Reasons For Research

• To familiarize myself with the technology
• It is a very fast growing market
• It has revolutionized Medical diagnoses and treatment
Fiber Optics Principles

- Total Internal Reflection (TIR)
- Makes use of TIR to transmit light through a glass tube.
- When light travels from light to air a small fraction is reflected back in to the water.
- When light travels from glass to air at about an angle of 45° or more the light is totally internally reflected back into the glass.
Cross section of a glass tube
Numerical Aperture and Acceptance Cone

• To calculate the maximum angle at which total internal reflection we must consider the Numerical Aperture. (NA)

• NA is the maximum cone of transmittable light.

• It depends on the indices of refraction of the fibers core and cladding.
Basic optical fiber components

**FIGURE 4.7** Total internal reflection in a bent slab.
Fiber structure

- Its structure consists of an inner rod (central core) and outer tube (cladding).
- A fiber that has both a core and a cladding is called a clad fiber.
- The core has a higher index of refraction than the cladding.
- One that has no cladding is called an unclad fiber.
Maximum angle for transmission

- For light to be transmitted through a fiber $\alpha_0 < 33^\circ$.
- This causes total internal reflection
- If rays are incident at an angle greater than 33 degrees, they are refracted into the cladding layer and the air.
- The angle of the acceptance cone is called the angle of acceptance.
Acceptance Cone
Travel of light through the fiber

- Light rays travel through the fiber by totally reflecting several times and finally emerging at the end of the fiber.
- The distance traveled by ray between two consecutive reflections is given by
  \[ L_1 = \frac{d}{\tan \alpha} \]
  where \( d \) is the diameter of the core.
- If the total length of the fiber is \( L \), then the number of total internal reflections in the fiber is given by
  \[ N_1 = \frac{L}{L_1} = \left[ \frac{L}{d} \right] \tan \alpha \]
Travel of light through fiber

- Fiber optics transmit light whether or not the are bent.
- Also high reflectance is need in the fiber for maximum light transmission since intensity of the light decreases due to reflections.
Fiber Bundles

• For imaging applications we need thousands of fibers bundled together to be able to transmit images from point to point.

• So a fiber bundle is made up of tens of thousands of fibers inserted in a plastic tube.

• These are used in applications to image transmission and illumination.
Fiber bundles

- Bundles in which the fibers are systematically ordered are called ordered bundles and are used for image transmission.

- Bundles that are not ordered are called light guides and are used for illumination. Both types made it possible to manufacture imaging fiberscopes.
Fiber bundles
Fiberscope
Operation of the fiberscope

- The fiberscope is a device used for imaging external organs.
- An objective lens is attached to the distal end of the ordered bundle.
- Image is formed at distal end of the ordered bundle and transmitted to the proximal end.
- An illumination bundle attached to the light source is used to illuminate the object.
Operation Continued

• Another compound lens system (eye piece) is used to facilitate viewing of the image at the proximal end.

• A photographic camera can also be connected or a television (video) camera can also be connected to the proximal end of the bundle with a special adapter.
Focusing

- The focusing of the fiberscope can be adjusted by changing the distance between the objective lens and the fiber bundle.
- The optical set up is often designed to provide a fixed focus with large depth of focus.
Light Sources

• The light needed as the source is usually light from high-intensity lamps such as high-pressure Xenon, quartz halogen, or mercury lamps.

• This light is focused on the bundle end by a simple lens system.
The Operation of the Endoscope

• Much More complex so I have included that in my report.
The End

Questions?