FLAAR Reports

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Creating 3-Dimensional OBJECTS WITH INKJET PRINTHEADS?

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Contents

PRINTING 3-DIMENSIONAL OBJECTS WITH HP INKJET PRINTHEADS?

Whoa, no way! Solid, actual 3D objects created with inkjet printheads?

Not just printed on 3D objects, but actually building 3-dimensional physical objects.

But yes, several companies make printers that create objects of various sizes; they can even have moving parts. The Bowling Green State University lab has a printer, using Canon printheads, that prints three-dimensional objects up to about six inches in size (six by six by six). This is the lab of the Center for Applied Technology, the facility that also houses the FLAAR wide format inkjet evaluation center. Sebastien Dion (College of Art, BGSU) works here every day, and most nights and weekends too, creating innovative objects (and developing unusual new materials to work with as well).

These inkjet printers are normally used to create exact 3D models of machine parts, any kind of small product (cell phone parts such as the cover), body parts for medical prosthetics, and so on. Archaeologists can make scale models of ancient buildings too.

The first rapid prototyping process was stereolithography, invented by 1986. The use of inkjet printers for 3D rapid prototyping was invented by a professor at MIT in 1993, Emanuel Sachs. Prior to the invention of additive-built rapid prototyping technology, models were made by subtractive processes, cutting away at a solid block of material, often by CNC machines.

A prototype requires a 3D model using appropriate 3D solid form software. This is translated into an STL format for the actual machine to build the object, layer by layer.

The 3D object is sliced into a software that the prototyping machine can understand: STL software. Software then slices the 3D CAD image into layers. Each layer is built up by the prototyping machine. An object may have a thousand layers, or several thousand layers if larger, or if more detail is desired.

This is called solid freeform fabrication, layered manufacturing, or the most common term today, 3D rapid prototyping.

Earlier versions of a different FLAAR Report were co-authored by Jim Zubricky. This has been rewritten so many times since he graduated that the primary contribution from him are a few of his photographs. Most of the present report is based on research I did to deliver a lecture on 3D rapid prototyping at Appalachian State University. Then an even more comprehensive update came after I attended two days of RAPID (lectures, workshops, and two trade shows: 3D scanning and 3D rapid prototyping. I thank Sebastien Dion for his answers to occasional questions on 3D rapid prototyping.

GLOSSARY OF TERMS

ABS, a polymer made of three monomers: Acrylonitrile, Butadiene Styrene (K & N 2005:18).

CAD, computer aided design

CNC, computer numeric controlled

DMD, direct metal deposition

DMLS, laser sintering

EBM, electron beam melting

FDM, fused deposition modeling, uses a filament cartridge that passes through a heated extrusion head (Grimm 2005:167).

freeform fabrication is another name for rapid prototyping

layered manufacturing is another name for rapid prototyping

LOM, laminated object manufacturing, used by Solidimension and its US distributor 3D Systems

SFF, solid freeform fabrication

SLS, selective laser sintering, uses a CO2 or other appropriate laser on a special powder. This acronym is trademarked by 3D Systems. LS (laser sintering) produces material that is strong yet can be flexible, such as coiled springs.

STL software, stereolithography, the standard software for interfacing with the rapid prototyping machines.

Stereolithography (called SLA by 3D Systems), a process that uses UV light to solidify a photopolymer from a layer of resin.

Rapid Prototyping Technologies

Most of these processes are described on the website of Castle Island and their "Worldwide Guide to Rapid Prototyping."

Powder-Binder Printers (3D Printing)

Jetting a binder (glue) onto a powder with an inkjet printhead is the technology that we discuss in this FLAAR Report because the Z-Corp printer in the BGSU lab is of this technology. The focus of this report is on 3D printing technology because FLAAR's background is with inkjet printing technology since 1997.

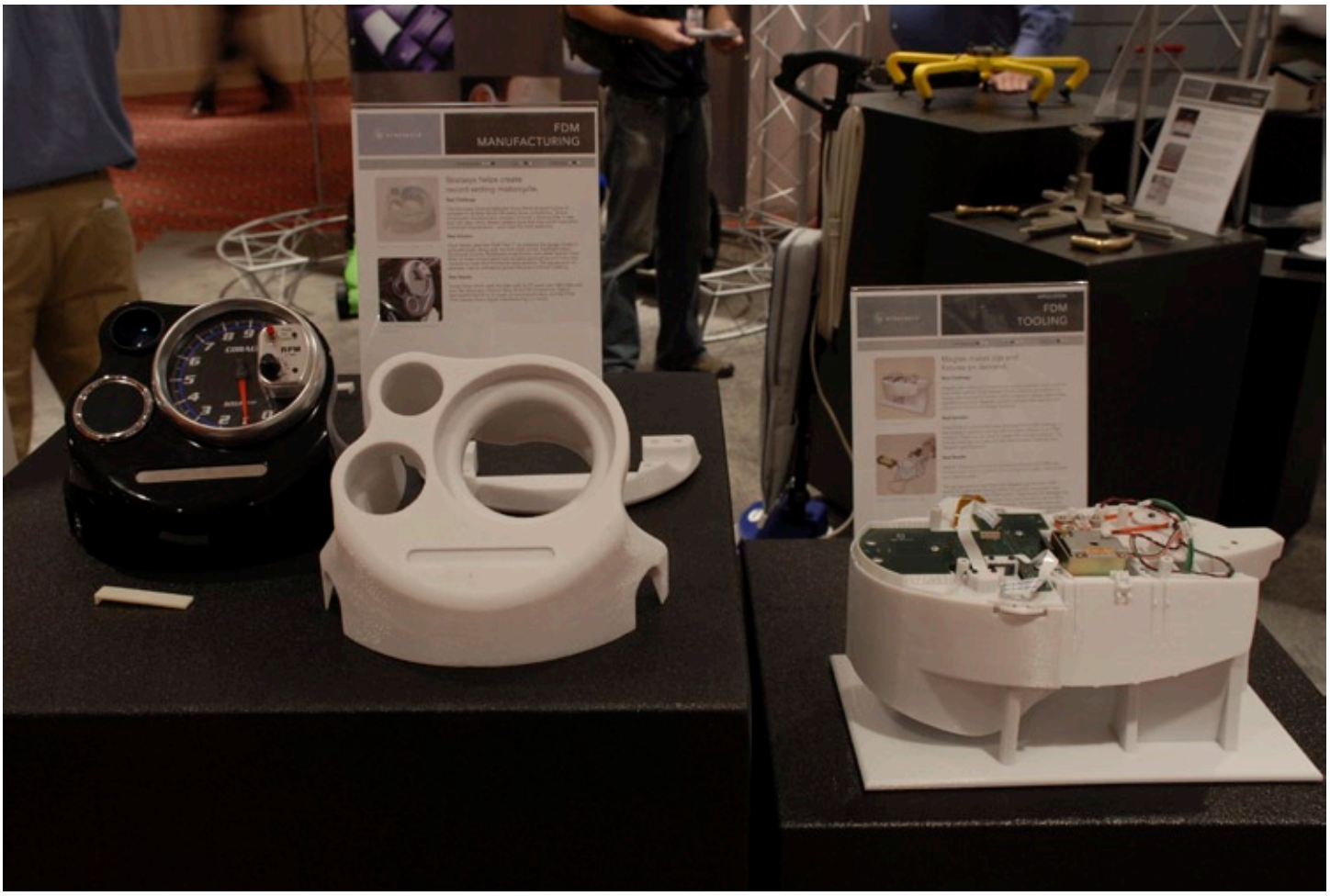
Z-Corporation samples.

Electron Beam Melting (EBM)

I did not notice this described the first time I looked at the Castle Island site. EBM is used for metal powders by the Swedish company, Arcam.

Fused Deposition Printing (FDM)

This technology uses extrusion of ABS and polycarbonate materials. Stratasys is one of the primary manufacturers.



Stratasys 3D FDM samples.

Stereolithography (SL)

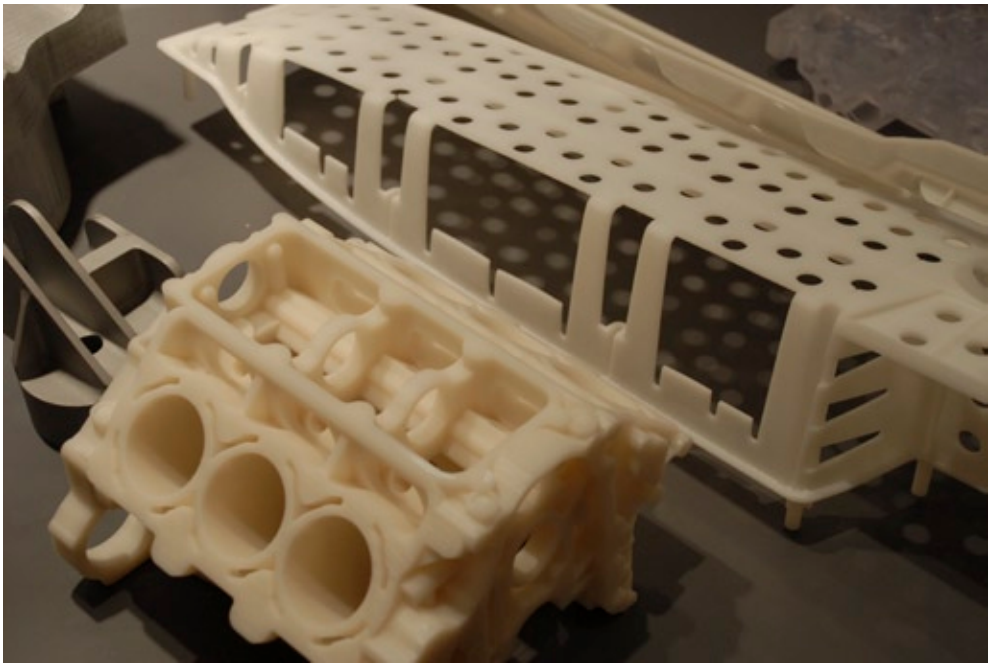
3D Systems comes from the first year of a prototype rapid prototyping machine, 1986. This company thus comes from the world of stereolithography.

Selective Laser Sintering (SLS)

3D Systems is the main company using SLS. Some of the materials can produce a flexible model.

A presentation by Graham Tromans, Loughborough University, also lists:

- Concept Modelers
- Additive Metal Processes
- Rapid Casting
- Vacuum casting



3D Systems samples.

3D Systems booth.

Materials & Sources for Materials

In the beginning materials were limited, especially for 3D printers. Now, since companies realize there is money to be made if they can produce innovative materials, a more diverse variety of materials are available. Since the long term goal is rapid manufacturing of hundreds and potentially thousands of widgets, not just rapid prototyping of a few prototypes, there is a drive towards being able to use metallic materials. So today, in 2007, there are definitely more materials than before.

We recommend you attend a combination seminar, conference, trade show such as RAPID (www.SME.org/rapid). Here you can see samples and exhibits of many of the materials, and the companies manufacturing or selling them.

Whereas plaster-like powder is the main substance used in the ZCorp printer, there are other systems which use thermoplastics which are cured into a solid by UV light or other technologies. You can find out more information about these from Stratasys, info@stratasys.com or www.Solid-scape.com.

ABS polymer is used in stereolithography, fused deposition modeling and selective laser sintering (K&N 2005:18).

Fused deposition modeling technology can also use ABS thermoplastics, as well as polycarbonate and polyphenolsulfone.

Z-Corporation 3D map sample.

Materials Used in 3D Printers: the substance that gets bound together

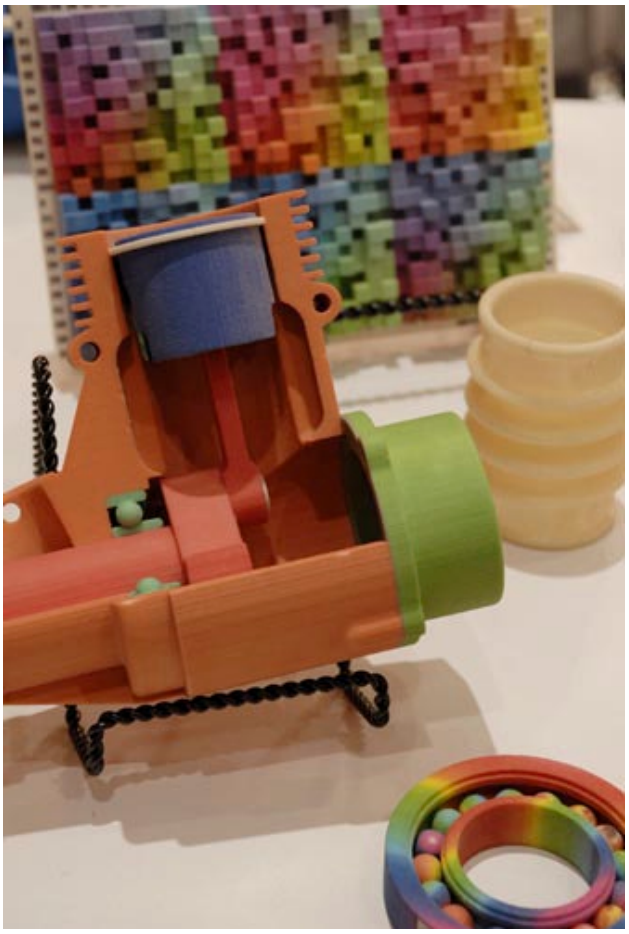
The Z Corp printer "prints" with a binder (think glue). The glue is used to hold powder in layers about .003 inch in thickness. So the model is built up with microscopic layers, one layer at a time, using CAD software.

This type of printer is called a rapid prototyper because it is used to make prototypes for future products or scale models of buildings, even entire oil refineries. The objects are fully three-dimensional, and even have all the hollow tubing and open interior spaces that the actual motor or gizmo will have once manufactured out of metal, plastics, or whatever.

The sample that always wows visitors is the ball bearing, which is fully functional: the balls inside are completely free to turn within the sealed bearing. A student created a 3D model of the main pyramid at Chichen Itza, Yucatan, Mexico. You can make chains too, with each chain fully linked to the next one, and all fully moveable.

- Plaster-based powder
- Starch-based powder
- Cellulose-based powder
- Photocurable resin (Objet Geometries)
- metals

After printing, it often helps to add additional chemicals to make the model stronger. This is called infiltration. Now (in 2007) there is a new chemical that allows you to dip your freshly built prototype in plain water, and the water reacts with the build materials to further strengthen the prototype (from a lecture given at RAPID conference, 2007, I believe by Wohlers).



Z-Corporation samples.

Flexible (Rubber-like) Materials

Objet and newer Z-Corp materials can create objects that are flexible, even rubber-like. This is a huge advantage for many types of prototypes, such as for shoe soles.

Z-Corporation samples.

The Printing Process

The best description is available from a Pennsylvania State University web site:
At least six different rapid prototyping techniques are commercially available, each with unique strengths. Because RP technologies are being increasingly used in non-prototyping applications, the techniques are often collectively referred to as solid free-form fabrication, computer automated manufacturing, or layered manufacturing. The latter term is particularly descriptive of the manufacturing process used by all commercial techniques. A software package "slices" the CAD model into a number of thin (~0.1 mm) layers, which are then built up one atop another. Rapid prototyping is an "additive" process, combining layers of paper, wax, or plastic to create a solid object. In contrast, most machining processes (milling, drilling, grinding, etc.) are "subtractive" processes that remove material from a solid block. RP's additive nature allows it to create objects with complicated internal features that cannot be manufactured by other means.

Their entire report is available from www.me.psu.edu/lamancusa/rapidpro/primer/chapter2.htm.

The model of Z Corp binder printer here at the university produces models that are monochrome (off-white). But polychrome color models are also available from Z Corp, at correspondingly multiple price.

Printing takes several hours, since the machine has to lay down thousands of fine layers of powder to build up the 3D model. So the machine is usually left to print overnight.

Ease of Use

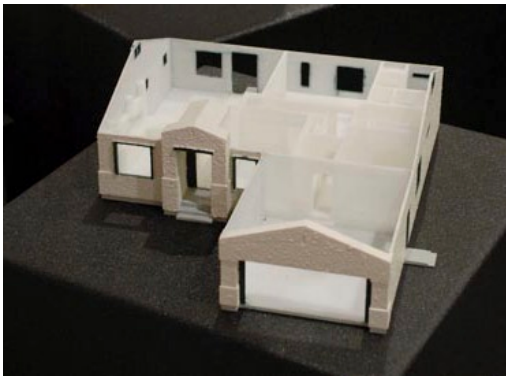
Naturally it helps to have some training from the manufacturer when the machine is installed. But from then on most employees can be trained to operate the printer. Students here at the university learned in a few hours. Obviously it helps if you are astute and interested in this sort of thing.

Finishing (Post Processing): Cleaning and Strengthening

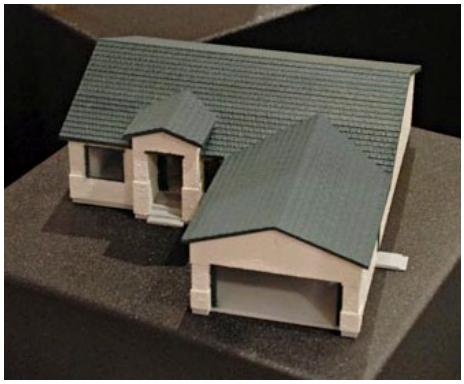
When the build is finished the automated part is over. From now on you must manually finish the object.

- Let the object cool (in some technologies)
- Remove excess material (this may be dusty when cleaning powder)
- Remove any support structures (only some technologies require supports)
- Remove any blemish caused by removing the support structures
- Adding extra binder to strengthen the object (depends on build technology)
- Improving the surface finish
- Painting the surface

Complex models can be further strengthened after they are fashioned by infiltrants such as epoxy. You just brush this on by hand after the model has been built and removed from the machine. If you can find the User Manuals on line they can explain a bit how the machine works.



Stratasys architecture sample.



Finishing (post processing).

Manufacturers of 3D Rapid Prototypers

A few of the manufacturers we found so far include:

- Arcam (uses metal to build objects)
- 3D Systems
- Buss Modeling Technology
- Objet Geometries Ltd. (www.objet.com)
- Sanders Design International (SDI)
- Solidscape
- Specific Surface Corp.
- Stratasys
- Therics
- On Demand Manufacturing
- Z (Z Corp) now owned by Contex, a scanner manufacturer in Denmark

(Technology Review, Nov. 2003, www.odm.bz/pdfs/mit_review_nov-2003.pdf). Any list this early is not reliable for year 2006 but it helps to know which companies used to exist since they are part of the history of this technology.

Some earlier companies went belly up, such as Helisys (www.me.psu.edu/lamancusa/rapidpro/). We list a few companies that did not survive in Appendix A. Its tough to do research on the Internet because you don't really know in advance whether the company that you are reading about still exists or not. This is one of several reasons why we recommend visiting an industry event, such as RAPID (trade show and conference about 3D rapid prototyping, held every year).

Other technologies exist for creating 3D parts, especially for casting metal. These you can find at www.Soligen.com

Stratasys lamp sample.

Industrial Inkjet Printers

Inkjet printers can "print" with a wide variety of materials. One unique printer is a Solder Jet (www.microfab.com/papers/ishm96/ishm96.htm). If you are curious about the complete range of industrial applications check out the IMI Conference Proceedings. It is worth noting that although it is usually piezo printheads which are used, in fact the SolderJet uses HP printheads. In other brands piezo printheads are used. But it is worth citing one comment, "The …printers are using piezoelectric operated nozzles, which repeatedly clogged and proved unreliable…" They were evidently trying to jet unusual materials from a Solid Scape Modelmaker II (report by Leroy Magwood and Thomas Boland on tissue construction using ink-jet printers).

Inkjet printheads, especially those of Xaar and Spectra, are used to jet a variety of materials: not just ink but actual substances to build electronic parts, even video monitors or the electrical circuits for FM radios. Anything that can be constructed of a liquid and built up in layers is a potential manufacturing application for an industrial inkjet.

But this particular FLAAR Report is more on rapid prototyping than just inkjet printing in deep relief. For printing low relief we have a multitude of publications on UV-curable flatbed inkjet printers.

Manufacturer by Manufacturer: 3D Rapid Prototypers

3D Systems

This company offers both stereolithography and selective laser sintering technologies. In stereolithography a UV laser causes a resin to solidify (where the light hits it, based on the CAD drawing). Some materials can be transparent. Or you can select a white material. Their range of equipment includes:

- Sinterstation H1Q
- Viper
- Viper Pro

A reasonably priced desktop unit is now available.

DTM Systems, owned by 3D Systems, uses selective laser sintering. There the laser is CO2 whose heat fuses a powder. (Grimm 2005:163).

www.3dsystems.com

Desktop Factory

At present (summer 2007) this is still a start-up, with a concept for building a RP machine for under $5000. They have yet to ship a machine, and the machine is not yet proven in the real world. We hope they succeed and will report back once their product is realistic and has survived it's first bumps after birth.

Dimension Printing

The brand name of Stratasys is an abbreviation for Strata Systems. Stratasys could be considered one company makes two lines of products. At trade shows they even have two completely separate booths: one booth for Dimension; a separate booth for Stratasys itself. Their entry level (actually far more sophisticated than entry level) is called Dimension.

The following models were available in September 2006.

- Dimension BST 768, $18,900, creates 8 x 8 x 12 inches
- Dimension BST 1200, $21,900
- Dimension SST 768, $24,900
- Dimension SST 1200, $29,900, creates 10 x 10 x 12 inches

Check to be sure prices have not changed. These or comparable models are still available in 2007. New for 2007 is the

Dimension Elite 3D Printer.

A nice aspect of the Dimension system is that you can buy the rolls of material in

- Green
- Yellow
- Black
- gray
- Red
- Blue
- green
- white

But no brown or orange. But you can always paint the prototype, or apply "vacuum metalicized" that looks absolutely beautiful

These 3D printers use ABS plastic in filiment form. It looks like single-wire electrical wiring (comparable coil that its delivered in, same diameter and feel. The Stratasys website points out that this ABS plastic can subsequently be sanded, milled, drilled, painted, and even electro-plates. You can't easily drill some of the materials printed with some other simpler brands; they would break apart. You can paint almost all of them, but sanding and milling would be too much for some materials from other systems. ABS plastic prototypes can also be cleaned with water.

Stratasys uses FDM technology: Fused Deposition Modeling. They hold the patent on this technology.

Stratasys also used to be the distributor in the US for the machines of companies from other countries (that use technologies other than fused deposition modeling). Stratasys distributed machines from Objet Geometries (from Israel) in the US from 2003 until the end of 2006. Objet now has their own office in the US.

www.stratasys.com and www.dimensionprinting.com.

Envisiontec

This is an additional 3D rapid prototyping company that is German (EOS is another). Perfactory is the name of the Envisiontec model. They list medical and dental as their main applications, though their web site shows diverse other kinds of mechanical prototypes.

www.envisiontec.de

EOS

EOS Electro Optical Systems (EOS GmbH), is a German company with offices in the US and several other countries. They offer laser-sintering systems.

- EOSINT P 730
- EOSINT P 390
- Formiga P 100

www.eos.info

Next Factory

This company makes rapid prototypes for the jewelry industry that require a relatively small machine.

Objet Geometries Ltd

What most impressed me about the results of their technologies is that the objects can be flexed. So you can build the sole of a shoe. This is because the build material is a polymer that is cured with UV lamps. The machines are named Eden.

I am personally interested in the printers from Objet Geometries because they use piezo printheads and feature UV-curing: just like UV-cured wide-format flatbed inkjet printers. I first learned about this company at an IMI conference where the printhead manufacturer displayed some prototypes built with an Objet system.

Objet originally sold through Stratasys in America, but as of 2007, Objet (an Israeli company) is now opening their own office in the US. Their demo center is in Boston.

The two main models for 2007 are the Eden250 and the Eden500V.

www.objet.com

Solidscape

The Holy Grail of some 3D RP manufacturers is to have a simple desktop unit that a normal person can operate without long training. So some of the Solidscape systems are desktop sized.

Solidscape sued Sanders Design International in 2004, and seems to have won the first round. Solidscape was formerly Sanders Prototype Inc. This is not the same Sanders as STI or Sanders Associates; indeed those confusions alone are valid reasons to have changed their name to Solidscape.

At RAPID 2007 Solidscape featured its desktop machines for making jewelry prototypes such as their model R66.

www.solid-scape.com

Stratasys

They had a large attractive booth at RAPID 2007, with helpful staff. But no brochures (they said too many people pick them up and then discard them). But, with no old-fashioned paper brochures, we don't have the information we need to write about these printers.

So as soon as it is possible to visit their headquarters in Eden Prairie or get some brochures, we will update this section. In the meantime, we have more information on the other brands that had brochures at the trade show in 2007.

Stratasys booth.

Z Corporation

The machines we know the best come from Z Corp, since that is the brand in the BGSU Center for Applied Technology lab. Z Corp is a large and growing company, especially since it was purchased by a Danish company that also owns Contex sheet-fed laser manufacturing company.

Several models are available (some of these are retired now, as the newer models replace them), $19,900.

- Zprinter 310 System, 8 x 10 x 8 inches, accepts files in the following formats:
  - STL
  - VRML
  - ZCP
  - PLY formats
    The current model (2007) is the 310 Plus.

- Z406 System, accepts files in the following formats:
  - STL
  - VRML
  - PLY
  - SFX files

- Z810 System, color system.

- Zcast Direct metal Casting: you make the molds with a plaster-ceramic composite which can function as the mold.

- ZPrinter 450, color (current model, 2007), creates 8 x 10 x 8" prototypes, $39,900.

- Spectrum Z510, color (current model, 2007), builds 10 x 14 x 8", $49,900.

All Z machines use basic printheads, essentially the same printheads used in inkjet printers. Other brands of printers may use more industrial piezo heads. Rarely is the brand or model of printhead mentioned. But when you ask most of the staff can identify the brand name, in this case HP.

The newer models are significant improvements in user-friendliness, such as "snap-in" cartridges of the binder material. The availability of color is a huge plus, especially for doing architectural models.

The new models are enclosed, so are much cleaner for the office environment. Older models required spooning or otherwise adding and subtracting powder and left a powder film over the entire office within a ten foot radius (not to mention what got into the air and circulated everywhere else).

The newer Z Corporation ZPrinter 450 is under a vacuum and is sealed with a lid, so you don't have fine white powder everywhere.

The architectural models produced with the ZPrinter and Spectrum Z510 are very attractive.

There are several things I like about ZCorp products: first, you can create images in color. Second, ZCorp now also makes 3D scanners. FLAAR is extremely interested in 3D scanners for cultural heritage preservation. FLAAR has worked on Maya archaeological projects in Guatemala and adjacent countries since the 1960's. So we have a natural interest in 3D scanning of artifacts.

Plus, FLAAR has been doing research on cacao and other indigenous plant species for the last several years. There are several distinct species of cacao which you can notice when you compare their external seed pods next to each other. One thousand years ago the Classic Maya made copies of each species of cacao pod in ceramic, at 1:1 size (as a drinking cup, to drink cacao beverage out of a ceramic cacao cup in the shape of a cacao pod). So we would like to be able to scan actual cacao pods, then scan the thousand-year old ceramic effigy cups, and compare them. FLAAR has two botanists on staff in-house as well as two archaeologists, and several photographers. Thus you can understand our interest in both 3D scanning and 3D prototyping.

Since ZCorp is, so far, the first company to offer full-color 3D prototyping machines, you might wish to contact them yourself, directly:

Andy DeHart, Vice President of Sales - Americas
Z Corporation, 32 Second Avenue, Burlington, MA, 01803, USA
Phone: +1 262 377-3438, Fax: +1 781 852 5100
Email: adehart@zcorp.com

www.zcorp.com

Summary on Systems Manufacturers

The thrust today is creating 3D rapid prototypers that fit comfortably into a normal office, so that anyone and everyone can do 3D rapid prototypying in their own company. This is a huge potential market.

Then there are thousands of universities and community colleges that should be considering acquiring a 3D rapid prototyper. Every department will have different needs: for some a small desktop machine that can do jewelry would be ideal. For technology departments they should consider a more elaborate laser sintering machine. Architects might like the Stratasys, Objet or Zcorp systems.

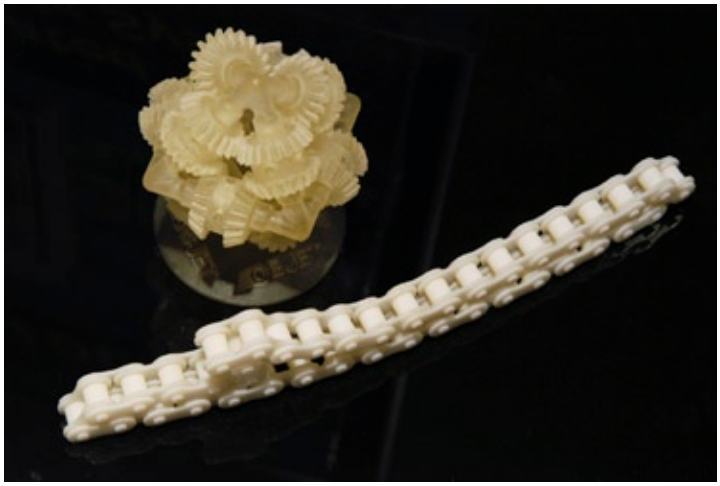
Here is our summary of the principal manufacturers as we enter 2007. I have featured here the systems which most interest me personally and professionally. My person interests are primarily in creating architectural models and recreating artifacts (pre-Columbian Mayan art of Guatemala, Belize, etc).

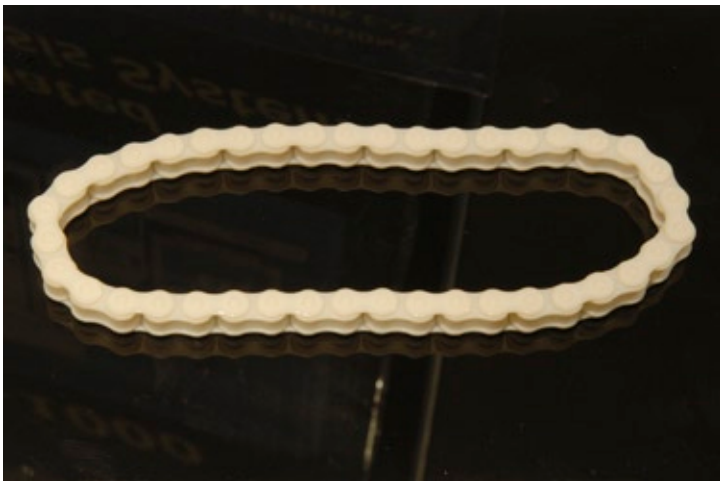
	Technology	Materials	Special capabilities
3D Systems	SLS, selective laser sintering,		Parts may be flexible (rubber-like), if desired
Arcam	EBM, electron beam melting	metal powders	
Dimension	FDM, Fused Deposition Modeling	ABS plastic, some materials come in colors	Related to Stratasys
EOS	DMLS, laser sintering	Stainless steel, cobalt chrome, titanium	
Objet Geometries	3D printer using printheads		
Stratasys	FDM, Fused Deposition Modeling	ABS	Dimension is their entry level system.
Z Corp	3D printer using printheads	powders	Most models can build in colors

List of Printheads used in 3D Printers

Only some of the 3D technologies use inkjet printheads, powder-binder printers being the main one. The printheads used can be either thermal or piezo.

- Canon thermal printheads, "Bubblejet" are used buy older Z-Corp printers.
- HP thermal printheads are now used by the newer Z-Corp printers.
- Piezo-electric printheads by Ricoh are used by Objet Geometries.





3D models of Ricoh and Konica Minolta printheads at IMI, Lisbon '05.

Colors

Several models from Z Corp can print in multiple colors, just like a regular inkjet printer (indeed the new Z Corp machines use HP printheads). But most systems are monochrome. Those that can print in color can do only one color at a time (Dimension is one example). But you can also paint or otherwise coat the prototype after it is built.

Some prototypes are best if transparent, so you can see inside, especially if you need to run liquids through them. 3D Systems makes such printers and appropriate materials.

Z Corp can print in multiple colors.

Practical Applications

The applications are endless and depend somewhat on the material used (powder or plastics, inkjet or UV-cured).

- Cartographers can create relief maps, both to show relief in 3D but also so blind people can read with tactile help.
- Medical applications are becoming useful, such as orthopedic implants.
- Machine parts, car parts, the list goes on and on.
- You can "print" almost anything that you can create in a CAD program.

Go to www.google.com, type in 3D rapid prototype applications and you get enough to keep you reading for hours.

Benefits of additive build over machining a prototype (subtractive)

A rapid prototyping machine can run on its own, with no operator needed, overnight.

With cutting tools you have limitations of the complexity of an object or details, since not all tools can work at all angles inside a complex design.

Machining tools require experienced operators, where as some of the rapid prototyping machines require only basic training in the machine operation itself.

Nonetheless, Matthew Frank has an entire chapter on how a CNC milling machine can indeed be used as a rapid prototyper (K&N 2005:165-196). Todd Grimm also provides an entire chapter on comparing CNC machines with rapid prototyping build machines. Callicott provides five or six chapters on CNC machines. Numerically controlled machine tools were developed by the end of the 1950's; computers came into play during the 1970's.

Benefits of doing traditional machining (with a CNC machine)

Subtractive processes can use more durable materials, larger sizes, and can obtain a better surface finish (Narain and Sarkis in K&N 2005).

CNC milling may be more accurate for certain shapes.

You can machine parts made of materials that may better approximate the final product.

Multiple reproductions of the same object are more repeatable on a CNC machine than on an RP machine (Grimm p. 148).

Objects produced with CNC machines do not tend to need extensive finishing.

Issues and Limitations of 3D rapid prototypers

Surface texture may be rough, and surface texture may depend on what part of the structure the surface is facing.

Since the structures are built in layers, the resultant object will reveal the pile of layers at the outside, so you may not always get a perfectly smooth-surfaced shape.

Some of the materials are not particularly strong and not all the materials can be sanded, drilled, or worked with tools.

Sometimes the prototype is stronger in one dimension than in the other dimension.

The rapid prototype object will usually not be in the same or even similar material to the original or final intent.

Deformation (including slight shrinkage) of some materials in some shapes may occur due to temperature or other factors.

Prototypes tend to be in one color, even though ZCorp does make a model that can print in colors.

So far have not seen or heard a peep about the need for ventilation or protection of the operator from breathing the dust (from 3D printers) or other powders or fumes that result from fusing, melting, etc. The machine at our university is the largest producer of white powder dust in the building (mostly from handling the powder by the operator).

Some materials and some technologies require support structures to hold up delicate parts during construction. These can be removed, but that's one more step in the workflow. And you may have to sand down or otherwise remove the stub of the support where it touches the prototype.

It is natural for every process to have benefits and then some aspects that need to be taken care of. But as these products are marketed more and more for normal office environments, the need for ventilation and protecting the health of workers is cheaper to do up front in advance. We find that the benefits of the new rapid prototyping technologies are impressive, but just be sure to adequately plan to provide modest ventilation. For example we would tend to use an air purifier from Island Clean Air for almost any installation (especially for using wide-format inkjet printers that use any ink besides water-based ink). It would be worthwhile to test comparable charcoal filtering air systems in the proximity to 3D rapid prototypers.

Applications in Art

Innovative universities are incorporating 3D prototypers in their courses. http://artandtech.osu.edu/452/felice/index.htm is one example.

The University of Arizona School of Art offers a "Digital 3D Modeling and Rendering" course. What I like about this course is that it also addresses the need to learn about 3D scanning: http://web.cfa.arizona.edu/art437a/index.php

Potential Applications in Archaeology

Since my background is in archaeology, art history, and architectural history, my interest in 3D prototyping is considerable. Just quickly I can already envision a multitude of uses:

- Physical anthropologists can reconstruct body parts or reproduce body parts
- Curators and archaeologists can recreate artifacts for traveling shows (and thus protect the original).
- Curators and archaeologists can show what a fragment would have looked like a thousand years ago when it was complete
- Architectural historians can recreate ancient buildings in 3D (now even in full color)

3D model of pyramid at Chichen Itza.

Be intelligent when making a buying decision

For nine years we have evaluated printers in order to assist individuals and companies figure out which printers they should consider. We can use this considerable experience to assist companies in deciding which 3D rapid prototyper to select.

First step, research so you know what technology you need. With traditional printing it can be laser toner, inkjet, offset, etc. Within inkjet there are more than 7 completely different families of ink types of ink chemistry. The same is true with rapid prototyping.

Second, concurrent step as part of research, be sure of what you want to achieve and what your clients are willing to pay for.

Third, check out each machine on your short list, start by going to a trade show.

Fourth, once you have narrowed your short list down to two or three brands, find a company that actually owns and uses one, visit them, and learn whether this make and model is good, average, a headache.

Fifth, with your final short list, visit the manufacturer's headquarters or main demo room.

Trade Shows: Where to see 3D Rapid Prototyping Machines

The first two steps, research, has landed you in this FLAAR Report and that in turn provides a general introduction and a good list of further suggested reading to get you started. Now comes the trade show visit part.

Sign Madrid 2006 (Viscom, Reed Exhibitions) had the full-color Z-Corp machine on display.

FESPA Digital, 2006, had a full-color Z-Corp machine on display by students of a FESPA-related association in the Balkans area.

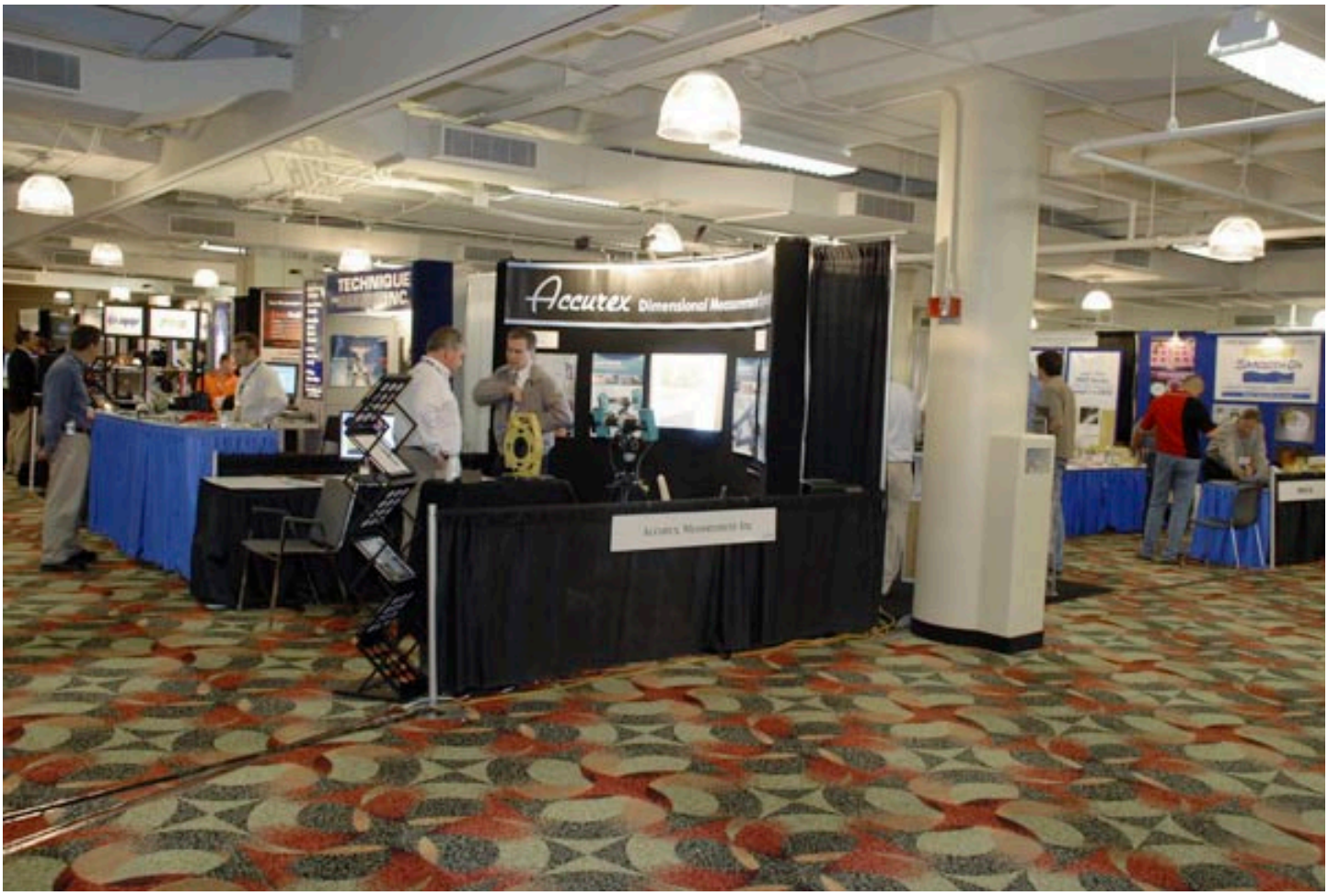
I do not often see any 3D Rapid Prototypes at SGIA, ISA or other signage or general digital printing shows. To really see a lot of these machines you need to go to the specialized events such as Rapid 2007, a conference with an exhibit. This is organized by the Society of Manufacturing Engineers, www.sme.org/rapid. Their next show is May 1-3, 2007, in Detroit. The following companies are exhibiting; they may be considered a who's who of 3D rapid prototyping.

- 3D Systems
- Arcam AB
- Envisiontec
- EOS
- Objet Geometries Ltd. (www.objet.com)
- Roland ASD Corp
- Solidscape
- Stratasys
- Z (Z Corporation)

Materials exhibited
- DSM Somos
- Sanyo Chemical Industries LTD
- Shin-Etsu Silicones of America
- Silicones Inc
- ThyssenKrupp Materials

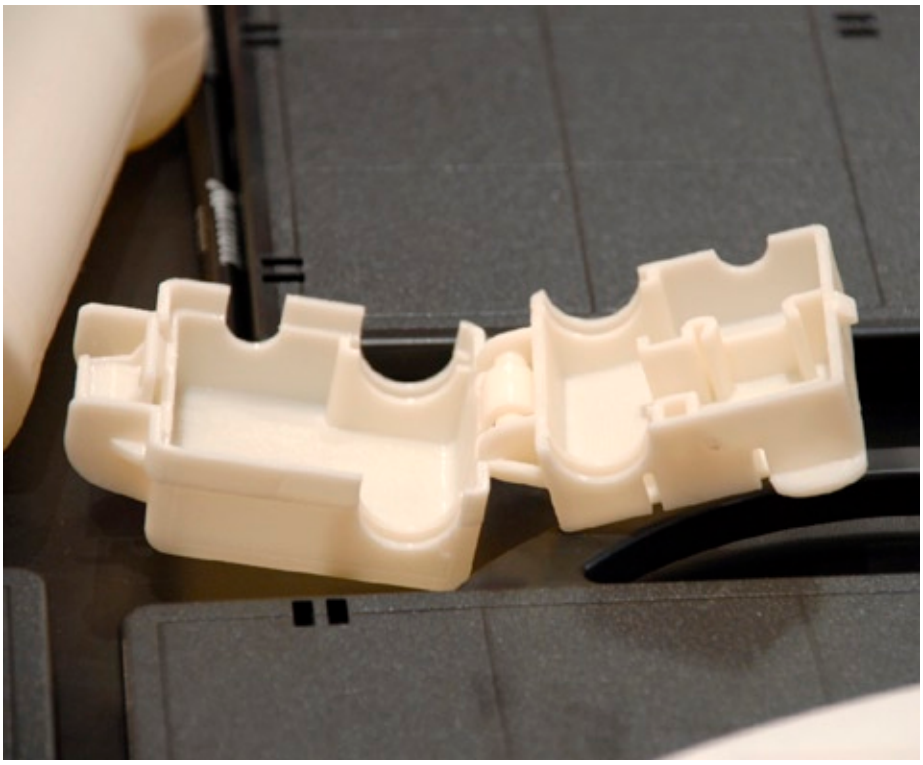
The following companies are not listed as exhibitors under their names:
- Neither ODM nor RMB
- Specific Surface Corp.
- Therics

SIGGRAPH is another trade show where you can see 3D rapid prototyping equipment and processes, http://www.siggraph.org/
- 3D Systems
- Dimension 3D Printing (part of Stratasys)
- Objet Geometries Ltd
- Solidscape
- Z Corporation



RAPID trade show.

Dimension 3D RP machine and samples.



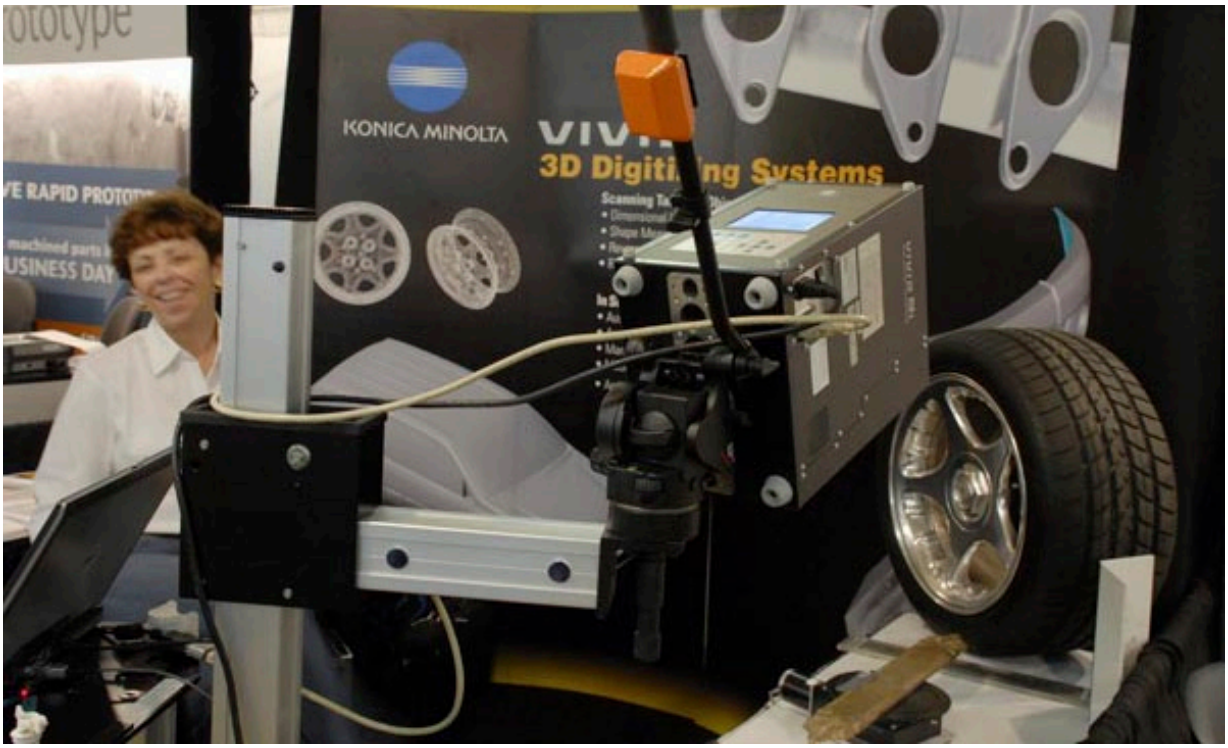
Dimension 3D RP sample.

Roland booth.

Roland Picza 3D scanner.

Faro 3D scanner and booth.

Metris 3D scanner and booth.



Minolta 3D scanner and booth.

Minolta Vivid 9i.

Objet Geometries booth.

RAPID 3D Dimension booth.

Site-Visit Case Study

In the world of wide-format inkjet printing, the president of one printer company said of the advertisements for these products, "they are all lying."

Another industry person, a high-ranking manager of another inkjet printer company said "most advertisements are lies and deceits." Fortunately, a few companies such as Mimaki have honest advertising, but otherwise you get the point. To be polite we call the average advertisement "misleading."

Since FLAAR does not sell printers or 3D rapid prototypers, we can be honest when we discuss the pros and cons of any given make or model. But another good way to lean about the truth of a particular machine is to visit a place that already has one installed. It helps if it has been there several months.

Once you visit an installation you will quickly notice the difference between real life and a canned Success Story. Success Stories are the things that are handed out at trade shows and downloaded at the manufacturer's web sites. In the world of UV-cured inkjet printers, it would be a challenge to find a single success story in a trade magazine that lists the significant glitches, issues, and shortcomings of any printer. When I visit an actual print shop with the same machine, I hear the painful details of what fails, breaks down, or otherwise causes loss of productivity. Nary a word of that in a Success Story.

I will take an educated guess that as soon as I start doing site-visit case studies of 3D rapid prototypers, that a similar pattern will develop: one or two brands and models will be actually better than the success story says. Most models will be okay in real life but do have an occasional glitch which is not listed in the Success Story. A few machines will be horror stories.

It is worth noting, however, that just because a product has a few issues is no reason not to buy it. Everything in life has good features and a few weaknesses (like us, our spouse, some of our children or siblings, etc). You do your best to work around the occasional issue, but it does help to know potential problems in advance.

Factory Visit

FLAAR undertakes factory visits whenever and wherever possible. One reason we suggest a factory visit after a site-visit is because the problems you see at a site-visit may be because of

- Operator unfamiliarity with the nuances of the hardware or software.
- There may be a new model that will overcome the issues of the model you saw.
- Or the particular machine that you saw may have been damaged or "made on Monday".

We have a separate FLAAR Report on factory visits. These visits are primarily to manufacturers of UV-curable inkjet printer companies, but the gist is the same for visiting the demo room or factory of a 3D rapid prototyping machine.

It was possible to visit the world headquarters of Objet Geometries while in Israel during 2007, but it was a brief visit; there was no time to have full-scale product demos nor to print any samples from the FLAAR archives.

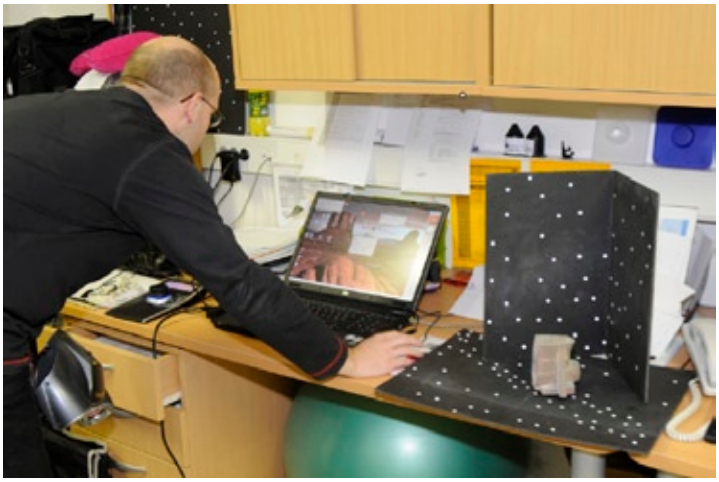
Alternative Shortcuts to making a decision

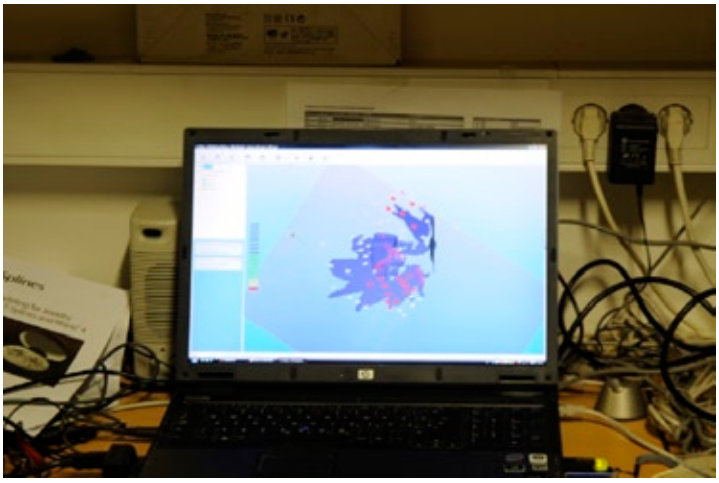
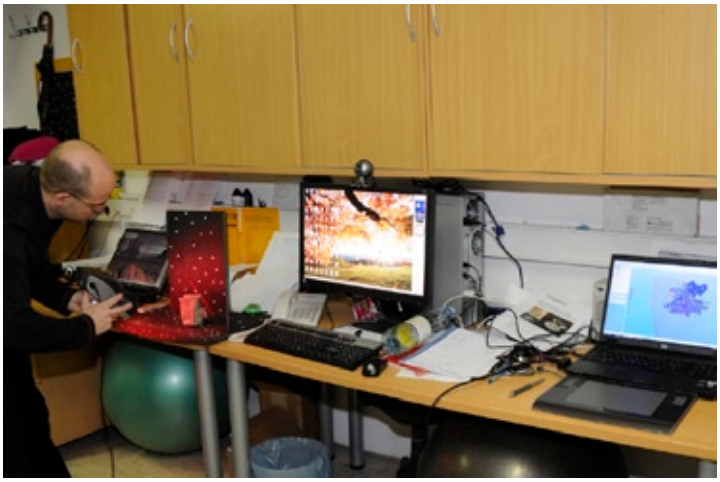
In most cases busy companies don't have the time to go around to site-visits, factory visits. Some don't even have the time to visit key trade shows. That's why Fortune 500 companies and architects and engineering companies all over the world come to FLAAR to seek our help. So far we cover

- Large format digital cameras, 48 to 80 megapixels (yes they do exist and we have them in our testing facilities)
- Medium format digital cameras, 22-39 megapixels
- 35mm digital SLR; we evaluate only the better ones, 10-17 megapixels
- scanners; we evaluate only the ones of true professional quality
- water-based inkjet printers, 17" and wider, up to 72 inches (we have 27 of these printers in our testing facilities so far)
- solvent-based inkjet printers (54" up to 5 meters in width)
- UV-cured inkjet printers (1 to 5 meters in width)

You can find all our FLAAR Reports on www.wide-format-printers.NET.

We are considering moving into evaluating 3D rapid prototyping equipment. This introductory report is our first step. Our second step was visiting the international headquarters of Objet Geometries in Israel (summer 2007). Our third step has been to make several visits to the leading European center of 3D rapid prototyping, namely IB-ProCADD in Ljubljana, Slovenia. For 2009 we are planning a training session at ZCorp headquarters near Boston, Massachusetts.



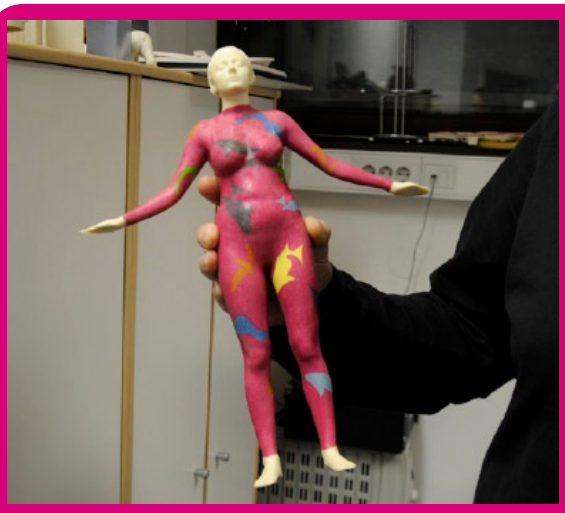

ZS Scanner 700 at IB ProCADD, at Slovenia.

Book scanner

Z Printer 450

Vacum Machine

Contex 3D printer



3D Samples at IB ProCADD

Summary

Rapid prototyping is the creation of three-dimensional objects layer by layer using resins, powders, and other materials. Rapid prototyping builds up the object layer by layer, following a 3D CAD software image translated into the computer language currently accepted by the industry, namely STL.

The books that I have found the most useful are those that describe each process, and then show a test product prototyped on each of several systems. The pros and cons of each RP technology are then clearly evident.

Like every process or technology, there are good features as well as issues or deficiencies. For rapid prototyping technologies, the down sides are surface finish, color (or lack thereof), and the limited kinds of materials that can be used.

It is precisely to improve the kinds of materials used where most research is taking place, including at Bowling Green State University, College of Technology (Sebastien Dion, College of Art is doing all the work). But as this project is under NDA, it cannot yet be discussed.

You can buy and operate your own RP machine or you can send your job to a commercial service bureau that will do your part for you.

Bibliography: Books & Reports

Considering this is almost a billion dollar industry, it is surprising there are not more books with recent publication dates, and so far not much from 2007. But you can catch up with additional material from the Internet; we list key web sites after this list of books.

CALLICOTT, Nick
2001 Computer-Aided Manufacture in Architecture: The Pursuit of Novelty. Architectural Press, Oxford, Boston, etc.

This book is mistakenly titled; the book has effectively nothing to do with architecture. And it is more on rapid prototyping than on computer-aided manufacturing. The title is misleading advertising. Worse, it is really a history of industrialization. There is, however, a useful two chapters on CNC machines.

COOPER, Kenneth G.
2001 Rapid Prototyping Technology: Selection and Application. Marcel Dekker, Inc, New York and Basel.

A useful book, albeit considerably dated. For example, the technology used by Objet was so new in 2000 that although it was listed the full implications were not yet known at the date the book was written. Most books are researched and written at least one year before they eventually get published.

GIBSON, Ian, editor
2002 Software Solutions for Rapid Prototyping. Professional Engineering Publishing.

This is an edited book of contributions from a workshop. Although I enjoyed reading through the book, the contributions vary from too technical for a general reader to slightly off the subject. But if you are a student taking a course or, like me, a professor doing research, it is worth perusing the book. But it is not a book I would buy to keep. Besides, a book published in 2002 was written in 2001 and this is not up to date in 2006.

GRIMM, Todd
2004 User's Guide to Rapid Prototyping. Society of Manufacturing Engineers.

Even though the Todd Grimm book is now several years old, it is the best of the books from those years. Most of what is discussed is still valid today. He is a popular speaker at RAPID (conference, seminars, and trade show of 3D rapid prototyping and 3D scanning) associated with the Society of Manufacturing Engineers.

KAMRANI, Ali K. and Emad Abouel NASR, editors
2006 Rapid Prototyping: Theory and Practice. Springer.

The book is unclear of whether it was published in 2005 or 2006. Both dates are in the front matter, so I would guess the book is 2005 which means it is based on research and material of 2004-2005.

WOHLERS, Terry
2006 Wohlers Report 2006.

Costing $475, this is an industry bible. Being a non-profit institute our budget does not allow purchasing books at commercial prices, but from the list of contents I would judge that this publication is worthwhile.

WOHLERS, Terry
2007 Wohlers Report 2007: Executive Summary.

The Executive Summary (8 pages) is handed out free at conferences such as RAPID. The fully report (below) is 220 pages.

WOHLERS, Terry
2007b Wohlers Report 2007: Executive Summary.

This report is available updated every year.

Universities with Significant 3D Rapid Prototyping Programs

Georgia Institute of Technology

Milwaukee School of Engineering

University of Utah, http://home.utah.edu/~asn8200/rapid.html, outstanding links.

Virginia Tech

York Technical College (associated with 3D Systems.

Unfortunately BGSU, as an overall university, is not dedicated to research and publications (other than in aspiration); BGSU is primarily a college for undergraduate teaching. In this it does a good job.

Plus several universities in the UK, including

University of Warwick and many others.

Bibliography: Sources & Resources on the Internet

You could easily spend weeks on the Internet reading information about rapid prototyping. Here are a few of the web sites that you can look at.

Since web sites, and individual pages, come and go, naturally a few of these may be dead links and other newer sites will be developing elsewhere. Nonetheless, this list will save you hours; actually we spent several days tracking down the best articles while preparing to lecture on this subject at Appalachian State University in their technology courses. [1]

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[1]We were at this university to lecture primarily on wide-format inkjet printing on thick and rigid architectural materials such as concrete, glass, wood, floor tiles, etc. The two days of lectures also included discussions of circumferential photography, which unrolls the circumference of a cylindrical object (we do it to photograph the paintings and incised scenes on 7th century Maya funerary vases of Guatemala and Honduras).

The search keywords are relatively obvious. A less obvious one is nonetheless specially valid, namely Emanuel Sachs whose patents at MIT got a lot of rapid prototyping started. Many of the companies making systems today license MIT patents.

www.alphaprototypes.com
A service bureau, but they provide basic information about the processes.

www.answers.com/topic/3d-printing
Brief, illustrated, informative.

www.bathsheba.com
3-dimensional geometric art created with a rapid prototyper.

www.cadalyst.com
The manufacturing section of the Cadalyst magazine web site has helpful information on 3D rapid prototyping, including articles by Mike Hudspeth, IDSA.

www.designnews.com/article/CA6282013.html
Brief comparison of 3D Systems, Z Corp and Stratasys.

www.deskeng.com/articles/01/mar/cover/index.htm
Has helpful information, list of companies that make 3D equipment, and downloadable PDFs.

www.digimorph.org/resources/3dprinting.phtml
Three dimensional printing for paleontology at University of Texas.

http://herobuilders.com/PROTOTYPES/
Albeit a commercial site, this page has tidbits of information that is useful, sort of like a glossary.

http://home.utah.edu/~asn8200/rapid.html
Comprehensive set of links. Like all other such lists of links, many are obsolete, but the ones that are still active are worth looking at.

www.mne.psu.edu/lamancusa/rapidpro/
Brief description of the various machines this university institute has used.

www.mne.psu.edu/lamancusa/rapidpro/primer/chapter2.htm
"Rapid Prototyping Primer," by William Palm (1998) updated 2002. So far this is the best, most comprehensive, and most understandable-for-the-layperson report that we have found. Another nice feature of this particular primer is that it has nice illustrations.

www-rp.me.vt.edu/bohn/RP.html
Dates back to 1997, but still has lots of information. Lists courses, books, journals (albeit dated to 1997, but it gets you started, and allows you to realize how much of this was available in the previous millennium). Although the URL has an unusual start, that's actually the URL.

www.plasticstechnology.com/articles/200408cu3.html
Informative article on rapid prototyping equipment.

www.sldtech.com/zcorp.htm
Like most of the material on the Internet, this is a PR release or an advertisement. Nonetheless, you can still learn from some of the moderate PR releases.

www.SME.org/rapid
Society of Manufacturing Engineers has an official publication, Time-Compression Technologies, and an annual conference with trade show, "RAPID."

www.tagrimm.com/information/articles.html
A list of articles available for download.

You can find countless pages on google.com if you do a search for ink-jet printers 3-D tissue construction. Vary the search by spelling it inkjet and 3D instead of ink-jet and 3-D. The amount of material is endless if you search for the proper keywords. Obviously if you search for rapid prototyping you get enough reading material to keep you busy for days and days.

Appendix A

Manufacturers that are not as active any more (most are inactive)

Buss Modeling Technology

BMT was a German company still active in 2001. Their goal was to make a desktop-sized machine. But they were sued for patent infringement by both Z Corp and MIT; BMT lost in 2002.

Sanders Design International (SDI)

Their rather informal web site does not list any 3D prototyping equipment, probably because they were successfully sued by Solidscape recently. Another partner of Sanders, BMT, were sued by MIT and Z Corp. So SDI got hit rather hard.

Therics

This company prints in 3-D to create replacement bones for medical purposes. So their 3-D machine is rather specialized for these purposes.

www.therics.com

Appendix B

Companies in Transition

On Demand Manufacturing

ODM uses selective laser sintering technology. ODM was a subsidiary of Boeing (aircraft). ODM was recently bought by RMB Products.

www.odm.bz is now part of www.rmb.com

Specific Surface Corp.

This company specializes in making filters for cleaning up diesel exhaust, and other niche applications. Most of the dates on their web site are 1998; the most recent I could find easily was 2000. Their web page was updated in 2004.

www.specificsurface.com

Most recently updated May 09
Updated December 2008 after visiting IB ProCADD in Slovenia.

First issued February 2004. Updated March 2004. Substantially updated September 2006. Updated February 2007 with major updates May 2007. Updated June 2007.

These reports on RIP software and Color Management for serious UV printers are free downloads on all FLAAR web sites (follow the link to 'free downloads') http://www.wide-format-printers.net/reviews_reports_evaluations/free_download.php

RIP, COLOR MANAGEMENT, and ICC Color Profiles options

Once you have a serious UV-curable wide-format printer, you may prefer to have an equally serious RIP software and color management equipment.

The RIP software for simple water-based printers such as Canon, Epson, and HP may not be the same RIP software that could be most effective and productive on a UV-curable flatbed or UV-cured roll-to-roll production printer.

I first noticed Caldera RIP on Gandinnovations UV printers several years ago, then I saw Caldera being used at the Mutoh Europe factory demo room in Belgium.

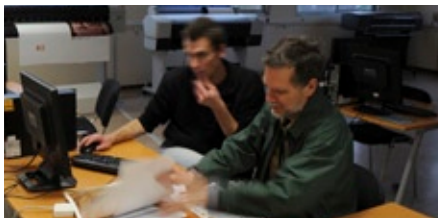
When I was visiting the Durst factories in Europe I again noticed that they were using Caldera RIP software.

So I requested access from Caldera so I could visit their world headquarters in Strasbourg, France, to spend several days learning more about their RIP. As a result there is now a FLAAR Report photo essay on this software.

Most recently I have seen Caldera RIP at the Shanghai printer trade show in China, at DRUPA in Germany, at FESPA DIgital in Geneva, SGIA '08 and Viscom Italy '08.

When I visited a large printshop in Maribor, northern Slovenia, they were using Caldera RIP and the manager of technical services for this company said, "*Caldera does a good job*." This company in Slovenia has about eight UV printers (about five of them from Durst) and an equal number of large solvent printers. They originally used a GretagMacbeth color management system but switched to BARBIERI because the BARBIERI spectrophotometer can read more efficiently and can handle textiles, backlit, wood and other materials that are either awkward or difficult on other brands of color management instruments. You can learn about the BARBIERI equipment either from their headquarters in Brixen or their distributors worldwide.

Caldera also offers a highly regarded spectrophotometer from Barbieri, the leading color management company in Italy (they are headquartered in the same city as Durst, the manufacturer of Rho UV-cured printers).



For further information on Caldera contact Joseph MERGUI
mergui@caldera.fr
If you have questions about color management, if you are in the US you can contact: ImageTech at:
www.ImageTechDigital.com
Mark Spandorf (owner and president), mark@imagetechdigital.com
or 510 238-8905.
If you are in Europe or the rest of the world you can contact **BARBIERI** directly at: BARBIERI electronic snc,
info@BARBIERIelectronic.com
www.BARBIERIelectronic.com
Tel.: +39 0472 834 024
Fax: +39 0472 833 845

Reality Check

Being a university professor for many years does not mean we know everything. But intellectual curiosity often leads us to enter areas that are new to us. So we do not shirk from entering areas where we are obviously not yet expert. If in your years of wide format printing experience have encountered results different that ours, please let us know at ReaderService@FLAAR.org. We do not mind eating crow, though so far it is primarily a different philosophy we practice, because since we are not dependent on sales commissions we can openly list the glitches and defects of those printers that have an occasional problem.

FLAAR and most universities have corporate sponsors but FLAAR web sites do not accept advertising, so we don't have to kowtow to resellers or manufacturers. We respect their experience and opinion, but we prefer to utilize our own common sense, our in-house experiences, the results from site-visit case studies, and comments from the more than 53,000 of our many readers who have shared their experiences with us via e-mail (the Survey Forms).

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Update Policy

Starting in 2008, updates on UV-curable wide-format inkjet printers are available for all individuals and companies which have a subscription, or to companies who are research project sponsors. If you are a Subscriber or manager in a company that is a research sponsor, you can obtain the next update by writing ReaderService@FLAAR.org. If you are neither a Subscriber or a research sponsor, simply order the newest version via the e-commerce system on www.wide-format-printers.NET. Please realize that because we have so many publications and many are updated so frequently that we have no realistic way to notify any reader of when just one particular report is actually updated.

There is a free PDF that describes the UV-curable inkjet printer Subscription system. Subscriptions are available only for UV-related wide-format printer publications.

FLAAR Reports on UV-curable roll-to-roll, flatbed, hybrid, and combo printers are updated when new information is available. We tend to update the reports on new printers, on printers that readers ask about the most, and on printers where access is facilitated (such as factory visits, demo-room visits, etc).

Reports on obsolete printers, discontinued printers, or printers that not enough people ask about, tend not to be updated.

FLAAR still publishes individual reports on solvent printers, and on giclee printers, but subscriptions on these are not yet available; these FLAAR Reports on solvent, eco-solvent, and water-based wide format printers have to be purchased one by one.

Please Note

This report has not been licensed to any printer manufacturer, distributor, dealer, sales rep, RIP company, media, or ink company to distribute. So, **if you obtained this from any company, you have a pirated copy.**

If you have received a translation, this translation is not authorized unless posted on a FLAAR web site, and may be in violation of copyright (plus if we have not approved the translation it may make claims that were not our intention).

Also, since this report is frequently updated, if you got your version from somewhere else, it may be an obsolete edition. FLAAR reports are being updated all year long, and our comment on that product may have been revised positively or negatively as we learned more about the product from end users.

If you receive any FLAAR Report from a sales rep, in addition to being violation of copyright, it is useful to know if there is a more recent version on the FLAAR web site, because every month new UV printers are being launched. So what was good technology one month, may be replaced by a much better printer elsewhere the next month.

To obtain a legitimate copy, which you know is the complete report with nothing erased or changed, and hence a report with all the original description of pros and cons, please obtain your original and full report straight from www.FLAAR.org.

Your only assurance that you have a complete and authentic evaluation which describes all aspects of the product under consideration, benefits as well as deficiencies, is to obtain these reports directly from FLAAR, via www.wide-format-printers.NET.

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A license from FLAAR is required to use any material whatsoever from our reports in any commercial advertisement or PR Release.

If you intend to quote any portion of a FLAAR review in a PowerPoint presentation, if this is in reference to any product that your company sells or promotes, then it would be appropriate to ask us first. FLAAR reports are being updated every month sometimes, and our comment on that product may have been revised as we learned more about the product from end users. Also, we noticed that one company cited the single favorable comment we made on one nice aspect of their printer, but neglected to cite the rest of the review which pointed out the features of the printer which did not do so well. For them to correct this error after the fact is rather embarrassing. So it is safer to ask-before-you-quote a FLAAR review on your product.

The material in this report is not only copyright, it is also based on years of research. Therefore if you cite or quote a pertinent section, please provide a proper credit, which would be minimally "Nicholas Hellmuth, year, www.FLAAR.org." If the quote is more than a few words then academic tradition would expect that a footnote or entry in your bibliography would reference the complete title. Publisher would be www.FLAAR.org.

If you intend to quote any portion of a FLAAR review in a PowerPoint presentation, if this is in reference to any product that your company

sells or promotes, then it would be appropriate to license the report or otherwise notify us in advance. FLAAR reports are being updated every week sometimes, and our comment on that product may have been revised as we learned more about the product from end users. Also, we noticed that one company cited the single favorable comment we made on one nice aspect of their printer, but neglected to cite the rest of the review which pointed out the features of the printer which did not do so well. For them to correct this error after the fact is rather embarrassing. So it is safer to ask-before-you-quote a FLAAR review on your product.

Legal notice

Inclusion in this study by itself in no way endorses any printer, media, ink, RIP or other digital imaging hardware or software. Equally, exclusion from this study in no way is intended to discredit any printer.

Advisory

We do our best to obtain information which we consider reliable. But with hundreds of makes and models of printers, and sometimes when information about them is sparse, or conflicting, we can only work with what we have available. Thus you should be sure to rely also on your own research, especially asking around. Find another trustworthy end-user of the same make and model you need to know about. Do not make a decision solely on the basis of a FLAAR report because your situation may be totally different than ours. Or we may not have known about, and hence not written about, one aspect or another which is crucial before you reach your decision.

The sources and resources we may list are those we happen to have read. There may be other web pages or resources that we missed. For those pages we do list, we have no realistic way to verify the veracity of all their content. Use your own common sense plus a grain of salt for those pages which are really just PR releases or outright ads.

We are quite content with the majority of the specific printers, RIPs, media, and inks we have in the FLAAR facilities. We would obviously never ask for hardware, software, or consumables that we knew in advance would not be good. However even for us, a product which looks good at a trade show, sounds good in the ad literature, and works fine for the first few weeks, may subsequently turn out to be a lemon.

Or the product may indeed have a glitch but one that is so benign for us, or maybe we have long ago gotten used to it and have a workaround. And not all glitches manifest themselves in all situations, so our evaluator may not have been sufficiently affected that he or she made an issue of any particular situation. Yet such a glitch that we don't emphasize may turn out to be adverse for your different or special application needs.

Equally often, what at first might be blamed on a bad product, often turns out to be a need of more operator experience and training. More often than not, after learning more about the product it becomes possible to produce what it was intended to produce. For this reason it is crucial for the FLAAR team and their university colleagues to interact with the manufacturer's training center and technicians, so we know more about a hardware or software. Our evaluations go through a process of acquiring documentation from a wide range of resources and these naturally include the manufacturer itself. Obviously we take their viewpoints with a grain of salt but often we learn tips that are worthy of being passed along.

FLAAR has no way of testing 400+ specifications of any printer, much less the over 101 different UV printers from more than 46 manufacturers. Same with hundreds of solvent printers and dozens of water-based printers. We observe as best we can, but we cannot take each printer apart to inspect each feature. And for UV printers, these are too expensive to move into our own facilities for long-range testing, so we do as best as is possible under the circumstances. And when a deficiency does become apparent, usually from word-of-mouth or from an end-user, it may take time to get this written up and issued in a new release.

Another reason why it is essential for you to ask other printshop owners and printer operators about how Brand X and Y function in the real world is that issues may exist but it may take months for these issues to be well enough known for us to know the details. Although often we know of the issues early, and work to get this information into the PDFs, access to information varies depending on brand and model. Plus with over 300 publications, the waiting time to update a specific report may be several months. Plus, once a printer is considered obsolete, it is not realistic to update it due to the costs involved.

For these reasons, every FLAAR Report tries to have its publication date on the front outside cover (if we updated everything instantly the cost would be at commercial rates and it would not be possible to cover these expenses). At the end of most FLAAR Reports there is additionally a list of how many times that report has been updated. A report with lots of updates means that we are updating that subject based on availability of new information. If there is no update that is a pretty good indication that report has not been updated! With 101 models of UV printers, several hundred solvent printers, and scores of water-based printers, we tend to give priority to getting new reports out on printers about which not much info at all is available elsewhere. So we are pretty good about reporting on advances in LED curing. But glitches in a common water-based printer will take longer to work its way through our system into an update, especially if the glitch occurs only in certain circumstances, for example, on one type of media. With several hundred media types, we may not yet have utilized the problem media. While on the subject of doing your own research, be sure to ask both the printer operator and printshop owner or manager: you will generally get two slightly different stories. A printer operator may be aware of more glitches of the printer than the owner.

If a printer is no longer a prime model then there is less interest in that printer, so unless a special budget were available to update old reports, it is not realistic to update old reports. As always, it is essential for you to visit printshops that have the printers on your short-list and see how they function in the real world.

But even when we like a product and recommend it, we still can't guarantee or certify any make or model nor its profitability in use because we don't know the conditions under which a printer system might be utilized in someone else's facility. For ink and media, especially after-market third-party ink and media, it is essential that you test it first, under your conditions. We have no way to assure that any ink or media will be acceptable for your specific needs in your specific print shop. As a result, products are described "as is" and without warranties as to performance or merchantability, or of fitness for a particular purpose. Any such statements in our reports or on our web sites or in discussions do not constitute warranties and shall not be relied on by the buyer in deciding whether to purchase and/or use products we discuss because of the diversity of conditions, materials and/or equipment under which these products may be used. Thus please recognize that no warranty of fitness or profitability for a particular purpose is offered.

The user is advised to test products thoroughly before relying on them. We do not have any special means of analyzing chemical contents or flammability of inks, media, or laminates, nor how these need to be controlled by local laws in your community. There may well be

hazardous chemicals, or outgassing that we are not aware of. Be aware that some inks have severe health hazards associated with them. Some are hazardous to breathe; others are hazardous if you get them on your skin. For example, some chemicals such as cyclohexanone do not sound like chemicals you want to breathe every day. Be sure to obtain, read, and understand the MSDS sheets for the inks, media, and laminates that you intend to use. Both solvent, eco-solvent, and UV-curable inks are substances whose full range of health and environmental hazards are not yet fully revealed. It is essential you use common sense and in general be realistic about the hazards involved, especially those which are not listed or which have not yet been described. FLAAR is not able to list all hazards since we are not necessarily aware of the chemical components of the products we discuss. Our reports are on usability, not on health hazards.

Most inks are clearly not intended to be consumed. Obviously these tend to be solvent inks and UV-curable inks. Yet other inks are edible, seriously, they are printed on birthday cakes. Indeed Sensient is a leader in a new era of edible inks. Therefore the user must assume the entire risk of ascertaining information on the chemical contents and flammability regulations relative to inks, media or laminates as well as using any described hardware, software, accessory, service, technique or products.

We have no idea of your client's expectations. What students on our campus will accept may not be the same as your Fortune 500 clients. In many cases we have not ourselves used the products but are basing our discussion on having seen them at a trade show, during visiting a print shop, or having been informed about a product via e-mail or other communication.

Results you see at trade shows may not be realistic

Be aware that trade show results may not be realistic. Trade shows are idealized situations, with full-time tech support to keep things running. The images at a trade show may be tweaked. Other images make be "faked" in the sense of slyly putting on primer without telling the people who inspect the prints. Most UV inks don't stick to all materials; many materials need to be treated.

Or the UV prints may be top-coated so that you can't do a realistic scratch test.

Booth personnel have many standard tricks that they use to make their output look gorgeous. In about half the cases you will not likely obtain these results in real life: in most cases they are printing unidirectional, which may be twice as slow as bi-directional.

Trade show examples tend to be on the absolutely best media. When you attempt to save money and use economy media you will quickly notice that you do not get anywhere near the same results as you saw in the manufacturer's trade show booth, or pictured in their glossy advertisement. Five years ago we noticed Epson was laminating prints to show glossy output because their pigmented inks could not print on actual glossy media. The same equipment, inks, media, and software may not work as well in your facility as we, or you, see it at a trade show. All the more reason to test before you buy; and keep testing before you make your final payment. Your ultimate protection is to use a gold American Express credit card so you can have leverage when you ask for your money back if the product fails.

Images printed at trade show may be in uni-directional mode: so you may not realize the printer has bi-directional (curing) banding defects until you unpack it in your printshop. Bi-directional curing banding is also known as the lawnmower effect. Many printers have this defect; sometimes certain modes can get rid of it, but are so slow that they are not productive.

You absolutely need to do print samples with your own images and the kind provided by your clients. Do not rely on the stock photos provided by the printer, ink, media, or RIP manufacturer or reseller. They may be using special images which they know in advance will look fabulous on their printer. Equally well, if you send your sample images to the dealer, don't be surprised if they come back looking awful. That is because many dealers won't make a serious effort to tweak their machine for your kind of image. They may use fast speed just to get the job done (this will result in low quality). Check with other people in your area, or in the same kind of print business that you do. Don't rely on references from the reseller or manufacturer (you will get their pet locations which may be unrealistically gushy): find someone on your own.

Factors influencing output

Heat, humidity, static, dust, experience level of your workers (whether they are new or have prior years experience): these are all factors that will differ in your place of business as compared with test results or demo room results.

Actually you may have people with even more experience than we do, since we deliberately use students to approximate newbies. FLAAR is devoted to assisting newcomers learn about digital imaging hardware and software. This is why Nicholas Hellmuth is considered the "Johnny Appleseed" of wide format inkjet printers.

Therefore this report does not warranty any product for any quality, performance or fitness for any specific task, since we do not know the situation in which you intend to use the hardware or software. Nor is there any warranty or guarantee that the output of these products will produce salable goods, since we do not know what kind of ink or media you intend to use, nor the needs of your clients. A further reason that no one can realistically speak for all aspects of any one hardware or software is that each of these products may require additional hardware or software to reach its full potential.

For example, you will most likely need a color management system which implies color measurement tools and software. To handle ICC color profiles, you may need ICC color profile generation software and a spectrophotometer since often the stock pre-packaged ICC color profiles which come with the ink, media, printers and/or RIPs may not work in your situation. Not all RIPs handle color management equally, or may work better for some printer-ink-media combinations than for others.

Be aware that some RIPs can only accept ICC color profiles: you quickly find out the hard way that you can't tweak these profiles nor generate new ones. So be sure to get a RIP which can handle all aspects of color management. Many RIPs come in different levels. You may buy one level and be disappointed that the RIP won't do everything. That's because those features you may be lacking are available only in the next level higher of that RIP, often at considerable extra cost. Same thing in the progression of Chevy through Pontiac to Cadillac, or the new Suburbans. A Chevy Suburban simply does not have all the bells and whistles of the Cadillac Escalade version of this SUV.

Don't blame us… besides, that's why we are warning you. This is why we have a Survey Form, so we can learn when you find products that are inadequate. We let the manufacturers know when end users complain about their products so that the manufacturers can resolve the situation when they next redesign the system.

Most newer printer models tend to overcome deficiencies of earlier models. It is possible that our comparative comments point out a glitch in a particular printer that has been taken care of through an improvement in firmware or even an entirely new printer model. So if

we point out a deficiency in a particular printer brand, the model you may buy may not exhibit this headache, or your kind of printing may not trigger the problem. Or you may find a work-around.

Just remember that every machine has quirks, even the ones we like. It is possible that the particular kind of images, resolution, inks, media, or other factors in your facility are sufficiently different than in ours that a printer which works just fine for us may be totally unsatisfactory for you and your clients. However it may be that the specific kind of printing you need to do may never occasion that shortcoming. Or, it may be that your printer was manufactured on a Monday and has defects that are atypical, show up more in the kind of media you use which we may not use as often or at all during our evaluations. Equally possibly a printer that was a disaster for someone else may work flawlessly for you and be a real money maker for your company.

So if we inspect a printer in a printshop (a site-visit case study), and that owner/operator is content with their printer and we mention this; don't expect that you will automatically get the same results in your own printshop.

In some cases a product may work better on a Macintosh than on a PC. RIP software may function well with one operating system yet have bugs and crash on the same platform but with a different operating system. Thus be sure to test a printer under your own specific work conditions before you buy.

And if a printer, RIP, media, or ink does not function, return it with no ands, ifs or buts. Your best defense is to show an advertising claim that the printer simply can't achieve. Such advertising claims are in violation of federal regulations, and the printer companies know they are liable for misleading the public.

But before you make a federal case, just be sure that many of the issues are not user error or unfamiliarity. It may be that training or an additional accessory can make the printer do what you need it to accomplish. Of course if the printer ads did not warn you that you had to purchase the additional pricey accessory, that is a whole other issue. Our reviews do not cover accessories since they are endless, as is the range of training, or lack thereof, among users.

The major causes of printer breakdown and failure is lack of maintenance, poor maintenance, spotty maintenance, or trying to jerry-rig some part of the printer. The equally common cause of printer breakdown is improper use, generally due from lack of training or experience. Another factor is whether you utilize your printer all day every day. Most solvent and UV printers work best if used frequently. If you are not going to use your printer for two or three days, you have to put flush into the system and prepare it for hibernation (even if for only four or five days). Then you have to flush the ink system all over again.

Also realize that the surface of inkjet prints are fragile and generally require lamination to survive much usage. Lamination comes in many kinds, and it is worth finding a reliable lamination company and receiving training on their products.

Also realize that no hybrid or combo UV printer can feed all kinds of rigid materials precisely. Some materials feed well; others feed poorly; others will skew.

Although we have found several makes and models to work very well in our facilities, how well they work in your facilities may also depend on your local dealer. Some dealers are excellent; others just sell you a box and can't provide much service after the sale. Indeed some low-bid internet sales sources may have no technical backup whatsoever. If you pay low-bid price, you can't realistically expect special maintenance services or tech support later on from any other dealer (they will tell you to return to where you paid for the product). This is why we make an effort to find out which dealers are recommendable. Obviously there are many other dealers who are also good, but we do not always know them. To protect yourself further, always pay with a level of credit card which allows you to refuse payment if you have end up with a lemon. A Gold American Express card allows you to refuse payment even months after the sale. This card may also extend your warranty agreement in some cases (check first).

Most of the readers of the FLAAR Reports look to see what printers we use in our own facilities. Readers realize that we will have selected the printers that we like based on years of experience and research. Indeed we have met people at trade shows who told us they use the FLAAR web site reports as the shopping list for their corporate purchases.

Yes, it is rather self-evident that we would never ask a manufacturer to send a product which we knew in advance from our studies was no good. But there are a few other printers which are great but we simply do not have them in our facilities yet.

So if a printer is not made available by its manufacturer, then there is no way we can afford to have all these makes and models in our facility. Thus to learn about models which we do not feature, be sure to ask around in other print shops, with IT people in other corporations, at your local university or community college. Go to trade shows…. but don't use only the booth…ask questions of people in the elevator, in line at the restaurant, anywhere to escape the smothering hype you get in the booth.

Realize that a FLAAR Report on a printer is not by itself a recommendation of that printer. In your local temperature, in your local humidity, with the dust that is in your local air, with your local operator, and with disorientation of the insides of a printer during rough shipment and installation, we have no knowledge of what conditions you will face in your own printshop. We tend to inspect a printer first in the manufacturing plant demo room: no disjointed parts from any shipment since this printer has not been lifed by cranes and run over a rough pot-holed highway or kept in smeltering heat or freezing cold during shipment.

Taking into consideration we do not know the conditions in which you may be using your hardware, software, or consumables, neither the author nor FLAAR nor either university is liable for liability, loss or damage caused either directly or indirectly by the suggestions in this report nor by hardware, software, or techniques described herein because.

Availability of spare parts may be a significant issue

Chinese printers tend to switch suppliers for spare parts every month or so. So getting spare parts for a Chinese printer will be a challenge even if the distributor or manufacturer actually respond to your e-mails at all. Fortunately some companies to have a fair record of response; Teckwin is one (based on a case of two problematical hybrid UV printers in Guatemala). The distributor said that Teckwin sent a second printer at their own expense and sent tech support personnel at their expense also. But unfortunately both the hybrid UV printers are still abandoned in the warehouse of the distributor; they were still there in January 2009. But Teckwin has the highest rating of any Chinese company for interest in quality control and realization that it is not good PR to abandon a client or reseller or distributor all together.

Recently we have heard many reports of issues of getting parts from manufacturers in other countries (not Asia). So just because you printer is made in an industrialized country, if you are in the US and the manufacturer is X-thousand kilometers or miles away, the wait may be many days, or weeks.

Lack of Tech Support Personnel is increasing

The book of sales in the third quarter of 2008 resulted in many tech support problems.

The recession resulted in even more: some manufacturers may need to skimp on quality control during a recession, or switch to cheaper parts suppliers. Plus they are not hiring enough tech support during a recession. So the bigger and more successful the company, in some cases the worse these particular problems may be.

Any new compiled printer may take a few months to break in

Any new printer, no matter who the manufacturer, or how good is the engineering ane electronics, will tend to have teething issues. Until the firmware is updated, you may be a beta tester. This does not mean the printer should be avoided, just realize that you may have some downtime and a few headaches. Of course the worst case scenario for this was the half-million dollar Luscher JetPrint: so being "Made in Switzerland" was not much help.

Counterfeit parts are a problem with many printers made in China

Several years ago many UV printers made in China and some made elsewhere in Asia had counterfeit parts. No evaluation has the funding available to check parts inside any printer to see if they are from the European, Japanese, or American manufacturer, or if they are a clever counterfeits.

Be realistic and aware that not all materials can be printed on equally well

Many materials don't feed well through hybrid (pinch roller on grit roller systems) or combo UV systems (with transport belts). Banding, both from poor feeding, and from bi-directional (lawnmower effect) are common on many UV-curable inkjet printers.

It is typical for some enthusiastic vendors to claim verbally that their printer can print on anything and everything. But once you unpack the printer and set it up, you find that it requires primer on some materials; on other materials it adheres for a few weeks but then falls off.

And on most hybrid and many combo printers, some heavy, thick, or smooth-surfaced materials skew badly. Since the claim that the printer will print on everything is usually verbal, it is tough to prove this aspect of misleading advertising to a jury.

Not all inks can print on all materials. And at a trade show, many of the materials you see so nicely printed on, the manufacturer may be adding a primer at night or early in the morning: before you see the machine printing on this material.

We feel that the pros and cons of each product speak more than adequately for themselves. Just position the ad claims on the left: put the actual performance results on the right. The unscrupulous hype for some printers is fairly evident rather quickly.

Be sure to check all FLAAR resources

Please realize that with over 200 different FLAAR Reports on UV printers, you need to be sure to check the more obscure ones too. If a printer has a printhead issue, the nitty gritty of this may be in the FLAAR Report on printheads. The report on the model is a general introduction; if we discussed the intimate details of printheads then some readers might fall asleep. And obviously do not limit yourself to the free reports. The technical details may be in the reports that have a price to them. Our readers have said they prefer to have the general basics, and to park the real technical material in other reports that people can buy if they really want that level of information.

So it may be best to ask for personal consulting. The details of the problems with the ColorSpan 5400uv series are rather complex: namely the center row of the Ricoh printheads. This would require an expensive graphic designer and consultants to show the details. And the design of the printhead would probably be altered by the time we did any of this anyway. So it is essential to talk with people: with other end-users, and with FLAAR in person on a consulting basis.

Acknowledgements

With 15 employees the funding has to come from somewhere, so we do welcome project sponsorship, research grants, contributions that facilitate our educational programs, scholarships for co-op interns and graduate students, and comparable project-oriented funding from manufacturers. The benefit for the end-user is a principle called academic freedom, in this case,

- The freedom of a professor or student to speak out relative to the pros and cons of any equipment brought to them to benchmark.
- The freedom to design the research project without outside meddling from the manufacturer.

Fortunately, our budget is lean and cost effective as you would expect for a non-profit research institute. As long as we are not desperate for money we can avoid the temptation to accept payment for reprinting corporate PR hype. So the funding is used for practical research. We do not accept (nor believe) and certainly do not regurgitate corporate PR. For example, how many manufacturer's PR photos of their products have you seen in our reports or on our web sites?

Besides, it does not take any money to see which printers and RIPs function as advertised and which don't. We saw one hyped printer grind to a halt, malfunction, or otherwise publicly display its incapabilities at several trade shows in a row. At each of those same trade shows another brand had over 30 of their printers in booths in virtually every hall, each one producing museum quality exhibits. Not our fault when we report what we see over and over and over again. One of our readers wrote us recently, "Nicholas, last month you recommended the …… as one of several possible printers for our needs; we bought this. It was the best capital expenditure we have made in the last several years. Just wanted to tell you how much we appreciate your evaluations…."
FLAAR is a non-profit educational and research organization dedicated for over 36 years to professional photography in the arts, tropical flora and fauna, architectural history, and landscape panorama photography.

Our digital imaging phase is a result of substantial funding in 1996 from the Japanese Ministry of Public Education for a study of scanning and digital image storage options. This grant was via Japan's National Museum of Ethnology, Osaka, Japan. That same year FLAAR also received a grant of $100,000 from an American foundation to do a feasibility study of digital imaging in general and the scanning of photographic archives in particular.

The FLAAR web sites began initially as the report on the results of these studies of scanners. Once we had the digital images we began to experiment with digital printers. People began to comment that our reports were unique and very helpful. So by 1999 we had entire sections on large format printers.

FLAAR has existed since 1969, long before inkjet printers existed. Indeed we were writing about digital imaging before HP even had a color inkjet system available. In 2000 FLAAR received an educational grant from Hewlett-Packard large format division, Barcelona, Spain, for training, for equipment, and to improve the design and navigation on the main web sites of the FLAAR Network. This grant ran its natural course, and like all grants, reached its finishing point, in this case late 2005.

In some cases the sponsorship process begins when we hear end-users talking about a product they have found to be better than other brands. We keep our ears open, and when we spot an especially good product, this is the company we seek sponsorship from. It would not be wise of us to seek sponsorship from a company with a sub-standard or otherwise potentially defective printer. So we usually know which printers are considered by end-users to be among the better brands before we seek sponsorship. After all, out of the by now one million readers, we have heard plenty about every single printer out there.

We thank MacDermid ColorSpan (now part of HP), Hewlett-Packard, Parrot Digigraphic, Color DNA, Canon, Gandinnovations, and other companies for providing funding for technology training for the FLAAR staff and our colleagues at Bowling Green State University in past years and for funds to allow us to attend all major international trade shows, which are ideal locations for us to gather information. We thank Sun LLC, Caldera, Raster Printers (EFI Rastek), DEC LexJet, DigiFab, Barbieri electronic, Mutoh Europe, IP&I, Dilli, Yuhan-Kimberly, GCC, Grapo, Durst, and WP Digital for providing funds so that we can make more of our publications free to end-users. During 2000-2001 we had grants to cover all the costs of our publications, and all FLAAR Reports were free in those early years. As that early grant naturally expired after a few years, we had to begin charging for some of our reports to cover costs. Now (in 2009), we are seeking corporate sponsorship so we can gradually make another 20% of our publications free to our readers.

Since 2006 we do a major part of our evaluations at a factory and headquarters demo room. Since the university does not fund any of these trips, it is traditional for the manufacturer to fund a research sponsorship. In the US this is how most university projects are initiated for decades now, and it is increasing. In fact there is a university in Austria that is not an “edu” but is a “GmbH”, funded by the chamber of commerce of that part of Austria. In other words, a university as an educational institution, but functioning in the real world as an actual business. This is a sensible model.

It has been helpful when companies make it possible for us to fly to their headquarters so we can inspect their manufacturing facilities, demo rooms, and especially when the companies make their research, engineering and ink chemistry staff available for discussions. When I received my education at Harvard I was taught to have a desire to learn new things. This has guided my entire life and is what led me into wide-format digital imaging technology: it is constantly getting better and there is a lot to learn every month. Thus I actively seek access to improving my understanding of wide format printer technology so that we can better provide information to the approximately quarter-million+ readers of our solvent and UV printer web site (www.large-format printers.org) and the over half a million who read either our wide-format-printers.org site or our roughly half million combined who read our digital-photography.org and www.FineArtGicleePrinters.org sites.

Barbieri electronic (color management), Caldera (RIP), ColorSpan, DEC, Durst, Gerber, Grapo, IP&I, Mimaki USA, Mutoh, Dilli, GCC, NUR, Oce, Shiraz (RIP), Sun, Teckwin, VUTEk, WP Digital, Xerox, Yuhan-Kimberly, Zund have each brought FLAAR staff to their headquarters and printer factories. Bordeaux, InkWin and Sunflower ink have brought us to inspect their ink manufacturing facilities and demo rooms. We have visited the world headquarters and demo rooms of HP in Barcelona and received informative and helpful technology briefings. We are under NDA as to the subjects discussed but it is important that we be open where we have visited. Mimaki Europe has had FLAAR as their guest in Europe to introduce their flatbed UV printer, as have other UV-curable manufacturers, again, under NDA as to the details since often we are present at meetings where unreleased products are discussed. Xaar has hosted an informative visit to their world headquarters in the UK. You don’t get this level of access from a trade magazine writer, and I can assure you, we are provided much more detailed information and documentation in our visits than would be provided to a magazine author or editor. Companies have learned that it’s a lot better to let us know up front and in advance the issues and glitches with their printers, since they now know we will find out sooner or later on our own. They actually tell us they realize we will find out on our own anyway.

Contributions, grant, sponsorships, and project funds from these companies are also used to improve the design and appearance of the web sites of the FLAAR Information Network. We thank Canon, ColorSpan, HP, ITNH, and Mimaki for providing wide format printers, inks, and media to the universities where FLAAR does research on wide format digital imaging. We thank Epson America for providing an Epson 7500 printer many years ago, and Parrot Digigraphic for providing three different models of Epson inkjet printers to our facilities on loan at BGSU (5500, 7600, 7800). We thank Mimaki USA for providing a JV4 and then a Mimaki TX-1600s textile printer and Improved Technologies (ITNH) providing their Ixia model of the Iris 3047 giclee printer.

We thank 3P Inkjet Textiles and HP for providing inkjet textiles so we could learn about the different results on the various textiles. IJ Technologies, 3P Inkjet Textiles, ColorSpan, Encad, HP, Nan Ya Pepa, Oracal, Tara and other companies have provided inkjet media so we can try it out and see how it works (or not as the case may be; several inkjet media failed miserably, one from Taiwan, the other evidently from Germany!). We thank Aurelon, Canon, ColorGate, ColorSpan, ErgoSoft, HP, PerfectProof, PosterJet, Onyx, Ilford, CSE ColorBurst, ScanvecAmiable, Wasatch and many other RIP companies for providing their hardware and software RIPs.

We thank Dell Computers for providing awesome workstations for testing RIP software and content creation with Adobe Photoshop and other programs. We also appreciate the substantial amount of software provided by Adobe. As with other product loaned or provided courtesy of ProVar LLC (especially the 23” monitors which makes it so much easier to work on multiple documents side by side).

We thank Betterlight, Calumet Photographic, Global Graphics, Westcott, Global Imaging Inc. Phase One, and Bogen Imaging for helping to equip our archaeological photo studios at the university and its archaeology museum in Guatemala. Heidelberg, Scitex, CreoScitex (now Kodak) and Cruse, both in Germany, have kindly provided scanners for our staff to evaluate.

We really liked some of the results whereas some of the other products were a bit disappointing. Providing samples does not influence the evaluations because the evaluators are students, professors, and staff of Bowling Green State University. These personnel are not hired by any inkjet printer company; they were universities employees (as was also true for Nicholas Hellmuth). The testing person for the HP ColorPro (desktop printer) said he frankly preferred his Epson printer. When we saw the rest results we did not include this Heweltt-Packard ColorPro printer on our list of recommended printers, but we love our HP DesignJet 5000ps so much we now have two of them, one at each university.

Sometimes we hear horror stories about a printer. The only way we can tell whether this is the fault of the printer design, or lack of

training of the operator, is to have the printer ourselves in-house. Of course some printer manufacturers don't understand the reasons we need to have each make and model; they are used to loaning their demo units for a week or so. That is obviously inadequate for a serious review.

Some of the media provided to us failed miserably. Three printers failed to meet common sense usability and printability standards as well (HP 1055, one older desktop model (HP Color Pro GA), and one Epson). Yet we know other users who had better results; maybe ours came down the assembly line on a Monday or Friday afternoon, when workers were not attentive. One costly color management software package was judged "incapable" by two reviewers (one from the university; second was an outside user who had made the mistake of buying this package).

So it's obvious that providing products or even a grant is no shield from having your products fail a FLAAR evaluation. The reason is clear: the end user is our judge. The entire FLAAR service program is to assist the people who need to use digital imaging hardware and software. If a product functions we find out and promulgate the good news. If a product is a failure, or more likely, needs some improvement in the next generation, we let people know. If a product is hyped by what an informed user would recognize as potentially false and misleading nonsense, then we point out the pathetic discrepancies very clearly.

This is what you should expect from an institute which is headed by a professor.

Actually, most of our reviews are based on comments by end users. We use their tips to check out pros and cons of virtually every product we discuss. You can't fool a print shop owner whose printer simply fails to function as advertised. And equally, a sign shop owner who earns a million dollars a year from a single printer brand makes an impact on us as well. We have multiple owners of ColorSpan printers tell us that this printer is their real money earner for example. We know other print shops where their primarily income is from Encad printers. Kinkos has settled on the HP 5000 as its main money maker production machine, and so on.

Yet we have documentation of several print shop companies whose business was ruined by specific brands that failed repeatedly. It is noteworthy that it is always the same brand or printer at both locations: one due to banding and printheads then simply no longer printing one color; the other brand due to pokiness of the printer simply not being competitively fast enough. Same with RIPs, we have consistent statements of people using one RIP, and only realizing how weak it was when they tried another brand which they found substantially better. Thus we note that companies which experiment with more than one brand of product tend to realize more quickly which brand is best. This is where FLAAR is in an ideal situation: we have nine RIPs and 25 printers. Hence it is logical that we have figured out which are best for our situation.

Grant funding, sponsorship, demonstration equipment, and training are supplied from all sides of the spectrum of printer equipment and software engineering companies. Thus, there is no incentive to favor one faction over another. We receive support from three manufacturers of thermal printheads (Canon, ColorSpan and HP) and also have multiple printers from three manufacturers of piezo printers (Epson, Mutoh, and Mimaki). This is because piezo has definite advantage for some applications; thermal printheads have advantages in different applications. Our reviews have universal appeal precisely because we feature all competing printhead technologies. Every printer, RIPs, inks, or media we have reviewed have good points in addition to weaknesses. Both X-Rite and competitor GretagMacbeth provided spectrophotometers. Again, when all sides assist this program there is no incentive to favor one by trashing the other. Printer manufacturer ad campaigns are their own worst enemy. If a printer did not make false and misleading claims, then we would have nothing to fill our reviews with refuting the utter nonsense that is foisted on the buying public.

It is not our fault if some printers are more user friendly, print on more media than other brands. It is not our fault that the competing printers are ink guzzlers, are slow beyond belief, and tend to band or drop out colors all together. We don't need to be paid by the printer companies whose products work so nicely in both our universities on a daily basis. The printers which failed did so in front of our own eyes and in the print shops of people we check with. And actually we do try to find some redeeming feature in the slow, ink gulping brands: they do have a better dithering pattern; they can take thick media that absolutely won't feed through an HP. So we do work hard at finding the beneficial features even of printers are otherwise get the most critique from our readers. Over one million people will read the FLAAR Information Network in the next 12 months; 480,000 people will be exposed to our reports on wide format printers from combined total of our three sites on these themes. You can be assured that we hear plenty of comments from our readers about which printers function, and which printers fail to achieve what their advertising hype so loudly claims.

We turn down offers of funding every year. These offers come from PO Box enterprises or products with no clearly visible point of manufacture. Usually the company making the offer presumes they can buy advertising space just by paying money. But that is not what our readers want, so we politely do not accept such offers of money.

Contributions, grants, sponsorships, and funding for surveys, studies and research is, however, open to a company who has an accepted standing in the industry. It is helpful if the company has a visible presence at leading trade shows and can provide references from both end users and from within the industry. Where possible we prefer to visit the company in person or at least check them out at a trade show. Obviously the product needs to have a proven track record too. Competing companies are equally encouraged to support the FLAAR system. We feel that readers deserve to have access to competing information. Competition is the cornerstone of American individualism and technological advancement.

FLAAR also covers its costs of maintaining the immense system of 8 web sites in three languages and its facilities in part by serving as a consultant such as assisting inkjet manufacturers learn more about the pros and cons of their own printers as well as how to improve their next generation of printers. It is especially useful to all concerned when manufacturers learn of trends (what applications are popular and for what reasons). For example, manufacturers need to know whether to continue designing software for Mac users, or concentrate software for PC users. So the survey form that you fill out is helpful to gather statistics. You benefit from this in two ways: first, you get the FLAAR reports in exchange for your survey form. Second, your comments bring (hopefully) change and improvement in the next generation of printers. When we do survey statistics, then the names, addresses, and telephone numbers are removed completely. A survey wants only aggregate numbers, not individuals. However, if you ask about a specific brand of printer, and do not opt out, we forward your request to a pertinent sponsor so you can obtain follow-up from that brand, since we ourselves do not have enough personnel to respond to each reader by telephone. But we do not provide your personal information to outsiders and our survey form has an opt out check-off box which we honor.

FLAAR also serves as consultants to Fortune 500 companies as well as smaller companies and individuals who seek help on which printers to consider when they need digital imaging hardware and software.

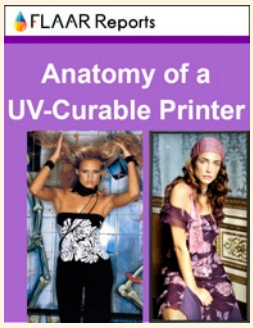
A modest portion of our income comes from our readers who purchase the FLAAR series. All income helps continue our tradition of independent evaluations and reviews of inkjet printers, RIPs, media, and inks.

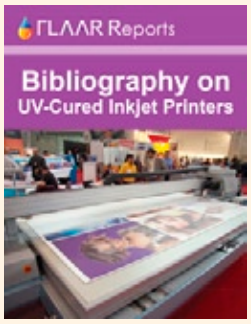
These are some of the most

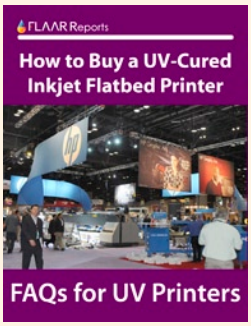
Recent FLAAR Reports (2007-2009)

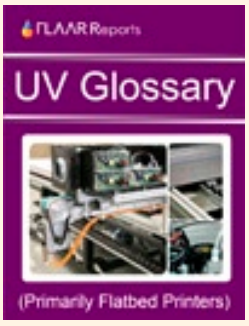
You can find these and more reports at: www.wide-format-printers.NET

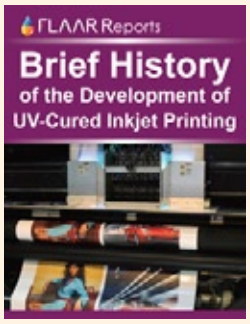
Introduction to UV Curable Inkjet Flatbed Printers

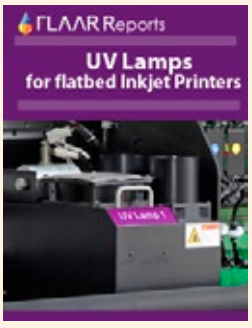


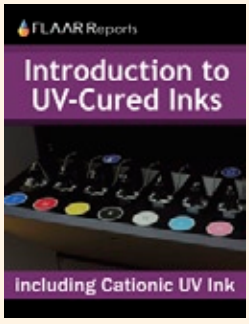




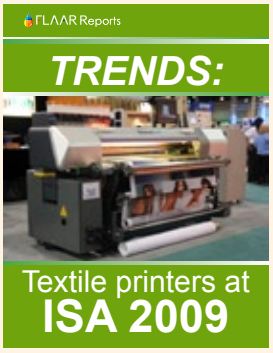


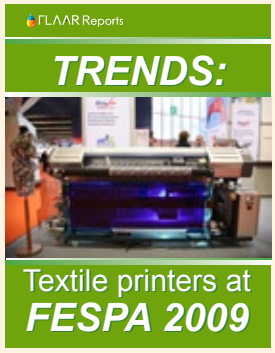






Comments on UV Inkjet Printers at Major Trade Shows 2007-2009





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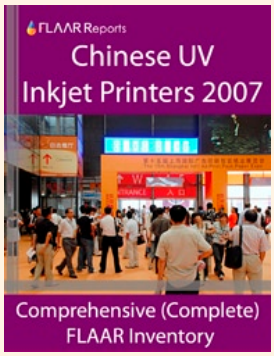
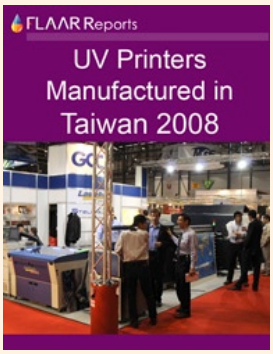
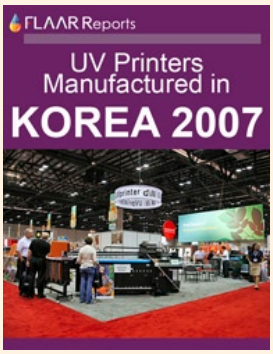
UV Printers Manufactured in China, Korea and Taiwan







Most recent UV Printers