FluidFlow

BUSINESS CASE

1 Introduction

This document sets out the business case for the use of the FluidFlow software. The document is organised into three parts:

1. A summary of how FluidFlow fits into the design process.

2. A description of how particular attributes of FluidFlow enhances that design process.

3. A description of some actual design applications of the program.

Although the cost of software must be considered when evaluating its contribution to the business, this really should not be the main or only criteria under consideration. It is vitally important to give due consideration to; the speed which you can obtain system results, accuracy and reliability of results, ability to consider alternative operating conditions and evaluate design alternatives. This ensures your systems have been designed accurately as well as allowing your engineering team to become more productive and efficient and developing system designs.

When a program such as FluidFlow is used for major project design work, for example in oil/gas or mining, then the cost of the software will be minimal compared to;

- the engineering time spent using it and,

- the capital and operational costs potentially saved by virtue of its efficient simulation of fluid flow systems.

Testimonial:

"FluidFlow is fast, easy to use, accurate and a reliable package. The software drastically cuts design time - these benefits apply not only to the designer but also to the peer review team. During operation of the built systems, the agreement between running plant pressure readings against design data was highly accurate. That bought my full trust in the package".

Mat Landowski, Lead Process Engineer PM GROUP

2 Part 1: The Design Process

A typical process design project, whether it is greenfield (new project) or brownfield (rework of an existing system), usually comprises the stages of:

- Concept.
- Preliminary engineering design.
- Detailed engineering design to construction level.
- Construction.
- Commissioning.
- Post-commissioning.
- Upgrade.

If pipe flow systems are involved, there is a role at all these stages for FluidFlow.

2.1 Concept

The concept stage is mainly concerned with the economic viability of the project. Detailed design is not required, but the sizing and therefore costing of major items of equipment is necessary. Pumps, fans, heat exchangers, even large diameter valves constitute major capital costs of a project. Without some level of design of the equipment items and associated pipework and systems, a reasonable cost estimate cannot be achieved.

FluidFlow includes powerful automatic equipment sizing functionality allowing you to quickly and accurately size pipes, pumps, fans, control valves, orifice plates, relief devices and other equipment items. A bill of materials for your project can also generated. This means a better understanding of equipment costs and associated items such as motors, cabling, switchgear and power requirements can be estimated at this early stage of a project.

2.2 Preliminary Engineering Design

One of the primary concerns at the preliminary engineering design stage is the correct sizing of long-lead-time equipment items and their ordering.

The *FluidFlow* hydraulic model developed at the *Concept* stage can simply be updated and extended as necessary. FluidFlow allows the designer to insert equipment items to pipes by selecting them from the component toolbar and 'dropping' them onto the relevant pipe. Pipe and equipment sizes can be varied for "what if ?" analyses. Manufacturers' data on pumps, pipes and all other equipment items can be added to the database as suppliers provide specifications. This data can then be used in the model.

With *FluidFlow,* the preliminary engineering stage can also include a bankable feasibility study where predicted costings are developed.

Considering its ease of use, rapid calculation and informative reporting capabilities, FluidFlow is ideal for both the Concept and Preliminary stages of a design.

2.3 Detailed Design

The use of *FluidFlow* for the detailed design stage is self-evident. Fine-tuning of pipe sizes, control valves, heat exchanger performance, pipe lagging design etc are all carried out at this stage. *FluidFlow* provides the necessary pipe flow design interface between the following related professionals:

- Process engineers concerned with the process conditions: mass balance, heat, fluid flow rates, control valve performance, instrument controls (*FluidFlow* is ideal for the design of instrument and process air systems).

- Structural and civil engineers who have to design the pipe racks, supports, pump bases etc.

- Electrical engineers who design power supplies and switchgear.

FluidFlow software is for piping system design, calculation and optimisation and supports liquids, gases, two-phase fluids, settling slurries, non-Newtonian fluids non-settling slurries, pulp and paper stock flow systems.

2.4 Construction

The need for *FluidFlow* during the construction stage arises when changes to the design are found to be necessary during installation – which as we are all aware, happens quite frequently. *FluidFlow* can be used to quickly modify and re-work the design allowing you to evaluate any effects on system performance. This is highly valuable in preventing construction hold-ups while re-design is in progress.

2.5 Commissioning

Fully developed hydraulic models of process flow systems are massively useful when commissioning a project. If flows do not meet expectations then the *FluidFlow* models provide the analytical tools for investigating and understanding why. Could there be a blockage in the line? Did changes during construction affect the system? Are pumps and other equipment operating to specification? All these issues can be very quickly considered.

Dynamic analysis in FluidFlow enables you to consider real world operating scenarios as well as review what-if scenarios. This can also prove highly beneficial at commissioning stage.

2.6 Post Commissioning and Upgrade

During the life of a plant, its performance is constantly interrogated and reviewed, changes are required and efforts are made to improve performance and efficiency. The hydraulic models of *FluidFlow* become an essential engineering resource for the entire life of the project. They have an asset value far beyond the cost of the software and even the engineering time utilised to develop them.

FluidFlow is ideal for improving and optimising energy efficiency.

3 Part 2: Attributes of FluidFlow

The Design Process described in Part 1 is enhanced by *FluidFlow's* intelligent and easy-to-use graphical interface. For example, the flowsheet schematic of the pipe system is synchronised with all other displays and the flowsheet and data palette are displayed simultaneously. The flowsheet immediately updates with user-selected information after each calculation. Default properties for equipment items and the 'fly-by' display of data can all be pre-set by the user.

As a consequence the use of *FluidFlow* is highly intuitive. It has been designed by hands-on engineers for hands-on engineers.

The table below summarises the main attributes and capabilities of *FluidFlow*.

3.1 Databases

	Attribute	**Notes**
FLUIDS DATABASE	Approximately 1250 fluids with full thermophysical properties. Water/steam properties according to IAWPS standard. Petroleum fractions can be added to the database.	The *FluidFlow* fluids database is the kernel of this program. The fluid data is fundamental to the calculation capabilities of *FluidFlow*, namely heat change and combining fluid streams in the one network. Fluids' thermophysical properties are used for two-phase liquid/gas calculations.
EQUIPMENT DATABASES	Equipment items include: end-suction centrifugal and PD pumps; control valves, vessels with multiple connections; manual valves including 3-way, needle etc; filters and packed beds; shell and tube and plate heat exchangers.	Each component in *FluidFlow* is represented by a unique icon on the flowsheet and is connected to an underlying database containing manufacturer, material, application and hydraulic data details. Default values for every component can be specified by the user.

ADDITIONAL DATABASES	Pipe and equipment materials and properties; pipe roughness and pipe scaling.	The additional pipe characteristic databases allow for conditions to be preset (the default values described above), for example: roughness values can be set to represent, say a 10 year deterioration of the pipe; scaling can be set to reduce all pipe internal diameters by a fixed % to simulate sliming. This can also be achieved within an existing model by globally updating values.

3.2 Calculation Capabilities

	Attribute	**Notes**
FLOWS AND PRESSURES	Solves for flows and pressures in complex pipe networks, simulating the performance of almost any type of line equipment. The compressible flow algorithm is very advanced taking into account the expansion of the gas and properly handling choked conditions. Also, there is no differentiation between liquid, gas and two-phase networks; the phase state of the fluid is determined solely on the basis of temperature and pressure within the network.	With *FluidFlow* fluid temperature and pressure are specified only at the boundary conditions and the temperature propagates throughout the network unless a heat change calculation is included. For temperature changes within the network the user must specify a heat loss model if applicable.
HEAT CHANGE	Heat loss/gain through pipes walls taking into account temperature difference, lagging, surface emissivity and wind speed. Heat/temperature change at equipment items. Buried pipe heat transfer calculation can also be completed.	Shell and tube and plate heat exchangers are solved for both pressure loss and heat change. With multiple fluids allowed within the one network and multiple networks allowed on the same flowsheet, this means that both the process and cooling sides of a system can be modelled simultaneously. (Note, the software does not calculate surface areas necessary for the heat transfer).

	Attribute	Notes
COMBINING FLUIDS	Different fluids may be specified at boundary conditions.	*FluidFlow* will estimate the thermophysical properties of the mixture at the point in the network where the fluid streams join. Data in the fluids database is fundamental to this process. "Mixtures" of fluids can also be developed and saved within the database, say a mixture of pure gases making a natural gas.

3.3 Flowsheet

	Attribute	Notes
LAYOUT	Orthogonal and isometric view. All entered or calculated data can be displayed on the flowsheet – specified by the user. Free text allowed. Choice of pipeline thicknesses and wider range of colours allows a more informative schematic to be drawn. Multiple flowsheets can be opened at the same time.	The printed flowsheet in *FluidFlow* becomes a powerful communication medium for the simulation, the flowsheet displays user-selected entered data, calculated results, free text and the pipe layout.

3.4 Results Visibility

	Attribute	Notes
DATA PALETTE	Data palette is totally under the control of the user. All data can be displayed or hidden at the command of the user.	*FluidFlow* displays the pipe network in flowsheet or schematic format with the tables of entered data and calculated results synchronised with the flowsheet. *FluidFlow* allows for a wide range of warnings to be displayed if an equipment item operates outside a user-defined range. Any equipment item with an associated warning is flagged red on the flowsheet. Flowsheet display immediately updates after, say, a units change or re-calculation.

3.5 Reports

	Attribute	Notes
REPORT DESIGNER	Internal report designer allows printing from *FluidFlow* but also export of the report in PDF, Word and HTML format.	
EXCEL	Export any input or calculated data to Excel and import changes from Excel.	The export to Excel capability is extremely useful. Whilst tabular data can be exported, it's the export of a full annotated flowsheet as an Excel picture which is particularly useful in communication with colleagues and clients.

3.6 Optional Modules

	Attribute	Notes
SCRIPTING	Scripting allows goal-seek, what-if and extended time simulations.	A scripting example might be: Calculate the fall in head in a tank as fluid is extracted (via a sequence of incremental calculations) and then activate a pump at a set level. Or calculate the time taken for a gas pipe network to reduce in pressure to a safe level via a pressure relief valve.
NON-NEWTONIAN/NON-SETTLING SLURRIES, SETTLING SLURRIES AND PULP & PAPER STOCK FLOW.	This module is divided into three parts: 1) non-Newtonian/non-settling (typically Power Law, Bingham plastic) fluids. 2) Settling slurries with a Newtonian carrier fluid – based on Wilson Addie Sellgren Cliff, Durand, WASP, Four Component Model or Liu Dezhong. 3) Pulp & Paper Stock Flow – Moller K & TAPPI TIS 408-4.	The database includes physical properties of suspended solids, viz density, particle size distribution and shape factor.

TWO-PHASE	Calculation methods include: Friedel, Chisholm, Lockhart Martinelli, Whalley Criteria, Muller Steinhagen and Heck, Beggs Brill, and Drift Flux.	Allows for gas-liquid flow to be analysed. To accomplish this additional components appear on the component palette. New components allow for two-phase separation as well as direct entry of two phase mixtures at boundaries. Two-Phase detection automatically occurs on mixing of gas and liquid phases at an element, on the addition/subtraction of heat into the network, or at the loss of pressure energy within any network element.

4 Part 3: Design Applications

Fluid flow design is not an exact science. Even with new systems the actual roughness values of pipes may not be known (at least after a period of use); uncertainties may exist about the head loss characteristics of fittings; manufacturers' pump and fan curves may not be precise unless certified by witness tests and the performance of control valves may not be precisely known. With existing pipe systems these issues are even more pertinent.

However, despite these uncertainties - or perhaps because of them - there are real benefits to be obtained from the use of an advanced computer software package such as *FluidFlow* for the simulation and modelling of pipe flow systems.

One of the main advantages of *FluidFlow* is its interactive nature. Data can be quickly changed, pipe sizes varied, different pump speeds and impeller sizes simulated, pumps in parallel and series can be modelled. If head loss or friction coefficients (or other data) are not known with precision *FluidFlow* allows 'what if?' calculations to be performed speedily and accurately. Designers can rapidly evaluate a range of possible solutions within a "window of opportunity" in order to make informed judgments.

FluidFlow is used in almost every industry sector in over 68 countries to design real-life piping system solutions, from the everyday mundane of removing water in a coal mine to the exotic of pumping aviation fuel on an aircraft carrier. The following examples illustrate some of *FluidFlow's* design capabilities…

Different Use-Case Studies:

The user interface and global updating capability mean that different-use case studies can be quickly carried out. Two examples include:

Example 1: *Worsley Alumina had an upgrade project where a green liquor pumping system required the purchase of large expensive pumps. Design of the delivery side pipework was relatively straightforward. But design of the suction side pipework required much more precise analysis as the net positive suction head available with the hot fluid was crucial to the pumps' performance. The large number of 'what if?' scenarios investigated was only practical with the use of the software.*

Example 2: *This again was a hot fluid - sodium cyanide - where NPSH was an issue. Use of the software showed that a smaller diameter suction pipeline than had previously been anticipated would not generate NPSH problems. The cost saved on just one isolation valve on the suction pipework more than paid for the software.*

Design Costs:

Software cost is a minimal part of the total cost of design. Engineering hours must also be included in overall project costs. The following is a cost benefit analysis example.

Example 3: *The State Electricity Corporation of Western Australia (SECWA) considered that 200 hours of design time would be required for the design of a fire protection scheme of which 30% would be spent on establishing design data and specifications and 70% on actual flow analysis – by hand! It was estimated that the analysis time could be reduced by more than 80% using the software package. Based on an internal engineering resource rate at that time of $60.00 per hour this represented a saving of $6,720.00. On this basis, a single project would more than pay the cost of the software.*

In addition to the cost saving from engineering resource utilisation, there can be savings in reduced material use by optimising designs. In another example from SECWA a fuel oil system included $217,395 for pipework and associated equipment. Every saving of 1% on this material cost as a result of confidence in design, from using the software to explore say the use of pipes of smaller diameter or lower pressure rating, would result in a cost reduction of more than $2,000. SECWA was able to save just under 10% in this project.

Capital and Operational Costs:

Over-sizing equipment "just in case" is both capital and operationally expensive. Under-sizing leads to poor performance. Effective design ensures appropriate equipment selection and optimal capital and operation costs.

Example 4: *With falling cost the use of VSDs (variable speed drives) has become much more common instead of expensive control valves. FluidFlow allows speed changes to be made to an end-suction centrifugal pump, for example, and the resulting performance observed. This feature is greatly enhanced by the use of the FluidFlow Scripting module where these speed changes can be automated.*

Queensland Alumina used FluidFlow to determine the cost-benefit of replacing control valves with VSDs.

Brownfield Projects and the benefits of modelling:

Existing systems inevitably need to be upgraded and extended. Documentation of past changes frequently does not exist. Detailed information about pipe internal conditions, equipment performance, pump impeller wear, etc is often unknown or uncertain. In these situations *FluidFlow* comes into its own. Its flowsheet representation of the pipe network with its choice of colours for different pipes, on-screen text etc, provides an excellent reference schematic of pipe networks in the absence of original engineering drawings.

5 Summary

Computer models developed using a software package while time-efficient still represent a considerable investment in engineering time. As noted in the SECWA case (example 3), some of that time will be spent in establishing data, and this time would have to be spent whether a software package was being used or not. Time is also spent in model development, simulation and report generation.

Together these activities represent a considerable investment for an organisation – almost certainly exceeding the cost of the software for a single project, more so if a number of projects are considered. The outcome – a model or set of models – should therefore be regarded as an asset, a valuable engineering resource of the organisation.

This is a great strength of *FluidFlow*. It ensures that this resource – the data, the design, the development of the model – is not lost but retained for subsequent use if the pipe system needs to be modified or upgraded later. As *FluidFlow* is so easy to use, it doesn't matter if the original engineer has left the organisation; a new engineer can easily pick up the model. (Compare this to a set of hand calculations or an engineer's own spreadsheet analysis – how difficult is this for a replacement engineer to understand?).

Customer Testimonial:

"FluidFlow paid for itself the first time we used it. Pro-Tech Engenharia Química is a consultant engineering company specialising in the petro-chemical sector. We had a very challenging job designing a large vapour collection system. We researched the market very thoroughly before selecting FluidFlow for its completeness and ease of use. With this software we were able to reduce the time of the job and do in two weeks what would have taken us well over 4 weeks. On this first job the software paid for itself and because of that work we now have other similar job opportunities."

Carlos Eduardo Pantoja, Chemical Process Engineer, Pro-Tech Engenharia Química, Sao Paulo, Brazil

So far, the focus has been on the **tangible** design process and costs;

- Conceptual and preliminary design for decisions on large capital components.
- Detailed design of the systems and perhaps capital and operational costs.
- Commissioning and long-term operation.

Equally important can be the **intangible** benefits.

FluidFlow will enable the organisation to do a superior job, either for itself or for its clients. Engineers using *FluidFlow* will gain more personal satisfaction from using class-leading reliable software that enables them to be more creative and thorough in their designs. Also the software will widen the range of design capabilities of the organisation and provides total confidence, repeatability and consistency.

The consistency of design method that can be achieved by using *FluidFlow* throughout an organisation or its consultants is an important added benefit. Standardising on *FluidFlow*

means that different engineers and different design offices can follow the same principles and assumptions in design from using the same software package. This approach also allows easy exchange of data and cooperation in design which are particularly easy because of *FluidFlow's* shared database structure and communication options.

Robert Brookes, Carbon Manager, British Sugar, UK

"British Sugar has a corporate licence for FluidFlow. It is used throughout our business, mainly for liquids and occasionally for gas. Before selecting FluidFlow, we researched the market thoroughly. We like the way that for very complex software it is relatively simple to use and users require minimal training. It is functionally intuitive and we like features such as the graphics, pseudo-isometric projection and drag and drop. It is ideal for both design and "what-if analysis". It has paid for itself many times over, year after year. Also Flite Software is very responsive and knowledgeable whether it's a technical query about fluid dynamics or about the software".

Norman Kurth, System Engineering, MAN Diesel & Turbo, Germany

"MAN Diesel & Turbo's activities in the power plant sector are based on a well-established range of diesel engines and a rapidly growing gas engine offering. The products range from small emergency power generators to turnkey power plants with outputs of up to 400 MW. We use the liquid, gas, and two-phase modules of FluidFlow and make extensive use of its simulation capabilities for engineering sub systems as fuel gas lines or cooling water pressure systems, including for the development of new systems. Before we bought we carried out extensive product research and chose FluidFlow because of its completeness and value for money. We have had to make occasional technical support calls and have been impressed by the responsiveness. We have found Flite Software to be extremely knowledgeable and helpful, really excellent."

6 Conclusion

As with any software product, there are other products available in the marketplace which are aimed to compete with *FluidFlow.* However, *FluidFlow* is the first and only integrated software product for piping system design, calculation and optimisation that supports liquid flow, gas flow, two-phase flow, settling slurry flow, non-settling slurry (non-Newtonian) flow and pulp and paper stock. In addition, *FluidFlow's* user interface, display of data and ease of use contribute to its major advantages over competitors.

Paul Prout, P.E. Partner/Vice President, EAPC, North Dakota, USA

"EAPC is a consulting engineering firm working primarily on heavy industrial plant engineering assignments involving liquid, gas and steam across many industrial sectors. With FluidFlow we have the capability to solve certain technical problems that otherwise we would not be able to tackle. It's very easy to construct network systems, the modelling is very good, the product is powerful and logical, it is very easy to use and it provides excellent results. We have been a customer from 1995 and when we've needed some advice Flite Software has been extremely helpful and quick to respond.".

FluidFlow is expertly supported from the UK and throughout the world by its accredited Partner Network. Custom-written, fully developed, 2 to 5-day training courses on the software are available from Flite Software and its Partners and the website www.fluidflowinfo.com is packed with examples, videos and support materials. Free trial of the software can be requested from the website, or contact us.

Hazel Steel, Process Engineer, RWEnpower, UK

"We were looking for a product for gas and liquid and have found FluidFlow easy to use and it's relatively simple to set up and design even quite complex system models. It's easy to change the model around and being able to simulate and try out various operational conditions is very powerful. I'm self-taught in the product and haven't needed training or support."

7 FluidFlow Customers

The customers we serve range in size from small consultancy firms to large multi-national corporations, covering many different industries, in many different countries. ***FluidFlow*** is used in almost every industry sector to design real-life piping system solutions, from the everyday mundane of removing water in a coal mine to the exotic of pumping aviation fuel on an aircraft carrier. The following is a short selection of some of *FluidFlow's* customers…

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