NC Space Grant Report

Summer 2018

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Abstract

During the summer of 2018 I supported the Safety & Mission Assurance Directorate (SMA) and Operations Support Division (QA-20) at Stennis Space Center. The mission of the SMA team is to prove safety, risk, reliability, independent assessments, configuration management and quality assurance guidance, and services for all NASA Stennis Space center (SSC) programs, facilities, and supporting infrastructure. The office actively participates and contributes to the Agency-level Safety & Mission Assurance (S&MA) effort.

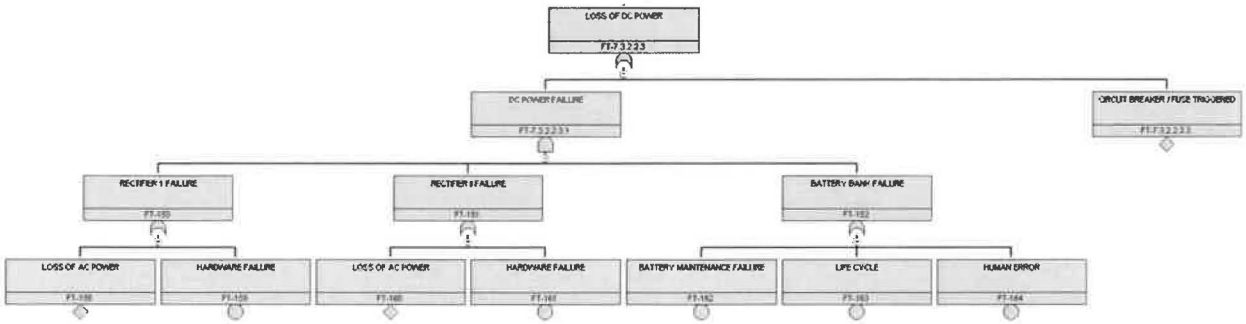
Over the course of the Summer I participated in three projects. Two of them were focused around Fault Tree Analysis (FTA) and the third focused on relief valves for their E-1 engine test stand.

Project 1

Fault Tree Analysis (FTA) is a method of analysis where a large problem is broken into as many smaller problems as possible. A fault tree typically resembles a tree with its roots. The ultimate issue rests at the top of the tree while its children rest below it. Such charts are necessary in recognizing where smaller problems could lead into larger problems.

In preparation for the Space Launch System test, current fault trees needed to be moved to a more recent software. To assist with this I recreated the B-2 and E-1 fault trees into NASA's Root Cause Analysis Software (RCAT).

Each individual branch looked similar to this:



On the small scale, the tree looks nice, however when more branches are added the tree begins to break down. Each tier on the tree is contained on the same level, which causes the fault tree to become very long when placing adjacent braches in the tree.

The end result:

This chart is quite long, too long for practical use.

One of the goals of the importation was to make the fault tree modular, and the RCAT software had no capacity to do so.

Project 2

The current software at my disposal for RCAT proved not to be adequate for supporting large fault tree. A new software needed to be selected.

A few software were looked at

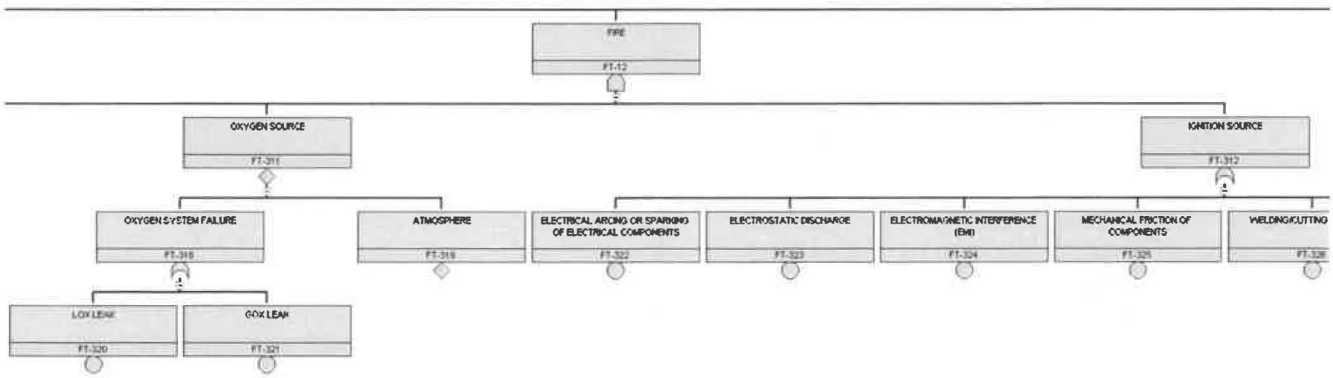
- CAFTA
- RCAT
- Windchill FTA
- Sapphire

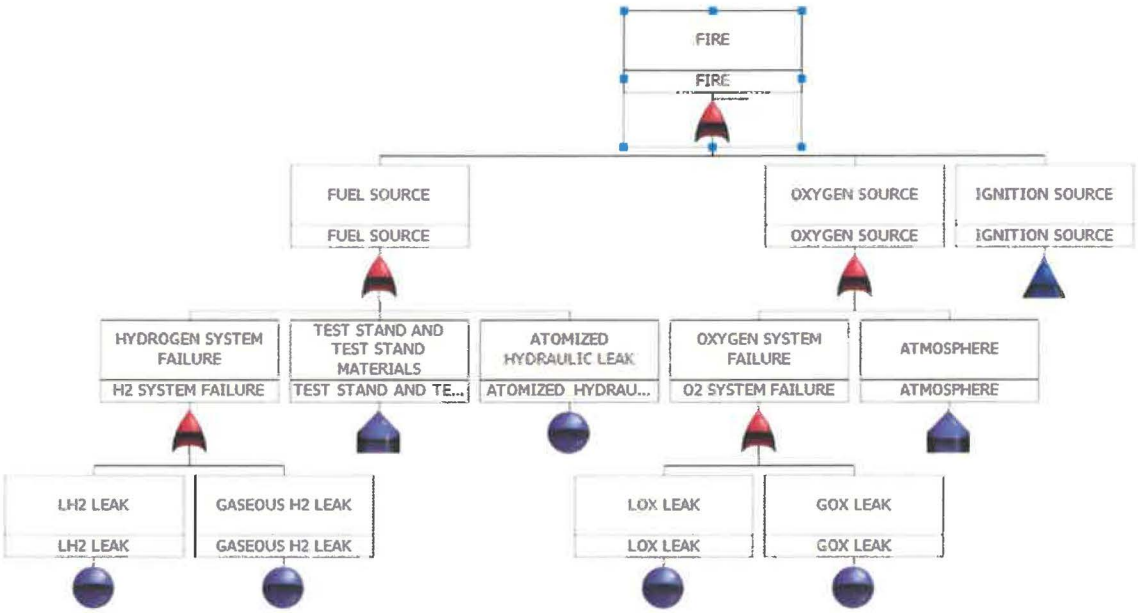
And a few main traits were focused on

- Ease of use, flexibility
- Cost to procure/use
- Update frequency, product support
- Ability to modularize fault trees
- Ability to track and verify implementation of recommended controls/mitigations
- Ability to support RCA, E&CFTA, and FMEA
- Capability to integrate within the SSC Design and Data Management System (DDMS)

Although all software programs perform a similar function, each had their quirks and advantages. For example, RCAT is very simple and easy to use, but it is very bare bones. Windchill is more complex but is able to do more.

Below are two recreations of the same tree in different in software. Top is RCAT, bottom is Windchill



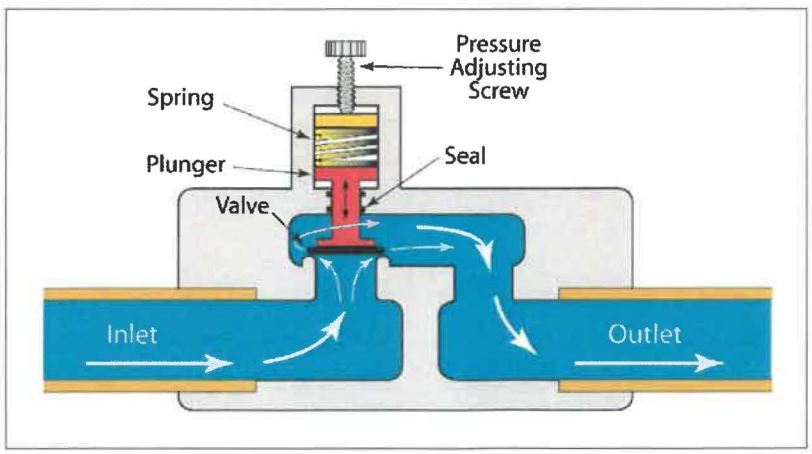


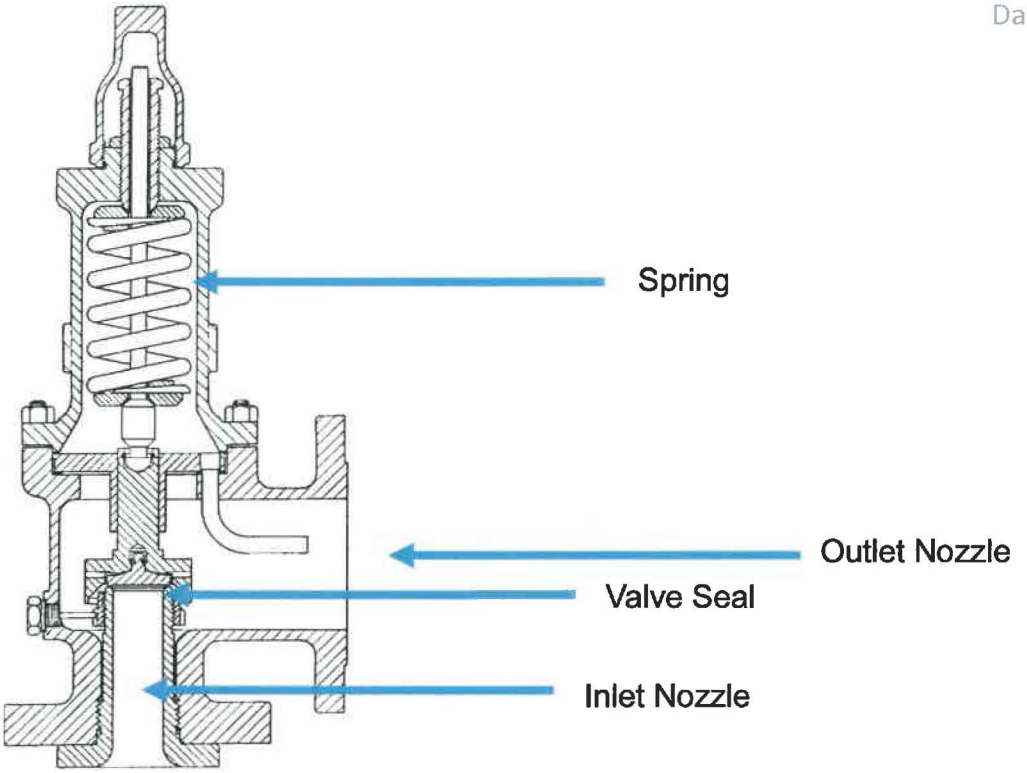
Due to the flat structure of RCAT, the whole FTA cannot be represented in this small space, while the Windchill FTA can fit quite comfortably. This is due to the fact Windchill FTA has transfer gates (represented by a triangle) which link to stand alone trees. The gate content is displayed elsewhere, allowing representation of a complete branch. Windchill may also linked to SSC's DDMS.

Each software has its tradeoffs and one needs to determine what they value most

Project 3

Relief valves (RV) are used for pressure regulation in high pressure systems. Piping systems are rated to a certain pressure, and pressure about the rated pressure could break the system. Relief valves are placed to ensure the pressure does not go over the design. When pressure goes over the standard, the relief valve triggers, and ejects excess fluid out of an outlet until the allowed pressure is reach





Recently there was a close call where an RV operated while a worker was nearby. The RV outlet was aimed in close proximity to where a worker was standing, and the worker was nearly sprayed with sub-zero gaseous nitrogen

In order to avoid similar events, a walk down of the E-complex was performed to identify other relief valve/device discharge outlets which may present hazards.

Along with the area SMA representative from QA20, we referenced the Piping schematics and walked down the system evaluating each RV discharge outlet in relation to personnel work areas. A few potential hazards were found. Relief valve outlets were positioned where they would release where a worker would commonly stand. Steps are currently in work to have the relief valve discharges reconfigured.