APPLICATIONS OF NANOTECHNOLOGY IN AIRCRAFT

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CURRENT SITUATION

Aircraft manufacturers constantly attempt to develop and implement new ideas in aircraft design, results of which can be seen over the years [1]. The use of composite materials has increased in the aircraft industry, and have slowly replaced metals and alloys due to the following factors:

- Weight reduction – There is a significant difference in the weight of composite materials composed aircraft when compared to an aircraft with a metallic structure of up to at 8% [3],
- Fuel efficiency – Over time, the decreasing weight of aircraft has also decreased the fuel consumption [2],
- Cost effectiveness – The cost of building aircraft using composite materials is less when compared to the cost of building aircraft with metal and alloys.[1]

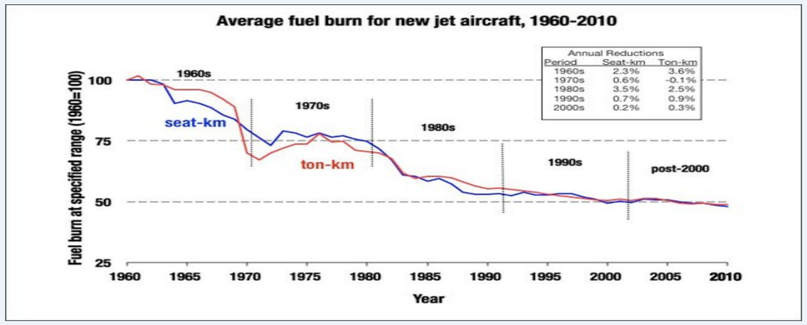

Figure 1: Cost Analysis chart [2]

PROBLEMS

Composite materials

- Brittle properties leads to unpredictability of failure,
- Inflammable, and hazardous to environment,
- Moisture absorption affects strength and overall performance [4],
- Delamination forms a structure with separate layers, which affects toughness, and strength [6],

Metals and alloy materials

- Corrosion weakens material and reduces operational life [6],

Figure 2: Passenger door plate corroded and cracked [5]

SOLUTIONS

- There have not been any reports of health hazards among workers who are involved in the manufacture of carbon nanotubes (CNT) [1],
- The nanotubes are made of carbon, which is not hazardous,
- CNT's are lighter and more ductile than the composite material currently being used [5],
- Due to the brittle nature of CNT's, the aircraft will be able to withstand higher amounts of stress, and so will not undergo Stress Corrosion Cracking (SCC),
- By using carbon nanotubes the amount of aluminum used in manufacturing aircraft will be minimized, hence reducing corrosion.[10]
- Embedded sensors pose a problem for the structure and integrity of the material, CNT enables us to get rid of the sensors and use the material as a sensor in itself,
- When CNT are incorporated within the existing material, self-sensing becomes easy as CNT's electrical property is used to detected damage,
- The property in question is electrical resistivity. When the physical state of a material changes its electrical resistivity changes also,
- When electrical resistance increases, it means the material sustained damage,
- This self-sensing ability can solve the issues of recurring unnecessary maintenance cost,
- Mapping out these the resistance with the help of a software could enable the pinpointing of a defect and accelerate the maintenance of the aircraft.

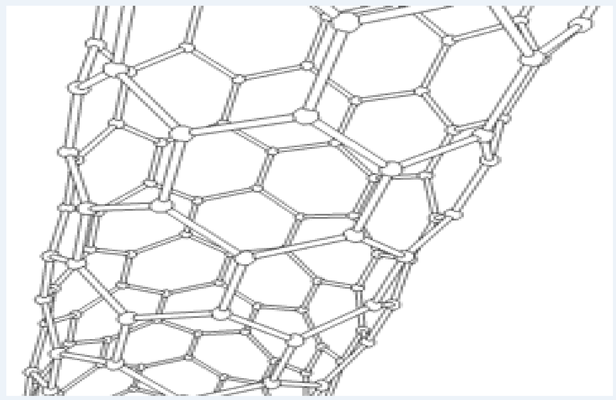

Figure 3: Structure of Carbon Nanotube

EVALUATION

Through the proposed solutions, nanotechnology could play a fundamental role in the development of the aerospace industry. This technology improves on the vital properties of the aircraft:

- Implementing carbon nanotubes in already existing composite materials would greatly increase the strength of the structure overall. Strength of materials in the aircraft industry is a significant issue,
- Carbon nanotubes are considerably lighter than the composite material currently being used. This would affect altitude traveled and fuel efficiency [9],
- Auto-detection of structural weaknesses and flaws with this new nanotechnology is possible. This means that check-ups and repairs will be more efficient and as a result, safety within the aircraft will also be enhanced,
- Carbon nanotubes are not metals therefore they do not have to be protected against corrosion.

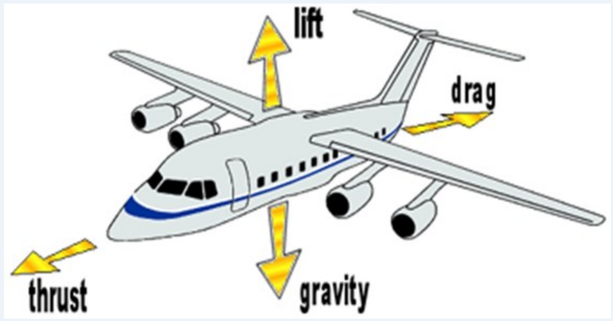

Figure 4: Forces on an aircraft [10]

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