

Borescopes – Here’s Looking at You

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If you are of the “baby boomer” generation, you know what a borescope is. The last time you went for a colonoscopy you got intimate with one. But for those of you that are of a younger age, or have not yet had the opportunity to work with a borescope, read on.

A borescope is an instrument that works like a microscope, telescope or camera. It allows people to explore areas that are too small, too remote or out of reach. It has an eyepiece at the top attached to an insertion tube that can either be rigid or flexible. When the borescope's insertion tube is directed through an opening, it takes the lenses and the light source to what needs to be checked. On the other end of the tube there are two lenses, a light source, nozzles and other openings.

Aircraft A&P Mechanics frequently use borescopes to look inside engines or places inside an aircraft that are not otherwise visible without taking them apart. Since disassembling a piece of an aircraft can create more problems and is very time consuming, borescope usage cuts out this step and diagnoses problems or determines the soundness of a particular part.

Types

There are several types of borescopes. When the borescope has a flexible insertion tube, it is called an endoscope or a fiberscope. These include the various endoscopes used for medical and veterinary procedures, angioscopes for hearts, bronchoscopes for lungs, colonoscopes for colons, otoscopes for ears and gastroscopes for stomachs. When a borescope has a rigid insertion tube, it is likely to be made from either a glass or stainless-steel rod.



History

The person who invented the rod lens endoscope was the British physicist Harold Horace Hopkins, who also invented the zoom lens. His work made it possible for surgeons to do less invasive procedures using "key hole" surgery. Because the borescope makes it possible to see the internal organs, bones and muscles, a large incision can be avoided, which makes it easier and quicker for the patient to recover.

Question - When purchasing a borescope, how should you determine which probes, extensions and types of lighting used around the camera lens is right for your needs? What type of lighting control is best to have?

Answer 1 - A general rule in purchasing a borescope and determining the length and diameter is this: Never shorter, never fatter. The diameter of the probe is limited by the points of access you have available. The length will be determined by the area you want to access. Lighting options can be dependent on the area that is to be inspected. Larger areas may require more light to get a clear view as opposed to a smaller area where a lower intensity light source can be used. There are many borescope models that have different lighting options. LED, halogen, metal halide, and xenon are available to name a few. Depending on the application it may be necessary to have an adjustable intensity in order to not wash out the image.

Answer 2 - The diameter and length of the scope (probe) is entirely determined by the engine being inspected. Some engines require 4mm diameter or less, while others can be 6mm or even as much as 8mm. Regarding length of the scope, smaller turbines generally require 1.3m to 1.5m length scopes, while some of the larger engines require 3m length scopes.

The borescope should have controls that are easy to use and intuitive. The image capture and control buttons should be ergonomically placed near the articulation levers. The menu on the video monitor should also be simple and intuitive.

Regarding lighting, there are scopes with fiber optic illumination built in, and some scopes with LED's at the tip. The LED's are convenient, but the fiber optic illumination systems give the flexibility of using a variety of light sources, both portable handheld lights and extremely bright bench top units.

Question - How important is the digital quality of the camera in the borescope?

Answer 1 - It depends on the application and what is trying to be viewed. For the application of finding clear debris or blockage, a lower quality scope may be used. If you're looking for scratches or pitting, erosion, discoloration, or sand sized particles, a higher digital quality would be required.

Answer 2 - The quality of the digital camera is very important, but don't get too caught up in the resolution. There are many things that make up good image quality such as good contrast, color rendition, dynamic range, signal to noise ratio, etc. These things result in good sharp clear images. You can have a high-resolution camera with very poor-quality images. The best way to determine the image quality is to look at the image. Most people see things slightly differently as our eyes are different from person to person.

Question - How important is the light source and control of it?

Answer - The light source is very important, particularly when inspecting large dark areas such as combustion chambers. Often when people say they have a bad image what they really mean is it's too dark. They need a brighter light.

Question - What are the pros and cons of using a joystick controller?

Answer - **Pros:** Smooth operation, typically allowing articulation in all directions.
Cons: Difficult to feel resistance which is not good if you are operating inside a tight area where there isn't enough room for articulation. To counteract this, most units are built with tension relief but gradually articulation will lose strength and need to be serviced by the borescope manufacturer or a qualified repair facility.

Question - If I buy a base model, are upgrades available?

Answer - Some borescope models are available with interchangeable or upgradeable parts, but most are built to order. Others come as photo only models, but can be upgraded to video later on.

Question - Does the borescope manufacturer provide free training on the product?

Answer - Some manufacturers will provide free training. There are many borescope products that are very easy to use and do not require extensive training, and often the material included with the unit is sufficient for smooth operation. It's like buying a camera, read the manual before using it for the first time.

Question - What is the correct way to use the borescope?

Answer - As with most things in life, there is a right way and a wrong way to use the borescope. However, due to the wide variety of applications a borescope can be used for, it can be a trial and error basis for some users. Depending on where and how the borescope is used, it can last for years, or just a matter of months or even weeks. With any optical instrument, extreme care with how it is handled and operated is always prudent. When handling or using a borescope, avoiding any whip-lash, dropping, exposure to chemicals, or exposure to large heavy unstable objects which could fall onto and crush the borescope is good.

Finally, here are some examples of how a decent quality borescope helped to resolve some maintenance issues.

1. Prevent an unscheduled removal of a component.

When using a low-quality borescope (poor image quality, articulation control), this can inhibit the ability to decide on whether or not a part is needed to be changed prior to its scheduled maintenance date. Whether you're looking for abnormal erosion, discoloration, actual damage, or even if the part is there at all, image quality can play a key part in this. Also, with the articulation control giving the ability to scan an entire area or the ability to rotate the probe, this is instrumental in helping the operator to see everything needed.

2. Used to locate and recover FOD.

In one case of airframe inspection, a borescope can be used to get in through cramped passages to assist in the location of FOD. In this type of application, a compact unit is especially handy. A customer using the older units that you must roll around to each inspection can take up unnecessary time in set up and takes away from actual time do to the inspection. This scenario can be alleviated by purchasing a portable battery powered unit so that the mechanic can easily travel from inspection area to inspection area without the need to haul around extra equipment and be held back by a power cable.

3. Saved time/money by decreasing time required to perform Inspection/ Maintenance if one were not available.

In our business, time is money. When an aircraft is on the ground it is not making money. A borescope allows maintenance technicians to quickly inspect necessary components, eliminating the needless downtime of the technician slowly tearing down the aircraft to visually inspect something by eye. Many maintenance facilities know the value of having a borescope available and if one is not in the facility, it's a huge rush to find one by either renting one or finding an economical option to purchase one.



4. Utilized to capture video/images in order for the manufacturer to make a timely decision on serviceability of inspection/maintenance findings.

The ability to record video and still images proves to be invaluable when tracking the history of wear and tear on aircraft engines, or on normal maintenance items that require

periodic inspection. This not only allows you to keep a history of an item that requires periodic inspection, but it allows you to take an image of damage or any abnormality. This can be advantageous when an inspector finds something that might require a second opinion. Instead of him having to remove the borescope, find the appropriate mechanic and then re-insert and spend time trying to find the item again, he can simply snap a picture or record the area in question and show it to the mechanic.

Borescopes, another valuable tool in maintain your aircraft and saving you time, money and man-hours in the process. A special note of thanks goes to the folks at Gradient Corp for their help with this article.