# Concurrent Design Facility (CDF)

Prepared by:

Mohamed El-Hady Keshk

PhD student in Embedded System Lab.

# CDF-Concept

- Concurrent Design Facility (CDF) is an environment where engineers of different specialties come together to perform conceptual design for a satellite project.

- It is designed for the quick and efficient conceptual design of space systems ensuring consistent and high-quality results in a much shorter time.

# CDF-Concept

In Which Phase….?

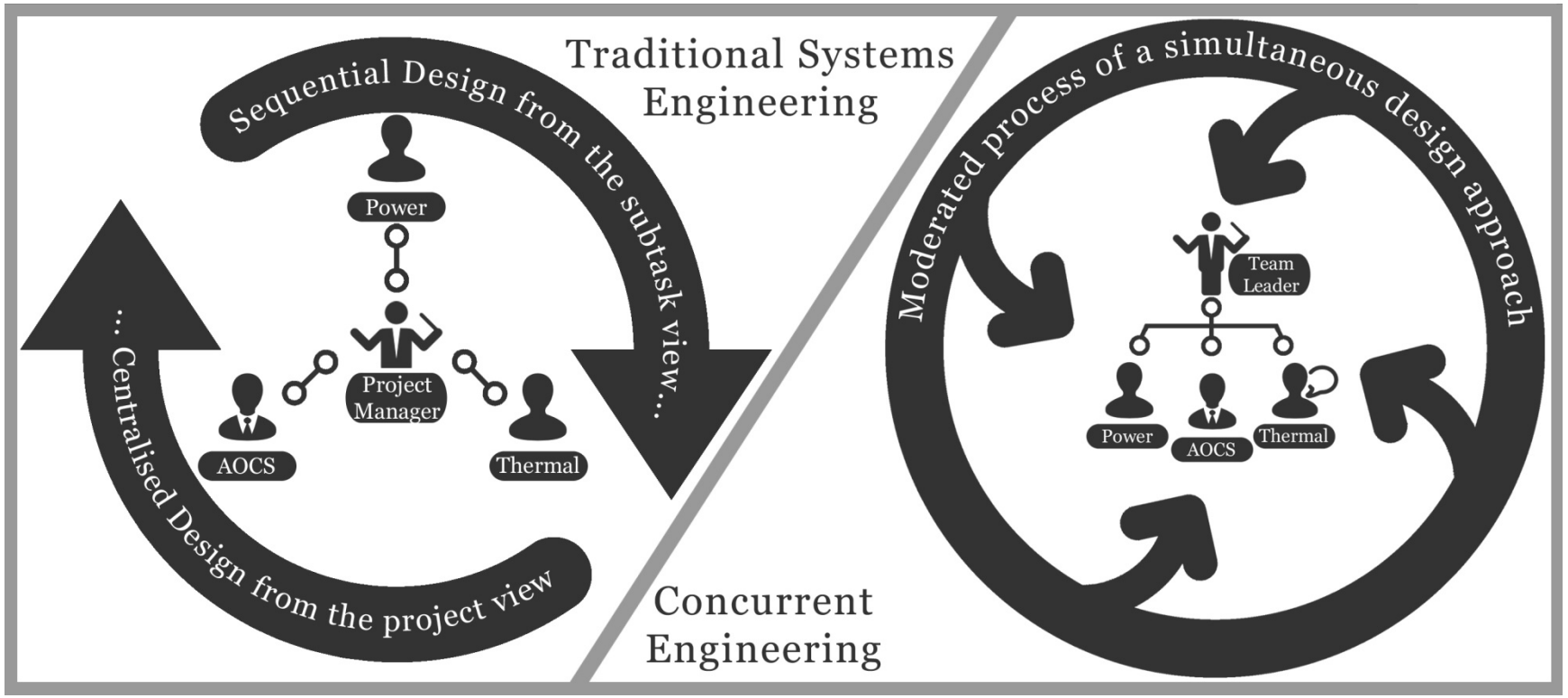
pre-phase A or Level-0 assessment studies

- assess the technical and financial feasibility of future space missions.

Providing …..?

- new mission concept assessment
- space system trade-offs and options evaluation
- new technology validation at system/mission level
- payload instrument conceptual design
- reviews of industrial phase A studies
- scientific requirements definition and consolidation
- education and training

# CDF Vs. Traditional System Engineering




http://www.dlr.de/irs/en/desktopdefault.aspx/tabid-11079/#gallery/27740

# CDF- which Agencies are using it…?

- ESA
  - Concurrent Design Facility (CDF) at European Space Research and Technology Centre (ESTEC ) (1998)
- NASA
  - Collaborative Modeling for Parametric Assessment of Space Systems (COMPASS) (unofficially in 2000 )
  - Concurrent Mission and Systems Design at NASA Glenn Research Center (officially 2006)
- Agenzia Spaziale Italiana (ASI)
- Centre National d'Etudes Spatiales (CNES)
- JAXA - Mission Design Center
- German Aerospace Center (DLR) - Concurrent Engineering Facility
- Egyptian Space Program (ESP) – Concurrent Design Center (2012)

# CDF-Team

- Prof. Yousry El-Nahhas (ESP Chairman)
- Eng. Osama El-Sayed (Team Leader)
- Eng. Yousry Solaiman (Network Engineer)
- Eng. Mohamed El-Hady (Software Engineer )

# CDF - Elements

- **The Facility:**
  - The room itself.
  - IT and communications hardware.
  - the specialist space mission design software that enable engineers to design individual elements of a complex mission.

- **The Software:**

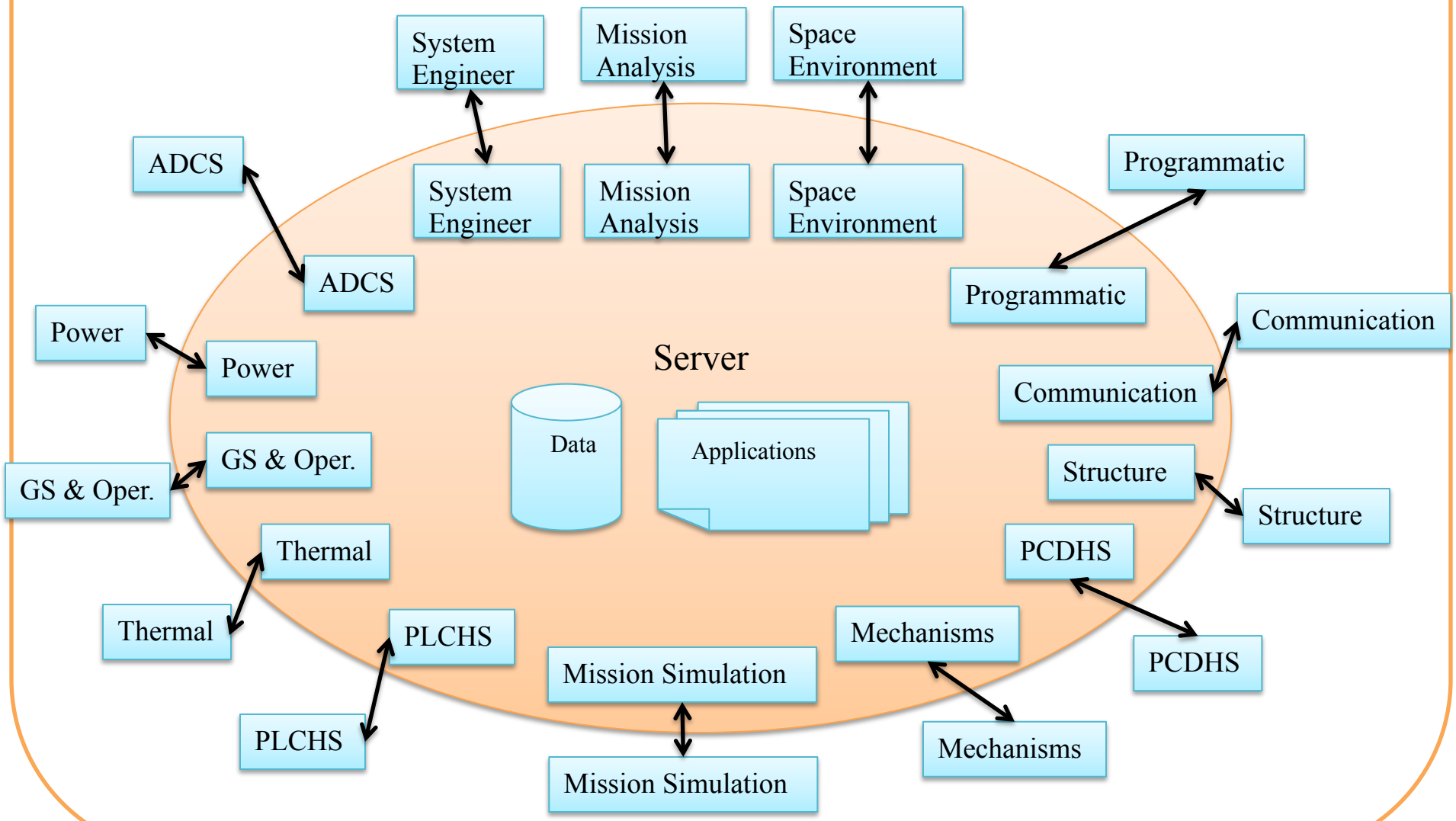
Is the design database software which automatically links the design of the individual elements of a mission into a coherent system (MS Excel)

- **The Methodology:**

The process for efficiently coordinating the design activities of Engineers in a concurrent design environment.

These three elements of the CDF enable a space concepts to be quickly and efficiently evaluated from technical, financial and programmatic points-of-view

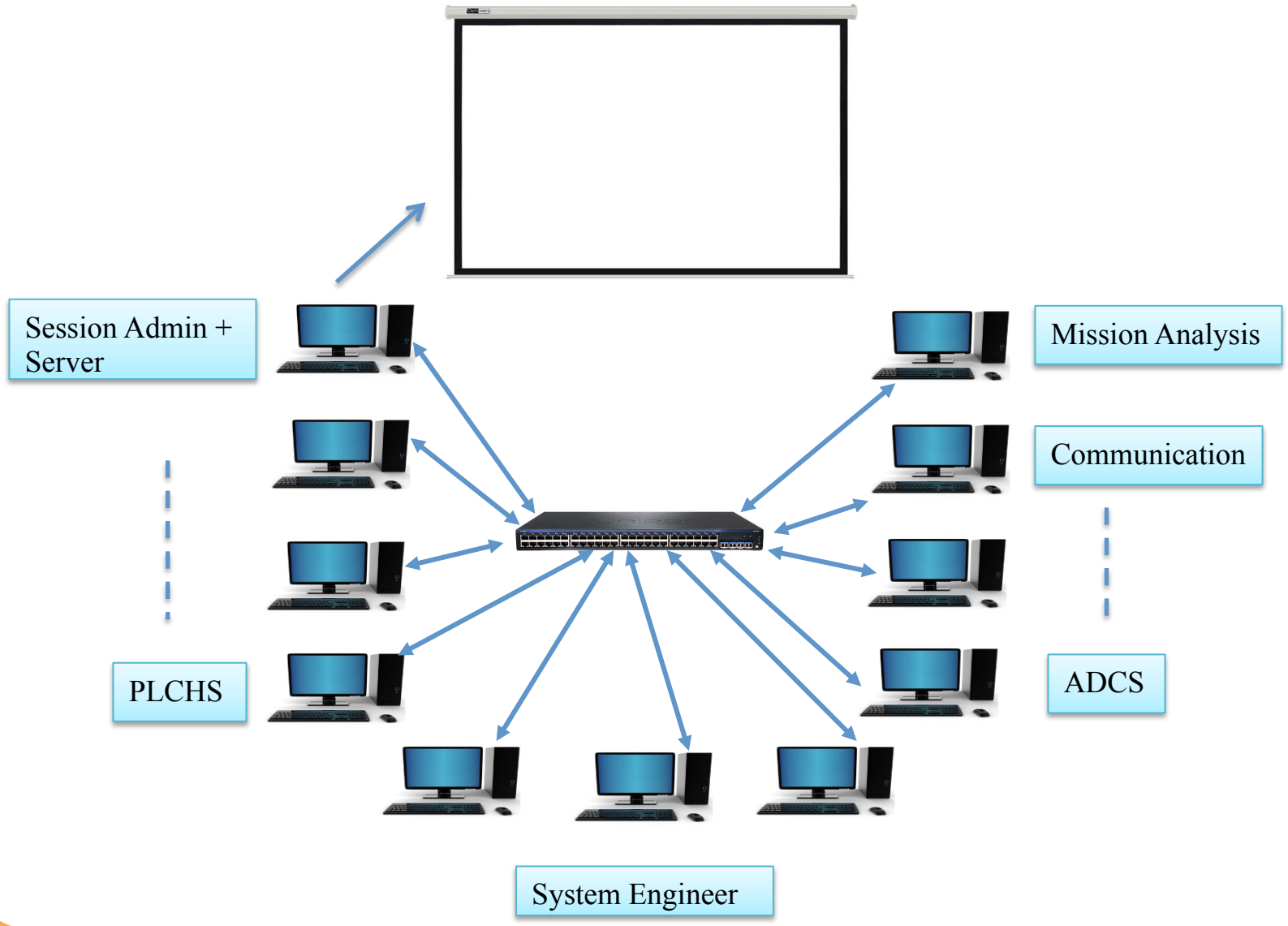
# CDF- Architecture



# CDF- Equipment

- The CDF room contains 13 desktops, 2 Workstations and 1 server.
- Each subsystem is capable of showing its data on the screen and the session administrator can switch between various subsystems.
- There is1 projector.

# CDF- Layout


Session Admin + Server
Mission Analysis
Communication
PLCHS
ADCS
System Engineer

# CDF- Software

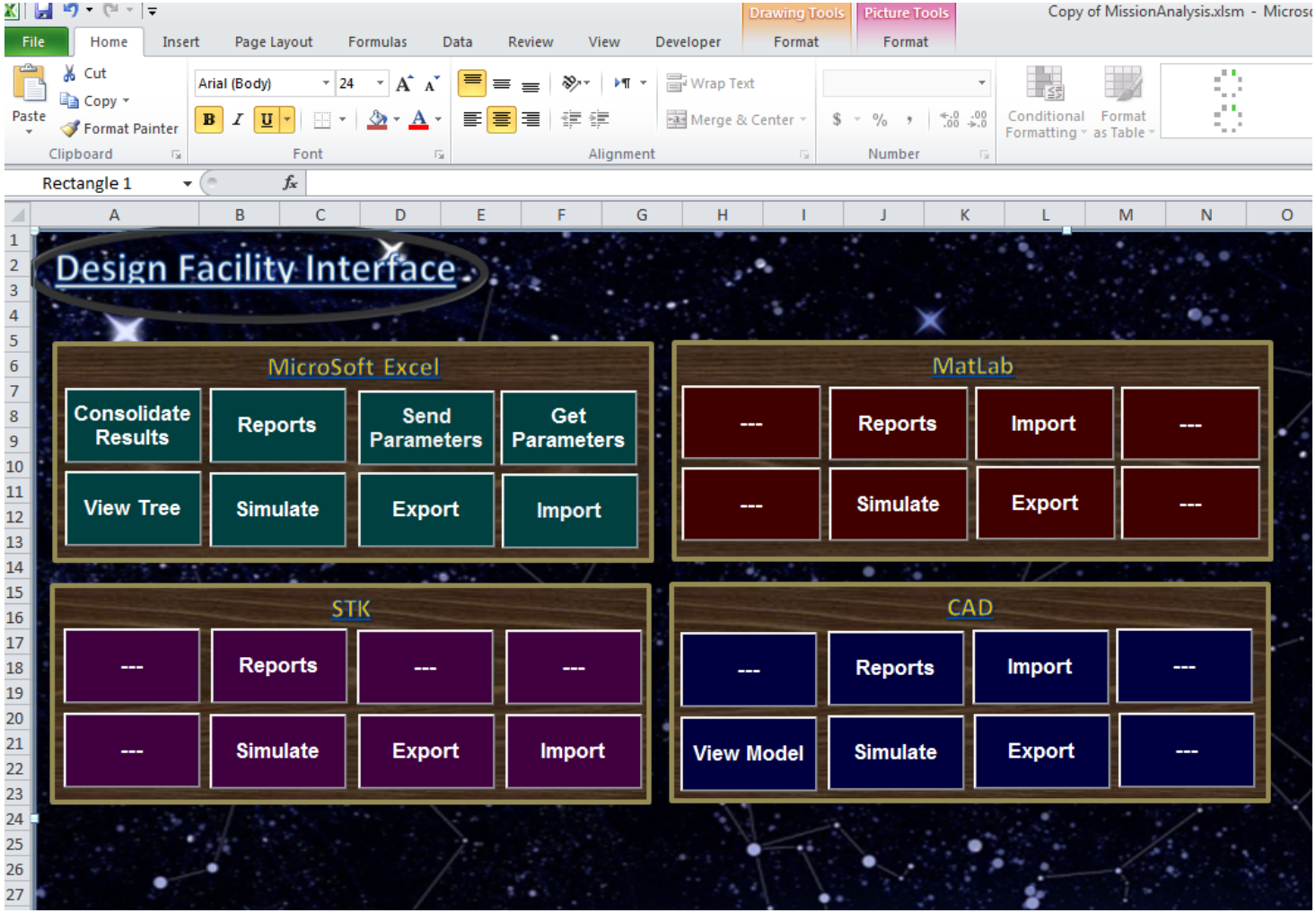
- Software is a set of Excel macros and visual basic codes.
  - ➢ included interaction between various software packages to improve productivity during sessions.
- The system is capable of interfacing with STK, MATLAB and CAD software packages.
- The software allows to introduce many parameters for the system and summarize necessary data for the most important trades.
- requirements tracking. All requirements are entered to database via a specialized interface on an Excel sheet.
- The interface allows to initiate, edit, confirm or validate requirements. User level access is controlled, hence subsystem engineers only have access to requirements from their subsystem.

# CDF- Tools

- One of the problems in concurrent design is to back track to a particular decision point, or understand why a particular decision was taken.
  - A simple version control system is implemented.

- To allow efficient exchange of parameters and modification of designs during session.
  - subsystem sheets are linked directly with engineering tools used at the CDF.
  - Structures Subsystem → CAD Tool
  - Mission Analysis, Power and Telecommunications subsystems → STK
  - Mission Analysis → MATLAB
  - Some specific models are being implemented in MATLAB and data are being exchanged by means of an Text file.

# CDF-GUI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Review
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Developer
Drawing Tools
Format
Picture Tools
Format
Cut
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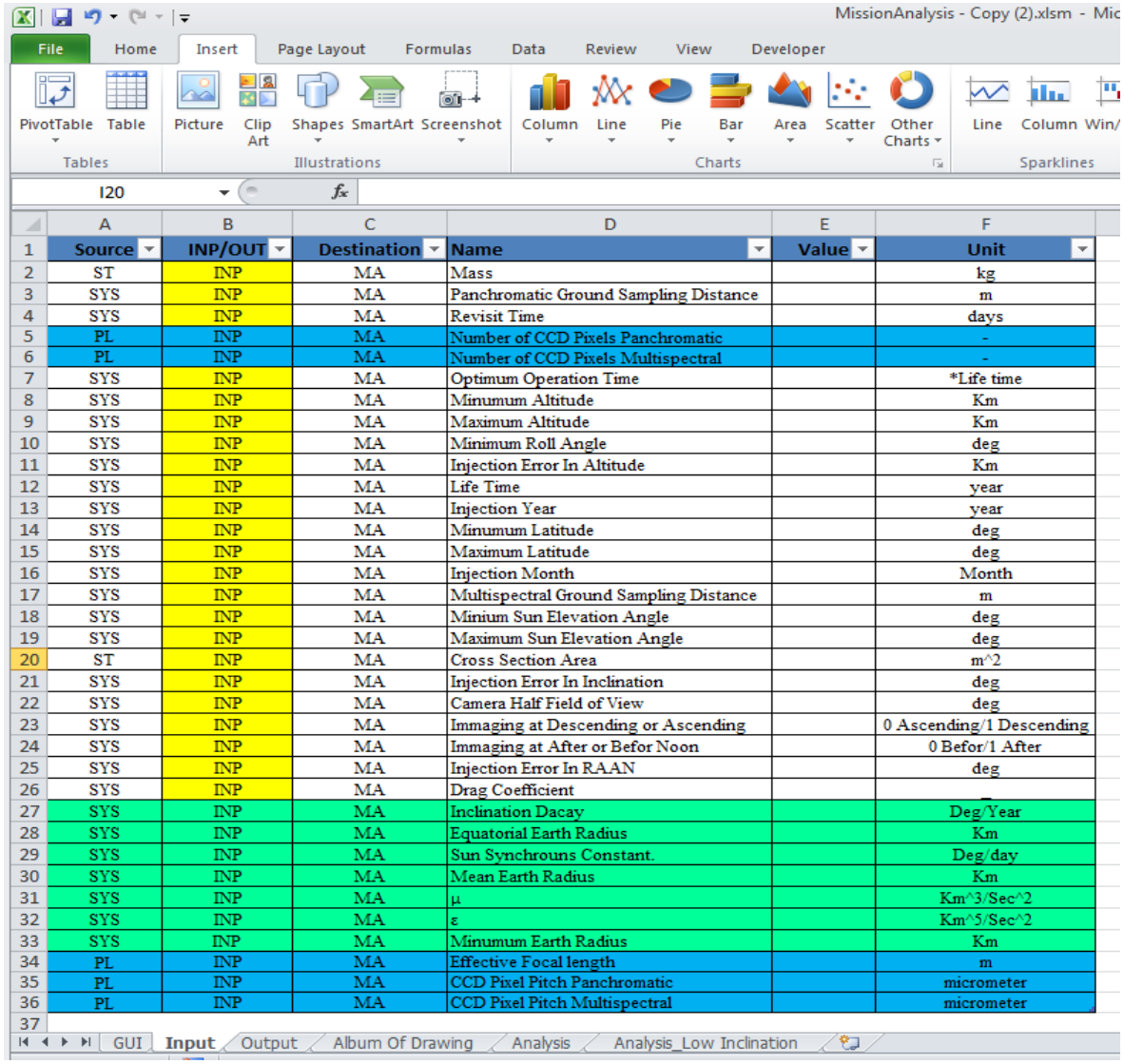
Format Painter
Paste
Clipboard
Arial (Body)
24
Font
Wrap Text
Merge & Center
Alignment
Number
Conditional Formatting
Format as Table
Rectangle 1
Design Facility Interface
MicroSoft Excel
Consolidate Results
Reports
Send Parameters
Get Parameters
View Tree
Simulate
Export
Import
MatLab
---
Reports
Import
---
---
Simulate
Export
---
STK
---
Reports
---
---
---
Simulate
Export
Import
CAD
---
Reports
Import
---
View Model
Simulate
Export
---

# CDF-GUI-MATLAB

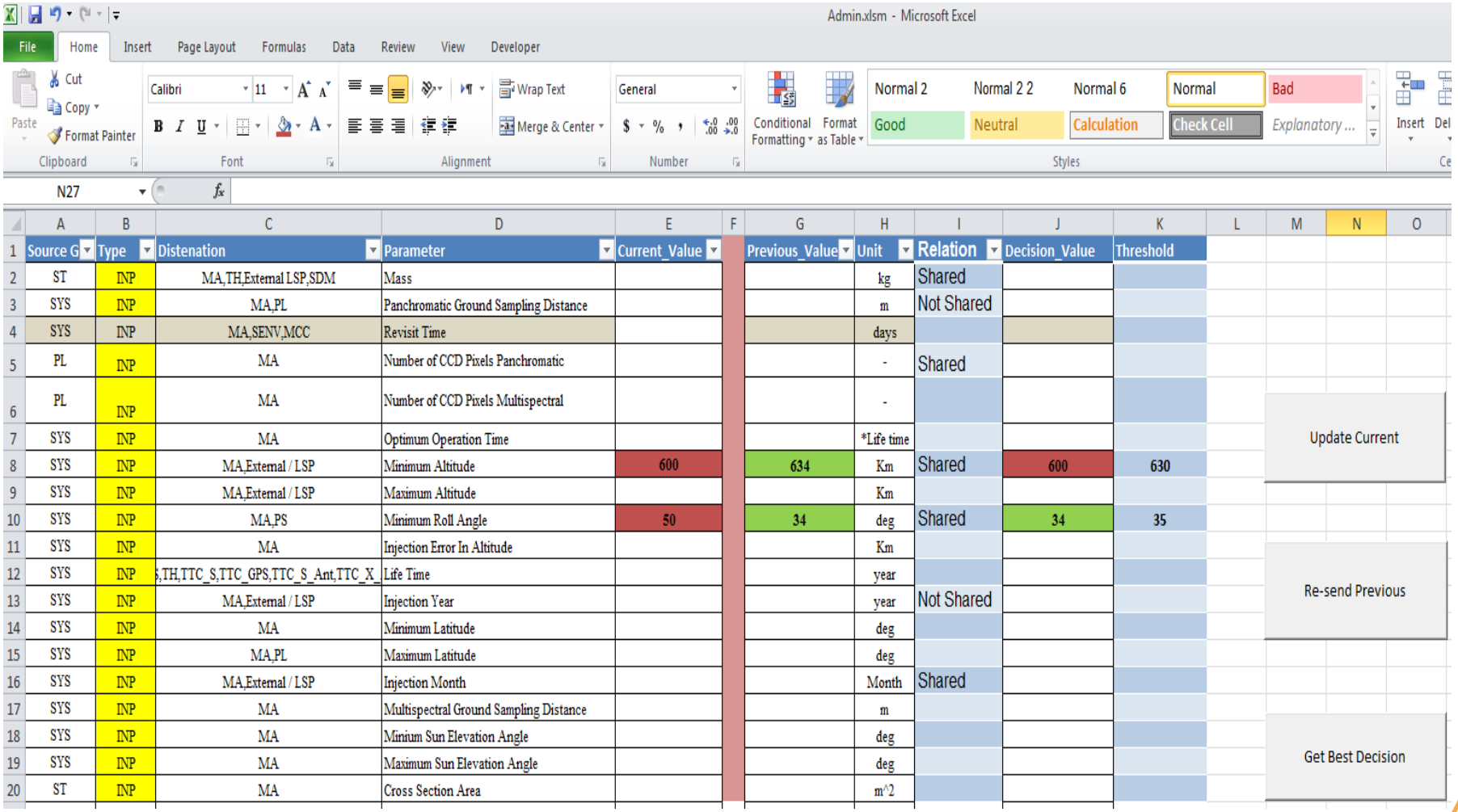
- Import Data
  - Text file (.txt) →MATLAB workspace
- Export Data
  - MATLAB workspace → Text format (.txt)
- Simulate
  - Import MATLAB file (.m) and run this file

# CDF-Sheet Example



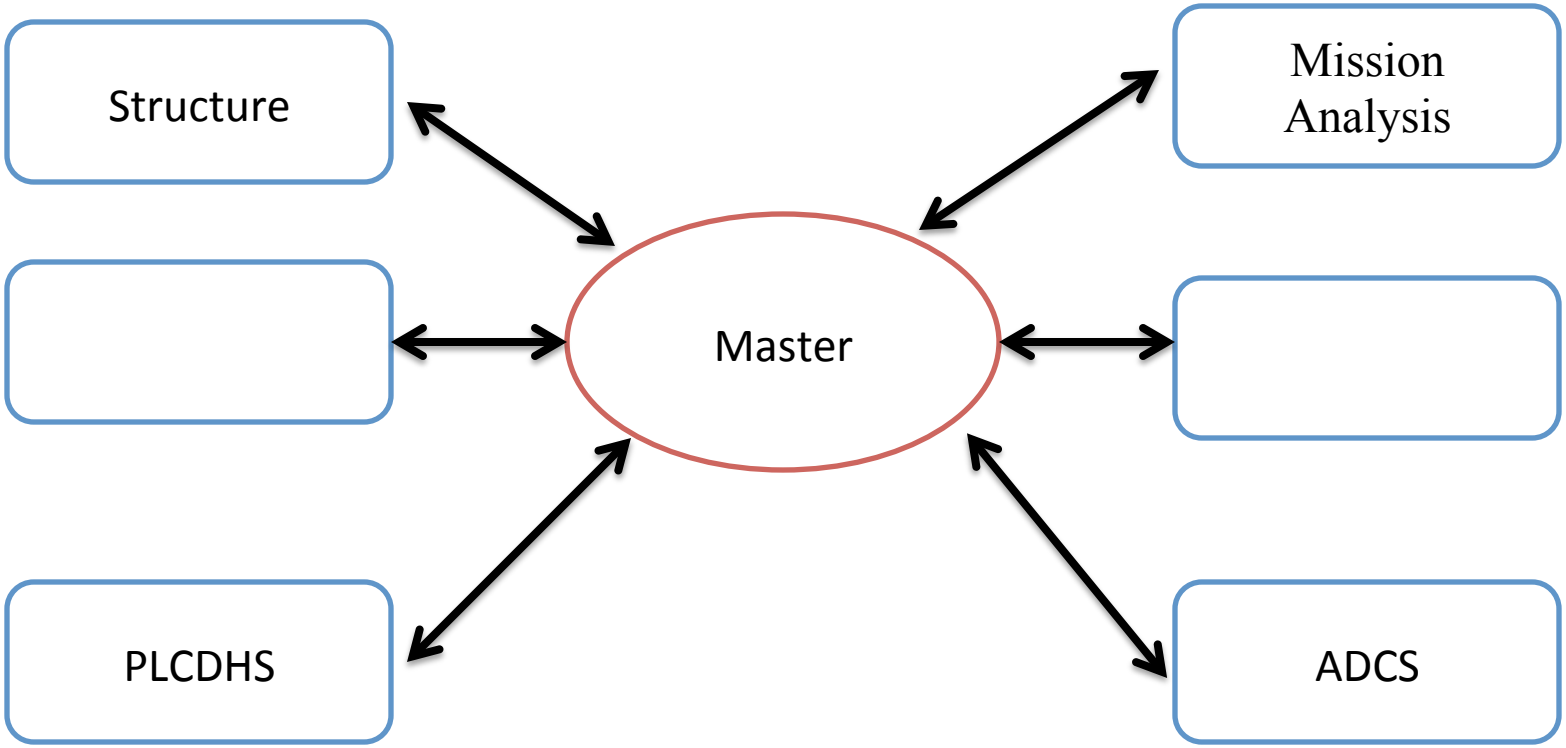

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Source | INP/OUT | Destination | Name | Value | Unit |
| 2 | ST | INP | MA | Mass | | kg |
| 3 | SYS | INP | MA | Panchromatic Ground Sampling Distance | | m |
| 4 | SYS | INP | MA | Revisit Time | | days |
| 5 | PL | INP | MA | Number of CCD Pixels Panchromatic | | - |
| 6 | PL | INP | MA | Number of CCD Pixels Multispectral | | - |
| 7 | SYS | INP | MA | Optimum Operation Time | | *Life time |
| 8 | SYS | INP | MA | Minumum Altitude | | Km |
| 9 | SYS | INP | MA | Maximum Altitude | | Km |
| 10 | SYS | INP | MA | Minimum Roll Angle | | deg |
| 11 | SYS | INP | MA | Injection Error In Altitude | | Km |
| 12 | SYS | INP | MA | Life Time | | year |
| 13 | SYS | INP | MA | Injection Year | | year |
| 14 | SYS | INP | MA | Minumum Latitude | | deg |
| 15 | SYS | INP | MA | Maximum Latitude | | deg |
| 16 | SYS | INP | MA | Injection Month | | Month |
| 17 | SYS | INP | MA | Multispectral Ground Sampling Distance | | m |
| 18 | SYS | INP | MA | Minium Sun Elevation Angle | | deg |
| 19 | SYS | INP | MA | Maximum Sun Elevation Angle | | deg |
| 20 | ST | INP | MA | Cross Section Area | | m^2 |
| 21 | SYS | INP | MA | Injection Error In Inclination | | deg |
| 22 | SYS | INP | MA | Camera Half Field of View | | deg |
| 23 | SYS | INP | MA | Immaging at Descending or Ascending | | 0 Ascending/1 Descending |
| 24 | SYS | INP | MA | Immaging at After or Befor Noon | | 0 Befor/1 After |
| 25 | SYS | INP | MA | Injection Error In RAAN | | deg |
| 26 | SYS | INP | MA | Drag Coefficient | | |
| 27 | SYS | INP | MA | Inclination Dacay | | Deg/Year |
| 28 | SYS | INP | MA | Equatorial Earth Radius | | Km |
| 29 | SYS | INP | MA | Sun Synchrouns Constant. | | Deg/day |
| 30 | SYS | INP | MA | Mean Earth Radius | | Km |
| 31 | SYS | INP | MA | μ | | Km^3/Sec^2 |
| 32 | SYS | INP | MA | ε | | Km^5/Sec^2 |
| 33 | SYS | INP | MA | Minumum Earth Radius | | Km |
| 34 | PL | INP | MA | Effective Focal length | | m |
| 35 | PL | INP | MA | CCD Pixel Pitch Panchromatic | | micrometer |
| 36 | PL | INP | MA | CCD Pixel Pitch Multispectral | | micrometer |
| 37 | | | | | | |

# CDF-Validation




| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Source G | Type | Distenation | Parameter | Current_Value | | Previous_Value | Unit | Relation | Decision_Value | Threshold | | | | |
| 2 | ST | INP | MA,TH,External LSP,SDM | Mass | | | | kg | Shared | | | | | | |
| 3 | SYS | INP | MA,PL | Panchromatic Ground Sampling Distance | | | | m | Not Shared | | | | | | |
| 4 | SYS | INP | MA,SENV,MCC | Revisit Time | | | | days | | | | | | | |
| 5 | PL | INP | MA | Number of CCD Pixels Panchromatic | | | | - | Shared | | | | | | |
| 6 | PL | INP | MA | Number of CCD Pixels Multispectral | | | | - | | | | | | | |
| 7 | SYS | INP | MA | Optimum Operation Time | | | | *Life time | | | | | | | |
| 8 | SYS | INP | MA,External / LSP | Minimum Altitude | 600 | | 634 | Km | Shared | 600 | 630 | | | | |
| 9 | SYS | INP | MA,External / LSP | Maximum Altitude | | | | Km | | | | | | | |
| 10 | SYS | INP | MA,PS | Minimum Roll Angle | 50 | | 34 | deg | Shared | 34 | 35 | | | | |
| 11 | SYS | INP | MA | Injection Error In Altitude | | | | Km | | | | | | | |
| 12 | SYS | INP | ,TH,TTC_S,TTC_GPS,TTC_S_Ant,TTC_X_ | Life Time | | | | year | | | | | | | |
| 13 | SYS | INP | MA,External / LSP | Injection Year | | | | year | Not Shared | | | | | | |
| 14 | SYS | INP | MA | Minimum Latitude | | | | deg | | | | | | | |
| 15 | SYS | INP | MA,PL | Maximum Latitude | | | | deg | | | | | | | |
| 16 | SYS | INP | MA,External / LSP | Injection Month | | | | Month | Shared | | | | | | |
| 17 | SYS | INP | MA | Multispectral Ground Sampling Distance | | | | m | | | | | | | |
| 18 | SYS | INP | MA | Minium Sun Elevation Angle | | | | deg | | | | | | | |
| 19 | SYS | INP | MA | Maximum Sun Elevation Angle | | | | deg | | | | | | | |
| 20 | ST | INP | MA | Cross Section Area | | | | m^2 | | | | | | | |

# CDF-Archive



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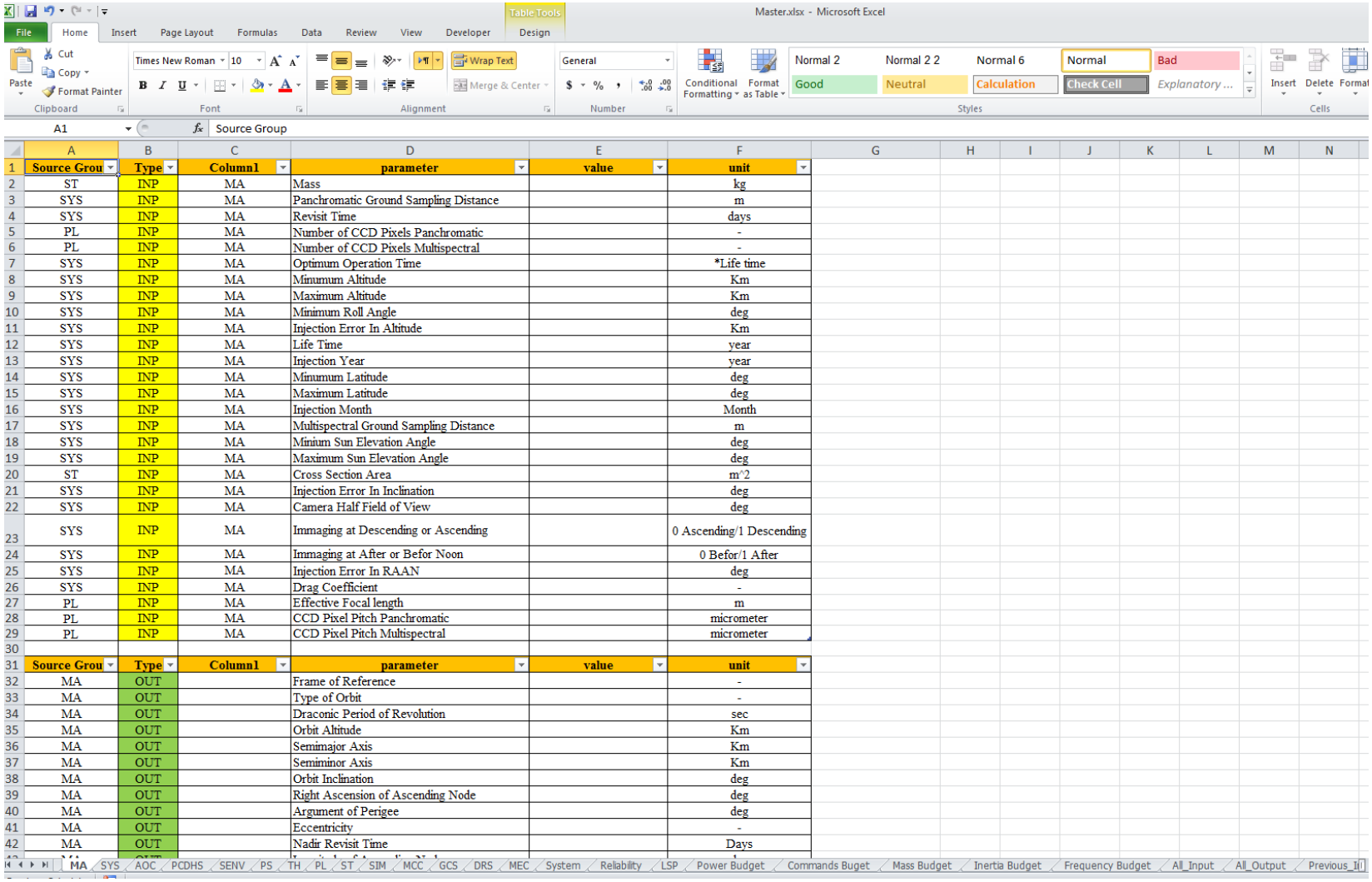


| | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Source Grou | Type | Column1 | parameter | value | unit | | | | | | | | |
| 2 | ST | INP | MA | Mass | | kg | | | | | | | | |
| 3 | SYS | INP | MA | Panchromatic Ground Sampling Distance | | m | | | | | | | | |
| 4 | SYS | INP | MA | Revisit Time | | days | | | | | | | | |
| 5 | PL | INP | MA | Number of CCD Pixels Panchromatic | | - | | | | | | | | |
| 6 | PL | INP | MA | Number of CCD Pixels Multispectral | | - | | | | | | | | |
| 7 | SYS | INP | MA | Optimum Operation Time | | *Life time | | | | | | | | |
| 8 | SYS | INP | MA | Minumum Altitude | | Km | | | | | | | | |
| 9 | SYS | INP | MA | Maximum Altitude | | Km | | | | | | | | |
| 10 | SYS | INP | MA | Minimum Roll Angle | | deg | | | | | | | | |
| 11 | SYS | INP | MA | Injection Error In Altitude | | Km | | | | | | | | |
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| 18 | SYS | INP | MA | Minium Sun Elevation Angle | | deg | | | | | | | | |
| 19 | SYS | INP | MA | Maximum Sun Elevation Angle | | deg | | | | | | | | |
| 20 | ST | INP | MA | Cross Section Area | | m^2 | | | | | | | | |
| 21 | SYS | INP | MA | Injection Error In Inclination | | deg | | | | | | | | |
| 22 | SYS | INP | MA | Camera Half Field of View | | deg | | | | | | | | |
| 23 | SYS | INP | MA | Immaging at Descending or Ascending | | 0 Ascending/1 Descending | | | | | | | | |
| 24 | SYS | INP | MA | Immaging at After or Befor Noon | | 0 Befor/1 After | | | | | | | | |
| 25 | SYS | INP | MA | Injection Error In RAAN | | deg | | | | | | | | |
| 26 | SYS | INP | MA | Drag Coefficient | | - | | | | | | | | |
| 27 | PL | INP | MA | Effective Focal length | | m | | | | | | | | |
| 28 | PL | INP | MA | CCD Pixel Pitch Panchromatic | | micrometer | | | | | | | | |
| 29 | PL | INP | MA | CCD Pixel Pitch Multispectral | | micrometer | | | | | | | | |
| 30 | | | | | | | | | | | | | | |
| 31 | Source Grou | Type | Column1 | parameter | value | unit | | | | | | | | |
| 32 | MA | OUT | | Frame of Reference | | - | | | | | | | | |
| 33 | MA | OUT | | Type of Orbit | | - | | | | | | | | |
| 34 | MA | OUT | | Draconic Period of Revolution | | sec | | | | | | | | |
| 35 | MA | OUT | | Orbit Altitude | | Km | | | | | | | | |
| 36 | MA | OUT | | Semimajor Axis | | Km | | | | | | | | |
| 37 | MA | OUT | | Semiminor Axis | | Km | | | | | | | | |
| 38 | MA | OUT | | Orbit Inclination | | deg | | | | | | | | |
| 39 | MA | OUT | | Right Ascension of Ascending Node | | deg | | | | | | | | |
| 40 | MA | OUT | | Argument of Perigee | | deg | | | | | | | | |
| 41 | MA | OUT | | Eccentricity | | - | | | | | | | | |
| 42 | MA | OUT | | Nadir Revisit Time | | Days | | | | | | | | |

# CDF - Benefit

**Study Quality**

The systematic approach to the design process helps ensure that the results are of a consistently high standard.

**Efficiency**

ESA and other CDF operators report a reduction in assessment study costs by a factor of two and elapsed time by a factor of four.

**Reduced Risk**

Examining the entire system at an early stage helps avoid surprises in the implementation phase of the project.

**Promote Collaboration**

Teams of engineers from different organizations and countries are able to start work together on real projects quickly, build collaborations and profit from each other's strengths.

**Stimulating Innovation**

New ideas and concepts can be refined, elaborated and assessed from scientific, technical and business points-of-view and take them to the next level of maturity.

Q & A

Thank you for your attention