

Appendix A: Assignment description template

- Fill all the areas of the template below and submit it to g.larocca@tudelft.nl for evaluation.
- When submitting the proposal, please **name the file** as in this example: **KBEproposal_Team 10_deVries_Jansen.pfd**
- Assignments proposal that are not compliant to the proposed template, or are incomplete will be rejected without feedback

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Generation of a KBE app to support the design of an electric airplane wing.

The design challenge that is going to be tackled in this KBE app is that of designing a wing of an electric airplane. Since sustainability is becoming more and more of a concern, electric and hydrogen aircraft are on the rise and their design is a hot topic. However, since they are radically different in loading and weight distribution than a regular airplane, it is necessary to integrate all these additional parts like wiring, multiple engines, batteries etc. This can be done using a KBE app. This immediately explains why it would be logical to make a KBE app for this and not use basic Python or Matlab. Because there are a lot of factors influencing each other and many combined designs are required, a KBE app can have a drastic impact on the design in the positive sense. Additionally for manufacturing and production, CAD is a must and the KBE app can help in that aspect as well.



Source: <http://skysoftairlines.blogspot.com/2010/06/indonesias-new-19-seater-entering.html>

----- do not exceed 400 words ----- use a couple of explanatory figures -----

Rule based parametric model requirements

Describe here the main functionalities of the rule based parametric model, which will be the core of your KBE application

- What systems components/features will be included in the parametric model?
- What are the main parameters used to define and control the various components/features?
- What are the main (engineering) rules governing the definition/interface of the various model components? Identify the main sources you will use to capture knowledge
- How will your app deal with rules violation? (warnings, automatic corrections, change suggestions)

----- max 2 pages including explanatory figures -----

The main functionalities of the rule based parametric model will be the following:

Using an input data set of layout of the wing, including span, chord, airfoil and aspect ratio, the app will find the required number and placing of spars, ribs, and stringers. This is from the structural point of view and depending on these fairly easily obtainable parameters, the model will use structural engineering as main background.

Additionally, the model will find the best place to attach the engines and wiring based on the structural model and iterating the two. This will partially be a structural engineering problem but also a Propulsion and Electrical Engineering approach. Rules for correct wire placement/distancing will be applied here.

Then, it will take the available battery mass/volume and calculate (using the internal analysis tool) the aircraft performance/range. The fuselage will not be able to hold any batteries, to simplify the model.

A size for a single battery pack will have to be provided, and the application will place these as blocks into the wingbox, taking into account the available dimensions and possible obstacles (such as flaps mechanisms).

These parts will be combined to form the full rule based parametric model and it combines structural, propulsion, and electrical engineering.

If required inputs are not provided, the application will show a notification asking for the required input, and to restart the calculation after the input has been entered.

For other rule violations notifications will be displayed, and based on the severity the program will either continue or terminate.

Internal analysis capabilities

- What analysis modules (capabilities) will be implemented **inside** your KBE application, thus coded in ParaPy. **At least one** internal analysis module should be present.

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Have external tools calculate L/D (probably Q3D), and use this, coupled with some ADSEE I type methods (to estimate masses and drag from other components), to calculate the possible range.

After the external tool EMWET has calculated the required thickness of the wingbox panels, an internal tool will analyse the torsion along the span, and determine the skin thickness required to withstand these torsional moments. If this is less than the thickness provided by EMWET, the difference will be subtracted from the skin and replaced with stringers.

Link(s) with external analysis module(s)

- What **external** analysis module will be connected to your KBE app? How will your app interact with such applications? **At least one** external analysis tool/module should be present. Examples of external tools/modules are AVL, XFOIL, EMWET and Q3D (from the MDO course) or some python or matlab code you developed yourself in some other course. The condition is that this external module is used as an off-the-shelf tool, thus not produced in ParaPy. Note that no points can be scored for the eventual development of such external modules/tools. Only the merit of the integration/connection of such tools/modules to your ParaPy app will be assessed.

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The tool EMWET will be used in order to calculate the thickness of the wingbox panels. Some supplementary matlab code will be utilized to generate the files required by EMWET.

In order to be able to calculate the range, the aerodynamic performance has to be calculated. For this, the matlab tool Q3D will be used, along with some additional matlab code to supply the correct input files.

Input data handling capabilities

- What data sets will be provided as input to your KBE app?
- In which format will the input data sets be defined?
- Which data (sub)set will be interactively editable in the ParaPy GUI?

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The main dataset that is required as an input to the KBE app is a general representation of the aircraft including main parameter such as wingspan, aspect ratio, CG and general dimensions. This dataset can be imported in an Excel sheet or text file and this will be a fairly straight forward sheet to fill in. Additionally, we would like the wingspan and general wing layout to be editable in the ParaPy GUI including things like the number of engines and the battery specifics. This way the app is a little bit more flexible and easier to change things.

Output data reporting capabilities

What output files is the KBE app supposed to generate and in what format?

At least one STEP(or IGES) file and one output file containing results from the analysis modules.

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The main outputs of the KBE app are going to be the STEP file to be used for 3D visualisation, an overview of the locations of the spars, ribs and stringers, and a description of the electrical wire routing as text or Excel files. Also a text file with the aircraft range will be an output.