Best AMT Magazine

Airframe Technology
Accessory Technology

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Accessory Technology

Preface

Technical reading material is, by its very nature, "dry." No laughs or chuckles can be heard as a technician reads through the typical A&P train ing manual, nor can you find the average technician sitting down on the weekend entertaining himself with a good A&P regulations book.

When we started publishing *Ail-craft Maintenance Technology Magazine* in 1989, we wanted to provide a technical training curriculum that technicians could use to advance themselves in their profession; yet, we realized that if it were to work, we would have to provide material that was not only technically accurate and relevant to the profession, but fun to read. We feel that we've accomplished this over the years, as our subscribers relate stories of actually reading the material during their leisure hours-and learning something from it.

The fact that the magazine is required reading material in many A&P schools and that the FAA and Transport Canada have approved the material for recurrency training purposes is testament to the fact that the material is also technically relevant.

After being hounded repeatedly for permission to reprint articles and to provide back issues to individuals, and after realizing that much of the material in the magazine was actually timeless, we finally decided to make the material available in book format.

The Best of Airaaft Maintenance Technology Magazine series represents the best articles published dlll'ing the years 1989 through 1995. It is divided into a three-volume set, which includes the Recip & Turbine Technology Series, Airframe & Accessory Technology Series, and Professional & Legal Series. The articles appear only in the order they appeared in AMT Magazine, not according to subject mat er. So read each volume from back to front, front to back, or select only the subject matter you are interested in.

But most importantly, find a nice quite place, and sit back and enjoy.

Happy reading!

Greg Napert
Editor, AMT Magazine

Airframe Technology

Composite machining

Basic techniques for working composites

By Cynthia Foreman

Composite materials are quickly becoming recognized as the most advanced substance for fabrication. Composite structures are made from a combination of materials in the form of fabrics, fibers, foams, and honeycomb materials bonded by a matrix or resin system.

The term composite is used to describe two or more materials that are combined to form a much stronger structure than either material by itself. The most simple composite is composed of two elements: a matrix which serves as a bonding substance. and a reinforcing material.

One of the most common problems associated with the use of composites is that there are too few technicians who are trained in the techniques and methods of composite repair. Composites represent new materials and techniques which must be mastered by those persons who want to stay in tune with the repair industry.

It's not difficult to complete an airworthy repair to a composite structure; however, the techniques, materials, and tools which are used are different than those which are used on conventional repairs. If care is not taken to do a composite repair correctly, the repair will not develop the full-strength characteristics that are desirable in a composite structure.

Besides having a good understanding of resins and the bonding process. the cfrilling, sanding, and cutting of the materials or "machining" is much more critical than most realize. Composite materials act differently than traditional aluminum or other common metals when machined. Each different type of fabric will machine differently, and understanding the interaction between the machining tools and the different fabrics can make a difference in the success of the repair.

Cutting uncured fabrics

Before a fiberglass or carbon/graphite fabric is combined with a matrix and cured, it can be cut with conventional fabric scissors. Aramid fabric or Kevlar, which is a trade name of DuPont, in its raw state is more difficult to cut, however. Scissors with special steel blades containing serrated or diamond edges are used to cut through aramid. Also desirable for use on aramid fabric are ceramic blades with serrated edges. These scissors will cut through aramid with ease and last many times longer. The serrated edges will hold the fabric and prevent it from sliding, while it cuts without fraying the edges.

Scissors that are used to cut aramid should only be used to Cltt aramid, never fiberglass or carbon/graphite. The l'eason for not interchanging scissors is that the different fabrics tend to dull lhe cutting surface in different ways. Keep your scissors and tools reserved for specific materials and the life of the tool will be dramatically extended.

Similarly, conventional fabric scissors can be used to cui fiberglass or carbon/graphit.e. However, scissors which are intended to cut fiberglass should never be used to cut carbon/graphite. and visa versa. Although fiberglass and carbon/graphite can be cut with the same type of scissors. they are not interchangeable.

Preimpregnated materials can be cut with a razor blade/utility knife, and a templat.e or straight edge. The resin tends to hold the preimpregnated fibers in place while the razor edge cuts th.rough the fiber. Very sharp, defect-free cutting edges are necessary to work with composite fabrics.

Machining cured composites

Because of the high sti·ength of cured composites, different machining tools and techniques are used as compared with metal structures. Machining characteristics of composites vary with the type of reinforcement fiber being used.

A note of warning however: Machining of cured composite structures will produce dust that may cause skin irritations. Breathing excessive amounts of this dust may irritate your lungs. Also. some composites decompose when being ti·immed or drilled at high speeds. Because of the friction generated. you may be burning away various materials, creating toxic fumes. Composites vary in their toxicity, so you should consider all composites equally hazardous and sholtld observe appropriate safety precautions while working \vith any of them.

Drilling and countersinking

The production of holes in composite materials presents different problems from those encountered in drilling metal. Composites are more susceptible than metal to material failures when machined. The prope1· selection and application of cutting tools can produce structurally sound holes.

Some problems that may occur when drilling composites are delamination, fracture, breakout, and separation:

Delamination... most often occurs as a peeling way of the bottom layer when the force of the drill pushes the layers apart, rather than cutting through the last piece.

Fracture... occurs when a crack forms along one of the layers due to the force of the drill.

Breakout... occurs when the bottom layer splinters as the drill completes the hole.

Separation... occurs when a gap opens between layers as the drill passes through the successive layers—usually from using too much pressure.

To combat these problems in drilling, the material being drilled should be backed with wood whenever possible. When the backside is inaccessible, a wood backup may not be possible. A drill stop is useful to limit how deep the drill will go through the composite structure. By limiting the depth of the drill passage, breaking the fibers on the backside can be eliminated. When exiting the backside of a hole with a drill, very light or no pressure should be used. A very sharp drill should be used to cut through the laminate, not push through. This will prevent the delamination of the last ply.

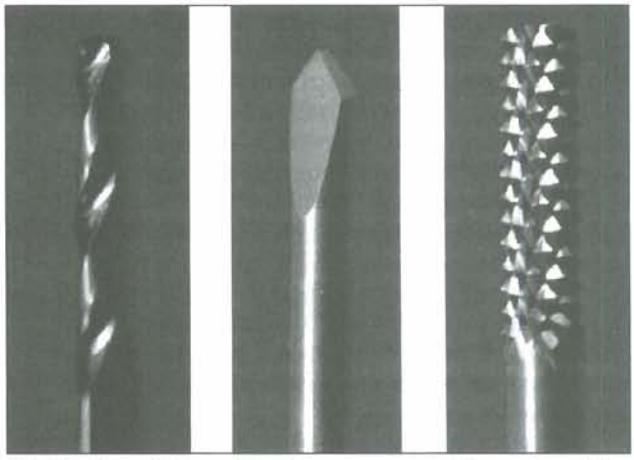
Carbide drill bits will work on all types of composites and have a longer life than a standard steel drill. Diamond dust charged cutters perform well on fiberglass and carbon; however, they will produce excessive fuzzing around the cut if used on an aramid or Kevlar component. Drill motor speed is important. A high speed will work best for most types of materials being drilled. However, do not use excessive pressure.

Drilling aramid

Machining and drilling materials reinforced with aramid or Kevlar fibers require different tools from those made of fiberglass or carbon/graphite fibers. The physical properties of aramid fibers are unique.

Because of the flexibility of the aramid fiber, the drill will pull a fiber to the point of breaking instead of cutting it. As each fiber is pulled before it is cut, a fuzzing appearance is produced around the edge of the drilled hole. Drilled holes in aramid often measure a smaller diameter than the drill which is used, because of the fuzzing of the fibers. The fuzzing around the hole may not produce a problem in itself; however, if a fastener is to be installed, it may not seat properly in the hole. Consequently, if the fastener doesn't seat properly, mechanical failure may occur when stresses are not properly distributed.

There are drill bits which are made specifically for aramid. The special bits cut through the fibers without fraying the material. The bits will last longer than conventional drill bits, and will usually produce a cleaner hole. If possible, use a drill made specifically for aramid, and use it only on aramid.



The brad-type bit used for Kevlar fabrics.

The dagger or spade bit for carbon/graphite or fiberglass.

Diamond cut bit for routing out honeycomb cores.

One such bit is a brad point which is designed specifically for aramid fabric. It is produced with a C-shape cutting edge to pull the fiber out, then cut through the fiber without stretching. Although they were specifically designed for aramid composites, they will also produce good holes in fiberglass and carbon/graphite.

Aramid should be drilled at a high speed. A better cut will be produced if the drill is very sharp. The pressure on the drill should be light; the weight of the drill motor alone is usually sufficient. When exiting out the backside of the hole with the drill, less pressure should be used in order to prevent breakout. This problem can be eliminated if a drill stop is used that is set so that just the tip of the drill will have clearance past the backside of the material.

Drilling fiberglass or carbon/graphite

Drilling fiberglass or carbon/graphite can be accomplished with most conventional tools; however, the abrasiveness of these composite materials will reduce the quality of the cutting edge and shorten the life of the drill drastically.

Carbide, diamond-charged, or carbide-coated tools are used to obtain better results and longer tool life. Diamond-charged tools are usually steel drills which have a coat of diamond dust to cut through the material. This type of drill works well in carbon/graphite and fiberglass components. When cutting fiberglass, the fibers in most cases fracture at the cutting edge of the tool.

Carbon/graphite fibers are stiffer and stronger and resist the cutting action of the tool. If a dull or improper drill starts to cut the individual fiber, it may break inside the composite structure, causing the hole size to be larger than that of the drill. Drilled holes in carbon/graphite will often show larger diameters than the drill

Sanding composite materials can be difficult but mastered with practice.

which is used. Dust chips which are allowed to remain in the holes during the drilling process can also cut, thus enlarging the hole diameter. This creates a problem in that the excessive hole size will cause the fastener to wear in the hole, and will not offer the required strength.

For fiberglass or carbon/graphite drilling, a dagger or spade bit can be used. The use of these bits will reduce the tendency of the fibers to break rather than be cut. This type of bit has a single cutting edge.

Mechanical sanding

Mechanical sanding is the fastest and easiest method, but it's also more likely to cause additional damage by sanding away too much material. One of the best tools for mechanically sanding of composites is a small pneumatic right-angle sander. Adequate control of the sanding operation can best be achieved with patience and experience.

Finer grit sandpaper will usually keep the fuzzing down when sanding aramid fabric. The finer grit also removes the material slowly, allowing more time to find the individual plies. The sanding operation may be accomplished by step-cutting or by scarfing.

When sanding laminates during a repair operation, a right-angle sander or drill motor should be used. The tool should be capable of 20,000 rpm and equipped with either 1-, 2- or 3-inch sanding disc. The sanding disc can be used in combination with a drill motor or with a sander. These come in many different diameters, but a smaller 1- or 2-inch disc will give you mote control when step-sanding or scruffing the composite structure.

The drill motor is widely used in the repair industry. It is used primarily for drilling, but can also be used with a disc as a sander. A right-angle sander is used for scarfing and step-cutting the repair. There is much more control, however, with a right-angle sander than with a drill motor because your hand is closer to the work.

Each material sands differently, and various techniques should be used with each material. When sanding aramid, expect the material to fuzz. When the sanding is almost through the layer, a lighter color of fuzz will be seen and spots of "gloss area may appear. During the sanding process it is important lo look carefully for a gloss area. When an area begins to gloss, it is indicating that one layer of laminate has been removed and the sander is just above the following layer.

Carbon/graphite material will produce a very fine powder when it is sanded. It is usually easier to see the layers of carbon/graphite than with aramid.

Another way to tell if sanding through one layer has been completed is to look at the weave. Since most composites are made with each layer's weave in different directions, seeing a change in weave direction may be an indication of a new layer. As the top ply is sanded, the next layer will produce the weave in a different orientation, signaling that one layer has been removed.

Use extreme care when sanding composites. The layers of a composite laminate are very thin, and it's not uncommon to sand with too much pressure, moving too quickly through the layers. Because of this, two layers can be mistaken for one. This may present a problem if there are only three layers in the laminate over a core structure and the repair calls for sanding down lo the core. If the first two layers are sanded down and counted as one layer, then when the next layer is sanded down, the honeycomb core is exposed, and there will not be enough surface area lo laminate a new patch over the plies.

Trimming cured laminates

Standard machining equipment can be used to trim composites; however, some modifications to the tooling may be necessary. All cutting surfaces should be carbide-coated whenever possible. Diamond-edged blades work well on carbon/graphite and fiberglass.

Routers

The most common types of routers operate at 25,000 to 30,000 rpm. They are used to trim composite laminates and to route out damaged core material.

For routing honeycomb, carbon/graphite or fiberglass laminates, a carbide blade diamond cut router bit works best. A diamond cut router bit does not refer to diamond chips or dust on the cutting surface, but rather to the shape of the cut on the flutes. These bits can be used for routing fiberglass, carbon/graphite, and for Nomex® honeycomb.

This brief overview of composite machining techniques reflects some of the more common problems and techniques involved with the repair of commercial aircraft. The techniques are not difficult to master, but may require some practice. ■ *November/December 1995*

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Interior refurbishing

An inside look on the inside jobs

By Greg Napert

A!though interior refurbishing may seem quite simple, at first glance, when \iewed more closely, it involves a host of skills, talents, and FAA approvals. For this reason, many maintenance facilities choose to leave interior refurbishmem up to specialty shops and/or facilities who offer the service.

Returning an aircraft to iLs original condition is about the simplest, form of refurbishment But it still takes Lhe skills and talents required to Llpholster, carpet, and finish surfaces-skills and talents t.hat are not within the scope of the average maintenance facility. And add one simple modification, upgrade, or accessory, and you're staring down the face of an FAA approval procedure that may require testing of materials, proof of performance, and a recalculation of weight and balance, at a minimum.

In the cot·porate market, there are also many aircraft operators requesting out-of-the-ordinary interior refurbishment options and installations. And designing, building. and approving these requests is time-consuming to say the least.

Fortunately, there "ls an array of facilities available which are desi$_{g\ n}$ ed to either help the average maintenance department. or to pro\':ide full-service interior refurbishment. to aircraft operators. Upholstery shops, cabinet shops and entertainment specialists al'e among some of Lhe specialty shops a\'ailable.

Then lhert' are the full-service refurbishers and completion centers. These facilities tf'nd to offer everything f'om maintenance lo cabinet work. to upholstery services all under one roof. AMT magazine traveled to one of those facilities, K-C Aviation in Appleton, WI, to get a taste of what they go through to refurbish interiors. Although K-C focuses on the high-end corporate market. the experience it has gained in the interior refurb and completion business can give anyone in the industry a feel for what interior refllll'bishment is all about.

Materials selection

Because K-C's clientele is primarily the corporate market, much of it". work involves customiznhon.

Customization of interiors means that rnrely is the same material used f'om a i'craft to aircraft. Customers often choose leathers, suedes, carpeting, and other materials that. must be tested to ensure they pass minimum FAA regulations. These regulations can include such things as ·•vertical bum" and "fire blocking" tests.

Technicians 1lt K<-C Avi«tion finish ·mterior p[lnels.

These regulations not only apply to fabric. they also apply to new foam, cushions. etc.

Dawn Jensen, design coordinator for K-C in Appleton. says. "The vertical burn test is something that is very important when we are talking about the type of material Lh:it can be used. Generally, we try very hard not to present anything to the customer that won't pass the fire block or vertical burn tesL

"The materials that can be used. however, are different depending if you're talking about a fir<· blocked airplane or not?

"If the aircraft is a Part 135 aircraft, it will need to be certified for fire block. Fire blocking is a much more stringent certification than the standard vertical burn requirement. Part 91 operators, which are usually corporate customers, don't typically choose to comply

with fire-blocking requirements. This gives them a larger selection of material to choose from.

"It's good to build in added safety, however. Part 25.853B addresses burn requixements that apply to every single item that goes into an airplane regardless **if** the airplane is operating under 91 or 135. Part 135 takes it one step further and requires fire blocking for materials such as upholstery and carpeting in the cabin." she says.

Vertical burn vs. fire blocking

Jensen e11.1}lains, "The vertical bw'll test is a very specific test where, the fabric is cut to a special length, placed into a controlled environment where a controlled flame is applied to the fabric for a specific amount of time. Then the flame is removed and the bw·ning fabric has to self-€xtinguish within so many seconds. At K-C. we have the capability of performing this test in-house.

"We have a policy here that we test all fabrics we use for vertical bw-n requi'emens in-house, regardless if the manufactw·er says the fabrics meet the requirements. There are companies that say their materials pass, but we just don't take their word for it. Since we're ultimately held responsible for the certification, we want to make sw-e the fabrics we use pass the FAA's requirements.

"Fire blocking, on the other hand," says Jensen, "involves treating the fabric so that it meets certain burn requirements. Because the treatment and the test are more complex for fire blocking, we don't perform the test at our facility; instead we source it out.

''What we do is select and pw·chase the material and make up three seat cushions and three backs for testing. These items require up to 90 square feet of fabric or leather plus the foam materials which are ultimately destroyed for the tests.

"Generally, if a material passes a vertical burn test, it can pass the fire-blocking test. The fire-blocking test, however, looks for such things as material weight loss after the 'blow torch' test. Factors that can affect whether or not the seat cushions pass these tests include such things as how tightly the fabric is stre'c hed over the cushion material. This is something we can easily control, and we have quite a bit of experience. We have occasionally had to send something back to retest," says Jensen.

"One thing that we do to ensure the materials are going to pass these tests is to always use natural fibers such as wool. Natw-al fibers are much more fire-resistant than synthetic materials," she says.

Typically, in order for many of these products to meet these fire-blocking tests, some sort of chemical treating is necessary.

Jensen says that "flame treating a fabric is a big operation, and when you're looking at 40 yards of fabric, flame treating is not a feasible operation for most FBOs. Also, treating leather can present many problems. **If** you're not careful, you can ruin the material"

Besides fabrics, all other materials need to be tested as well-counter tops for example.

STC vs. field approvals

Norm Kopesky, avionics systems coordinator for K-C works very closely with the FAA on many of the company's completions. "Coordinating FAA." he says, "is pretty much the same whether you're doing an avionics installation, an interior redesign, or a green completion."

There are several types of FAA approvals that K-C seeks, including: FAA Field Approved Form 337s, 81103/ FAA Form 337 combination, or STCs. The type of approval they seek depends on a couple of factors such as: what type of installation is being performed and how much time they have to get the approval. He says, "Because we have several FAA designated engineering representatives in our facility, the quickest form of approval is typically an 8110-3/FAA form 337 combination.

The 8110-3 is a statement of compliance that the DER fills out to certify the data (drawings or reports) conform to FAA specifications and regulations. This is essentially done on behalf of the engineering office of the FAA. A 337 then has to be filled out stating the installation of the system or component is done per the approved data; the aircraft can then be retw·ned to service.

"In the case of a microwave oven installation, for instance," Kopesky says, "we would typically do an 8110-3 approving the data and then return the aircraft to service on an FAA Form 337. In order to determine **if** it meets basic FAA design requirements, we will look at things like wire type, wire gauge, and all of the structural aspects related to how it's installed. But it doesn't make any difference if it is a microwave, a black box, or a brick; all aspects of the installation have to be thoroughl y reviewed and approved.

A decision to obtain a Supplemental T$_{yp}$e Certificate (STC) depends on a number of factors including: whether or not we have time to apply for and complete the STC, whether o1· not we think the modification or installation will have application on other aircraft of the same type, and whether or not we think there will be a demand for the STC.

"We often take one of our existing STCs and make mi.nor modifications to them. In these cases, we simply deviate from the STC and have ow· DERs approve the data. Then if we have future application, we will incorporate that deviai on into a revision or amendment to the original STC. **If** the deviations are significant enough, they may become separate STCs unto themselves," he says.

Kopesky explains, "A complete refurbishment can include a variety of STCs and field approvals. We try to keep certain 'packages' under one STC, but it's often impossible to include everything. Items such as

emergency lighting or oxygen systems will be a separate STC. Avionics items are usually going to be separate approvals, STC'd or otherwise. Antenna installations, phones, and entertainment systems are so customized that they are usually field approvals.

.One challenge today is all of the personal electronics items that customers want installed such as personal computers, faxes, displays, etc.

"A lot of customers are also requesting outlets and computer jacks to be installed and that way they don't have to approve the computer installation, only the installation of the jack. We have many customers who want cellular phones installed with external antennas. The only problem here is that the FCC has ruled them to be illegal for use when in flight. However, they can be used anytime you are on the ground or when you are taxiing around the airport. If we have installed a cellular phone system, we typically wire the phone to the squat, switch so that it is inoperative when once airborne, and we always placard the airplane stating the regulations related to cellular phone usage.

"Unfortunately, many customers now have the phones in their pockets and they do what they want to do," he says.

Soundproofing

Joe Thurman, supervisor for fabrication and installation at K-C, says that "soundproofing is something that we at K-C work very hard at. We try to reduce noise as much as possible when we design an interior. However, ultimately, any soundproofing you install adds weight to the aircraft. And that creates a penalty in terms of how many passengers or luggage you can carry.

"Our customers also sometimes specify cabin noise limits. We have to emphasize, however, that this may affect their selection of materials and/or design of the interior.

"To reduce noise, we can do things such as install fabric bulkheads instead of wood, or fabric oo the seats instead of leather. or insulated window shades. Additional soundproofing beyond manufactu'ers' designs, will usually result in some sort of tradeoff," he says.

"Most aircraft manufactw·e1·s have a completion center manual with recommended sound packages. But these are more or less guidelines to go by.

'As far as soundproofing materials go, the primary type of material used in the past was lead vinyl. However, lead vinyl is very heavy and cumbersome, and the adhesives that you need to use are very caustic. The technicians have to completely suit up just to install it. Also, lead vinyl is only effective if completely sealed. It acts as a barrier, sealing out, the sound rather than dampening it. If you have an opening anywhere in the lead vinyl, the sound gets through. So you have to make sure everything is sealed tightly, which is a tedious task.

All fabrics and materials used in refinishing must pass rigid FAA burn stllndards.

"We have found that we have more success with sound dampening instead. This starts at, the aircraft skin using a foam material with a foil backing. Skin dampen• ing materials have improved considerably over the years. The problem in the past was that in ell.il·eme cold temperatures, at altitude, the foam would get hard and would no longer serve its purpose. Newer dampening foam can withstand extreme temperatures and still be effective."

Probably the most success that K C has had with noise reduction is through the use of vibration isolation. Thurman explains, "We have found through experience that it is usually better to dampen or isolate vibrations rather than to block out the noise.

"For starters, we design our cabinetry to 'float' rather than hard-mount it. We shock-mount as many components as possible so the noise doesn't transmit from the ar craft frame into these units. If hard-mounted, the furnishings can become, essentially, big 'speakers' that tend to amplify these vibrations.

·'As more people are getting involved in vibration isolation, it's becoming more of an exact science. It's quite a change from the basic concept of soaking up or blocking noise. The move to vibration isolation allows us to implement noise controls without adding additional weight to the aircraft," he says.

"As promising as vibration isolation is, however, there are some items that you just can·t use it on. For example, you would not want to mount a table on vibration isolators because you don't want the table to flex; you want it to feel solid.

"But we're getting smarter. What we do in the case of the table now is to mount the table solidly onto a panel and then dampen the panel.

"We're also using headliner panels and side wall panels that are vibration isolated as well.

"In practice, what we do is incorporate many of these changes into a noise reduction package that we provide as part of a completion package," Thurman concludes.

Dealing with a variety of requests

Peg Docter, sales manager for K-C, says that they often deal with a variety of requests for installation of items in the ar craft. "Some of the most popular are new entertainment systems, phone systems, flat screen TVs and avionics requests for GPS installations. Most requests involve creature comforts.

"We also have many requests from pilots and from maintenance people. Maintenance folks want interiors that rue easy to repair or clean, for instance. We take all of these requests under consideration in our initial discussion. We also take into consideration whether the aircraft is going to be for charter or if it's going to have a lot of different people in it. For heavy traffic we would steer the customer toward an ultra leather rather than suede, or a dark carpet rather than a light carpet," says Docter.

Thmman says lhal "we also try to make things as accessible as possible for maintenance. When we put in a galley, we try to make it easy to *take* that galley out. We use as many quick disconnects and access panels as possible."

As a final note, Kopesky says, "Any aircraft modification or installation requires a look at the aircraft weight and balance. If it's a minor installation and the aircraft has been weighed recently, we will use existing numbers and recalculate the weight and balance based on the existing numbers. If it's a major installation or modification, we will reweigh the entire aircraft for a fresh weight and balance report."

AMT's interior services and supplies directory

Whether you're in the business of working on aircraft interiors or not, you'll want to keep this handy list of interior maintenance facilities and service providers nearby. The following are companies that responded to a mailing conducted by A M T magazine:

Accent Int.eriors
Offers fabrication and modification of interiors, desi$_{gn}$, upholstery, and cabinet work.
Opa Locka Airport, Bldg. 147, Opa Loka, FL 33054, Ruth Cannon, (305) 681-4010.

ADI Int.eriors
The company offers full interior design capabilities in-house, or \vill work with a desi$_{gn}$ er of yom choice. Also offered are certified fire blocking services, an on•staff DER. and a broad selection of fabrics, leathers, and carpets from around the wol'ld
Oakland/Pontiac Airport, 6544 Highland Rd., P.O. Box 270100, Waterford, MJ 48327-0100, Brian Wells (810) 666-3500.

Aero Air Inc.
A full service FBO specializing in extensive corporate jet and turboprop interior refw·bishing and exterior paint. Complementing these services rue aircraft maintenance, sales, charter, and entertainment systems installations.
2050 N.E. 25th Ave. Portland-Hillsboro Airport, Hillsboro, OR 97124, Tom Krueger, (503) 640-3711.

Airo **Industries** Inc.
Aircraft interior refurbishments include galleys. seats, and sidewall panels.
14675 Titus St., Panorama City, CA 91402, David Nejad, VP Sales/Mktg.. (818) 780-8733.

Arizona Aircraft Int.erior Designs, Inc.
Offers complete interior refurbishing of ar craft including: cabinets, fire blocking, interior painting. and soundproofing. Specializes in turboprops and small jets for corporate customers.
5047 E. Roadrunner Dr., Mesa, AZ 85215, Wayne Bryant. 602) 832-1330.

Brice Manufacturing
Manufactures aircraft seat components and offers refurbishment services for the integration of all telephonies and personal video system products. Also, turnkey service for the desi$_{gn}$, manufacture, and cet·tification of seat kits.
10262 Norris Ave.. Pacoima, CA 91331.
Sean Prendergast, (918) 665-2321.

Byerly Aviation Inc.
Complete business jet and turboprop refurbishing capability. Exterior paint and cabinet refinishing with complementary avionics support and GPS installations. Commander, Citation. and King Air maintenance and modifications.
Greater Peoria Airport, 1900 S. Maxwell Rd., Peoria, IL, 61607, R. Bruce Byerly, (309) 697-6300. Ex-t. 360.

Cameron Aircraft Interiors Inc.
Offers interior refurbishment of all categories of aircraft.
31W651 North Ave., Dupage Airport. West Chicago, 60185, Harry Cameron, (800) 866-4886, (708) 584-9359.

Cleveland Jet Center Inc.
Complete aircraft refurbishment, from design to paint, and wood shop. DAR, DER on staff. Aircraft worked include BAC 1-11 to piston twin. Full service maintenance facility.
38630 Jet Center PL., Lost Nation Municipal Airport, Willoughby, OH 44094, Jack Barnett, (216) 942-0087.

Commodore Aviation Inc.
Perform interior refurbishment of seats, galleys, lavs, interior mods, and painting for Boeing, Douglas and other commuter aircraft. Also accomplish heavy maintenance services.
5300 N.W. 36 St., Box 661078, Miami, FL 33266-1078, Rick Weltmann, Dir.-Nlktg./Contracts, (305) 871-1169, Ext. 201.

Custom .Aircraft Interiors Inc.
Manufactures complete interior components for MDHC 500 Series aircraft. Prototype and design capabilities for all aircraft interiors.
3701 Industry Ave., Lakewood, CA 90712, Patricia Erwin, {310) 426-5098.

Downtown Airpark Inc.
Specializes in all types of interior work-from minor repairs to complete custom design.
P.O. Box 26027,1701 South Western, Oklahoma City, OK 73121, Greg Groves, (800) 253-1456, (405) 634-1456.

Eagle Aviation Inc.
Full-service FBO offering such services as jet and turbo prop maintenance, avionics, completions, with 250 trained personnel.
2861 Aviation Way, Columbia Metro Airport, W. Columbia, SC 28170, Jim Neece, (803) 822-5586.

Elite Interior Designs
Offers aircraft interior refurbishment including: seats, headliners, sidepanels, carpets, and cabinet work. Also T.S.O. restraint belt refurbishment.
101 E. Reserve St., Pearson Airpark, Vancouver. WA 98661, Paul and Alana Sanchez, (206} 693-0051.

Gulfstream Aircraft Inc.
Now offers full-service interior refurbishment for Gulfstream aircraft in its Brunswick, Georgia facility.
500 Gulfstream Rd.. Savannah, GA 31408, David F. Fulcher, (912) 965 3472.

Gulfstream Service Center
Complete interior refurbishment for Turbo Commander, Westwind, Sabreliner, and Citation aircraft. Complete woodwork returbishment and cabinet design capabilities.
7301 N.W. 50th, Bethany, OK 73008, Mark A. Fulton, (405) 789-5000, Ext. 486.

Heli-Dyne Systems Inc.
FAA-certified full-service helicopter support facility. Offers complete in-house capabilities to include custom design and engineering, avionics and communications.
9000 Trinity Blvd., P.O. Box 966, Hurst, TX 76053, David Likes, (817) 282-9804.

Hill Aircraft Interiors
Hill Aircraft leads the way in the provision of master quality interior design, repair, and installation on Beechcraft KingAi.r, Leai·jeLs, and twin-engine aircraft such as Cessna, Piper, and others.
3948 Aviation Circle, Fulton County Airport Brown Field, Atlanta, GA 30336, Jacques Escalere, (404) 691-3330.

J.A Air Center
J. A. Air Center interior department offers the finest quality fabrics and leathers. Services range from simple repairs to full refubishing of interior.
3N060 Powis Rd., DuPage Airport, West Chicago, IL 60185, Rick Milburn, (708) 594-3200.

JetCorp
Technical capabilities include: major interior refurbishment, non-destructive testing, engine repairs, hot sections, pat-ts support, accessory repair and overhaul, airframe inspections, and avionics repair and installation.
18152 Eclison Ave., Spirit of St. Louis Airport, Chesterfield, MO 63005, Jerry Moore, (314) 530-7000.

Jet East Inc.
Full service FBO--Citation and Learjet authorized service center providing minor to extensive refurbishments. Avionics total on-site support. Also offers parts, sales and charter services.
7363 Cedar Springs, Dallas, TX 75235, Leticia Chacon, (214) 350-8523.

KaieerAir Inc.
Provides custom interior refurbishment for both 91 and 135 operations. Custom cabinetry, fabrication, and custom interior design consultant available.
Airport Station, Box 2626, Oakland, CA 94614, Andrew F. Fitzgerald, (510) 569-9622.

Kal-Aero Inc.
Is a full "one stop shop" fixed based operator. Capabilities include state-of-the-art paint, refurbishment, and maintenance.
15745 S Airport Rd., Battle Creek, Ml 49017,
John Hooskins, (616) 969-8400.

KC Aviation
Provides refurbishment, completion, maintenance services, avionics installation and repaii overhaul and repair services, and personnel and consulting services. DER and DAR on staff.
7440 Aviation Place, Dallas, TX 75235, Dallas Love Field,
John Rah.illy, (214) 618-7719.

King **Aerospace Commercial Corp.**
Aircraft brokers, interior design, installation and modification, maintenance and 1·epair station, painting, coating and cleaners.
4114 Westgrove, #250, Dallas, TX 75348,
Jeny King-Echevarria, (214) 248-4886.

Mechanical Ent.erpriBee Inc.
MEI is a manufactul'er of plastic seat parts, tray tables, arm shrouds, etc. FAA-approved repair station.
2961 A Olympic Industrial Dr., Smyrna, GA 30080,
Ron Kirschner, Pres., (404) 350-8489.

Midcoaet Aviation
Offers modification, reflll'bishment, and maintenance services, combining state-of-the-art technology with old-world craftsmanship.
8 Archview Dr., Cahokia, IL 62207, Rodger Renaud,
(618) 337-2100.

Million Air Inc.
Provides the highest quality craftsmanship on custom interior refurbishments, maintenance work, and avionics upgrades and installations. Specializes in corporate aii·craft.
4300 Westgrove, Dallas, TX 75248. Bob Tharp,
(214) 733-5821.

Omniflight
Offers completion/refurb. capabilities. Omniflight provides custom interiors for EMS, execui ve, law enforcement and new completions or refurbishments.
4650 Airport Parkway, Dallas, TX 75248, Allen Dales,
(214) 233"6464.

The Oxford Aircraft Refurbi.ehing Centre
Offers custom interior design service \vith owner participation. Standard refurbishing package includes: restyled seat cushions, carpeting, plastic paneling-ultra.suede covered. new headlining. cabinetry. and repolishing.
Oxford Airport, Kidlington, Oxford, OX5 IRA.
Don Tempest, 01865-370848.

Premier Aviation Inc.
Full service helicopter completion/modification center providing executive transport air medical, public service, and special missions interiors. Cockpit design and instrumentation available.
2621 Aviation Pkwy. Grand Prarie, TX 75050.
Tamera Bidelspach. (214) 988-6181.

Ranger Aviation Ent.erpriBes Inc.
Provides complete paint and interior on all aircraft from turboprop through jet. Have contract, to paint all U.S. Airforce Lear 35s.
P.O. Box 61010, San Angelo, TX 76906-1010, John or Sandy Fields, (915) 949-3773.

Rocky Mountain Helicopt.ers
Operates an in-house completion center for the desi$_{gn}$ and installation of medical interiors. The company's specialists desi$_{gn}$ and install each aircraft to customer specifications.
P.O. Box 1337, Provo, U'l' 84603, Jennifer Hunter ones, (801) 375-1124.

S1'y Harbor Aircraft Refinishing Ltd.
Provides airct·aft refurbishment services to include paint. interior, and maintenance. Over 40 years experience in complete interior and exterior aircraft reforbishment.
R.R. #5, Box 536. Goderich Airport, Goderich, Ontario N7A 4G7. D.E. (Sandy) Wellman, (519) 524-2165.

Skyworthy Int.eriors
Specializes in refurbishing and updating complete interiors in desi$_{gn}$ and production. FAA-certified upholstery shop, meeting all specifications.
3112 N. 74th E. Ave, Hangar 23. Tulsa, OK 74115,
D.A. Williams, (918) 835 4770.

South Coast Aircraft lnt.eriors Inc.
Complete interior restoration of executive aircraft since 1982. Fi.re blocking, desi$_{gn}$ and engineering services, window replacement. sound proofing, FAA repair station.
2898 Montecito Rd., Hangar A-1, Ramona, CA 92065,
Andy Mirabelli (619) 788-9276, (800) 550-9276.

Special Products Aviation Inc.
Builds and repairs fabric-<:overed airplanes. Also offers painting and composite services.
850 9th Ave., Conway, AR 72032, Kenny Blalock, (501) 327-4339.

Tri-Stat.e Airmotive LLC
Accessory overhaul, paint, interior, sheetmetal and airframe inspection.
20 Tri-State Rd., Berryville, AR 72616, Chuck Bennett. (501) 423-4911.

Unit.ed Beechcraft Tampa
Full service interior, cabinets, distinctive designs, S.T.C. approvals. Cabin displays, video and audio systems, and configuration changes.
2450 N. West.shore, Tampa, FL 33607, Skip Davies, (813) 878-4500.

West Star Aviation Inc.
Provides custom paint and interior refurbishments. Also log reproduction, super soundproofing, entertainment systems, commuter, medical, and custom business retrofits, and more.
796 Heritage Way, Grand Junction, CO 81506, J. Gregory Heaton, (970) 243-7500.

West Virginia Air Cent.er
Offers aircraft maintenance, sbeetmetal, interior, paint and composite on regional and corporate aircraft.
P.O. Box 908, 2400 Aviation Way, Bridgeport, WV 26330, Gary Palmer, (304) 842-6300.

ell September/October 1995