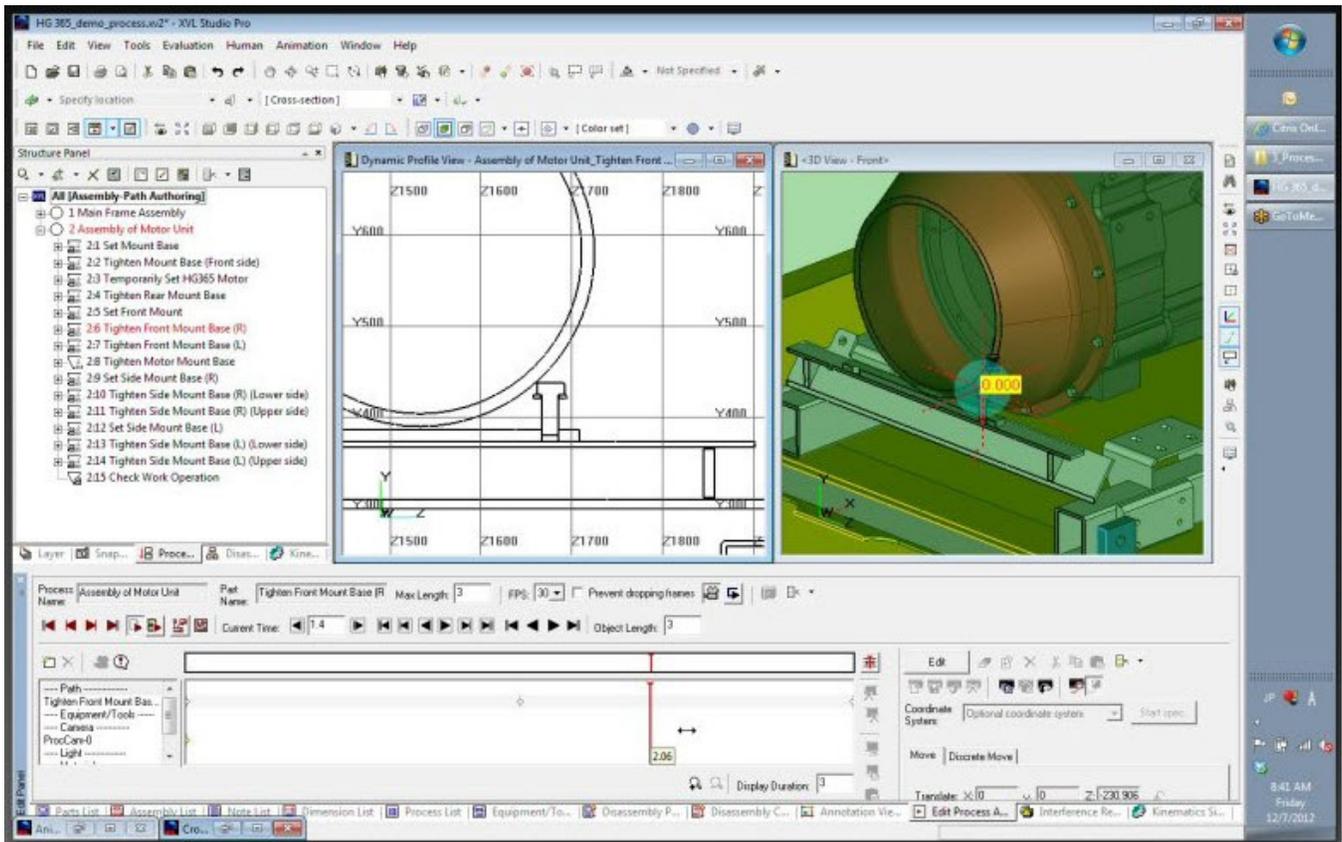


Figure 3: Clearances between objects can be seen in a 2D cross-section (at left) and in the 3D model (at right)

When there multiple revisions of models, Studio Pro can update them automatically or manually. In automatic mode, it looks at rev 1 and rev 2, notes the changes, and then brings anything different (or missing) from rev 1 into rev 2. In manual mode, you get to see the old and new designs overlaid before approving the changes.

## Downstream Publishing

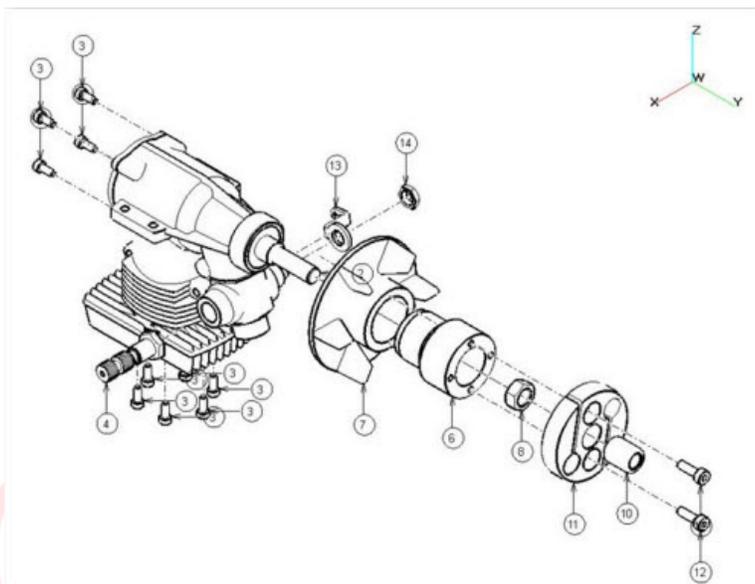


Figure 4: Tag numbers are applied automatically, and then can be manipulated by hand

Downstream publishing of XVL files is used to document procedures, such as work instructions, or to create illustrations for technical manuals, or to animate disassembly instructions. Studio Pro generates technical drawings to which tags, part numbers, and so on can be added automatically; if necessary, you can adjust them manually (see figure 4). Again, this is something done best with Studio Pro, because illustrators typically don't get access to MCAD systems or the PLM server; often, the employees are located in a separate department or work on contract outside the company.

In Studio Pro, the process of generating tag numbers is manual or automatic, as in other areas. It begins by reading the BOM (bill of material) structure from the 3D model and then creates a manufacturing tree. The tree can be tweaked to match the manufacturing process, because MCAD history trees always show the elements in the

order in which CAD operators designed products, and this order might not match the manufacturing workflow. Studio Pro is flexible enough to create multiple sub-assemblies for major and minor manufacturing steps.

A benefit of Studio is its ability to create function- or job-specific BOMS. There can be BOMS designed for manufacturing, services, customers, and so on.

With the advent of iPads, it has become popular to deploy movies that show how parts are disassembled for repair and maintenance, and then reassembled. Studio Pro creates these animations, either automatically or manually. The automatic animated version reads the coordinate system of each part, and then pulls apart the assembly. But it is not always exactly right, and so it can be tweaked manually.

You can drag parts into place (or else enter precise coordinates and angles) to create the animated assembly/disassembly instructions (see figure 5). This generates a keyframe-style animation, without the need to use keyframes, something most users prefer because they are not animators. But keyframes are available for those who are familiar with this animation method.

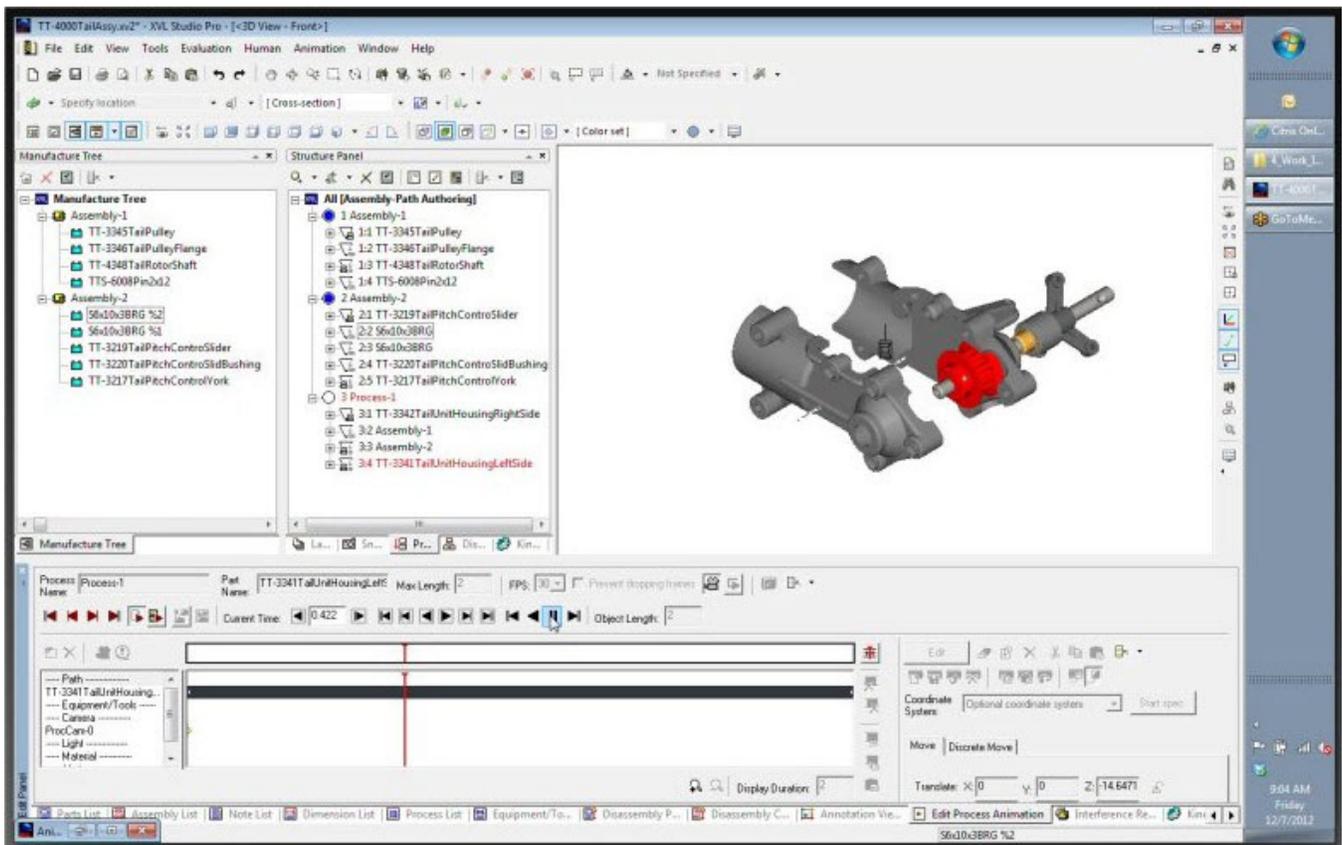
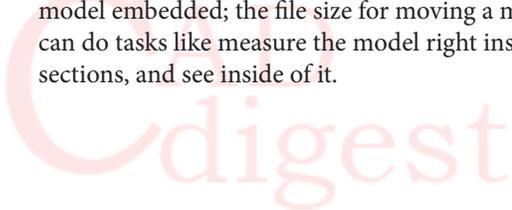


Figure 5: Animations are generated to see how parts are to be assembled

Studio Pro automatically adds part numbers to the assembly parts animation; you can, of course, rename parts to make things clearer. Pauses can be added to the animation, which continues when the user clicks the screen. (After adding all this animation functionality, one sample file grew only a small amount, from 124KB to 133KB.)

Studio Pro exports its 3D models to 3D PDF, which is popular in some areas, as well as to Excel spreadsheets through Lattice3D Reporter. Reporter embeds everything in the XLS file, so there is no need to send the model separately. Again, the file size is kept small; for example, a 352KB XVL file becomes an Excel file of about the same size, and that's with the entire model embedded; the file size for moving a model into Excel does not demonstratively change. Because it is embedded, you can do tasks like measure the model right inside Excel, view the assembly tree, and even slice the 3D model to generate cross sections, and see inside of it.



After the Lattice model is authored by XVL Studio, you have options for distributing it. The good news is that all “consumption” tools from Lattice are free. Users who receive XVL model can view, measure, even cross-section it. But Lattice has so many options that it’s necessary to break down the list, as follows:

- XVL Player runs on PCs and uses your desktop Web browser as its user interface
- 3D PDF
- Webmaster publishes HTML Web pages
- Lattice3D Reporter Authoring Plug-In outputs XVL files to Excel spreadsheets
- iXVL Publisher publishes to mobile iOS devices, such as the iPad

## Q&A

### **CADdigest: MCAD systems do interference checking, so why wouldn’t users just do it there, instead of with XVL Studio?**

**Lattice Technology:** Users can do interference checking on the MCAD system, but it tends to take longer there because of the model size. In some cases, users find it impossible to load the entire assembly into the CAD package. People who do the checks tend to be downstream and so are non-CAD designers, such as people looking at how to manufacture the parts. Or, a firm might use other staff to do the checking.

Our software generates a spreadsheet report about the problems found, which include detail views of the problem area.

### **CADdigest: When a 3D model is compressed to XVL, what is lost?**

**Lattice Technology:** When XVL imports the surface geometry, the insides are lost, as is the model history. But it doesn’t lose any accuracy; tolerance is applied only to sculpted surfaces or complex fillets.

XVL is a hybrid of surface modeling and polygon modeling. It keeps inside and outside surfaces, which are needed for clash detection. The genius of XVL is how it works to keep the accuracy, yet keep the model size small.

For speed of display, Studio and Player tessellate the models visually on the fly. As you zoom in, the accuracy improves dynamically. But inside the XVL file, it does not give up the mathematical accuracy. This means that measurements and tolerances are accurate.

### **CADdigest: Who would be a competitor?**

**Lattice Technology:** Delmia and 3DVIA Composer from Dassault, JT file format from Siemens PLM, and Inventor Publisher from Autodesk.

### **CADdigest: Is small size becoming less of a concern? After all, 64-bit Windows running on today’s computers can access dozens of gigabytes of RAM, and it’s common to have Internet today that’s much faster than when XVL was invented in 1996.**

**Lattice Technology:** The more bandwidth users get, the larger the models they can make, and so compression becomes even more important. MCAD software is able to create ever larger assemblies, with vendors claiming their software can load tens or hundreds of thousands of parts.

In any case, most of the world still does not have the high speed Internet found in developed countries. XVL makes models small enough to be sent by email, which even today tends to limit attachments to 10MB; XVL files are small enough to be loaded into a Web browser through an ActiveX component, or else viewed on mobile devices.



#### **Additional Information**

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