

# **DAD**

**DISCUSSION PAPER**

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**A MODEL IMPROVES EFFICIENCY  
AND ACCURACY.**

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## **INTRODUCTION**

To build and maintain control, communication and other electrical connected systems you must have the necessary information. Currently such information is created and stored on drawings and documents. We show here how the current documentation is inefficient and error prone and that DAD delivers better solution.

Current practices are growing more costly as systems grow in size and complexity.

In mechanical and civil engineering 3D models clash check and visualize the intended design. You can inspect and measure items. These drawings are drawn to scale and show the physical devices relative to one another. However it is not possible to represent electrical connections and concepts on scale drawings. They are shown 'schematically'. Information is repeated on several drawings to relate them together. The preparation of documentation is slow. The design emerges as the individual documents are completed. Then inconsistencies appear between the documents so that they must be re-edited. The final design only appears when all the documents have been cross checked and edited into a consistent whole.

Many features of systems cannot be found by visual inspection. Discovery may involve shutdown and loss of operating revenue. Repair times will be extended.

DAD allows you to capture the information in a model. It will deliver:

1. cost savings in engineering of between 50 and 90%
2. zero documentation errors
3. instant access to all relevant information
4. an auditable history for the complete model.

## FUNDAMENTAL ISSUES WITH CURRENT DOCUMENTATION

Consider this typical example - you need specific information about a panel such as that shown in Figure 1.

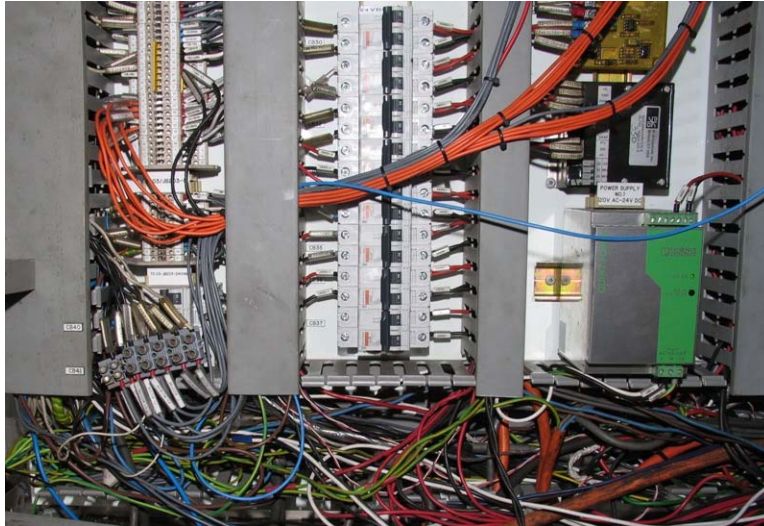


Figure 1.

You can read some markings on the components and their interconnections. To find what you need you must access the document archive.

Now your problem is to find which documents contain the information. You may judge that by reading titles such as:

- Termination Diagram Sheet x of n
- Power Supply Diagram for panel xxx
- Etc.

Having identified a possible document you must obtain a copy of it. Then you search visually to see if it shows the desired information. You may have to do this for many documents.

Alternatively, you will get copies of all documents for the panel. When you search these for the information it may not be complete so you must extend the search yet more documents.

Even when you find information you may not be able to determine:

- If there are more documents in the archive containing further relevant information?
- Or, if the documents show current and accurate information?

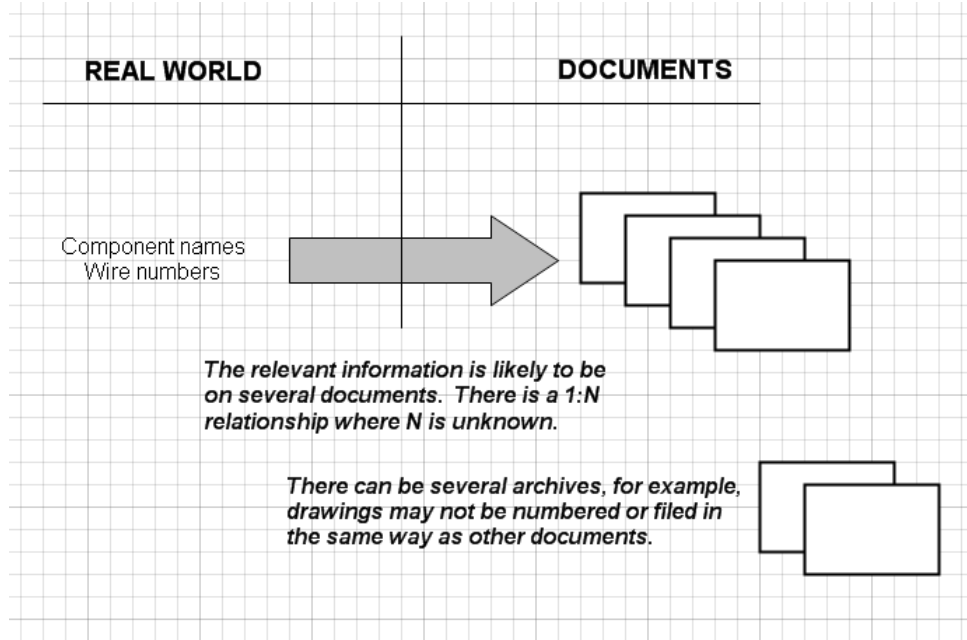


Figure 2.

The time taken to find information is a major impediment to you in performance of your work.

Now, consider how the information is distributed across the system documentation as this is prepared during engineering.

Concepts and requirements from many sources are translated on to documents and drawings in varying patterns. The same information must be placed on several documents to form relationships between them. Different information about the same component will be placed in different places so equipment and cable tags are often repeated.

As the documentation package evolves it is not possible to be certain:

- Which particular documents contain the same information
- Or which document show related information.

The documents require checking many times to make them accurate. Repeated information must be the same everywhere and making it so requires many iterations.

Requirement changes during design are extremely hard to manage and may cause major delays as many documents may have to be updated. It can be very difficult to predict the scope of the re-documentation required while the package is not yet fully completed.

Figure 3 shows major features of the process.

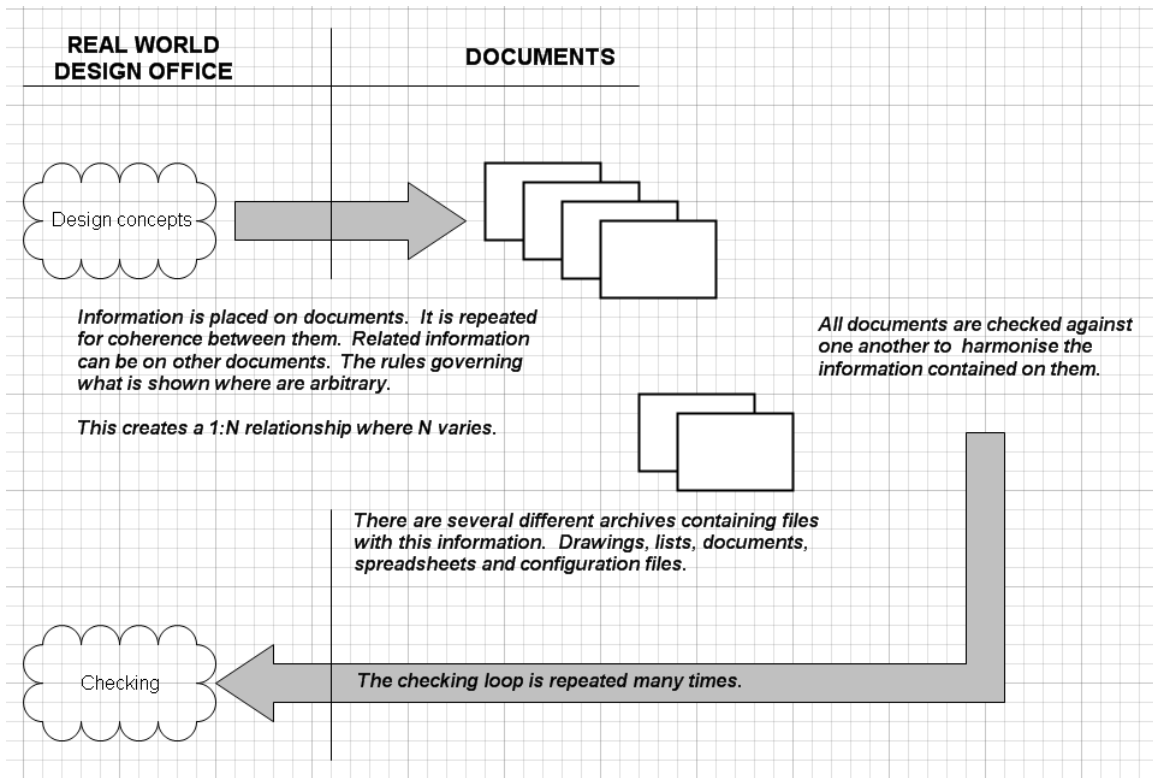


Figure 3.

100% accuracy is not achieved due to project schedule or budget limitations. A typical cost curve is shown in Figure 4.

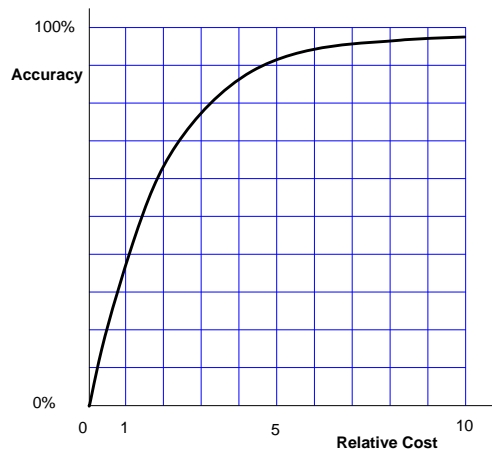


Figure 4.

As documentation errors will cause issues later system capacity is overdesigned to provide some risk mitigation.

Thus traditional system design breaks information in an arbitrary way across drawings and list. This renders them costly to produce and error prone. Users find information by 'fishing' in the document archive. The bigger and more complex the system the worse this gets.

## A MODEL APPROACH

DAD can store all the data for a system. It stores connections so that they can be traced on the screen. It creates a 1:1 relationship between the model objects and the real world objects in contrast to the n:1 relations of the conventional documentation as shown in Figure 5.

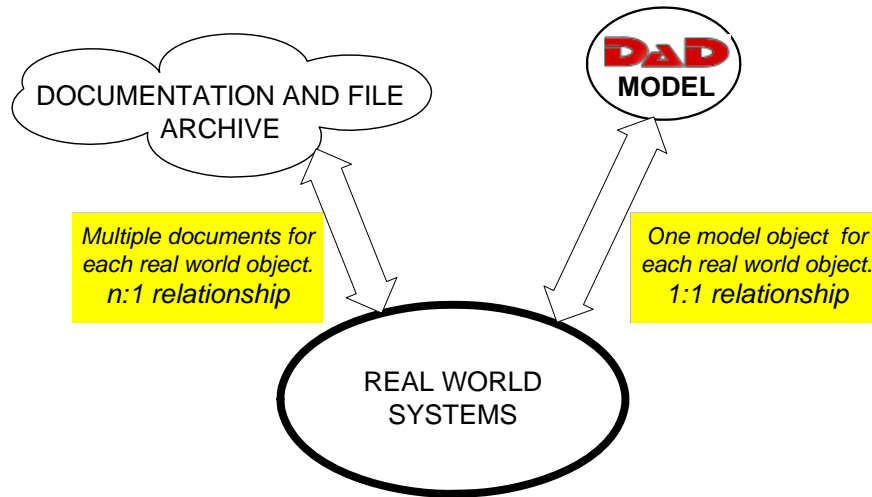


Figure 5.

So now you can find information fast in many ways such as:

- Name (or part)
- Type of component/connector
- Where it is installed
- What it is connected to
- Any data value in any item
- Which document it has been published on.
- Trace connections find circuits on the screen
- Discover spare capacity directly.

As there is no duplication of information engineering is more efficient. Any document or report is only a 'view' of the same information eliminating the major cause of error.

The model is multi-user. Teamwork is improved as the current state of all information is available to every user.

Objects in the model can be given shapes by users so that the published documents are similar in appearance to existing drawings.

Every component and connector accumulates a history log of all changes made to it. The DAD model is fully auditable.

You can store external files in the DAD SQL tables. This provides a direct link to external information such as:

- Vendor data sheets
- Layout drawings
- Test reports.

A short comparison of features is shown in Table 1.

Feature	Current Documentation	DAD
Technical drawing (CAD) skills required.	Essential	No
Format of deliverables	Large number of individual drawing and document files.	A single data model.
Information Management	A document manager is required. Different file types often managed separately from one another.	All information including external files can be stored in the model.  DAD has in-built document manager.
Amount of information that must be repeated.	Large	None
Cross references between documents.	Essential. Many must be created for the package to read coherently	Automatic.
Time required for engineering to produce full set of documentation.	Long	Between 10 and 50% of Current Documentation
Error Rate.	High unless extra time spent in checking.	The model is inherently coherent. Errors in data can be seen by all users immediately on entry.
Change history.	Drawings and documents have formal revisions. No direct history for the information shown on them.	Full history and utilities for auditing.
Security of information.	Relies on external measures.	In-built.
Cost of data extraction to interface with other packages for engineering tasks.	This is a manual process. It is high cost. Results in more copies of information.	Inherent measurement of material and status of components.  SQL Views can be provided for low cost IT interfaces.

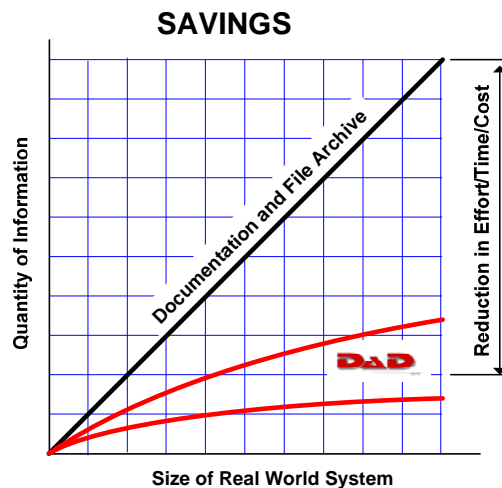
Table 1.

## BENEFITS FOR OWNERS/OPERATORS DURING ASSET LIFETIME

If DAD is used in the design of your systems and the model handed over to your advantages are:

1. improved asset management as you can rapidly and simply report
  - a. what is installed, where and all details
  - b. any external information such as test results, calibrations, calculations, etc., in DAD
  - c. spare space and system capacity
  - d. compliance of the system with any arbitrary requirements
  - e. DAD can be operated by engineers or technicians who do not need drawing or CAD skills
  - f. any error in the model found can be rectified promptly so that the accuracy of your information improves with time. Contrast this with traditional documentation which actually loses accuracy over time because it is costly to update and requires skills that are not readily available.
2. improved accuracy in performing maintenance tasks
3. shorter repair times
4. lower risk of accidental trips or service interruptions when working on the systems.

DAD reduces the size of the information necessary to describe systems by eliminating the duplication inherent in all documentation. This results in lifetime savings.



If you are considering adopting DAD outside any project there is the cost of data capture to consider. These vary depending on the quantity and quality of the existing information. I&E Systems will capture your existing data and build your DAD model for a lump sum fee.

You are more likely to be able to make a business case if:

- the poor quality of the existing information is causing production losses
- you have irreplaceable contractors who are the sole source of information/knowledge about your systems
- you cannot comply with statutory requirements for functional safety
- you intend to replace existing systems so improved scope definition will reduce both project risk and design and implementation costs. Read more about this below

## **BENEFITS WHEN UPGRADING EXISTING SYSTEMS**

DAD is of particular benefit replacing systems on operating assets as it deals with the special challenges of:

- identification of the functions and wiring in the existing system
- planning the cut over work for minimum interruption to operations
- assurance that the upgraded systems will conform with current statutory requirements.

Identification is always a major challenge. Existing drawings will be incomplete and contain errors. The (written) functional requirements will often be out of date. The existing system code will often be poorly commented. When you build a DAD model for the existing systems it will automatically highlight:

1. discrepancies between existing documents
2. essential information missing from the documents
3. discrepancies between the code and the functional requirement documentation
4. discrepancies between the code and the wiring,

DAD was originally developed for systems upgrades. It has been used with great success in many complex upgrades. The import/entry of data in DAD is far less costly than attempting to “as built” the existing documentation.

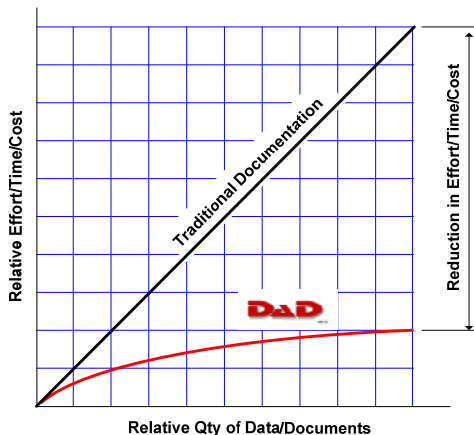
Planning an upgrade so the loss of production is minimized is greatly assisted by having a model where “What if...” scenario construction is possible and accurate. DAD’s inherent accuracy reduces the risk that design errors cause false alarms, asset outages or damage.

Existing systems may perform functions which are inappropriate or prohibited in (recent) legislation. A DAD model allows you to test and demonstrate conformance with codes and standards.

## BENEFITS DURING SYSTEM DESIGN

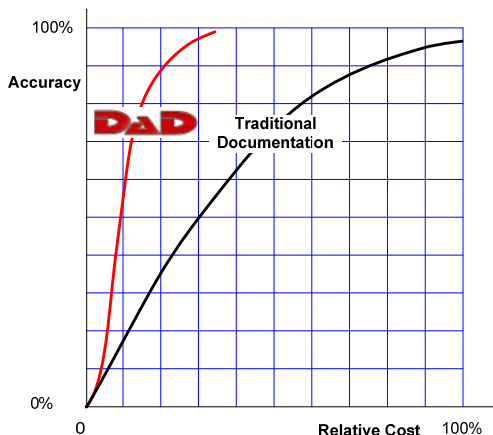
DAD improves productivity and accuracy in design because:

1. you enter data into the model only once
2. any data entered in the model is available to the full team immediately
3. any data entered in the model is available to be published on any report
4. checking is limited to simply confirming that the primary data is correct
5. object inheritance improves efficiency and consistency of data
6. data can be imported and exported for re-use
7. typical assemblies can be created and then copied for instant re-use
8. material take-offs are instantly available from the model.



Design costs are normally related to system size and the quantity of documentation to be prepared. The repetition of data and cross references make traditional documentation costly for large systems.

The relative cost advantage of DAD increases as the size of the project grows.



Design costs grow exponentially if greater accuracy is required. The amount of checking and rework limits most traditional documentation to much less than 100% accuracy.

DAD data is inherently consistent and so delivers greater accuracy at lower cost.

More accurate and complete design results in less on-site delays and rework. It also improves performance of commissioning and hand-over.

DAD enhanced actual system integrity. If you include test sheets, calculations, photos, external drawings and datasheets then systems are more fully documented. All users can access this information with a few clicks.

DAD provides tools to identify inconsistencies in your data. So you can write work procedures externally and then ensure they are being observed within the model.

The model structures you create in DAD make it behave like a real physical system. When changes are made the model illustrates their effect so reducing the risk of inappropriate changes.

DAD will design all forms of systems: you have full freedom to create the model most appropriate to describe your application.

An existing model can be restructured without significant rework. Good for prototyping.

The full history of all user actions in the model allows you new possibilities such as:

- measuring productivity
- checking whether appropriate procedures have been followed

When design changes are requested you can assess their impact by finding:

- any spare capacity such as cables, cores and terminals available to you
- the published documents that will require a new issue to reflect the change
- any additional material that must be ordered for the change.

DAD has sophisticated security allowing user rights to be precisely defined.

## CASE STUDY ILLUSTRATING DESIGN DOCUMENTATION SAVINGS

In 2006 I&E Systems prepared the documentation for a control system for an Australian client. This work was performed using DAD (v5.2). As the system engineering had been performed by others we were able to measure the relative productivity in documentation directly.

The details of the system were:

<b>Ammonium Nitrate Plant - Instruments by Type</b>	
Number of devices interfaced through Foundation Fieldbus	677
Number of conventional 4-20mA analogue inputs	280
Number of conventional 4-20mA analogue outputs	36
Number of conventional contact inputs	279
Number of conventional contact outputs	107
Total number of I/O channels	1379
Number of tagged sensor elements and passive devices	847
Total number of instrument tags	2231
<b>Ammonium Nitrate Plant - Cables</b>	
Total number of cables connected	1224
Total length of cables connected	38000m

The documentation produced using DAD was:

<b>Ammonium Nitrate Plant - Drawings</b>	
Title	Qty
Loop Diagram	458
Location Plan	8
Cable Schedule	91
Cable Block Diagram	81
Termination Diagram	177
Single Line Diagram	3
Termination Schedule	105
Cable Connection Sheet	16
Equipment Layout	5
Cabinet General Arrangement & Detail	11
I/O Allocation Chart	10
I/O Module Location Chart	6
Instrument Index	3
Installation Diagram	107
Miscellaneous Drawing	81
Total Drawings	1162

The results were:

	Quantity of Drawings	Manhours Each	Total Manhours
Budget (using CAD)	1,100	8	8,800
Model and Publish in DAD	1,100	2.1	2,300
Savings on budget			6,500
<b>Percentage saving in document preparation time.</b>	<b>74%</b>		