Auto-link UAV to CAD:

Software to Bridge the Gap Between UAV Design Optimization and CAD

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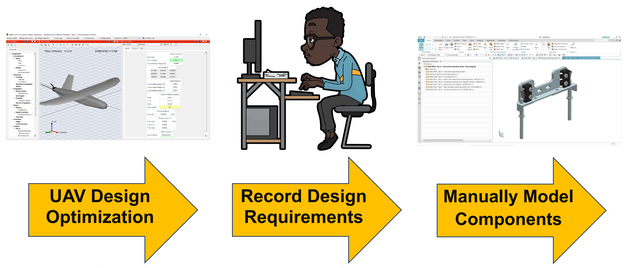
1. Introduction

Currently the method to design, optimize and model unmanned areal vehicles (UAVs) looks like this:

Current, flawed UAV development process



Programs optimize the structural design and topology of UAVs and computer aided design (CAD) is used to model the UAVs. However, there is room to:

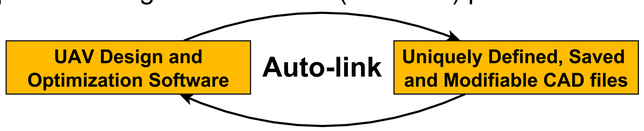
- Streamline UAV development
- Reduce time and cost to develop an optimal structure
- Improve accessibility, quality, and consistency
- Make models more reliable and with fewer errors

2. Objectives

- Address the overall UAV development process, linking UAV design optimization software and CAD though an integrated software interface
- Have component creation, dimensioning, and model assembly automatically accomplished with little or no intervention

3. Approach

Plan and organize the CAD model such that the outputs of the UAV design optimization software become the inputs to the CAD development through an automatic (Auto-link) process:



Streamlined Auto-link UAV development process

4. Software

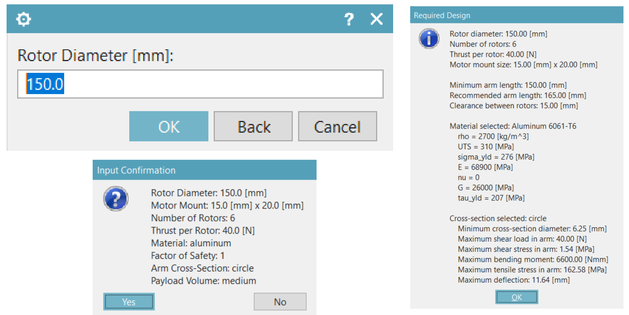
The Auto-link interface requires three software elements:

- Comquest Venture's Typhon UDX to serve as the UAV aerodynamic optimization software
- A Python interpreter to develop the software interface
- Siemens NX CAD software, with licensing for NXOpen (a collection of application programming interfaces)

Key to the linkage: Program NXOpen commands in a Python script (journal), run the journal through the developer tab in Siemens NX.

5. Auto-link Software Interface

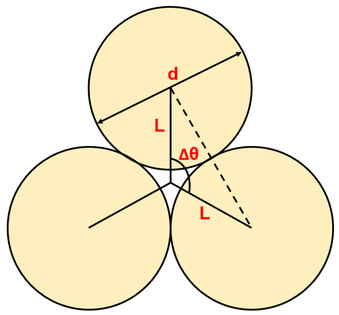
To transfer the design requirements from Typhon UDX to NX a custom user interface was created with NXOpen:



Custom user interface

The parameters “Auto-linked” include:

- Rotor diameter
- Motor mount bolt specifications
- Number of rotors
- Thrust per rotor
- Body and arm material
- Factor of safety
- Arm cross-sectional shape
- Payload volume

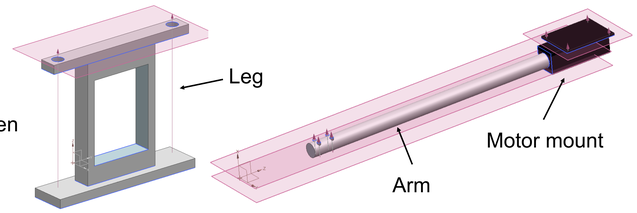


Example geometry problem for a three-rotor UAV

Required arm length is calculated from geometry, arm cross-section is calculated using Euler-Bernoulli Beam Theory for a cantilever beam under static loading. Given the design requirements:

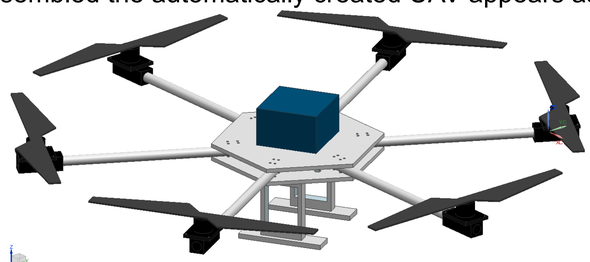
- Each component is modeled individually in CAD
- Each component and the final assembly are uniquely defined, saved, and modifiable part files which can be edited using NXOpen or by opening the file within the NX application
- Assembling the components to form the assembly is through the use of datum planes and datum axes, allowing for:
  - ◊ Appropriate tolerancing
  - ◊ Maintaining concentricity
  - ◊ Keeping the assembly intact after changes to part geometry

Sample components created using NXOpen



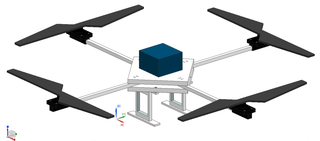
6. Results and Discussion

When assembled the automatically created UAV appears as follows:



Hexcopter created with Auto-link

A wide range of multi-rotor UAVs can be made extremely quickly with no modifications required to the program.



Small like DJI Mavic Mini quadcopter

Large like Skyfront Perimeter 8 octocopter

The Auto-link approach is significantly faster and more reliable:

Component to be Modeled	Avg. Time Manually [s]	Time with Auto-link [s]	% Decr.
Arm and Motor Mount	1322.00	3.06	99.77
Leg	777.00	12.38	98.41
Top Body Plate	1292.50	20.94	98.38
Bottom Body Plate	1307.50	19.47	98.51
Motor and Propeller	152.00	16.05	89.44
Instrument Box	30.00	0.50	98.33
Assembly	427.00	6.99	98.36
Total: Creation & Assembly	**5308.00**	**79.39**	**98.50**

Auto-link can also reduce the number of errors when modeling with CAD, such as incorrect tolerancing, not fully defining materials, and improperly constrained assemblies.

7. Conclusion

The gaps between UAV design optimization software and a final CAD can be addressed by auto-generating optimized UAVs. The Auto-link software demonstrated that a variety of UAVs can be modeled using this approach. The Auto-link software can model any multi-rotor in under 80 [s], which is much quicker and more reliable than the current manual method. Extending this research to more complex designs or other industries is possible and will have a significant impact on time and costs for CAD development. Linking UAV design and optimization software and arriving at a final CAD through an integrated approach, eliminating the need for specialized CAD designers, is proving to be an enabling technology for improving the accessibility, quality, and consistency of UAV design.

Acknowledgements

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