f

CDF DOCUMENT

document title/ *titre du document*

CDF USER MANUAL

prepared by/*préparé par* Ross Henderson

reference/*réference* CDF-UM-01
Issue/*édition* 2
revision/*révision* 1
date of issue/*date d'édition* 23 January 2003
status/*état* Final
Document type/*type de document* User Manual
Distribution/*distribution* See List

a

ESTEC
Postbus 299 - NL2200 AG Noordwijk - Keplerlaan - NL 2201 AZ Noordwijk ZH -
Tel. (31) 71 5656565- Fax (31) 71 5656040

TABLE OF CONTENTS

1 INTRODUCTION

This manual is a guide for a new CDF Team member to the use of the CDF environment for technical studies.

The document contains an introduction to the ESTIDWTSCDF01 server (locally referred to as CDF01) that forms the environment for the CDF, in particular the directory structure and the intended use of the Master and Working directories.

Instructions and methods are given for the use of the generic sections of the individual workbooks, and an explanation is given of the data exchange process. No detailed information on the use of domain-specific sheets of the workbooks is provided; this may be found in the respective User Manuals .

A general description of the CDF is provided in the *CDF System Description* [1] and detailed information for using the CDF network environment is provided in the *CDF ICA Client User Manual* [2].

1.1 Logging in to a CDF Computer

The computers at the positions in the CDF may be used by any number of people, and therefore should not be customised by any individual. To avoid some of the pitfalls of having multiple users logging in to one terminal at different times, you are requested to use a communal login ID for logging into Windows. Since your actual work will be done inside your personal ICA client environment, this should have no adverse effects. Log in to Windows using the Username and password “CDF”

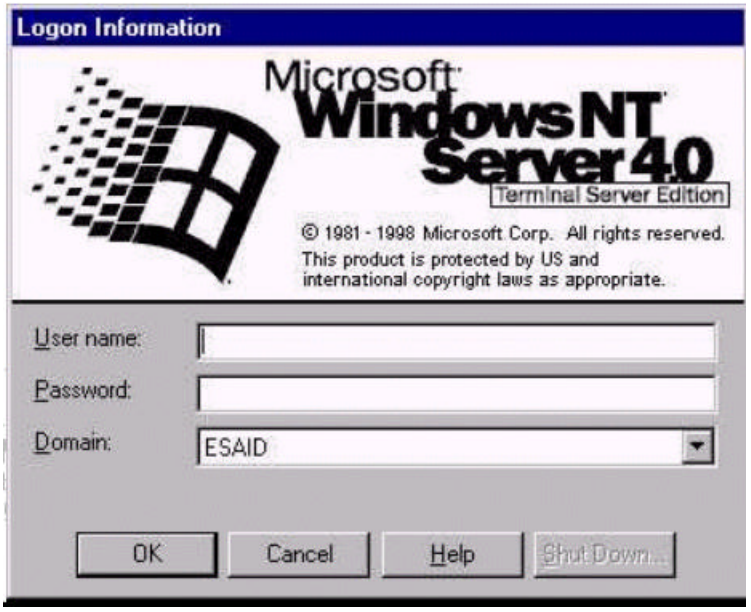
1.2 ICA Client Use

ICA Client properties are provided in the latest issue of the *CDF ICA Client User Manual* [2].

1) *If there is a CDF icon on your desktop:* Double-click the icon to launch the ICA client

2) *If there is no CDF icon: C*ontact the CDF Administrator for assistance.

3) The NT Terminal Server log on screen will appear



4) Log on using your normal user name and normal ESAID password.

You will now be logged on to the CDF01 server, with your own personal working environment.

2 CDF FILE DIRECTORY STRUCTURE

There are several network drives on the ESTIDWTSCDF01 server that are available to the CDF Study Team as follows:

D Contains the CDF 'Master' (M) and CDF 'Working' (W) directories. Rights to this drive are controlled by permissions granted to the individual user.

> Warning!
>
> Do not access the working drive W through D when using the Excel model workbooks, or all the links will be incorrect.

H H is the User drive and contains the settings and personal documentation available on the network to a specific user after logon, as set on the user's personal network workstation (wherever he logs onto the ICA client).

M 'Master' is a reflection of the `D:\M` drive and therefore contains exactly the same information. This drive is used for archiving the information resulting from completed studies. Facility administration information and reference documents and databases are also included in folders on this drive. Normally permissions are granted to administrators and team leaders only.

W 'Working' is a reflection of the `D:\W` drive and therefore contains exactly the same information. This drive is contains the models and documentation appropriate to on-going studies. Normally permissions are granted to all team members allocated to that study. Permissions to the 'Cost' directory are granted to a limited group only.

2.1 Working Directory (W:)

The Working directory is used for all ongoing study activities, and this contains the following structure:

[Study Folders] A specific folder is created to contain the files for each ongoing project. This is identified by the project abbreviation followed by the word Study, e.g. STORMS_Study. The structure within this folder is pre-defined (see below).

`0_Private` This contains the individual working folders of the CDF study team members, where any information can be stored. Any team member may create a folder here. Please note: **These files are not private!** Access to these folders is unrestricted.

Several other folders are present which are mainly used for the set up of new studies and reference material.

2.1.1 STRUCTURE OF A PROJECT FOLDER

Within a Project folder there are several folders related to different aspects of that study, each containing files and/or folders. The folders are named according to the individual project.

Project Admin Contains any files related to the administration of the study, such as manpower information.

Project Meetings Stores the minutes of all the meetings held during the project. Other files can be added to complement the main minutes file.

Project Miscellaneous Contains any other files needed for the study, including the Study Reference files.

Project Model Contains the MS-Excel® model workbooks being worked on during the design. *There should be only one workbook for each domain No other files should be stored here.* This also contains a folder called CATIA and IMAGES, used to store all CAD pictures.

The complete set of workbook files[1] includes as standard:

aocs	ground_systems	programmatics	simulation
comms	instruments	Propulsion	structures
cost	mechanisms	pyrotechnics	system
data_exchange	mission	Radiation	thermal
data_handling	power	Risk	

Project Notes This contains Word files for each domain that can be used to store information gathered during the design. These files can then be used to help in the writing of the final report. It should be noted that most information should be placed directly into the model.

Project Presentations containing folders for any presentations that will take place through the study, e.g. the final presentation.

Project Report Contains the Word files used for the *Project* final report based on standard templates. The following folders are contained within as follows:

- ***Project* Report Inputs:** individual chapter inputs by domain (or chapter) based on standard templates from each domain specialist as author.
- ***Project* Final Report:** chapter updates according to review cycle (systems, team lead and customer) and final and fully compiled report and cover page.
- ***Project* Yellow Book:** Inputs by chapter for Programme Board paper if required by study type (optional).
- ***Project* Cost Estimate Report:** Secure inputs for industrial and ground systems and operations chapters plus final compilation and cover page if required (optional).

Table 2-1 Study Documentation Structure

In Figure 2-1 below, 'Project' represents the actual study name as allocated.

[1] The workbooks required for a CDF activity may include all or a subset of the workbooks available and new workbooks as required. Additional workbooks are available for other activities, i.e. Human missions (ECLS, Human Factors), Re-entry vehicles (Aero-thermodynamics, Trajectory), Instruments (Antenna, RF).

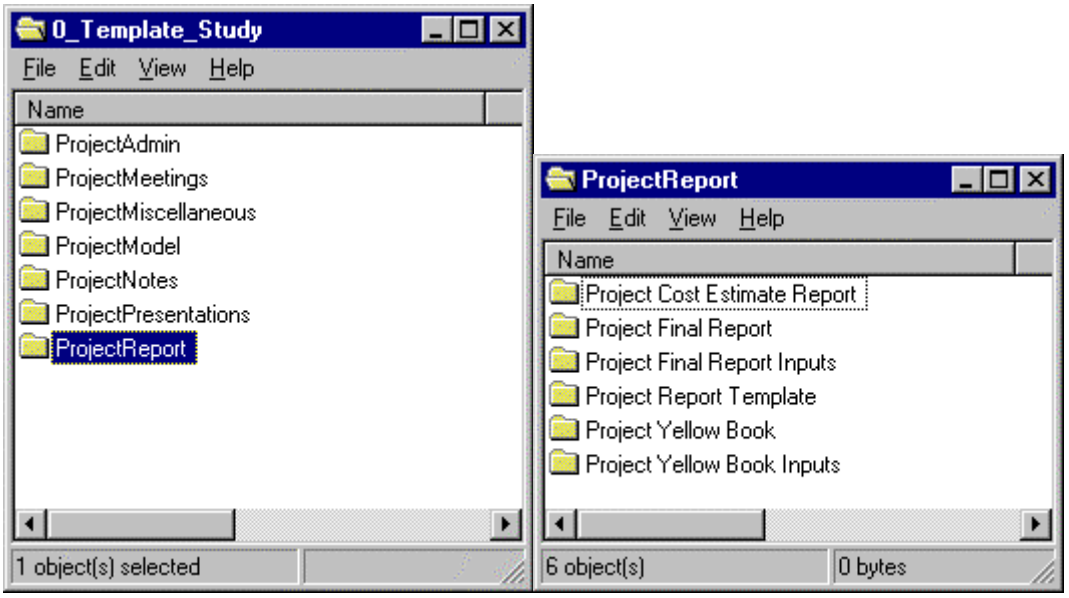
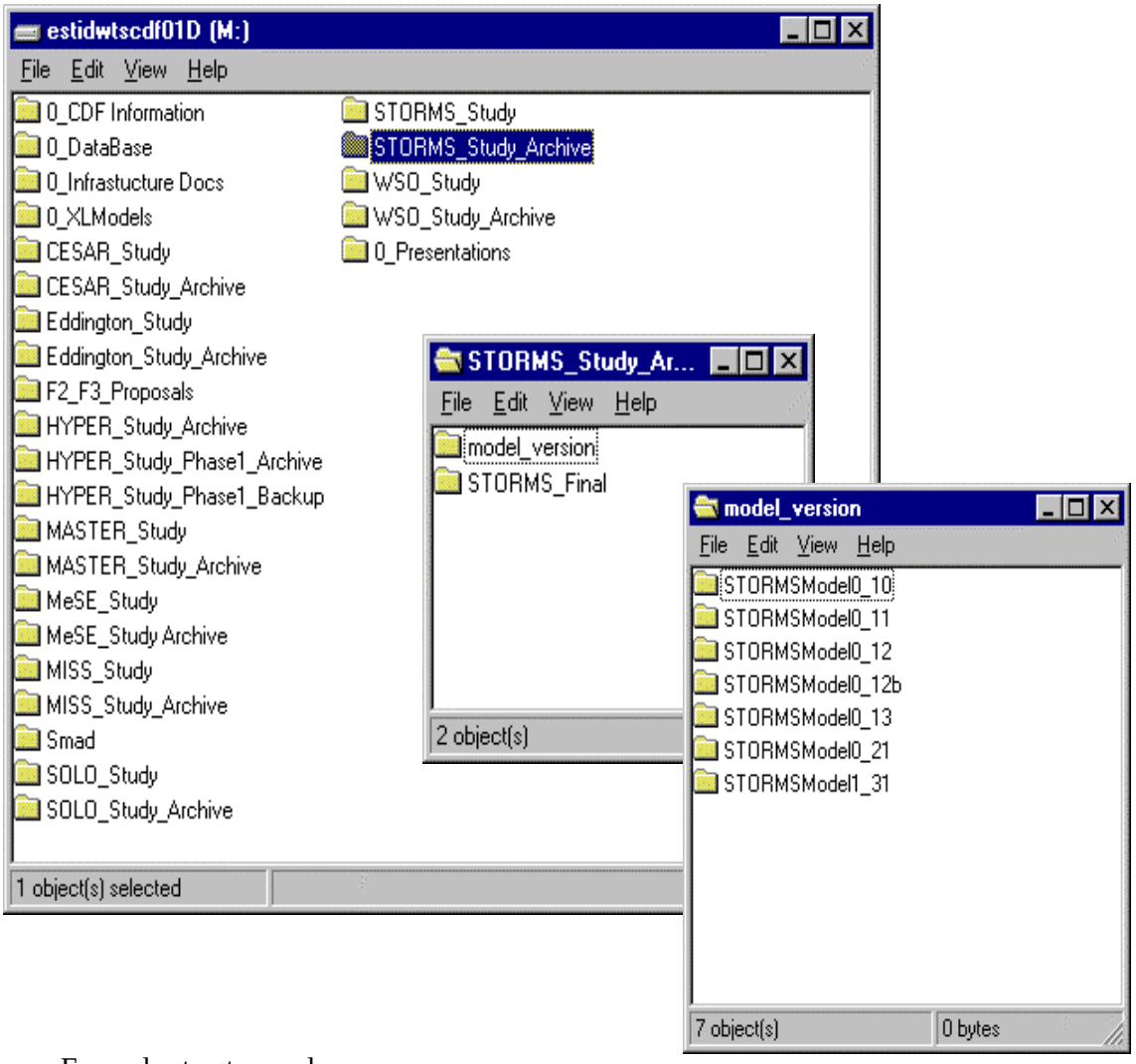


Figure 2-1: CDF01 Working Directory Project Directory Template

2.2 Master Directory

The ***MASTER*** directory contains archived data from completed CDF studies organised as folders under each study title. In addition CDF documents, reference databases and infrastructure documents are contained herein described the *CDF Documentation Management* [3]. Many information database and document sources are available to CDF engineers including International Space Station, Ground Segment, Launchers, Missions, Platforms, Components, Studies and Acronyms amongst others. Access to this directory is restricted as appropriate to a data repository. The structure is depicted for information in Figure 2-2. Each study folder contains the final reports and the model versions for reference.



Example structure only

Figure 2-2: ***MASTER Study Archive Folder Structure***

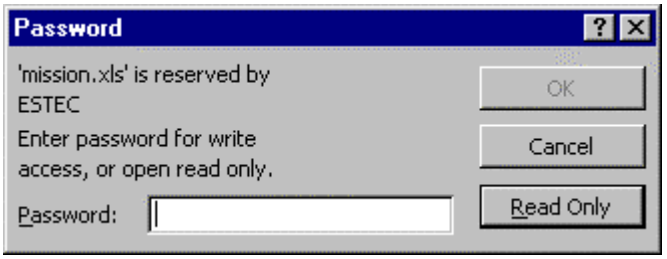
3 WORKING WITH WORKBOOKS

This section provides general information about using the CDF domain workbooks, for detailed specialist information please refer to the appropriate domain user manual.

3.1 Opening a Workbook

3.1.1 PASSWORDS

When a specific workbook is opened (example below) the user should be greeted with a window for entering a password for modifying the workbook. Both the domain specialist and the systems specialists should know this password. If you just wish to look at the file, click on the "Read Only" button.



If this window does not appear then the password should be re-applied to the file. This is done in the options when using the Save-As function. This password should be kept the same, and the System Analyst should be kept informed of correct password. The CDF Administrator is responsible for issuing permissions for the use of domain workbooks for each CDF study.

3.1.2 CONFIGURATION MANAGEMENT FORM

Another window should also appear when opening the workbook as shown in Figure 3-1. This "Updating the Model" form is used to help keep all workbooks up-to-date. It shows the System Date and System Version number which is currently stored in the Systems workbook (and the Data Exchange), and compares it with that stored in the users workbook, taken from the last time the workbook updated its values from the Data Exchange. If the two sets of values are different then it is down to the user to update their workbook. Do this by "clicking" the "update" button. The values should then change to show that the workbook is consistent with the system. The form can then be closed. Overall CDF configuration control including model version numbering is described in the *CDF Configuration Management* [4].

The macros associated with this form require links to other files. If the file is in the wrong directory for any reason then the macro will fail. The debug window will appear. If this appears just close it by clicking the "End" button. If this problem continues inform the Systems Analyst for solution.

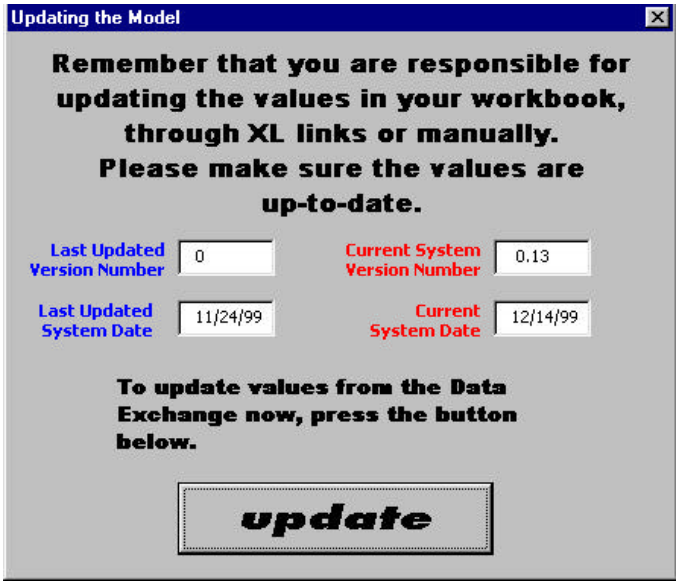


Figure 3-1: Domain Workbook Example Configuration Management Form

3.2 General Overview

Each Domain workbook consists of a number of sheets. These sheets can be categorised in three areas: ***Results***, ***Inputs***, and ***Working*** sheets that are customised by each specialist for general and study specific data. An **Administration sheet** is provided for configuration control purposes, the sheet displays the following:

a) Workbook version number for model template version control
b) Expert personnel responsible for the Workbook and sheets contents, and
c) Workbook change record.

A sheet called **MenuSheet** also exists, which contains information for the generation of special menus, as well as cells used for other functions (macros). This sheet is "*hidden*" and normally not used by the domain specialist whilst working on studies. However, the system analyst has permission to make additions on the request of domain specialists where new capability is agreed.

The ***Input*** and ***Results*** sheets link the workbook with the rest of the model. They can also be used to link to external tools that do not appear in the core model, this could include CAD for example. The Output and Input sheet are created using a template, which ensures all workbooks have the same format. The Template gives a simple list with specific columns, which varies slightly between the two sheets. There are also a number of comments and warnings added to aid the user. Both sheets contain parameters developed from previous studies. It will be necessary to remove irrelevant parameters and add new ones where appropriate when starting new studies.

The other sheets (***Working*** sheets) can be modified in anyway the domain specialist sees fit. The only requirement is that all outputs and inputs to and from the other parts of the model are directed through the ***Input*** and ***Results*** sheets. More ***Working*** sheets can be added as the user sees fit. Such additions are described in the domain workbook user manuals.

Other sheets may also be added containing templates to aid development of the design. With the sub-system workbooks, sheets might be added to aid the design process, such as requirement sheets. Study workbooks contain a sheet called ***Notes***, used to stored information generated during the Sessions. This will act as a sort of chronological data store for the domains.

Data exchange between all the workbooks is achieved through the ***Data Exchange*** workbook. This workbook links the data in all the ***Results*** (using the "Generate Outputs" worksheet macro) sheets of other workbooks whereas the ***Input*** sheets of the model workbooks are linked to certain output parameters within the ***Data Exchange*** workbook.

The overall structure of the model is shown in Figure 3-2.

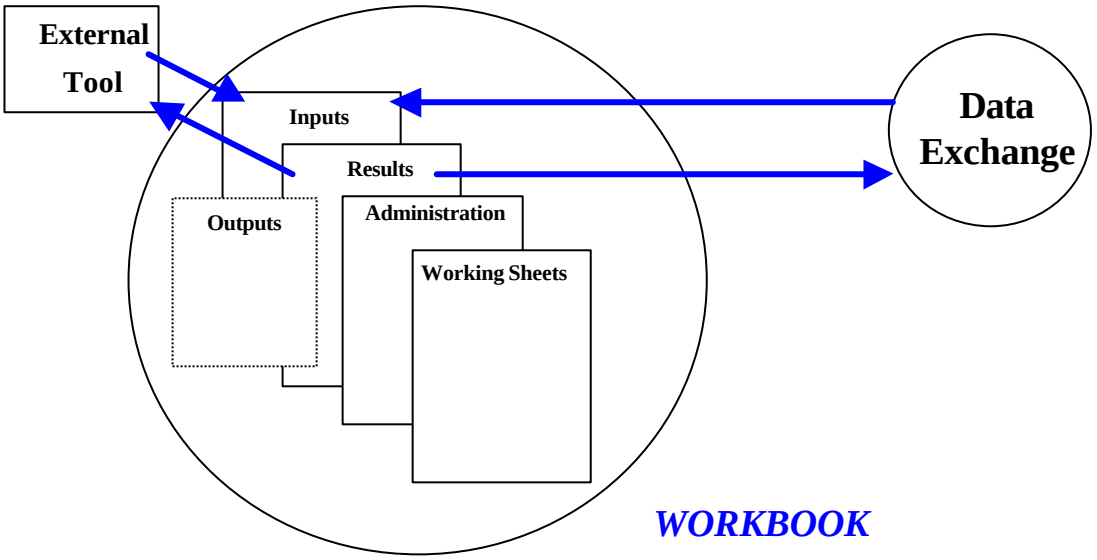


Figure 3-2: Model Structure and Workbooks

3.2.1 LINKS BETWEEN WORKBOOKS

The links required to transfer data are as follows.

Working Sheet → ***Results*** Sheet → Data Exchange Workbook → ***Input*** sheet of other Domain

(User workbook)

Working sheet ← ***Input*** sheet ←Data Exchange Workbook ←***Results*** sheet of other Domain

Possible Problem: If cells are copied into the ***Results*** sheet, rather than pasted as link, the link will not occur, i.e. if you change a value in the working sheets, this will not show up in the outputs. It is therefore important to make sure you produce a 'link to', rather than a copy of the data.

3.3 The Inputs sheet

3.3.1 LAYOUT

The ***Inputs*** sheet can be used for all inputs into the Domain workbook or just for those where the data is required from a link to another Domain. Their use depends on the preferences of the user of that workbook. When links are not available values can be added here by hand, however, this is not recommended and assistance or co-ordination must be obtained from System Analyst. The template for this sheet consists of a number of columns, which define each parameter and also allow a switch between manual inputs and linked (reference to ***Data Exchange*** workbook) inputs for parameter values. The columns are described below as follows:

Parameter – Simple Description of the parameter.(Parameter Name)

Linked Value – These cells must be linked to the ***Data Exchange*** workbook, referencing the corresponding cells within. If no link is available it must be left blank. (should only store references to ***Data Exchange*** cells).

Manual Value – These cells contain values for a given parameter which are manually input by the user of the workbook. This can be useful if the linked value is not available, or the user would like to experiment with different values. It can also be used to compare old and new linked value. The user can copy the linked value (not the reference!) into the manual input cell so there is a record to compare against if the linked value changes.

External – These cells contain values extracted from industrial studies for reviews or from external tools outputs.

Switch – Each cell contains a pull down menu where either 'Linked', 'Manual' or 'Not Used' can be chosen. This is then used to switch between the manual and linked values for use in the working sheets. The colour of the cell also changes to make it easier to see which value is being used, green = linked, Blue = Manual, White = Not Used.

Cell Name – Identifies the name given to the Used or Retained Value column cell. One can give a name to be used in the working sheets calculations.

Used or **Retained Value** – This holds the value which should be referenced in the working sheets. The cells contain an IF() statement which selects either the linked or manual value column depending on the selection in the switch cell of that row.

Units – Give the units of the numerical information, e.g. S.I. units.

Source – Used to identify where the Domain user expects that information to be generated. This is also useful in the initial phases of integration to establish what is expected from each Domain output.

Status – Can be used to give information about the parameter, such as "TBC" for example.

Remarks – Used for any other comment required about the data.

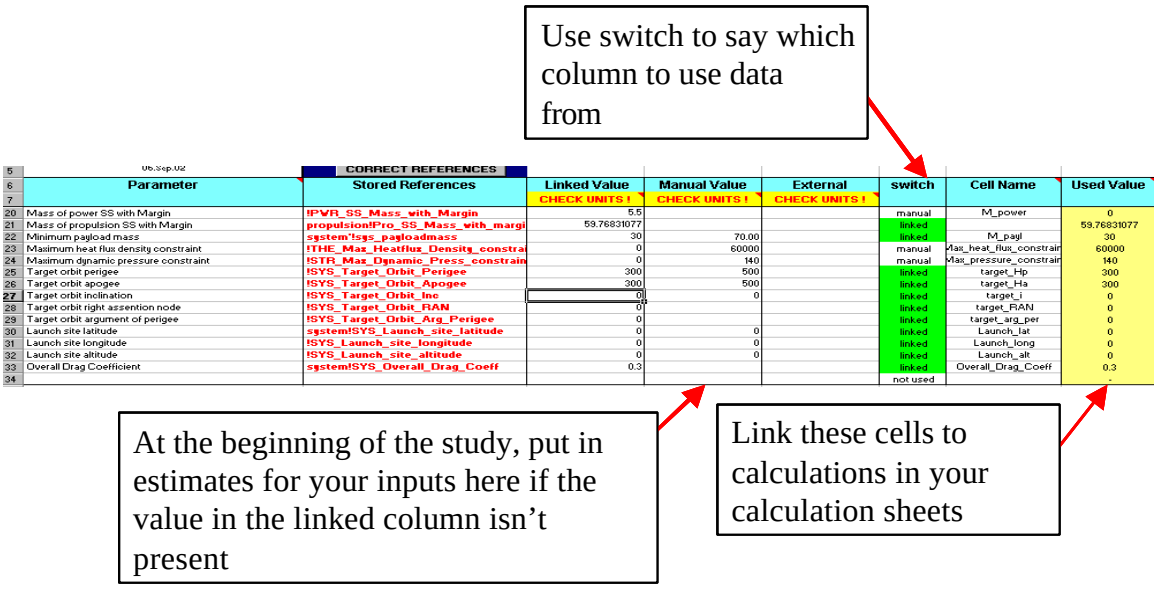


Figure 3-3: Summary of Input sheet use

An example *System Workbook Input* sheet is shown in Figure 3-4.

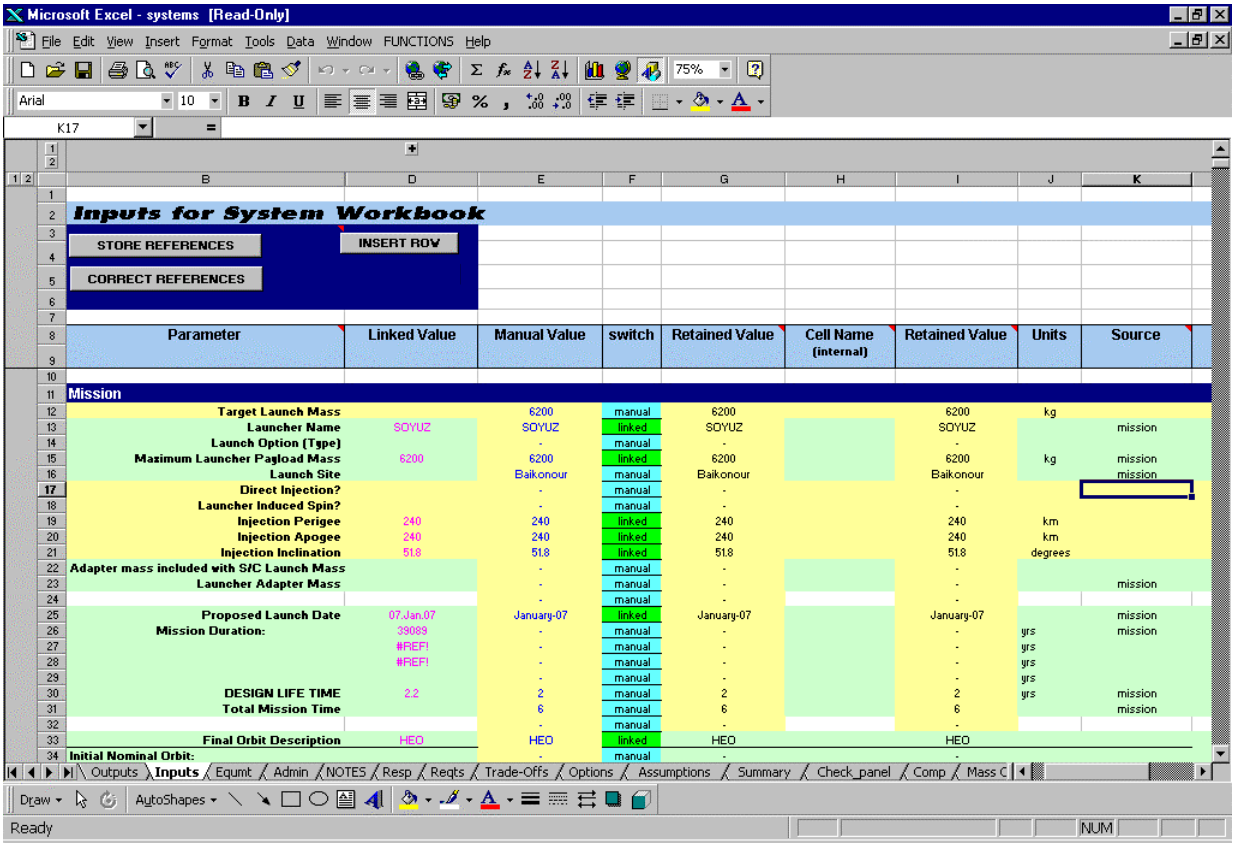


Figure 3-4: Example System Workbook Input Sheet

3.3.2 LINKED AND MANUAL INPUT

The ***Input*** sheet of each workbook can contain two possible types of input for your working sheets, these are values that are either manually put into the sheet, or values linked to the ***Data Exchange***. The ***Input*** sheet has been set up to allow the use of both types of data quickly. The columns required (as shown in Figure 3-5 for a subsystem workbook) are:

Linked Value column, which should only contain linked information. This column is the only one linked to the Data Exchange.
Manual Value column, which should contain values which have been inserted by the user. These can be values, which you have not been able to link, or values that the user just wishes to try out in their calculations. Note **External** column is used for external tools or industrial study outputs.
Used Value column, which contains the chosen values from either the manual or linked options. These cells are referenced by your working sheets and used in your calculations.
Switch column, this column allows you to quickly change whether you are using Linked or Manual values within your working sheets. Each cell contain three simple options: **manual** and **linked** which allows you to switch your **Used Value** to either the **Manual Value** or **Linked Value** columns. There is a third, **not used** option for simply identifying that a given parameter row is not being used in your working sheets. The **not used** option selects the **Linked** column for the **Used Value** column.

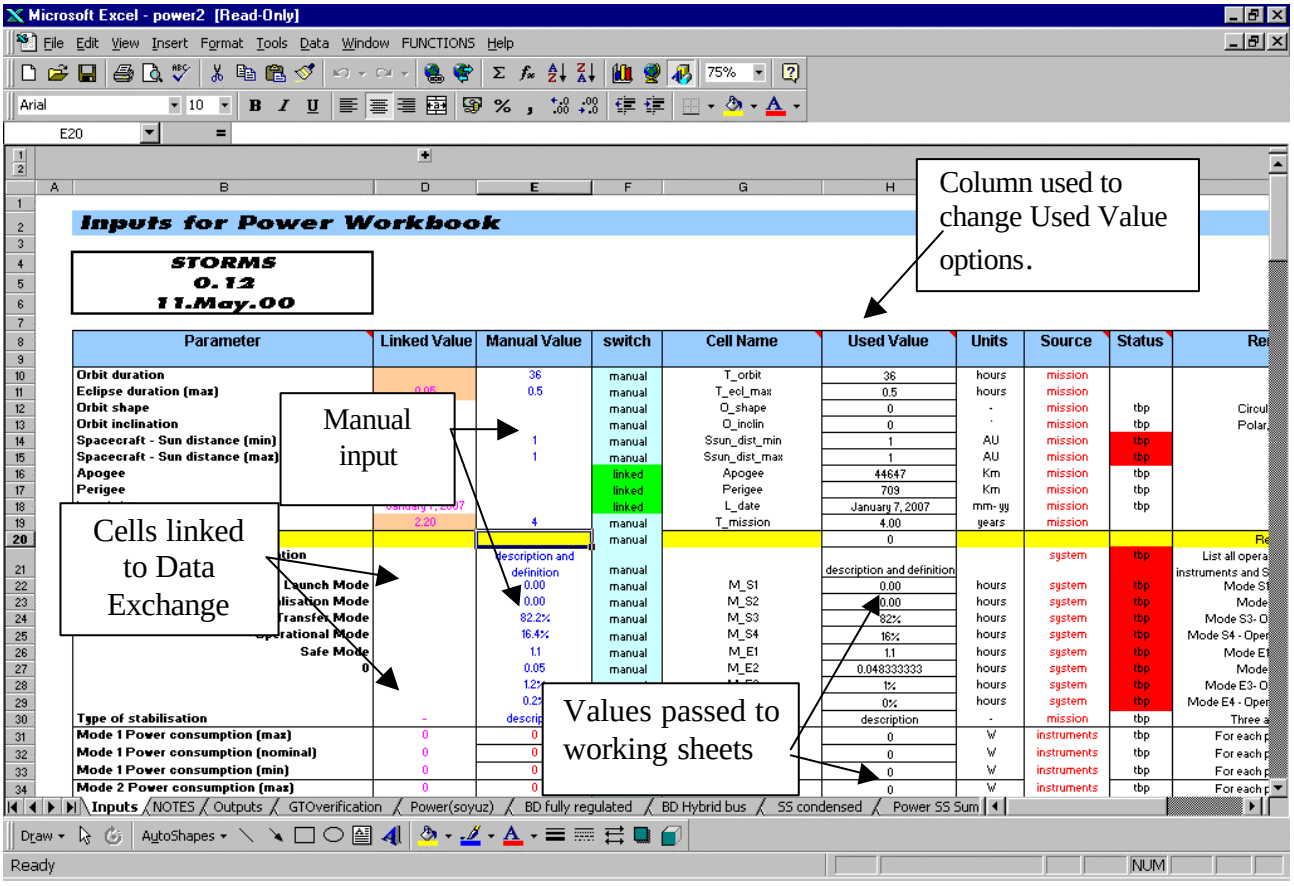


Figure 3-5: Worksheet column identification

To change which value is being used in the Used Value column simply select the relevant Switch cell and choose the required option from the list given.

3.3.3 REFERENCE FIXING

The links (references to the ***Data Exchange***) sometimes require changing, due to errors with Excel's automatic reference changes, or to add the workbook to a different directory or study. To change the reference a macro has been included which stores references to the Data Exchange. The accompanying macro takes the sheet name and cell name from the reference and stores it in the hidden column. Selecting the required cells in the Linked Value column and then pressing the ***STORE REFERENCES*** macro button at the top of the page can activate this macro (see Figure 3-6).

Two macros have been produced as follows:

1. Takes the original reference and stores the sheet and cell name each reference.
2. Replaces the complete references in the Linked Value column using the information stored.

The columns within the Input sheet required for reference macro-operations are:

The **Linked Value** column – This contains the cell references to other files, and should be column D of the sheet. This column should be completed by the user, creating references to other workbooks as and when needed.
The **Reference Store** column – This stores the sheet name and cell name from the reference in the adjacent Linked Value cell. The column can filled automatically using the macro provided. When revealed this is column C of the sheet.

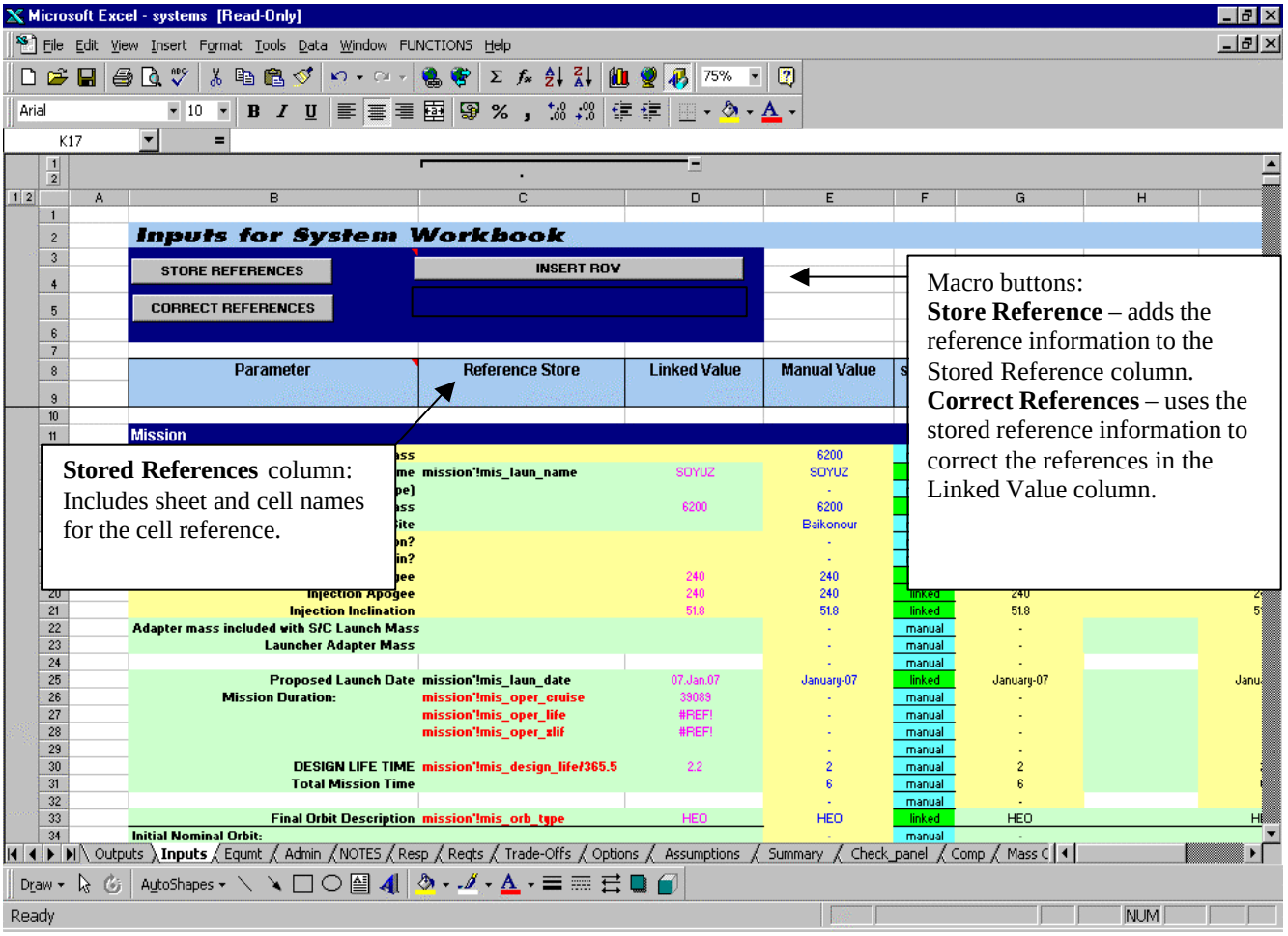


Figure 3-6: Reference Fixing Buttons

MACRO 1: Storing Correct References

This macro allows any reference in the ***Linked Value*** Column to be stored. The major information concerning the sheet name and cell name in the referenced (***Data Exchange***) workbook is stored in the Reference Store column.

IMPORTANT: The cell reference in the ***Linked Value*** column must be complete. Both the cell name (cell reference) and sheet name must be present. If the sheet name has been removed, it must be replaced in every cell before using the macro.

Using the Macro

1. Close all other workbooks.

2. Make sure the cell references (in the Linked Value column) you wish to save are complete, including the file path, sheet name and cell name.
3. Select the cells of the Linked Value column you wish to save.
4. Press the *STORE REFERENCES* button. A message box will appear asking you to check you have selected the correct cells.
5. Check you have selected the only the correct cells in the Linked Value column. Only select this column. If you would like to cancel and select the correct cells press the *No* button.
6. If correct press the *Yes* button, the macro will now proceed to place the sheet and cell names of the reference in the cells of the Reference Store column.

MACRO 2: Correcting References
This macro uses the sheet and cell names in the ***Reference Store*** column and combines them with stored file paths to create a new reference in the ***Linked Value*** column.

To operate this macro a list of file paths has to be present in the hidden ***Menusheet*** of the workbook. This list should only include the file name and its directory path, so that it can be combined with the ***Reference Store*** cells to create the reference.

The list has been given the reference name paths, the cells of which may need to be extended if many more directory paths a required. There should only be one entry, giving the path to the currently used Data Exchange file, e.g. W:\STORMS_Study\STORMSModel\[Data Exchange.xls]

IMPORTANT: The file must be surrounded by square brackets and include ".xls".

Using the Macro:
1. Close all other workbooks.
2. Select the cells of the Linked Value column you wish to create references in.
3. Press the ***CORRECT REFERENCES*** button. A message box will appear asking you to check you have selected the correct cells.
4. Check you have selected the only the correct cells in the ***Linked Value*** column. Only select this column. If you would like to cancel and select the correct cells press the ***No*** button.
5. If correct press the ***Yes*** button, the macro will now proceed.
6. A new window will appear asking you to select a file path from a list or create your own. If you have any doubts, read the help by clicking the "***?***" button. Select a file path, by making it visible in the box, and click on the ***Continue*** button. The macro will then proceed until all selected cells have been modified.

3.3.4 REFERENCING INFORMATION IN THE DATA EXCHANGE

Once parameter outputs have been loaded into the Data Exchange individual workbooks can begin referencing the data.

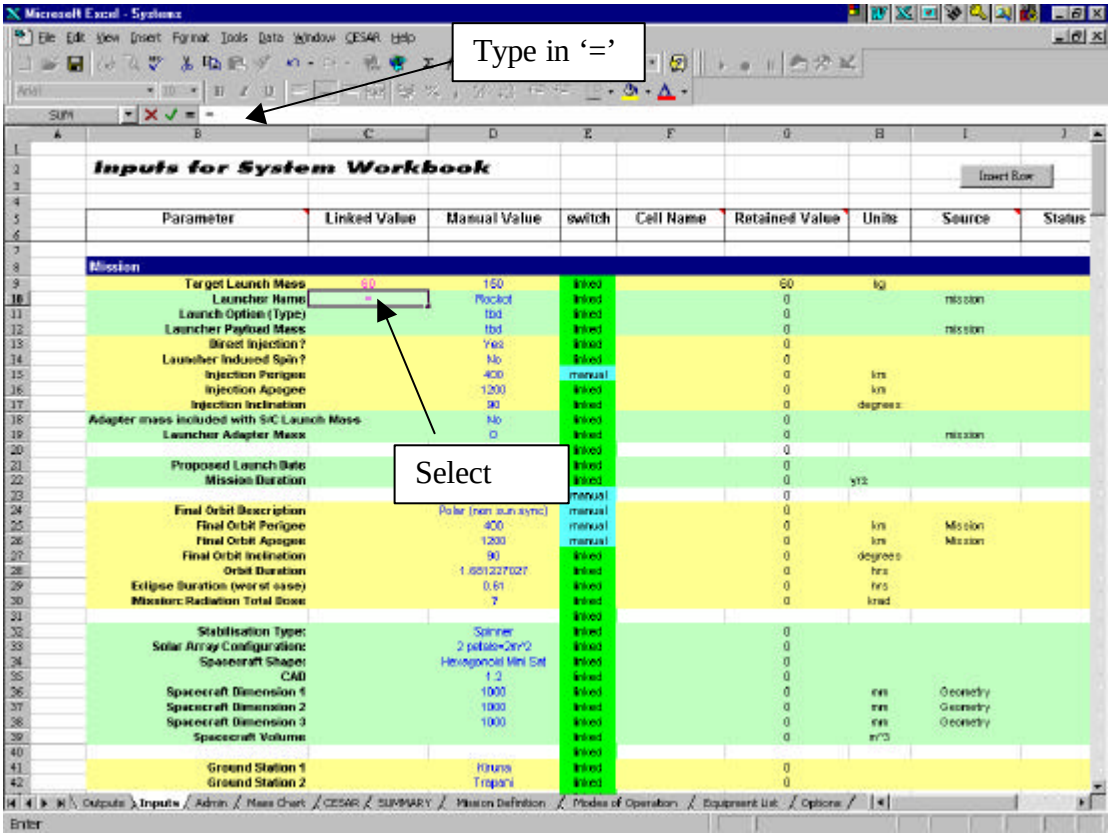
Data should only be referenced if it is certain that it gives the correct results. If the cell is blank, or has a zero in it, then it may not be wise to reference it. Contact should then be made with the supplier to verify their numbers.

Linking to Value Cells

The first method can be used when you have already created the parameter in a list, and only require the value cell to be linked.

Steps:

1. Open both the D**omain** and **Data Exchange** (Read Only) workbooks.
2. Select the domain **Input** sheet.
3. Highlight the **Linked Value** cell of a required input parameter.
4. Type in '=' (equals), so that it appears in the **Function Bar**.



5. Now go to the **Data Exchange** workbook, find the parameter you wish to reference. Make sure the value is usable, and that the units are matched to your inputs sheet. Select the **Value** cell of this parameter so that in the **Function Bar** it shows:
6. **='[Data Exchange.xls]domain'!sys_date**(for example)
7. Then press **<ENTER>**, the link should now be established. ***Check that you have linked to a cell name and not a direct reference (e.g. not D14)***
8. Change the Text colour of the input Value cell to ***pink*** to show that it has been linked.

3.3.5 MANAGEMENT OF INPUT PARAMETERS

Once links have been established input parameters should be managed with a workbook, so that the values required for a given version of the systems are correct. Some parameters might be needed for some versions and not others. Also the values of certain parameters may not be correct, i.e. the supplier has not updated for some reason. You should be aware of such problems, and try to avoid them.

It is possible (for example) that equipment will change, but the links will remain. Any ambiguities should be resolved by contacting the systems specialist, or other relevant people. In this way control can be gained over what constitutes a particular version of the model.

3.3.6 UPDATING INFORMATION FOR EXISTING INPUT PARAMETERS

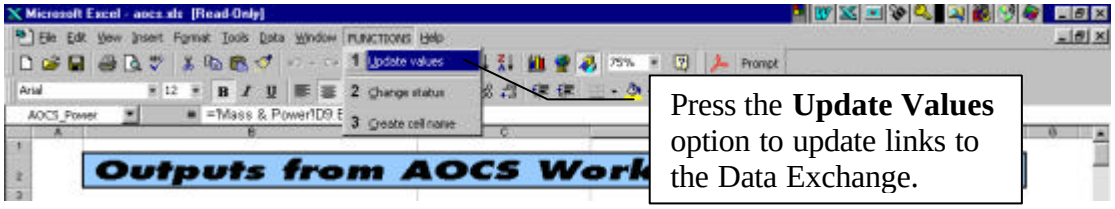
When an output parameter changes within a domain (sub-system) there is no automatic process for propagating this to the rest of the system. It could, in fact, be detrimental to the system if this update was automatic, as loops of information would move around the system without any real control. A process has therefore been defined to allow the updating and downloading of information through the network of Excel workbooks. This guide does not attempt to explain a process for passing any other information between domains. Excel only allows for simple values, letter codes, or a few words, to be passed through the electronic system. Descriptions have to be passed manually, or using other electronic means.

3.3.7 UPDATING WORKBOOKS

Using Supplied Macro

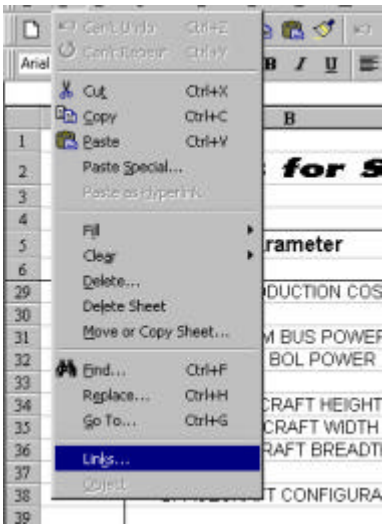
Within every workbook is a macro, which allows you to update from the Data Exchange quickly and easily. In the menu bar should be the FUNCTIONS menu, which contains a number of options. To update from the Data Exchange simply select the menu FUNCTIONS and the option Update Values. All your links to the Data Exchange should now be refreshed.

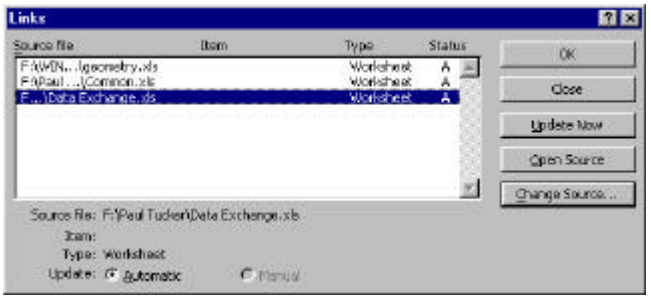
NOTE: You cannot use the macro if you have the Data Exchange open. However, when you open the Data Exchange you will automatically update your workbook. You should also make sure that the correct Data Exchange is being updated, i.e. that it is in the correct directory.



Back-up Method

The cell references to other Excel workbooks can be refreshed using the **'Update Links'** command in Excel. This is found in the **Links…** option in the **Edit** menu. To update a link, select the files you want to update (in this case just the Data Exchange), and then press the **Update Now** button.





The cells that are linked to the ***Data Exchange*** are then changed to the current values in the ***Data Exchange*** file. It should be noted that the update references the data in the saved copy of the ***Data Exchange***. This may be different from the current values, which appear in the open version of the file. It is therefore important to know whether the opened version has been saved to the stored file or not.

The update process can be put into a macro, so that you only have to press a button in a worksheet to update. If you don't know how to do this, then the System Model Engineer will do this for you.

3.3.8 SET UP OF INPUT SHEETS

As discuss above the ***Input*** sheet of each workbook is set up to allow the switch between manually inputted values and values gained via a reference to another workbook through the ***Data Exchange***. The switch between these values is achieved in a standard way that has been used throughout the model.

1. The sheet should be set out in the correct column order as shown in section 3.3.1.
2. The ***Linked*** value column should only contain cells that are either a reference to a cell in the ***Data Exchange*** workbook, or that are empty.

The ***Manual Value*** column should only contain cells that have directly inserted values (i.e. No links), or that are empty.

3.4 The Results Sheet

The Results sheet of each domain is very important for the integration of the overall model, at least within the Excel® environment.

It should be remembered that once a Results sheet has been linked to the Data Exchange using the "Generate Outputs" macro (FUNCTIONS menu), the parameter list is fixed. Parameters within the list can not be removed or moved to a different cell location. The information for an individual parameter can be changed, as long as it still refers to the same piece of data.

For example, the Name of the parameter 'Daylight Power' could be changed to 'Sunlight Power', because this is only a change in wording.

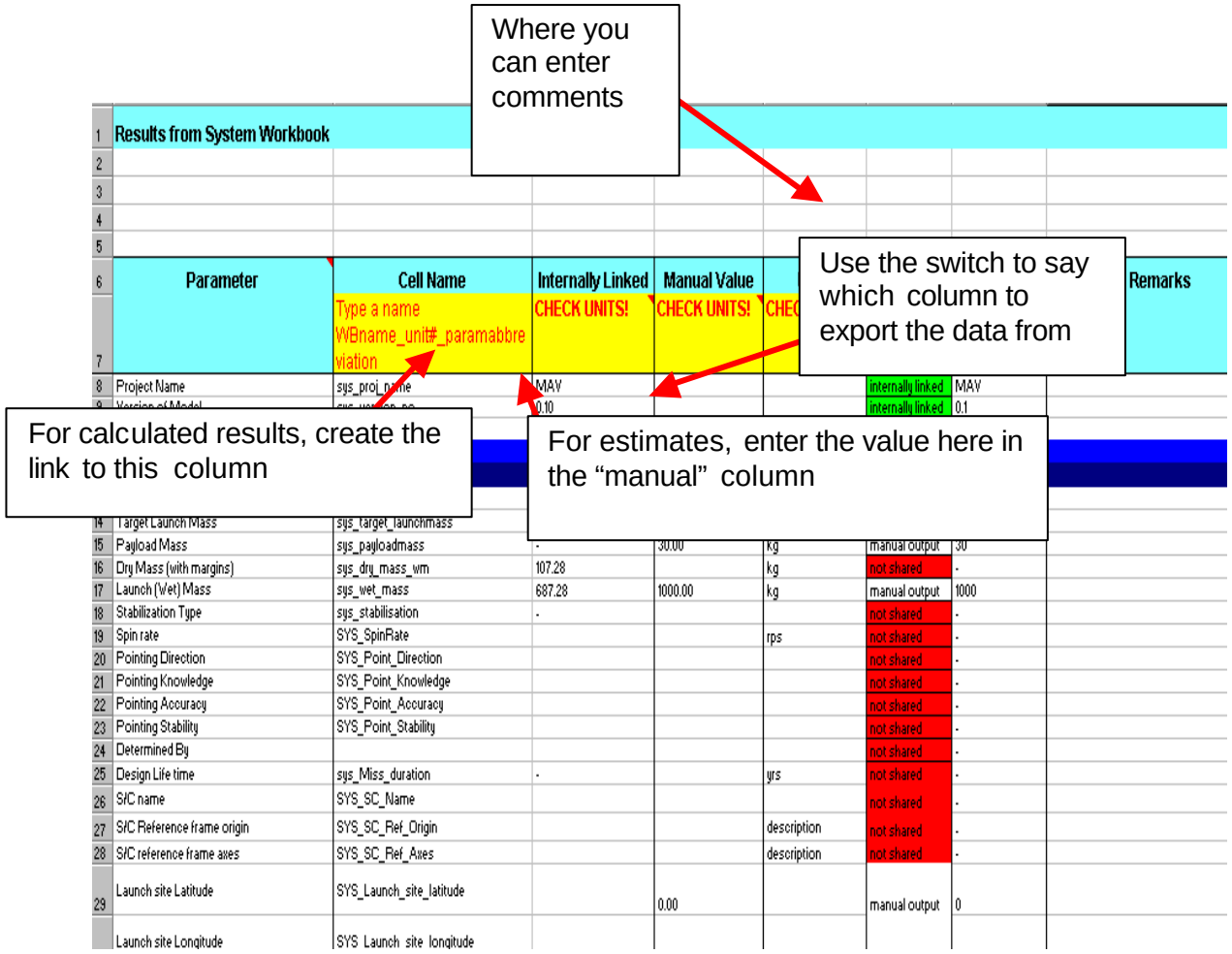
A Value of a parameter can also change, e.g. an estimate of 20kg for Sub-system mass could be changed to a value which references a sum of unit masses within a working sheet, giving a value of 15kg.

New Results parameters can be added to the bottom of, or inserted in the list, added to the ***Data Exchange***. To ensure that the " Switch" is included, select the row above the inserted row and drag to the inserted row.

3.4.1 LAYOUT

Both the ***Input*** and ***Results*** sheets consist of similar columns of information for a given parameter. Each parameter is contained in one row of the table, therefore only the value cell of each row should be linked to. If other links are required they should be added to a new row of the table.
The columns are described below (see also Figure 3-8):

- **Parameter** – Simple Description of the parameter.
- **Cell Name** – Identifies the name given to the Value column cell.
- **Internally Linked** – should contain only linked information, i.e. that in Data Exchange.
- **Manual Value** – should contain values inserted by the user, i.e. initial assumtpions or those not linked to working sheets.
- **Value** – Contains the data that has to be passed through the model. This data can be numerical or a small amount of text.
- **Units** – Give the units of the numerical information, e.g. S.I. units.
- **Remarks** – Used to pass on information about a parameter to the user referencing that data.



	Parameter	Cell Name	Internally Linked	Manual Value			Remarks
1	Results from System Workbook						
6		Type a name WBname_unit#_paramabbreviation	CHECK UNITS!	CHECK UNITS!	CHEC		
8	Project Name	sys_proj_name	MAV			internally linked	MAV
9	Version of Model		0.10			internally linked	0.1
14	Target Launch Mass	sys_target_launchmass					
15	Payload Mass	sys_payloadmass	-	30.00	kg	manual output	30
16	Dry Mass (with margins)	sys_dry_mass_wm	107.28		kg	not shared	-
17	Launch (Wet) Mass	sys_wet_mass	687.28	1000.00	kg	manual output	1000
18	Stabilization Type	sys_stabilisation	-			not shared	-
19	Spin rate	SYS_SpinRate			rps	not shared	-
20	Pointing Direction	SYS_Point_Direction				not shared	-
21	Pointing Knowledge	SYS_Point_Knowledge				not shared	-
22	Pointing Accuracy	SYS_Point_Accuracy				not shared	-
23	Pointing Stability	SYS_Point_Stability				not shared	-
24	Determined By					not shared	-
25	Design Life time	sys_Miss_duration	-		yrs	not shared	-
26	S/C name	SYS_SC_Name				not shared	-
27	S/C Reference frame origin	SYS_SC_Ref_Origin			description	not shared	-
28	S/C reference frame axes	SYS_SC_Ref_Axes			description	not shared	-
29	Launch site Latitude	SYS_Launch_site_latitude		0.00		manual output	0
	Launch site Longitude	SYS_Launch_site_longitude					

Figure 3-7: Summary of Results sheet general use

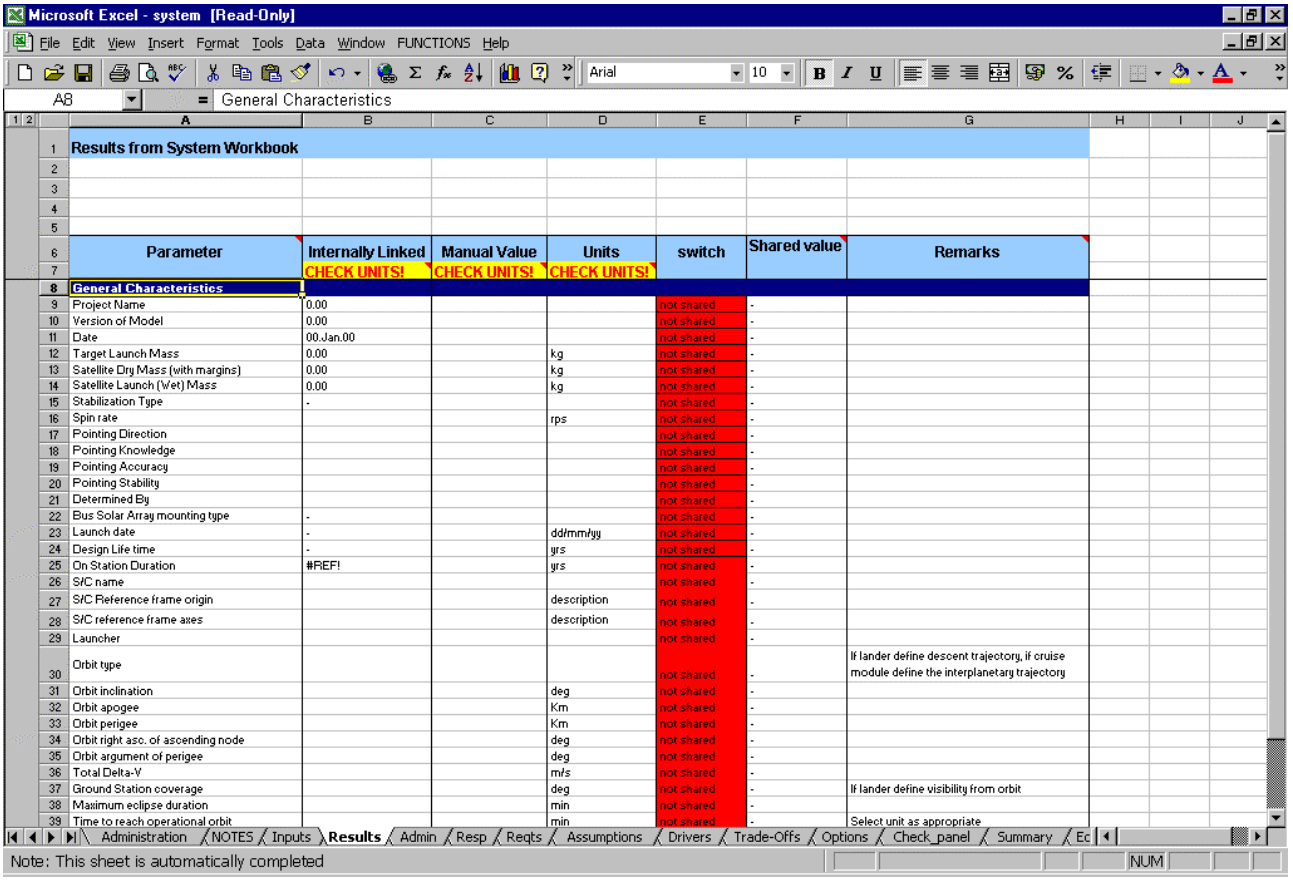


Figure 3-8: Example Results Sheet

The ***Results*** sheet of a workbook provides the essential analysis outputs. It is also for data that will be passed through the system through the Excel® Links using the "Generate Outputs" macro located in the FUNCTIONS menu. This also implies that the ***Results*** sheet will contain only links to data that is stored within your working sheets.

3.4.2 CELL NAMES

Due to the limitations of Excel® software the Results sheet of each Domain must be set out in a certain way. The sheet should be a list of parameters, set out as shown in the Template

To make ***Results*** sheets flexible enough so that rows can be added and/or moved, it is necessary to create cell names for every parameter. These names then have to be applied to the value column, so that when the sheet is copied to the Data Exchange other users can reference a cell name rather than an absolute cell position (e.g. =A1). This means that if the parameter changes its row (e.g. row 23 to row 24) referencing the information still gets the correct values. If the position (A1) of the cell is the reference, then when the row is moved the reference does not account for this and points to the wrong cell. It must be remembered that writing a cell name into the Cell Name column is not enough, the name must then be used in the Value column (see below).

The first three letters of any cell name should be an acronym given to that domain, i.e. “ABC_parameter_definition”.

This acronym should be the first three letters of the domain name. The rest of the name can be used to describe the parameter, e.g. “SYS_total_wet_mass”

The cell names can be applied to the Value column of the Results sheet by selecting the cells of the Cell Name column and Value column. Then select the “Create Cell Name” option on the CDF menu, and the names in the Cell Name column will be applied to the Value column. See example of Figure 3-9.

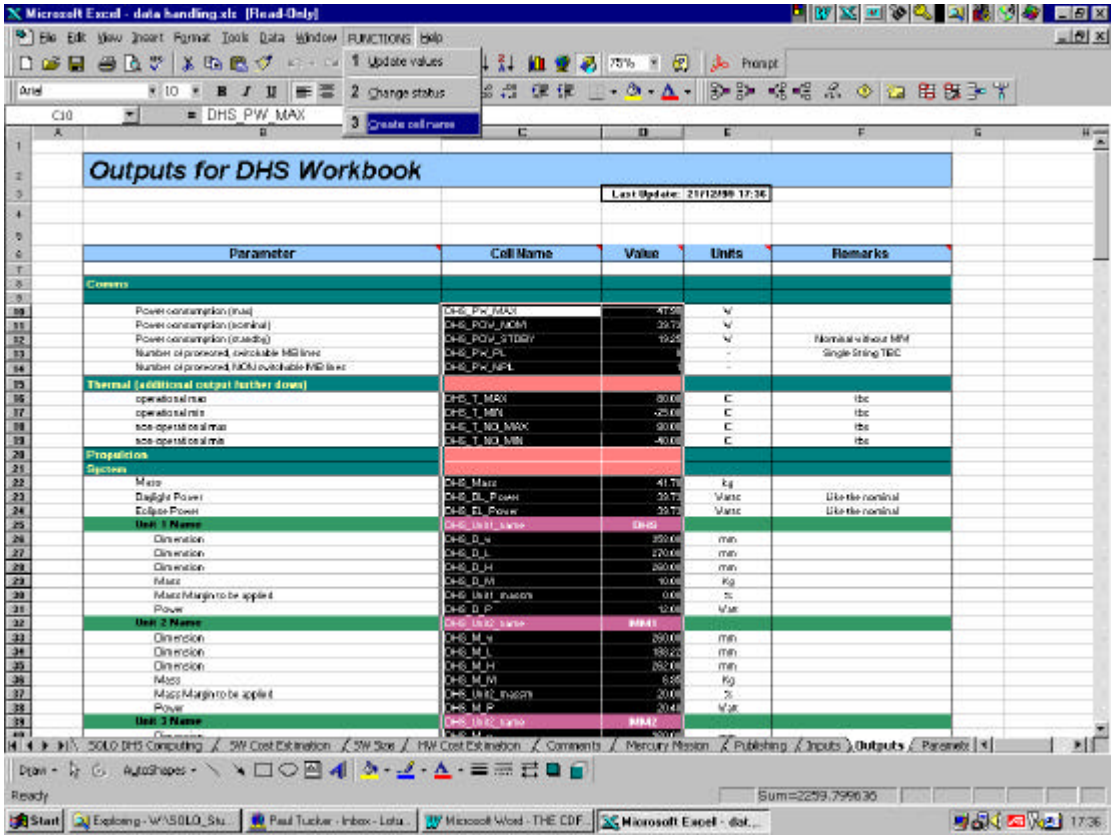


Figure 3-9: Example "Cell Names" in Output sheet

The workbooks should be set up so that a “results” parameter within a working sheet is referenced by the corresponding parameter value in the ***Results*** sheet list. When the value of the result changes, this should automatically be seen in the ***Results*** sheet. The Corresponding list in the ***Data Exchange*** should be able to update this value. This means that the new value will automatically be transferred to the ***Data Exchange*** when the ***Domain*** file is saved, and the ***Data Exchange*** is updated. No copying and pasting of the new value is required.

3.4.3 GROUPING OF PARAMETERS

Within the different workbooks the output parameters must be created and grouped in a way that is consistent with the overall model. The model is being continually developed to make parameters more generic to allow their use in different projects. In many cases parameters have been grouped and given specific cell names, which must not be changed.

The outputs of the spacecraft sub-system workbooks must be set out in a uniform way that is consistent throughout the model. Most of the outputs for these domains can be classed as either ***Sub-System*** level information, or ***Unit*** level information (a ***Unit*** is defined here as one level below ***sub-system*** level). A template has been used (known as the ***Unit Block***) which sets out generic parameters at ***System*** level, and also at ***Unit*** level. It is important that the cell names of the template are stuck to, so that integration of the model (i.e. referencing in the ***input*** sheets) can be simplified.

The ***Sub-system*** level parameters are placed at the top of the ***Results*** sheet and can be completed during the first iterations of the design. At the beginning this information may be just an estimate, but it is still important to include it within the *"Outputs"* for data exchange. The basic parameters will remain the same from project to project, but there will be some need for customisation between projects. An example is shown in Figure 3-10.

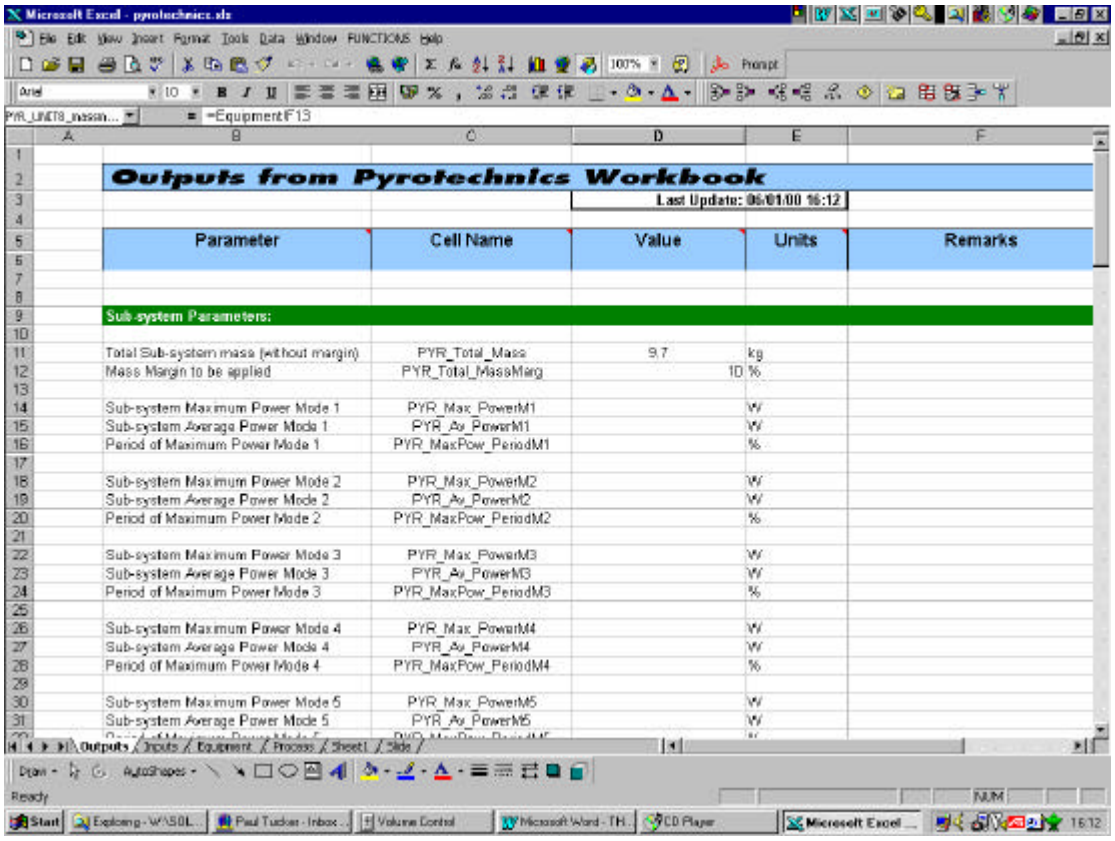
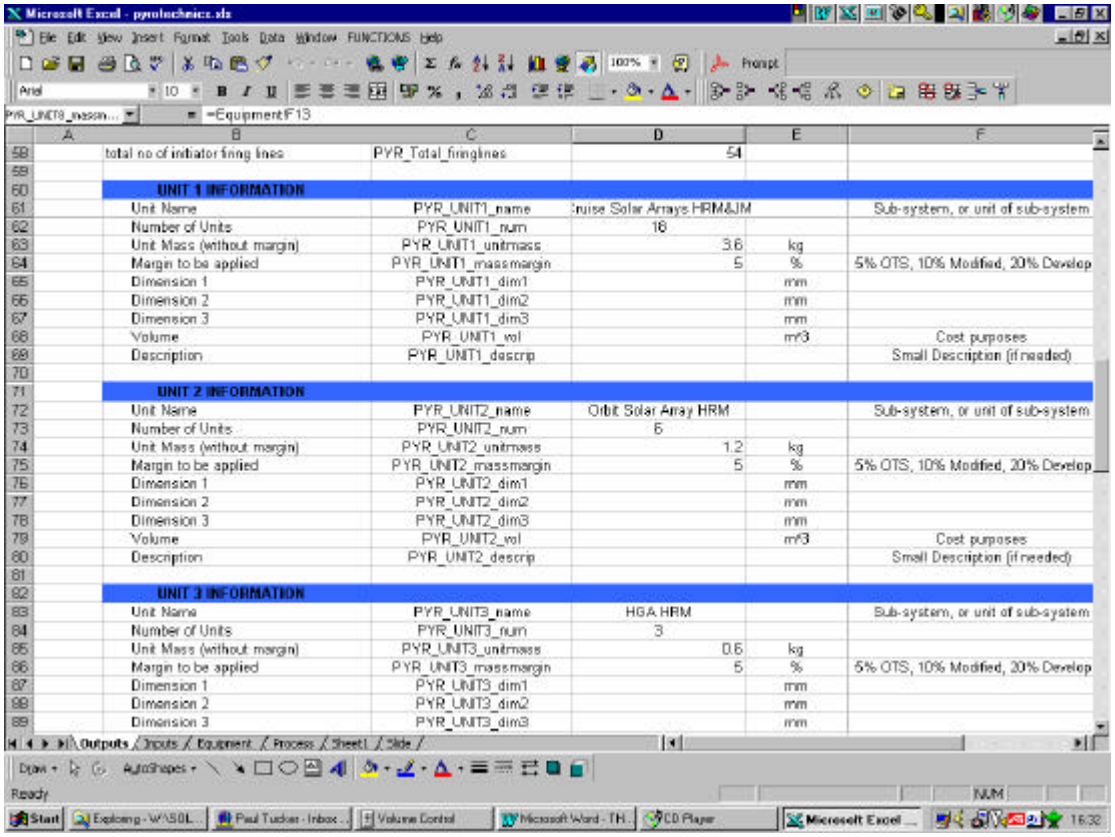


Figure 3-10: Example "Sub-system" parameters in Output sheet

Unit Level information is placed below the ***System Level*** parameters. There is a template available for the generic parameters. The outputs are set out in such away that all units are numbered. All

the parameters for a unit are distinguished by a change in unit number within the ***Results*** sheet. All specific information about the unit itself is stored within the value column for generic application because only the ***Value*** column will change between projects.

The ***Unit*** template contains parameters that various domains have requested from each sub-system. In some workbooks the entire template has been added, whereas in others, a basic set has been used, with the possibility of adding parameters as the project progresses. The model will be unified as time permits (see example of Figure 3-11).



	A	B	C	D	E	F
58		total no of initiator firing lines	PYR_Total_firinglines	54		
59						
60		**UNIT 1 INFORMATION**				
61		Unit Name	PYR_UNIT1_name	Cruise Solar Arrays HRM&JM		Sub-system, or unit of sub-system
62		Number of Units	PYR_UNIT1_num	18		
63		Unit Mass (without margin)	PYR_UNIT1_unitmass	3.6	kg	
64		Margin to be applied	PYR_UNIT1_massmargin	5	%	5% OTS, 10% Modified, 20% Develop
65		Dimension 1	PYR_UNIT1_dim1		mm	
66		Dimension 2	PYR_UNIT1_dim2		mm	
67		Dimension 3	PYR_UNIT1_dim3		mm	
68		Volume	PYR_UNIT1_vol		m^3	Cost purposes
69		Description	PYR_UNIT1_descrip			Small Description (if needed)
70						
71		**UNIT 2 INFORMATION**				
72		Unit Name	PYR_UNIT2_name	Orbit Solar Array HRM		Sub-system, or unit of sub-system
73		Number of Units	PYR_UNIT2_num	6		
74		Unit Mass (without margin)	PYR_UNIT2_unitmass	1.2	kg	
75		Margin to be applied	PYR_UNIT2_massmargin	5	%	5% OTS, 10% Modified, 20% Develop
76		Dimension 1	PYR_UNIT2_dim1		mm	
77		Dimension 2	PYR_UNIT2_dim2		mm	
78		Dimension 3	PYR_UNIT2_dim3		mm	
79		Volume	PYR_UNIT2_vol		m^3	Cost purposes
80		Description	PYR_UNIT2_descrip			Small Description (if needed)
81						
82		**UNIT 3 INFORMATION**				
83		Unit Name	PYR_UNIT3_name	HGA HRM		Sub-system, or unit of sub-system
84		Number of Units	PYR_UNIT3_num	3		
85		Unit Mass (without margin)	PYR_UNIT3_unitmass	0.6	kg	
86		Margin to be applied	PYR_UNIT3_massmargin	5	%	5% OTS, 10% Modified, 20% Develop
87		Dimension 1	PYR_UNIT3_dim1		mm	
88		Dimension 2	PYR_UNIT3_dim2		mm	
89		Dimension 3	PYR_UNIT3_dim3		mm	

Figure 3-11: Example "Unit Level" in Output Sheet

Parameters have also been created to be in line with the design processes developed for the facility. The application of the "***Modes of Operation***" feature is very useful for the exchange of information and require output parameters to be created in a certain way.

3.5 Working Sheets

The user of a domain workbook can add as many working sheets that they feel necessary for the conduct of a study. However, normally the available worksheets are adequate for most applications (see specific domain *User Manuals*). These sheets should contain everything necessary to produce the results required from a given domain. This may include calculations directly produced in the spreadsheet, or results gathered from external sources. A summary sheet also can be included, for use when writing reports and to help others to see the design status. This should be different from the ***Results*** sheet that should just be used for information passed through the various workbooks of

the model. Schematics can also be added to aid in the visual representation of the design. These diagrams can be linked to information within the workbook so that the information contained within them change automatically (see Figure 3-12).

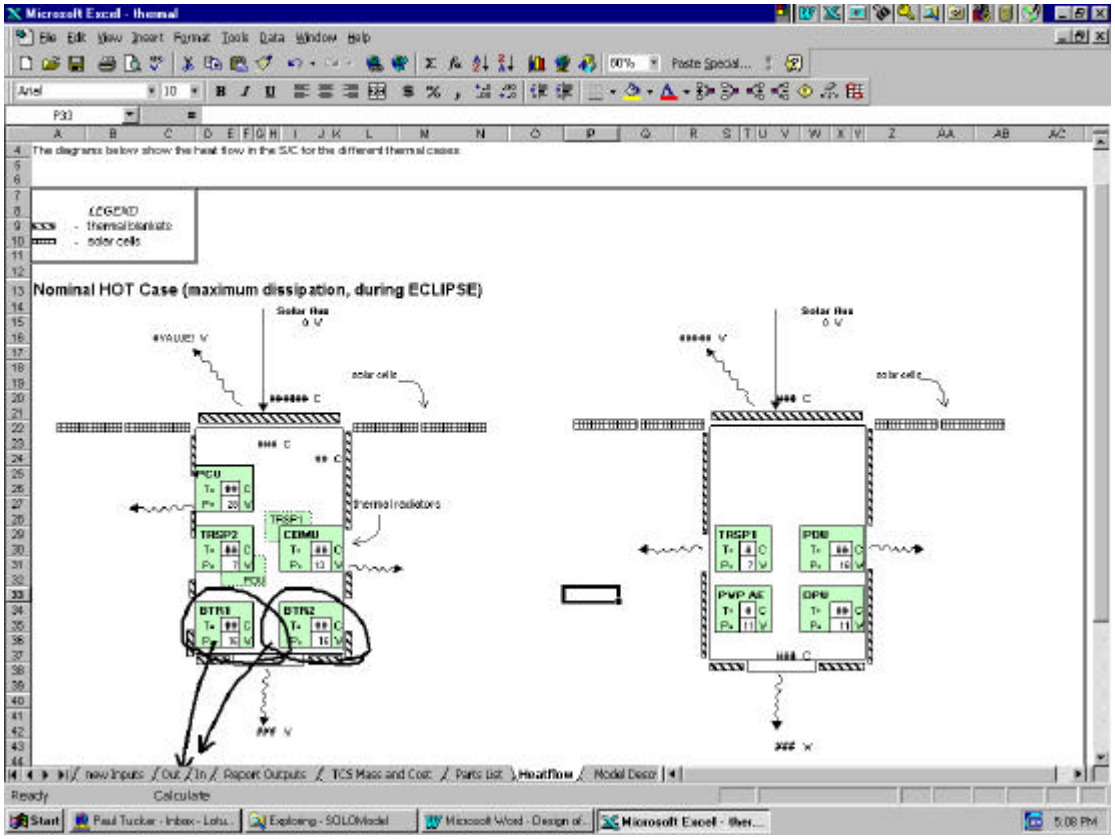


Figure 3-12: Example "Domain Specific" Worksheet

As much calculation as possible must take place within the domain workbook, external tools should only be used if absolutely necessary. This allows the design process to proceed faster, reducing the time needed to go and use analysis tools outside the design room. At the minimum the working sheets should be used to store the current information available on a given domain.

To aid speed and simplicity, databases of relevant information can be added, e.g. information on different equipment technologies and manufacturers. As the CDF develops and matures it will be possible to complete calculations on the demands of a sub-system and then be automatically access equipment information (from a database) capable of meeting those demands. The attributes of the equipment can then be passed to other domains.

3.6 Notes Sheet

A sheet has been added to each workbook that allows notes on various aspects of the design to be stored within Excel. This sheet has been given a flexible form to allow it to be used for several types of information, such as:

- Actions (open or closed)

- Design Assumptions
- Design Drivers
- Requirements
- Options
- Any other general notes

Several columns are present within the sheet that can be used to identify the note and filter through all of them more easily. There are help comments within the Title headers of each column which explain what they should be used for. The notes can then be filtered at any time using the Autofilter menus also contained within the Title headers as shown in Figure 3-13.

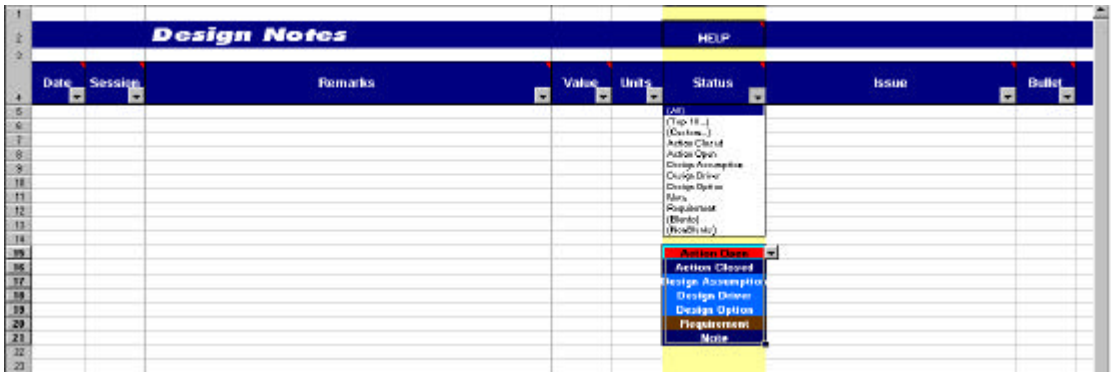


Figure 3-13: Autofilters in the *Notes* sheet

This sheet can be used during design sessions and at any other time to record issues related to the specialists involved. The domain specialist should add all relevant information here. It can then act as a record of the design process and also be used in the creation of presentations and reports. The filter allows different types of information to be displayed, which can then be used to create slides (e.g. Design Drivers), etc. The collection of sheets throughout the model can be used to form the minutes of sessions. They can also be used to communicate greater amounts of information through the model. It is important that each specialist fills in this sheet to the best level possible.

3.7 MenuSheet

This sheet is hidden from view to avoid any accidental changes and an example is shown for reference in Figure 3-14. The menu sheet was created to specify the parameters of a menu (called **FUNCTIONS**) created especially for the model. Macros within the workbook use the data within the sheet to set out the menu. This sheet is also used to store lists that are used in pull-down menus in other sheets. The list of menu option can be added to as more macros are created. The names used in the menu can also be changed here.

The sheet is also used to contain the "**choices**" cells for the switch column of the ***Input*** sheet. Both the lists for the menu and the "**choices**" cells can be extended if required. The **choices** cell name requires re-applying to the entire list if changes are made.

The sheet is also used to store the links to the system version number and date found in the ***Systems*** workbook. There is also a link to the ***Input*** sheet collecting to system version number and date stored from the last time the workbook was updated. These values are shown to the user when the workbook is opened to see whether the link to the ***Data Exchange*** needs updating.

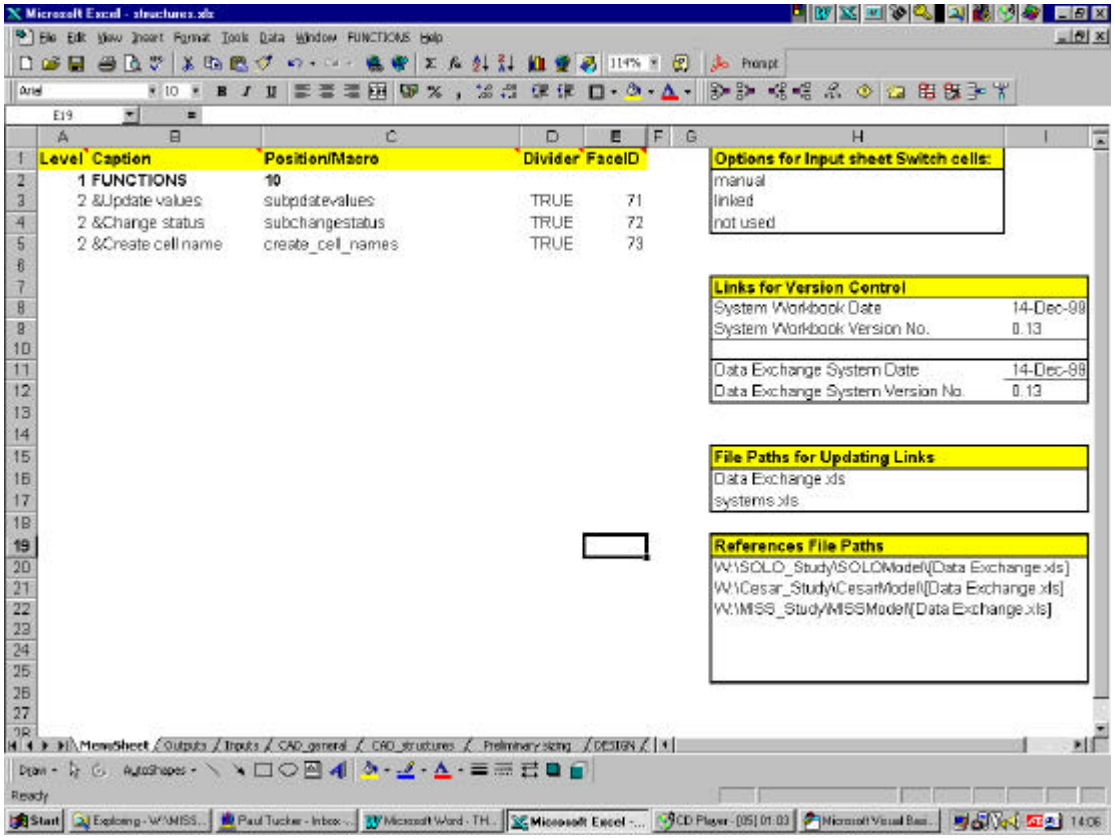


Figure 3-14: Example *MenuSheet*

3.8 The Data Exchange Workbook

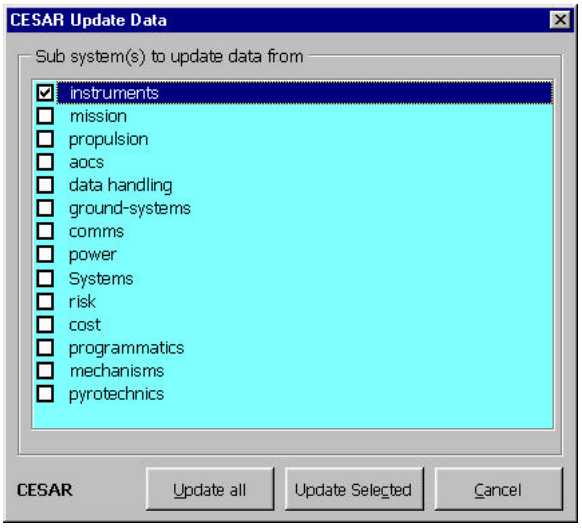
This workbook acts as a central junction for all information flow in the model. It should not be looked upon as a summary sheet, or as the model itself.

Parameters available in each ***Results*** sheet is copied into the ***Data Exchange*** using the "Gnerate Outputs" macro and therefore published for the rest of the system. To update the ***Data Exchange*** a new copy of the domain ***Output*** sheet is loaded, normally done by the System Analyst. It is necessary to make sure the numbers in your output sheet are correct as they will be used by other members of the team in their calculations. It is also important that you create and apply cell names to the value column, so that a more flexible system can be created. Updates can be made selectively, i.e. you can update individual sheets independently. This has the advantage that it is possible to keep the published values of some domains fixed while allowing others to change. It also means that updates can be made quickly, rather than having to wait for all the sheets to be updated, which can be slow.

It is only necessary for a domain specialist to open the Data Exchange (Read Only) when he/she wishes to establish references to the various sheets of the Data Exchange to their Inputs sheet. Only the Systems specialists can change and save this workbook.

3.8.1 DATA EXCHANGE MACROS

The workbook contains macros, which allow for the update to take place. A menu option called '***DATA EXCHANGE***' is available in the menu bar containing the option to update values. When selected a window appears allowing the selection of one or more sheets to be updated as shown in the example below.



The Instruments sheet is selected for update

3.8.1.1 New Inputs and Outputs

It is up to the user to add inputs/outputs to the tables provided by the new sheets. These values can then be linked to your working sheets. Links must be established so that if a value in the input sheet changes, the working sheets are updated automatically. Similarly, when values change with your workings, the ***Results*** sheet will reflect these new values automatically.

If a new value is required from another domain, then the user must approach the specialist concerned and ask them to produce the value and place it in their ***Results*** sheet to enable a link. If there is a major problem then the Systems Analyst should be notified.

Changing the ***Data Exchange*** could cause serious problems to the integration of the model. You must not attempt to do anything to this book, unless this is with the agreement of the caretaker of the model.

3.8.2 OVERALL DATA EXCHANGE PROCESS

The process for all workbooks including the ***Data Exchange*** is the same; i.e. the user has the responsibility for implementing the updating of information and the downloading of data to the rest of the system.

3.8.2.1 The Data Exchange

The ***Data Exchange*** will be the responsibility of the ***Systems*** specialist. They will have the responsibility for making sure the existing parameters in the ***Data Exchange*** are up-to-date. However, as mentioned in the previous sections, it is the responsibility of the individual domain specialist to make their inputs reference the correct cells of the ***Data Exchange***.

3.8.2.2 Steps to the Process

The ideal process for use of the model is given below, however, it is likely that the actual use of the ***Data Exchange*** may be more flexible. This includes updating values out of a session. At the beginning of a study many of the links will not be properly established. Thus, this will require inputs to be manually inserted in the ***Inputs*** sheet by the respective domain specialists.

1. A proposal will be made for changing a parameter of the spacecraft (e.g. orbit perigee).
2. This can then be discussed and accepted or rejected.
3. If accepted the parameter is changed.
4. Save the workbook of that domain – inform CDF Administrator to ensure model update.
5. The ***Systems*** station then updates the information in the ***Data Exchange***.
6. The ***Systems*** station then ***Saves*** the ***Data Exchange*** and this downloads the new information into the file saved on the network.
7. All domain workbook specialists can then update their link to the ***Data Exchange*** to get the current information.
8. The domains then download the changes in their outputs due to the initial parameter change; this download is done simply by "***Saving***" the domain workbook.
9. Steps 5 to 8 can then be repeated a number of times to propagate the effect of the initial change around the system.

It must be noted that there is no real way to tell when the effect of a parameter value change will be complete. It is possible that its effect will continue to affect the system through several iterations. This can complicates matters and care must be taken when updating and downloading information.

4 MODES OF OPERATION AND MECHANICAL STATES

To allow efficient use of the model and to reduce time wasting during sessions a number of approaches have been defined for the passing of information through the model (and therefore the design process).

It is important that design cases are identified and a clear way of passing the data relating to these cases is implemented. This requires certain rules to be followed by the domain specialist within sessions and when implementing their models. If these methods are deviated from, then this could lead to many internal problems in the model. Links have and will be set up specifically for approaches explained below. Changing procedure could very well mean that the links will become invalid and new links will have to be established wasting valuable study time.

4.1 Spacecraft Modes of Operation

The modes of operation of the spacecraft are defined to enable the electrical/data domains to size their systems. An approach has been followed to be flexible (generic) to enable use with different projects. The method has been specifically chosen, for the model data transfer, and to allow the power budget to be completed.

4.1.1 SUMMARY OF METHOD

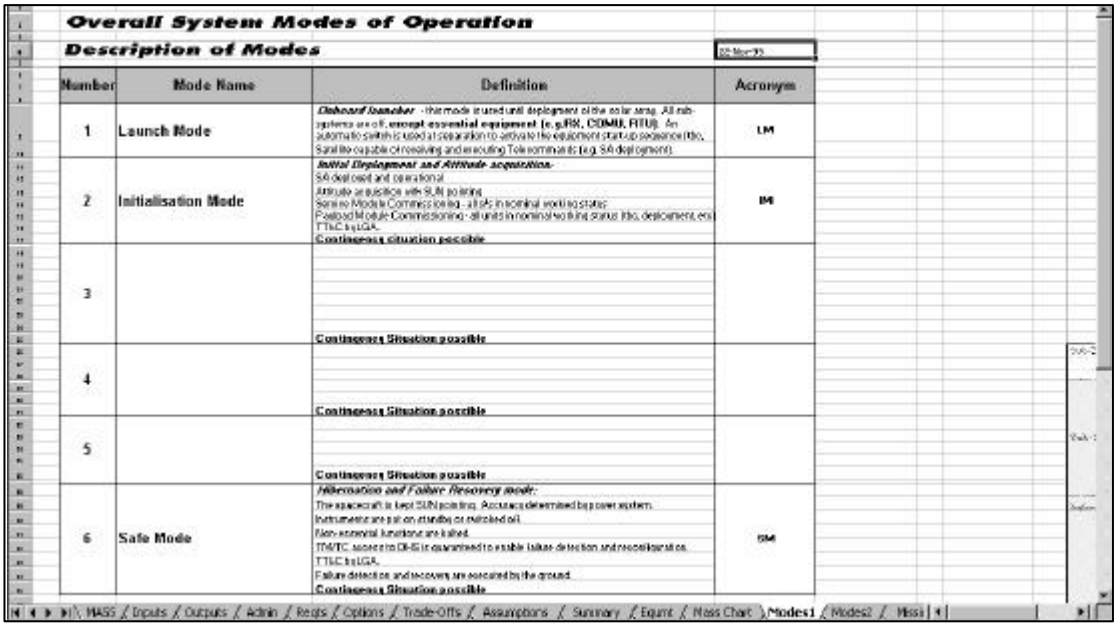
The following method is recommended as follows:

1. The modes of operation of the spacecraft are identified and defined (in the ***Systems*** workbook) to a level of detail that can be used by each sub-system to understand the requirements imposed during each mode.
2. Each sub-system then identifies the equipment that is required in each mode and the period of time needed for the equipment. This may mean identifying their own (sub-system) modes of operation, and then seeing what sub-system modes are used during certain System level modes.
3. Each sub-system then supplies maximum and average power levels in each mode for each piece of equipment. They can also supply other information per mode, such as data rate. The cell names of these values will be set out in a specific way to ease insertion into the power budget.
4. The power/data budgets can then be calculated and the electrical and thermal systems sized. Problems can then be highlighted, and specific problem areas focussed on.
5. (If required) sizing cases can be established and published to the rest of the model.
6. Sub-systems then supply information on the design cases to allow more detailed sizing of the electrical systems.
7. The design process can then iterate using the design cases, changing the requirement of these cases and to optimise the system.

4.1.2 DEFINING SYSTEM LEVEL MODES

As soon as possible in the design process the ***Spacecraft Modes of Operation*** should be defined. This initial definition can be done off-line (out of session time) and then verified within a session. These modes should be defined within the ***Systems*** workbook (***systems.xls***) using the sheets available as follows:

- **Modes1** sheet (see Figure 4-1) defines the modes at system level and summarises their major features. It also includes the definition of the mode name and acronym. Under the table, a space is provided for the flow diagram for mode change.



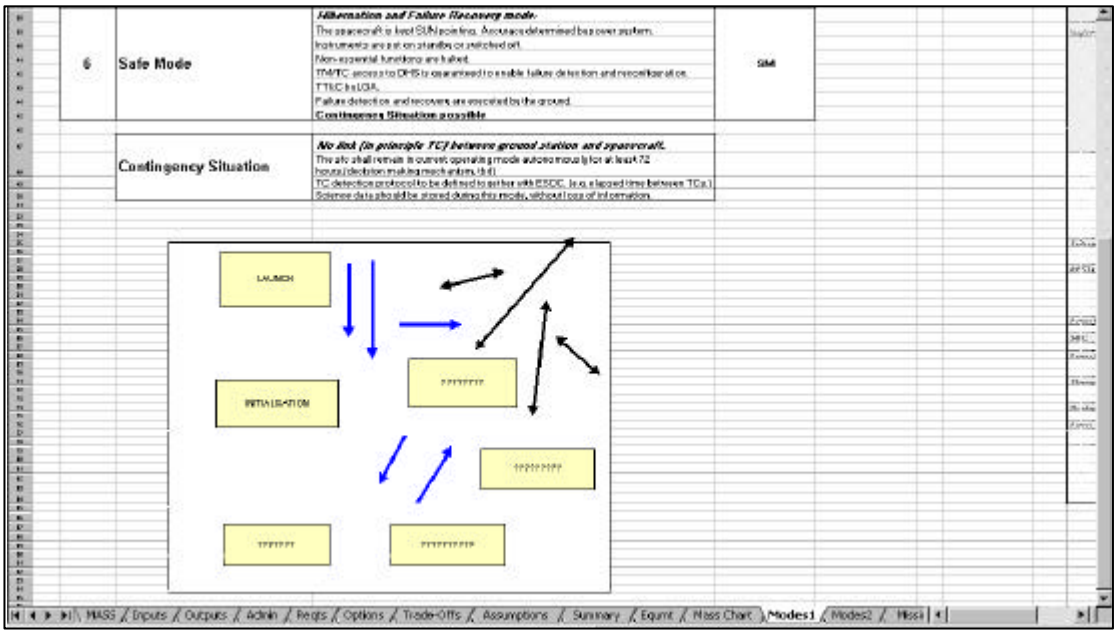


Figure 4-1: S/C Modes of Operation - Modes1 sheet

- **Modes2** sheet (see) defines the requirements placed on each sub-system by the system for each mode. Each sub-system is given a descriptive summary of the requirements placed on it. This information is connected to the ***Results*** sheet and passed via the ***Data Exchange***.

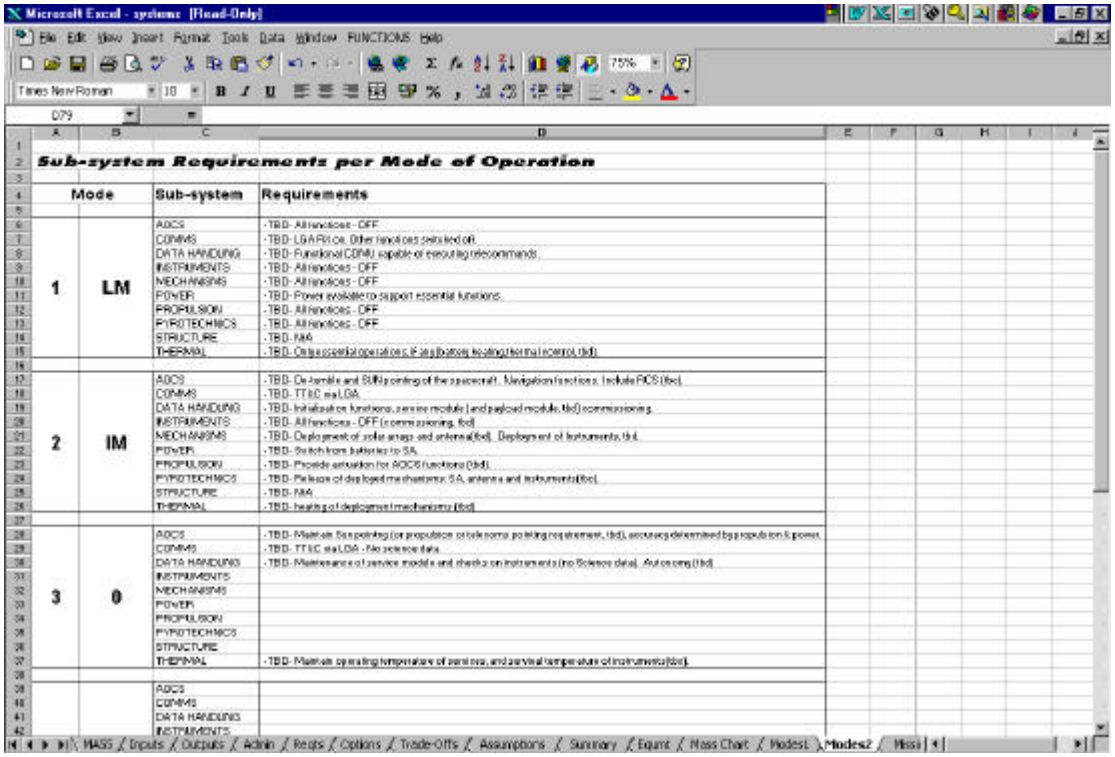


Figure 4-2: S/C Modes of Operations - Modes2 sheet

- **Sub-system**
  Each sub-system collects the information on its requirements for each mode, via the ***Data Exchange***. Other mode information can be taken from the verbal communication of the sessions and from the mode summary sheet in the systems.xls workbook. This information can then be used to identify the internal "Sub-System" modes required for each Spacecraft Mode. The power, data and other appropriate resources can then be calculated for each Sub-System Mode. The information that will be passed is as follows:

  - **Power (Sub-System Level)**
    - Maximum Power per Mode (W)
    - Minimum Power per Mode (W)
    - Nominal Power per Mode (W)
    - **Data –** Passing of Data information (e.g. data rates, volumes, etc.) still has to be assessed and implemented.

This information can then be placed into the Domain ***Output*** sheet, for use by the rest of the team via the ***Data Exchange***.

4.1.3 DESIGN CASES

When the spacecraft mode information has been produced by each sub-system it is possible for the other specialists who require system budgets (e.g. power systems) to size their sub-systems. At this stage the sub-systems will not be optimised, because the sizing is done at spacecraft mode level.

To optimise sub-systems further the "Design Cases" have to be established based on the modal information and the knowledge about the mission timeline/operations. Establishing Design Cases rather than sub-modes of the Spacecraft Modes reduces the amount of work required to optimise the system (see Figure 4-3). Some sub-modes may not be Design Cases, and so do not need defining during the study. Design Cases may also be more specific than a sub-mode, focusing on the exact design issues.

Optimising the system with "Design Cases" can mean that other operational cases then become Design Cases, and the initial cases are less critical. This may lead to several iterations. The initial Design Cases should remain stored in the model, with new cases added.

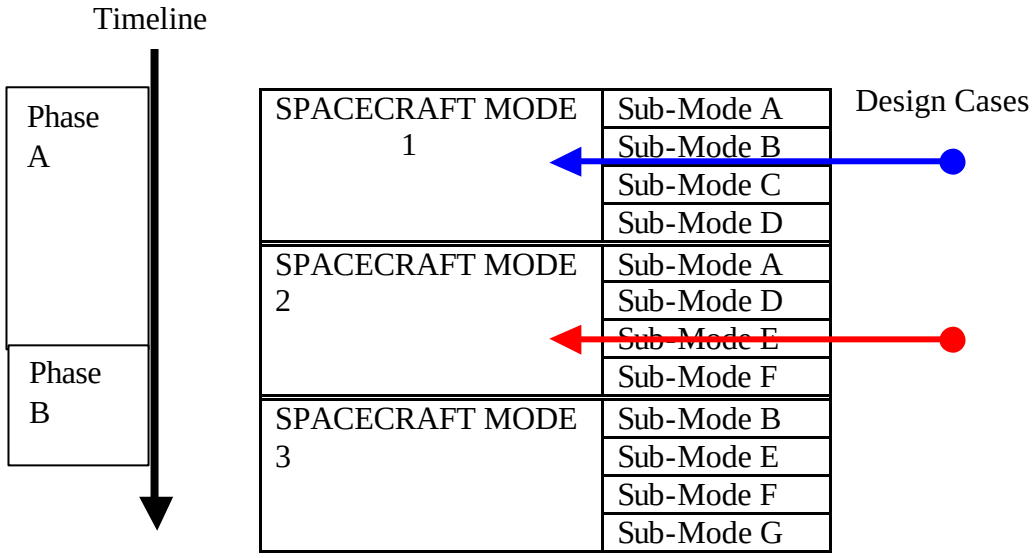
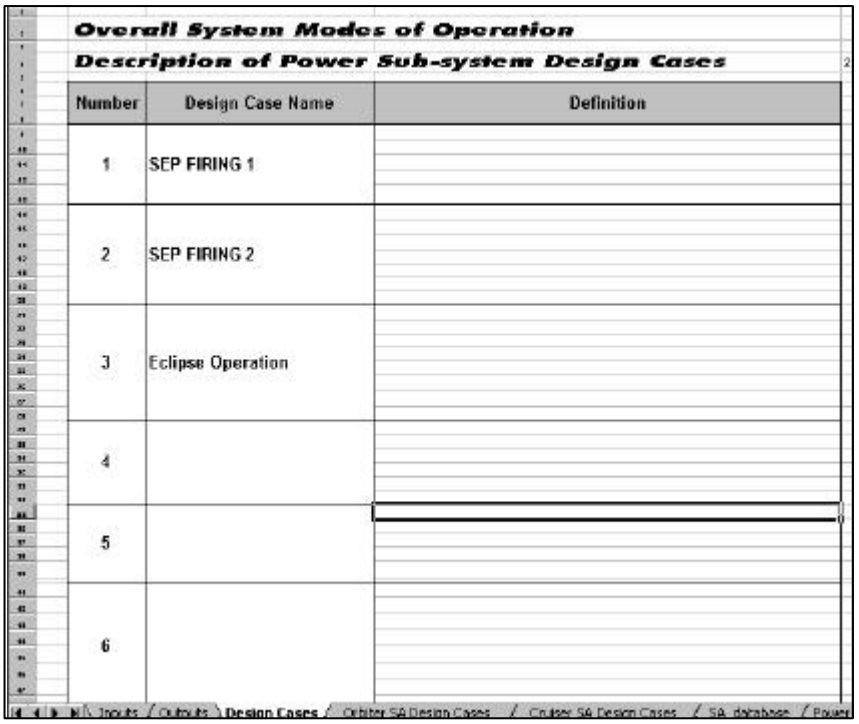


Figure 4-3: Design Cases selection to reduce study timeline

Design Case information can be passed across the model in a similar way to the Spacecraft modes. The description of each case can be written in the relevant workbook, e.g. power workbook for power Design Cases, and so on. The format can be exactly the same as for the Spacecraft Modes. An example of application of design cases is shown in Figure 4-4.



Overall System Modes of Operation

Description of Power Sub-system Design Cases

Number	Design Case Name	Definition
1	SEP FIRING 1	
2	SEP FIRING 2	
3	Eclipse Operation	
4		
5		
6		

Inputs / Outputs \ Design Cases / Orbiter SA Design Cases / Cruiser SA Design Cases / SA_database / Power

Figure 4-4: Example Application of Design Cases

Such design cases can then be used by other sub-systems to identify their operational state during these periods. The resulting information can be added to the ***Results*** sheet of all sub-systems, which can then be linked to the sub-systems that are using these design cases, e.g. Figure 4-5.

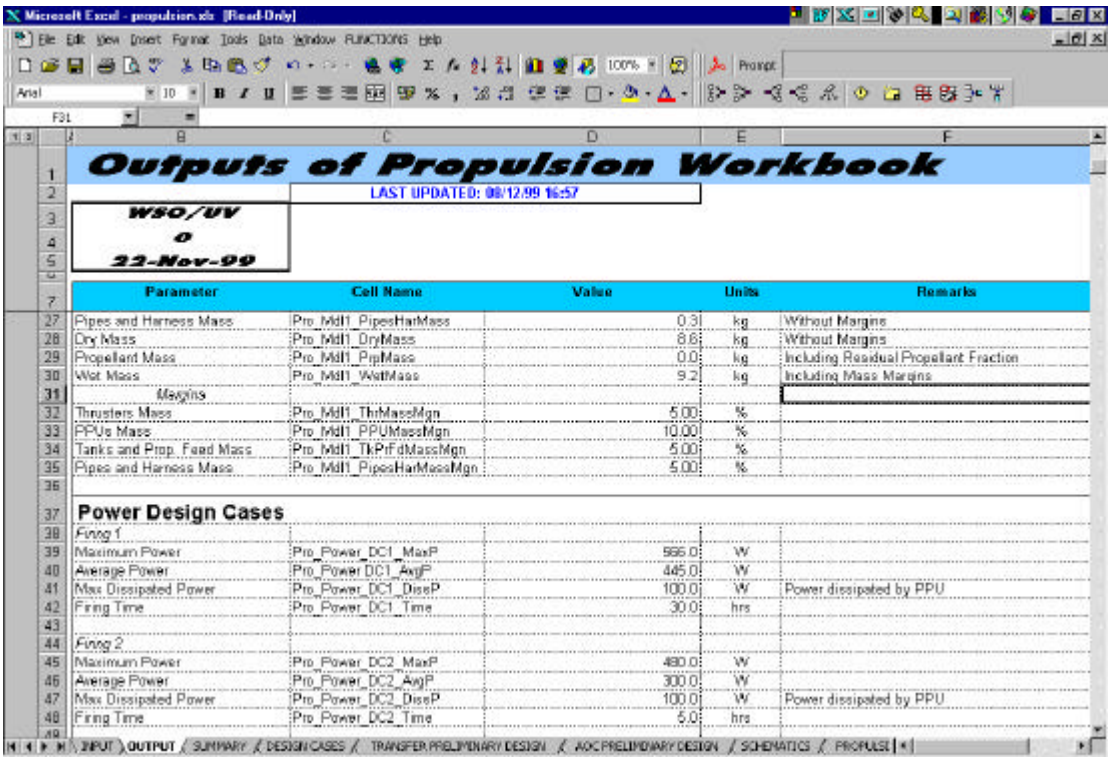


Figure 4-5: Application of Design Cases to Propulsion Results Worksheet

If there are operational states that are design cases for several sub-systems, then there must be only one source for the definition of that case. It should be decided in which workbook the definition should be stored. For most cases it will be added to the Power sub-system workbook.

4.2 Mechanical Changes - Events

As well as operational modes for electrical state, there is also a need for changes in mechanical states of a system. This change may be a reduction in mass or a change from stowed to deployed states. This will result in a change to mass values and/or moments of inertia.

The system can define mechanical states that are required for the design and sizing of various sub-systems, such as structures, AOCS, propulsion. These mechanical states can be related to phases of the mission, or even to the Operational Modes of the Spacecraft. They must be defined in the ***Systems*** workbook, in a similar way to the Modes of Operation. A single sheet in the ***Systems*** workbook can define the "***Mechanical States***" as shown in Figure 4-6. Only crucial states should be identified, i.e. those required for sub-system sizing and optimisation.

System Mechanical States

Description of Mechanical States 22-Nov-99

Number	Mode Name	Definition	Acronym
1	Stowed State	All mechanisms stowed for launch. Fuel tanks full	SS
2	Deployed with Fuel State	All mechanisms deployed: Solar Arrays Antenna - Protected from Sun postion Instruments Fuel tanks full	DFS
3	Nominal State	All mechanisms deployed: Antenna - Protected from Sun postion Fuel Tanks Mass: after apogee firing.	NS
4	Communications State	Antenna - Positioned for Ground Communications (not Sun protected) Fuel Tanks Mass: after apogee firing.	CS
5			
6			

Inputs | Outputs | Admin | Reqts | Options | Trade-Offs | Assumptions | Summary | Equmt | Mass Chart | Modes1 | Modes2

Figure 4-6: Example "Mechanical States" worksheet

Once these Mechanical States have been defined, it will be possible for each sub-system to identify their specific mass, and any other relevant mechanical properties and be added to their ***Results*** sheets. To achieve a generic approach that can be used for all types of mechanical state is difficult. To avoid overloading ***Results*** with extra parameters a very simple approach has been considered. Rather than setting out very specific parameters (such as the mass per unit for each mode), ***Description*** and ***Value*** parameters can be used. Several sets of Descriptions and Values parameters can be used for each Mechanical State to describe any change in ***Mechanical Property*** of a given sub-system. The Description parameter can be used to explain the change textually, and the Value parameter can be used for any related numeric data, such as change in mass.

These parameters can be used for every project, but the types of values and units will likely change from project to project. It will be down to the users of this information to organise their inputs from project to project to deal with this difference. The parameters can then be interpreted to modify results for Mechanical States and therefore ***Phases*** and ***Events*** during the mission.

5 MARGIN PHILOSOPHY

Margins are a key feature of all engineering design and their application and the values allocated are provided for within the CDF model.

5.1 Mass Margins

There are three levels of margin that can be placed on the Mass Budget of the model:

1. Equipment Level Margin
2. Sub-System Level Margin
3. System Level Margin

The way these margins are used depends on the customer and the needs of the study. Each sub-system takes a margin related to the level of technical knowledge about that particular design, as well as the likelihood of change. This margin is first given at sub-system level, but when units are identified it is applied then at equipment level.

5.1.1 EQUIPMENT MARGINS

Every piece of equipment for each sub-system is given a margin on mass based on its maturity. There are three levels that are applied in the CDF model:

- 5% for fully developed items.
- 10% for items to be modified.
- 20% for items to be developed.

One of these margins will be applied to each piece of equipment. Each piece of equipment can be given different margins depending on their maturity. In special cases it may also be necessary to give a piece of equipment a specific margin different from any of those above. However, in most cases the three levels above will be sufficient.

These equipment level margins can be used also by the cost and risk specialists to assess maturity. It may be possible also to correlate directly to other parameters used for both cost and risk calculations.

5.1.2 SUB-SYSTEM MARGINS

At the beginning of a study it will not be possible to identify all equipment, or assess its maturity. At that stage an estimate of sub-system masses will have to be made. An overall sub-system margin is also estimated. This can also follow the list in section 5.1.1.

Eventually equipment will be identified and margins produced for each of them. The overall sub-system margin can then be made as an average of the equipment margins. It may also be appropriate to increase this margin to account for overall sub-system uncertainties.

Example:

Equipment	Mass without margin, kg	Margin %	Mass with margin kg
Equipment1	12	10	13.2
Equipment2	5	5	5.25
Equipment3	10	20	12
TOTAL	**27**	**12.8**	**30.45**
Addition of Subsystem margin:		**15%** (12.8+2.2)	**31 kg** (27+15%)

In most cases it will be sufficient to leave the overall margin as the average of the equipment margins without adding any other extra margin. In some cases this will be a decision made at system level.

5.1.3 HIDDEN MARGINS

Within each sub-system there may also be margins placed on calculations or other parameters, which affect the mass (e.g. total power consumption margin). It is important that these margins are highlighted and taken into account when calculating sub-system mass margins.

5.1.4 SYSTEM MARGIN

A mass margin is also inserted at System level to account for possible design (e.g. missing equipment) and technology uncertainties. This is placed in addition to the total system mass with sub-systems margin.

Normally this is a figure of 20% as appropriate to the feasibility study level.

5.1.5 IMPLEMENTATION IN THE MODEL

All masses and margins shall be placed in the ***Output*** sheets of the sub-systems. Masses should be given at system level, and at equipment level. The equipment level figure may not be available at the beginning of the study, but they shall be included as soon as they become available.

5.1.5.1 SUB-SYSTEM LEVEL

At sub-system level a mass figure shall be given in the ***Outputs*** that **DOES NOT** include margin. A second output parameter shall give the margin that will be applied to the mass figure. This Margin parameter shall be in Number format and **NOT** in percentage format (within the Cell Format options). The % sign shall only appear in the "***Units***" column (see below). This is to remove the problems perpetrated by receiving a figure of 0.1 rather than 10 when it is written 10%.

AOCS mass without margin	AOCS_Mass	**1.992**	kg
AOCS mass margin	AOCS_Mass_Marg	**10.00**	%

When equipment level margins are defined, then sub-system level shall still give the overall margin to be applied, i.e. the sub-system margin does not become the extra margin in addition to the equipment margins, but it will include the equipment margins.

5.1.5.2 EQUIPMENT LEVEL

Each piece of equipment for each sub-system shall be added to the Outputs sheet. Similar to the Sub-system level mass figure, the Equipment mass parameter shall be without margin. Again the margin to be applied shall be a separate parameter. The value of the margin will be based on the philosophy set out in section 5.1.1.

In all, four parameters are required for the Mass Budget as follows:

Unit1 Name	AOCS_unit1_name	**Star Tracker**	
Number of units	AOCS_unit1_Unit	**1**	number
mass (without margin)	AOCS_unit1_Mass	**1**	Kg
Mass Margin to be applied	AOCS_unit1_MassMarg	**20**	%

The mass figure given for each unit (equipment) shall be the mass value for one item. Therefore the overall mass for the total number of a given piece of equipment shall be:

number of units * mass.

5.1.5.3 TOTAL MARGIN

The total margin for a sub-system can be the average of the equipment margin, or this can be modified by adding/subtracting extra margin. Therefore, the Sub-system mass margin can be higher (or lower) than the average of the equipment margins. It is down to the sub-system specialists to use their expertise to assess the correct sub-system margin to be used.

6 ABBREVIATIONS AND ACRONYMS

AOCS	Attitude and Orbit Control System
CAD	Computer Aided Design
CATIA	Computer Aided
CDF	Concurrent Design Facility
ESA	European Space Agency
ESTEC	European Space Technical and Engineering Centre
HYPER	High Precision Interferometry
ICA	Independent Computing Architecture
NT	New Technology
PR	Procedure
S/C	Spacecraft
SI	Système Internationale (d'Unités)
TBC	To be Confirmed

7 REFERENCES

[1] CDF System Description, CDF-SYS-01, Issue 2 rev. 0, 27/11/02.
[2] CDF ICA Client User Manual, 27/8/01.
[3] CDF Documentation Management, CDF-PR-004, Issue 1 rev. 0, 26/11/02.
[4] CDF Configuration Management, Issue 1 rev. 0, 25/11/02.