

# Automated Tool for Reporting Aircraft Damage For Repair

**Etegent Technologies, Ltd.**  
1775 Mentor Avenue, Suite 302  
Cincinnati, OH, 45212

**Dr. Thomas Sharp**  
Phone: (513) 631-0579  
Fax: (513) 631-0582  
Email: tsharp@etegent.com  
Website: <http://www.etegent.com>

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Wing damage repair on-board ship. Carriers have facilities for both sheet metal and composite repair.

## PROBLEM STATEMENT

An airplane structure made entirely from aluminum can be repaired almost anywhere using standard techniques. This is not the case for composite structures as they use different and more exotic materials. Repairs often must be developed using a detailed design process to ensure that the repaired structure still meets the loading requirements. To complete this detailed repair design, the location and size of the damage must be accurately known. Currently, capturing this location is a manual, subject to human-error with the concomitant need to recheck to ensure accuracy.

## WHO CAN BENEFIT?

At the highest level, owners of composite aircraft will benefit from improved repair accuracy, reduce repair time and therefore improved availability. At the maintenance level, this technology will reduce the time an effort required by to capture damage location information and will provide engineers with more accurate damage location and size information so they can better evaluate and design the repair to the aircraft.

## BASELINE TECHNOLOGY

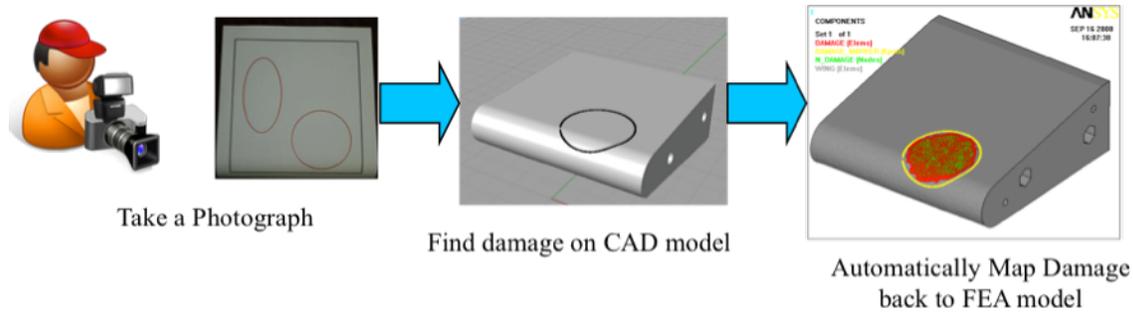
The current process of locating the damage on the composite aircraft consists of manually capturing a damage locations on a piece of clear Mylar, taking the Mylar to a workstation, and then manually transferring the location to a CAD model. This is a time-consuming and process subject to human-error with the concomitant need to recheck for accuracy that extends the period of time that planes are in maintenance to ensure aircraft safety.

Detailed costs are not known; however the following elements of a cost breakdown have been defined:

- Time required to trace damage on the Mylar
- Time required to enter data into the CAD model from the Mylar
- Accuracy problems lead to conservative repairs that are larger and more extensive than required
- Engineers do not always get the information required which leads to multiple interactions between the inspectors and the maintainers, further increasing the amount of time a plane spends grounded.

**TECHNOLOGY DESCRIPTION**

The technology being developed utilizes a standard digital camera to capture the location and size of damage on an aircraft. The process is depicted in the figure below. After an inspector has marked the damage on the aircraft surface, an image of the damage including the surrounding area is taken with a standard digital camera. This image is then automatically aligned to a CAD model of the aircraft (assigning each pixel in the image an x, y, z location in the CAD model). The damage contour is then identified in the image by extracting the colored lines. Combining the identified damage contour with the x, y, z pixel location allows for the damage contour to be automatically exported to a repair analysis package.



Below are a FAB table and a table comparing the alternative techniques used to solve the damage location problem.

**FAB Table**

<b>Features</b>	<b>Competitive Advantage</b>	<b>Benefit</b>
Automatically captures the location of a damage marking and exports it to damage analysis CAD tools.	Saves time and improves accuracy over existing manual approach.	<ul style="list-style-type: none"> <li>• Reduce repair time, thus increasing aircraft availability.</li> <li>• Improved accuracy increases aircraft safety.</li> </ul>
Requires no setup.	No special time or special training is required to setup our system.	<ul style="list-style-type: none"> <li>• Reduces overall time required to capture damage location.</li> <li>• Reduced training requirements.</li> <li>• Requires less physical space.</li> <li>• Minimal concern about equipment storage, reliability, and spares.</li> </ul>
Simple to use, anyone who knows how to use a digital camera can use our technique.	Minimal training is required.	<ul style="list-style-type: none"> <li>• A wide range of people can use the technology.</li> <li>• No special hardware required (digital cameras are present)</li> </ul>

**Solution Comparison**

	<b>Existing</b>	<b>Etegent</b>	<b>Other</b>
Training	Extensive	Minimal	Extensive
Physical space	Small	Small	Large

required			
Accuracy	Poor	Good	Good-Excessive
Time to capture damage location	Medium	Low	High
Special equipment & supplies	Medium	Low	High
Skill set of user	Specialist	Journeyman	Specialist

**CURRENT STATE OF DEVELOPMENT**

At the end of our Phase II we will have demonstrated the technology in a simulated operational environment. It will be demonstrated on the F/A-18 platform using images captured on a carrier. The image will be sent to PAX River where engineers will use our software to estimate damage location. At this point the technology will be at a TRL 6.

The technology will be seamlessly integrated with Etegent’s Nlign software suite. This suite of software organizes, archives and analyzes NDT inspection data. It is the “Google-Maps” for NDT inspection data. The software organizes the NDT data by aligning it to a CAD model of the structure being developed. This alignment data along with the original inspection data is then archived in to a database. The information in this database is then analyzed to provide valuable trending information. Nlign is being developed with support from the Air Force and Navy.

Maturing our technology through to TRL 9 for the Navy’s specific need will require extensive testing and refinement. This testing will need to be performed in an operational environment with Navy personnel. Additionally, training materials will need to be developed.

**REFERENCES**

NAVAIR TPOC - 301-757-2326

**ABOUT THE COMPANY**

Etegent was founded in 1996 by two academic researchers whose goal was to put state-of-the-art university research into products and services for commercial enterprises. The company principals, Stuart J. Shelley and Thomas D. Sharp earned their Ph.D. degrees from the University of Cincinnati and the company remains headquartered in Cincinnati today. Etegent's products and services reduce cost, uncertainty and time-to-market for development of “smart” products and process. Etegent has developed a broad client base since its inception; including the Department of Defense, the National Science Foundation, and NASA as well as numerous commercial customers like Procter and Gamble, General Electric, and Emerson Electric. Etegent recently formed a separate division to pursue the commercialization of NDT technology being developed for the Air Force and Navy. This division is developing a suite of software tools that organize, archive and analyze NDT inspection data. Our suite is the “Google-Map” for NDT inspection data.