UNIVERSITY OF GREENWICH

The Wolfson Centre
For Bulk Solids Handling Technology

VALUE ENGINEERING

- versus getting value from your engineering?

SHAPA

The SOLIDS HANDLING AND PROCESSING ASSOCIATION

- UK Trade Association
- 110 member companies
- £2.5 billion of products annually
- Around 50% exported

Mike Bradley, Chairman

"Value engineering is a systematic, organized approach to providing necessary functions in a project at the lowest cost"

- "Value engineering promotes:-
- ***The substitution of materials and methods with less expensive alternatives***
- ***Without sacrificing functionality***.
- It is focused solely on the functions of various components and materials, rather than their physical attributes"

- How could this possibly be a bad thing?

Background

SHAPA member companies' experience

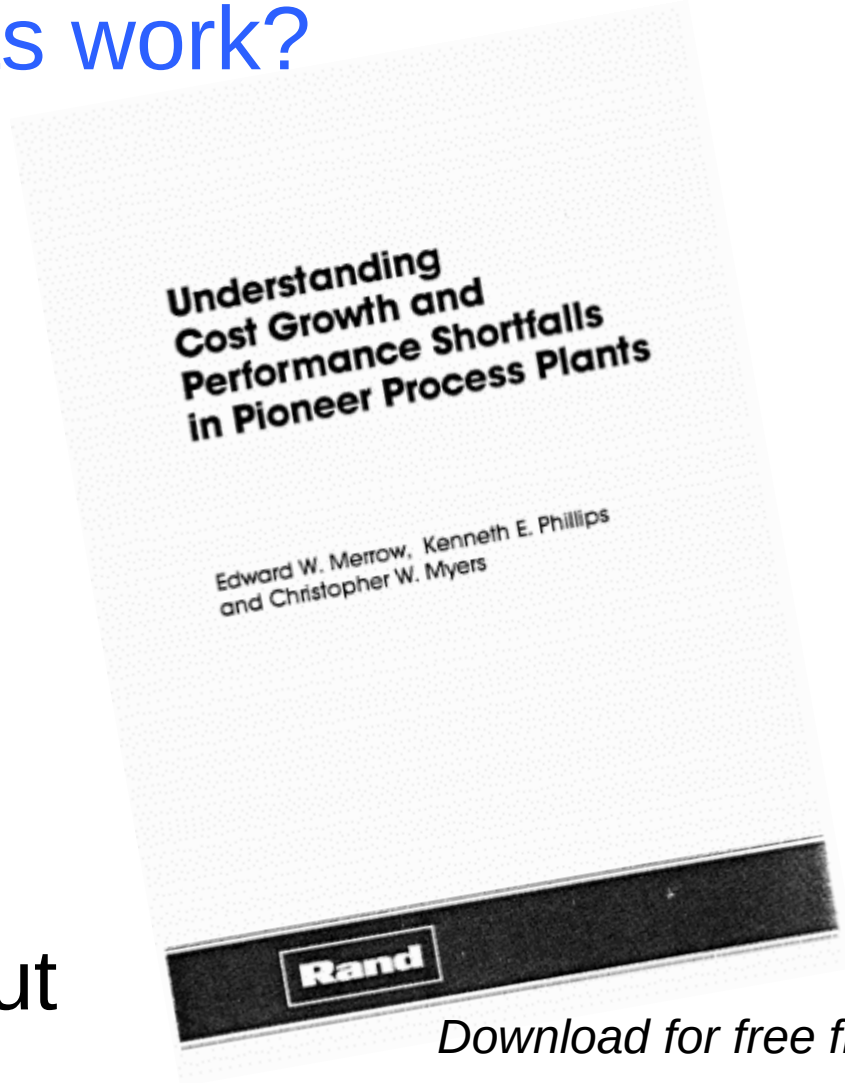
- Many equipment buyers put overwhelming pressure on capital price in a contract
- Perceived as an unwillingness to pay for the right tools for the job, preferring a cheaper thing that will "probably" pass
- Result:
  - Inadequate plant performance
  - Unreliability
  - Warranty claims
- ***Often running up costs far greater than the savings***

How well do solids processing plants work?

- The Rand Report

•60%

of solids processing plants never achieve full throughput 2 years after start-up!



Download for free from Rand Corporation web site

How high is technical risk with solids handling installations?

- The Rand Report (1990)
- ***Average cost over-run*** on novel
- solids processing systems is

110%!

- I.e. plants cost on average ***more than twice the original estimate*** on which the business case for building them was based!

Structural failure

Flow problems

Flow problems

Spillage from belts

- Limiting throughput to avoid excessive spillage

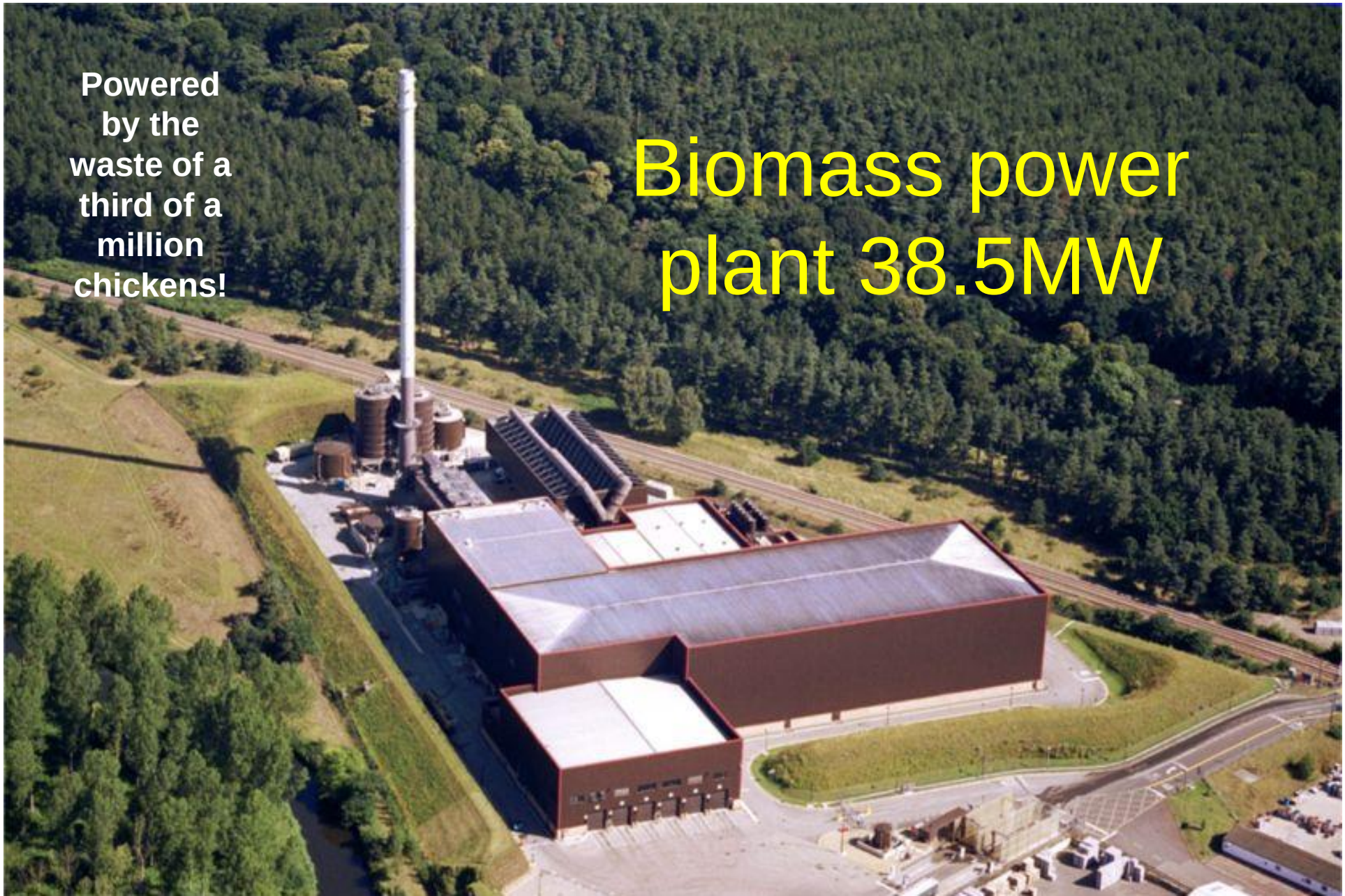
- Capability 500 tph on many commodities
- Excessive spillage if going above 350 tph on the most commonly handled one
- Result = extended discharge duration

- Overheating of drives
- Accelerated wear
- Breakdowns
- Fires
- Potential for dust explosion

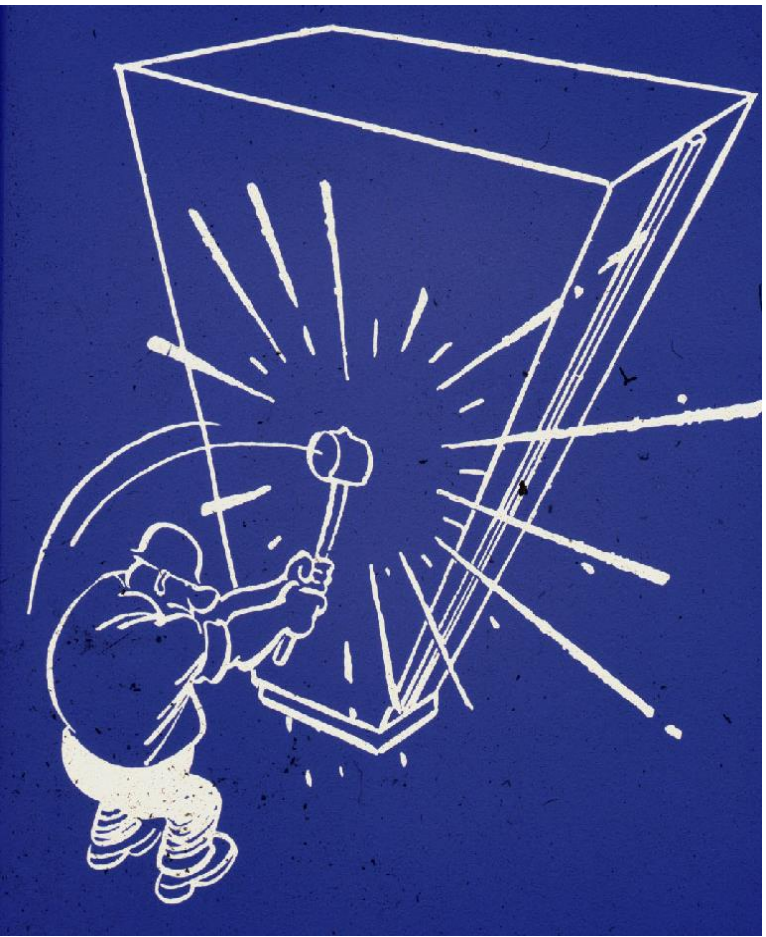
Fugitive dust build-up

- = downtime cost

What is the cost of short stoppages?



Flow problems in Ash Baghouse



- Manual “therapy” to persuade flow
- Manual digging out of half a tonne of ash from each of eight hoppers
- Downtime of 38.5 MW power plant about 35 minutes per week on average
- **0.35% = £239,000 p.a.!**

Output MW	38.5
Sales price £/kWh	£0.21
£/MWh	210
Days operation per year	355
hours/day	24
hours/year	8520
Total production MWh/year	328020
Electricity sales £ pa	£68,884,200
Downtime:-	
minutes lost per week average	35
	0.35%
Lost productivity £pa	**£239,181**

Segregation

Mixture: 20 percent salt
80 percent mung beans

Caking of silo contents (granular salt)

Environmental emission

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What equipment are we talking about?

- Ship loaders and unloaders
- Silo systems
- Hoppers
- Feeders
- Extractors and Filters
- Conveyors
- Stockpiles
- Reclaimers
- Mobile plant
- Control systems
- Instrumentation

Return On Investment
R.O.I.

Income a plant generates _ *Total cost of owning the plant*

- A new solids handling system will probably last you 30 years
- Over what timespan should ROI be calculated?
- Often 7 years is used for new plants
- For plant improvements, usually 2 or 3 years
- *Chosen timespan depends on many factors*

Expected operational costs:

Often in calculations!

- Annual maintenance contract
- Manning
- Interest on borrowing

Sometimes in calculations!

- Energy cost
- Cleaning

Unexpected costs: **Not in calculations!**

This is the seat of the problem!!

- High maintenance due to
  - Wear
  - Breakdown
  - Blockages of chutes and silos
- Excess manning
- Industrial injury claims
- Employee dissatisfaction
- Staff turnover

- ***Lack of expected performance***
  - ***Delayed start-up***
  - ***Downtime***
  - ***Low productivity***
- Environmental nuisance
  - Neighbour relations
  - Remediation
  - Restrictions on activity
- Product quality problems
  - Caking
  - Segregation
  - Particle breakage
  - Contamination

- Dust control loading hopper

Which costs more to buy?

Which costs more to run?

- Simple hopper

Why do buyers so often finish up with kit that performs poorly and costs too much to run?

The buyer’s perspective

- Little or no ability to judge the technical merit of a bid
- Thinks the supplier is the expert, he must know what he is doing
- Thinks it is easy to issue a spec for what the kit is to do, invite tenders, and choose the lowest cost
  - In the naïve belief that in the event of poor function, it’s not his problem
- Generally no understanding that there is work to be done to characterise the properties of the materials before a suitable design can be arrived at
- Who should pay for that work?

The supplier's perspective

- Knows he is one of 4 or 5 invited to tender
- Putting together a tender costs a lot of money
- Not reasonable to gamble additional money on extensive investigation of bulk solids properties on a 1 in 5 chance
- Therefore he doesn't know what he is dealing with, he has to guess
- But he dare not show that vulnerability to the buyer, he has to pretend he knows what he's doing
- And once the contract is awarded, it's too late to do the characterisation work and renegotiate the design and price
- ***Result: system is designed on guesses, assumptions and past experience – too many risks!***

“I want the lowest price bid that is ***fit for purpose***”

But here’s the problem:

- “Fitness for purpose” is not black and white in bulk solids handling at the tender stage
- There are risks, both known and unknown
  - ***Uncertainty over bulk solids behaviour***
  - Uncertainty over skills of operators and maintenance
  - Uncertainty over intensity of use
- **Pushing down the price hard pushes the supplier to take bigger risks**

Why does Value Engineering or the “Cost Reduction Exercise” cause so much damage?

- The deal agreed in principle – but then . . . . .
- “Value Engineering”
- “Programme acceleration”
- But many of the aspects of functionality on a solids handling plant are ***NOT possible to predict with absolute accuracy***

Things suppliers do to push down the price *– and the resulting risks*

- Run the belts faster - *More dust lift-off, more wear*
- Use cheaper or thinner materials – *Corrosion, structural failure*
- Reduced structure height – *Lower chute angles, more blockages*
- Cheaper SCADA software – *No data recording, so hard to troubleshoot*
- Faster programme – *poor QA on assembly*
- Corners cut on safety – *explosion, injury, fire, poor access*

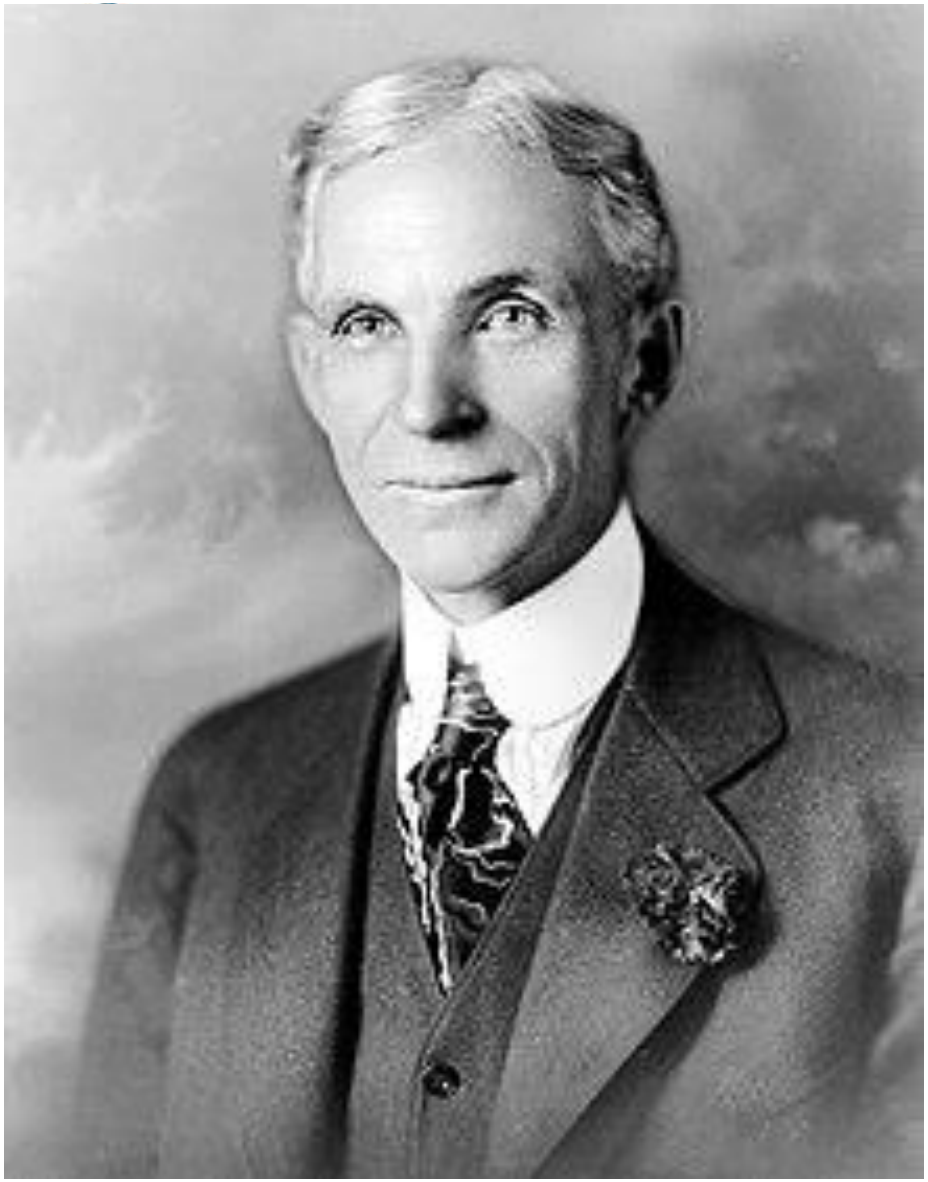
“What might we get away with?” instead of

“What is the solution we can be certain of?”

“I have a warranty: if it doesn’t do the nameplate performance then it’s the supplier’s outlay to fix it”

Don’t be naive:

- Cost of downtime (consequential losses) excluded from contract
- The fix will never be as good as the proper solution
- If the plant struggles through the warranty period, it’s then your problem
- **If you save 10% of capital cost and lose 1% of throughput for 30 years, is that a good deal - ?????**
- ***Seriously, put some numbers to it!***



Henry Ford

- "There's always someone willing to do it cheaper….

- but at what cost?"

To make a sound contract what we need most is……

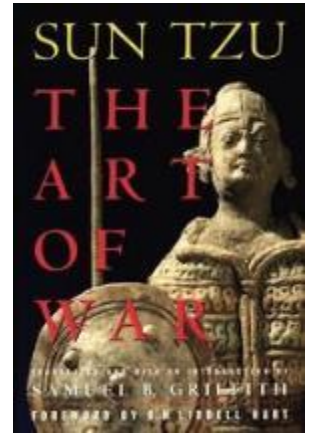
- A recognition by buyer that he has to recognise and account for the unique challenges in buying BSH equipment
- Not like buying a forklift or container crane
- ***The bulk solid is part of the working mechanism of the machine*** *in a dry bulk cargo terminal*
- Solutions must be built around the behaviour of the bulk solid

What is CHARACTERISATION and how can it help?

The First Rule of Warfare:

KNOW YOUR ENEMY!

(Sun Tzu, China, 600 BC)



- **All bulk solids are very different**
- **To get the material to do what you want it to, you have to understand how it behaves and reacts to what effects you apply to it**
- **E.g. does it flow readily, segregate easily, fluidise with air, go hard in store, pick up moisture etc**

The critical importance of CHARACTERISATION

Often quoted properties:

- Angle of repose
- Median particle size

Neither of the above are of any real use;

- ***They do not relate to flow properties of the material***
- ***Misleading at best***

Information required on:

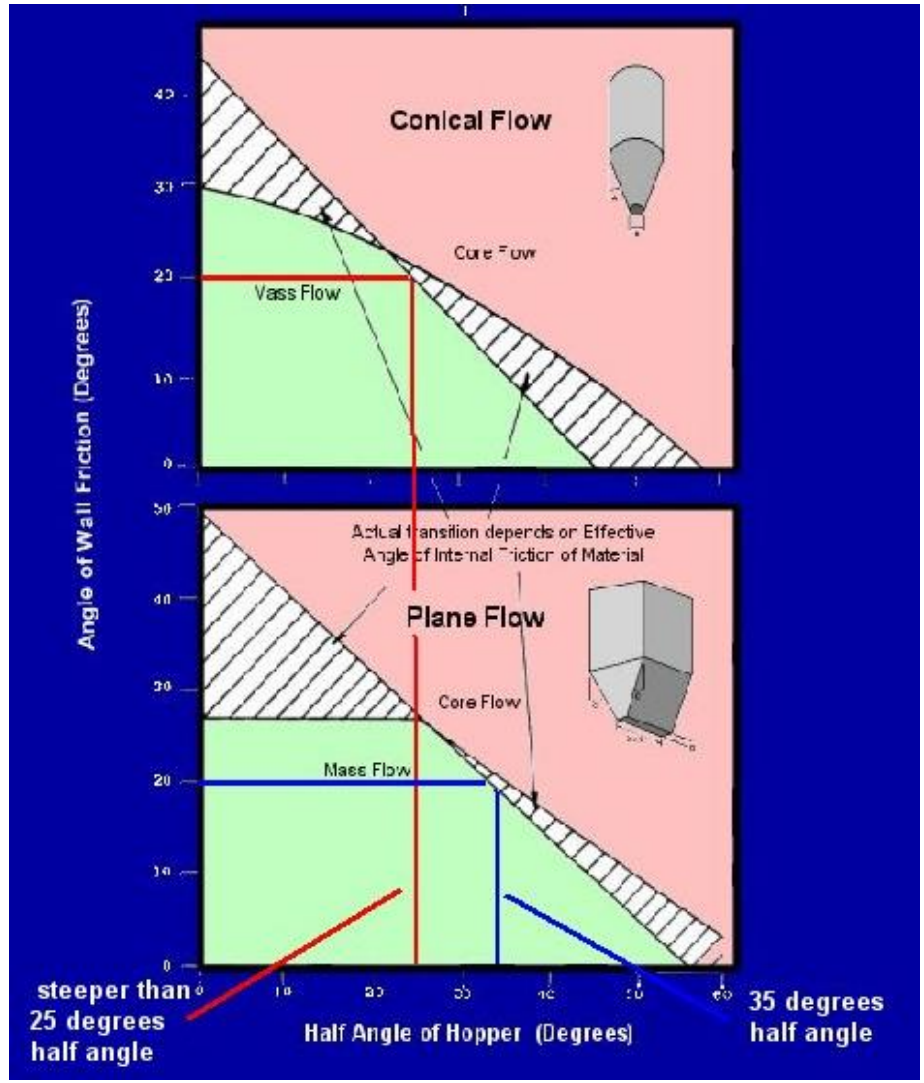
- Bulk density
- Internal flow properties
- Wall friction
- Time dependency
- Particle size distribution
- Segregability, Friability
- Caking tendencies
- Susceptibility to moisture, reaction, storage temperature etc.
- Pneumatic conveying properties
- **etc**

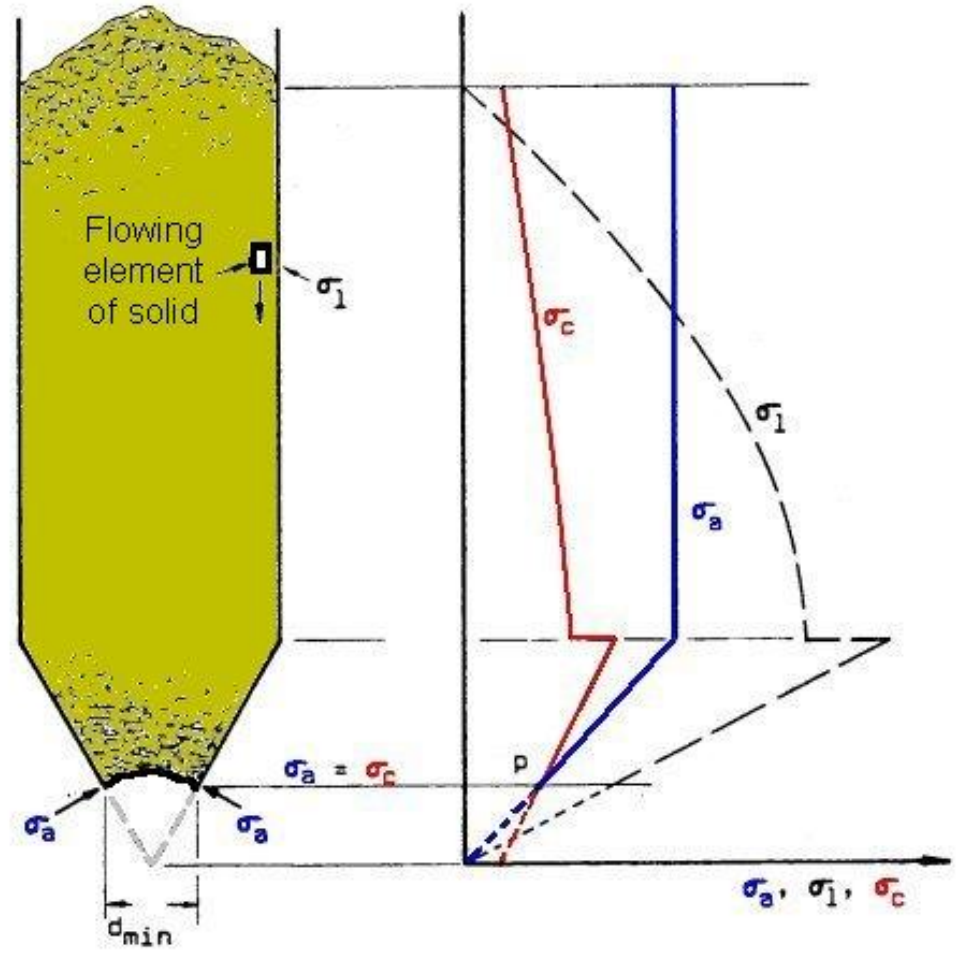
One example of use of handling properties for system design

HOPPER DESIGN

- Objective: reliable discharge

(Failure of silos and hoppers to discharge reliably is one of the most common practical failures on bulk solids handling plants)


Conical Flow
Core Flow
Mass Flow
Actual transition depends on Effective
Angle of Internal Friction of Material
Plane Flow
Core Flow
Mass Flow
Angle of Wall Friction (Degrees)
steeper than
25 degrees
half angle
Half Angle of Hopper (Degrees)
35 degrees
half angle


Flowing
element
of solid
σ_1
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σ_1
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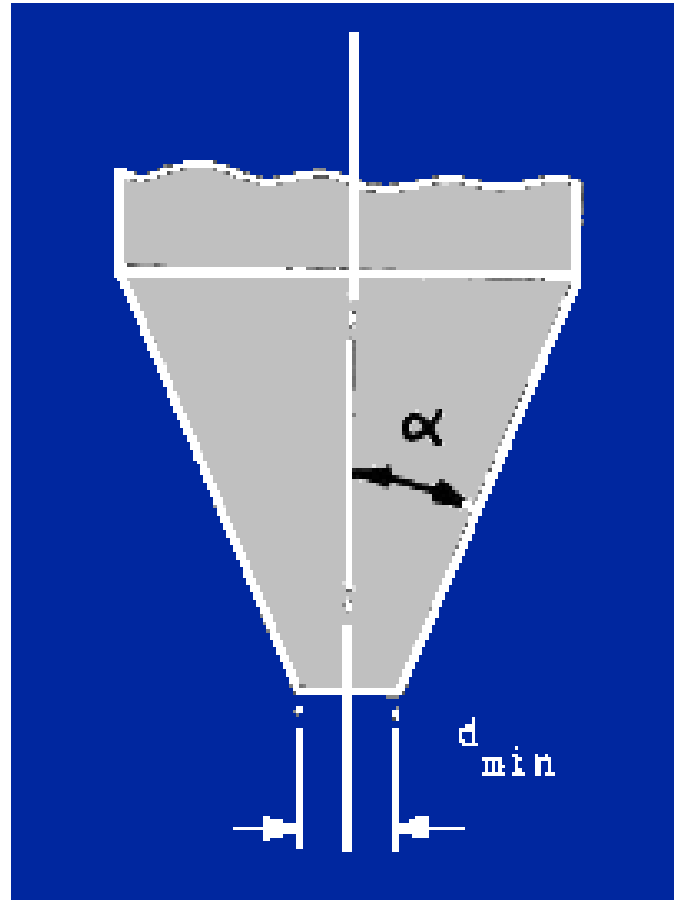
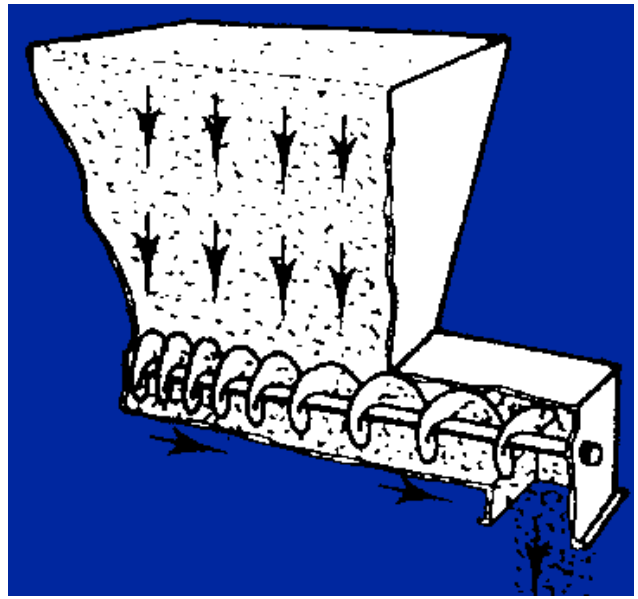
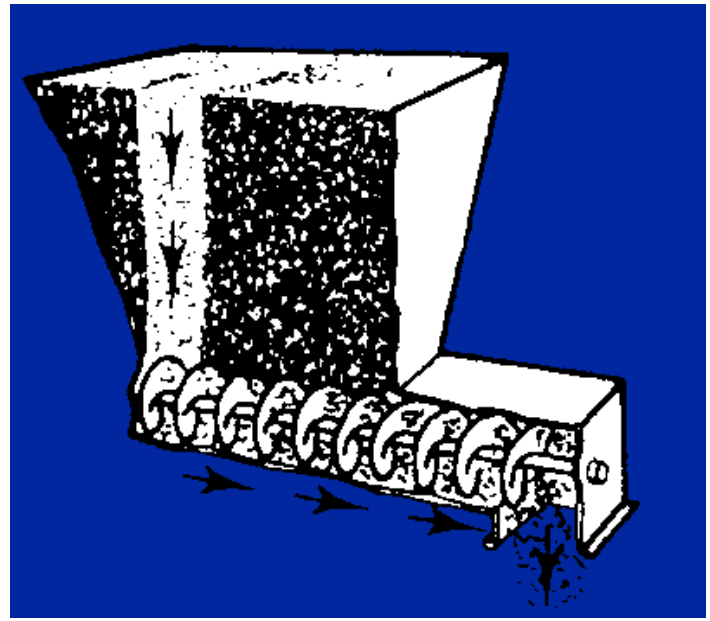


The importance of good interfacing





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No hammer marks!

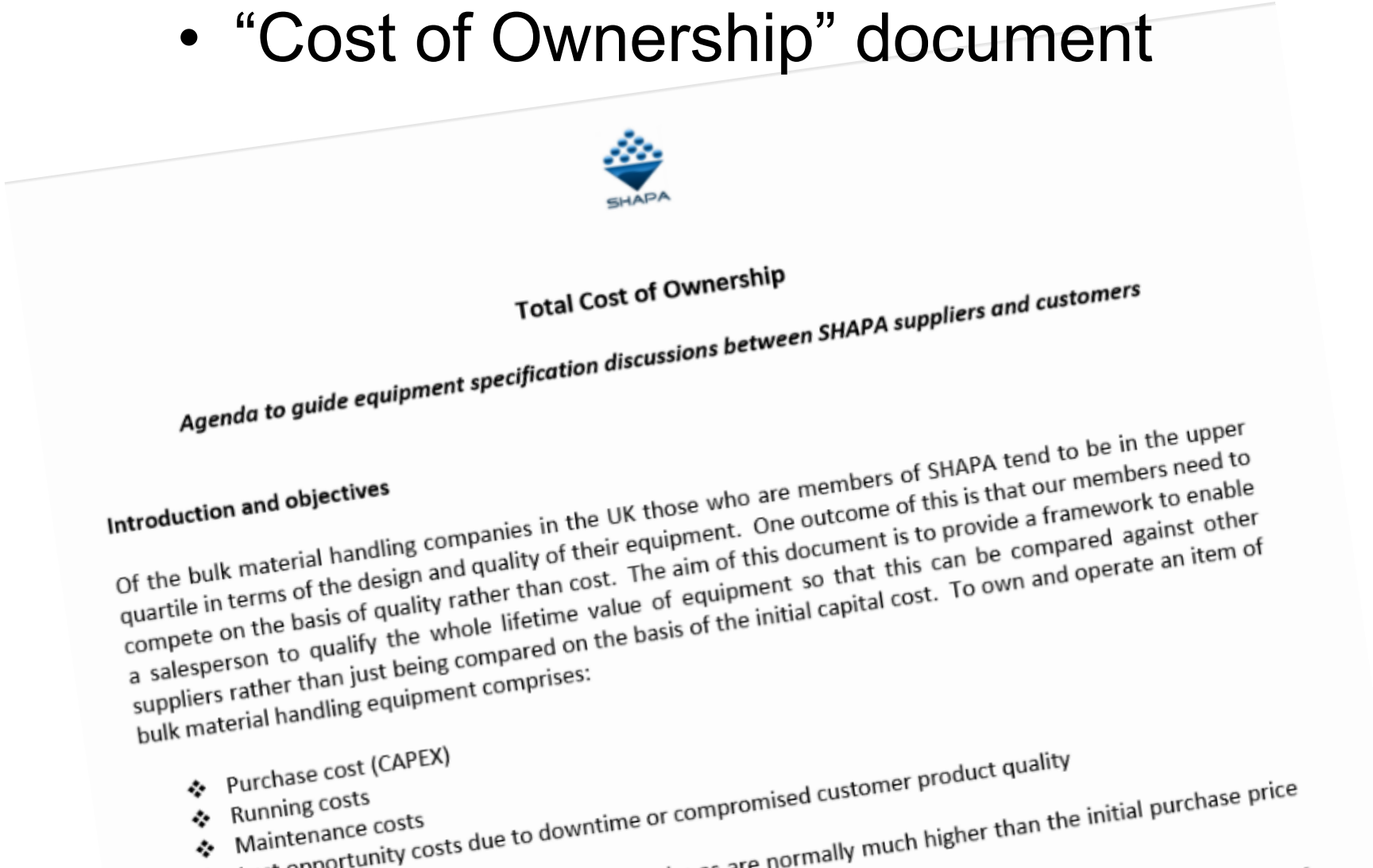
A more intelligent approach to systems and equipment procurement

- The result of 3 years of work by a subcommittee of system and equipment suppliers and users

- “Best practice” guidance on managing the procurement relationship to contain the risks

SHAPA Best Practice Guides

- Shapa.co.uk and select “Technical”
- “Cost of Ownership” document



Total Cost of Ownership

Agenda to guide equipment specification discussions between SHAPA suppliers and customers

Introduction and objectives

Of the bulk material handling companies in the UK those who are members of SHAPA tend to be in the upper quartile in terms of the design and quality of their equipment. One outcome of this is that our members need to compete on the basis of quality rather than cost. The aim of this document is to provide a framework to enable a salesperson to qualify the whole lifetime value of equipment so that this can be compared against other suppliers rather than just being compared on the basis of the initial capital cost. To own and operate an item of bulk material handling equipment comprises:

- Purchase cost (CAPEX)
- Running costs
- Maintenance costs
- opportunity costs due to downtime or compromised customer product quality

are normally much higher than the initial purchase price

Agenda for technical discussions

- An agenda designed to guide discussion between supplier and buyer
- To help tease out the “added value” (positive or negative) of offers

1. Is the proposed technology the best option for the duty?

- Look for an objective assessment of the technology options that could be used
  - Belt or pneumatic conveying
  - Grab crane or screw CSU
  - etc
- Why is the proposed technology the best solution?
  - Comparison of relative costs and benefits
  - Not just price! All ownership costs!
  - Including effect on product quality, safety, cleaning, maintenance
- Can the solution be demonstrated in a ‘test centre’ or through reference installations?

2. Loss of quality

- What measures of Quality or Process is important to you?
  - Low product damage during handling?
  - Minimal cross contamination between shipments?
  - Quick and easy to clean between batches / campaigns?
  - Enabling better process monitoring?
- Assess the costs of causing product quality loss
  - Lost customers?
  - Cargo damage claims?
  - Running at reduced speed?

3. Make sure the design matches the handling characteristics of the material

Material characterisation costs thousands – but it saves millions in lost production

- Material characterisation
  - To get the measure of the cargo behavioural properties
  - Who will assess the need for characterisation testing?
  - Is available data good enough?
  - Who will do material characteristics testing and when?
  - Who will pay for characterisation?
  - Where will we get a sufficient RANGE of RELEVANT samples?
- To ensure equipment design is fully informed to work well with the customer's specific range of cargoes? E.g:
  - Surface finishes, hopper / chute design
  - Dust control
  - Impact, wear and breakage etc etc

4. Equipment reliability: Expectations and cost of down-time

- It will break down! In the middle of production!
- How quickly can it be fixed?
- Calculate what it costs you to be down for an hour - a day - a week
  - Knock-on costs in delays to the next campaign or discharge
- How much down-time would be saved by having a person(s) permanently available on site or on-call?
  - Saving a day of down-time in a year may pay for a permanent maintenance crew
  - Invest in their training, practicing their skills in quiet periods
  - Invest in the workshop and get them using it! Keep them interested with engaging projects even if not of direct use (“Train hard – fight easy”)
  - A full time cleaning crew may prevent a costly dust explosion
  - Calculate manning costs sensibly

5. Spares & Service availability

- What spares and labour should reside on site? Do the maths!
- It costs thousands to store dozens of spare motors, gearboxes, inverters etc every year
- Most will never be used
- But it saves tens of thousands in lost revenue if just one of those saves a day's delay by being there when you need it
- Invest in keeping your spares stock up to date!
- If the supplier says "you don't need to keep that" – don't believe them!
- What is the Company Strategy for Disaster Recovery?
  - Fire, explosion. tsunami etc

6. Running costs

- How does your company monitor your lifetime costs for both capital and revenue items?
  - The quality of electrical motor can significantly influence running costs; an IE3 11 kw motor running for 22 hours / day will cost £4.6k less a year to run than a standard efficiency IE1 motor.
  - A correctly specified extraction or process fan can cost significantly less to operate for the same air movement performance
- A programme for continuous improvement

SUMMARY:

The keys to a profitable plant

Bulk solids characterisation

- Understand the need for measurements of the bulk solids properties
- Identify the properties which are likely to be important in this application
- Bulk solids are all different!
- Measure properties (or get them measured)
- Use sound design procedure

Understand the contractual problem around bulk solids characterisation:

- Property measurements cost money!
- Who pays?
  - At tender stage, no money for measurements;
  - Once contract let, price fixed so no opportunity for changing design!
- Many buyers look only at price
  - But design without proper information will lead to expensive problems!
- Need to educate buyer of value of proper design
- Cost of bulk solid property measurements through
  - Separate contract for design
  - Factor costs of measurement into tender

Risk management

- Reducing the quality of the design process, the programme timescale, the materials or the purchased components increases risk
- BSH is not an exact science!
- Often some doubt about whether a reduction in spec will cause complete failure
- Needs an honest discussion on the risks

Beware the “cost reduction exercise”!

- The deal agreed in principle – but then . . . . .
- “Value Engineering”
  - In most cases engineers the value out of the plant!
  - Must not be allowed to be led by parties that don’t have a deep understanding of the importance of details in design for BSH!
- Programme acceleration
- A cheap plant delivered quickly will in many cases cost both sides dearly! You DON’T want that plant!

Consider the full costs of ownership

- Include the unexpected costs
  - Slow start-up
  - Retrofit to correct design misjudgements
  - Downtime due to blockages, hang-ups etc
- Calculate optimal spares and service support
  - Based on down-time saved by fast, skilled remediation of breakdowns

Procurement support

- Get independent support and advice
- From MORE THAN ONE source
- Select INDIVIDUALS who can show you they have “been around the block”, not just companies with a respected name
- Be thorough in questioning their experience!

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For Bulk Solids Handling Technology

Understanding the Total Cost of Ownership

How to avoid future problems and buy bulk solids handling equipment intelligently

Wednesday 26 and Thursday 27 October 2022, 13:00 – 17:00 GMT – ONLINE

www.shapa.co.uk

The Wolfson Centre
For Bulk Solids Handling Technology

DON'T TRUST TO

~~GOOD~~ LUCK WITH YOUR PLANT PROCUREMENT!

USE THE SHAPA TOTAL COST OF OWNERSHIP GUIDANCE NOTE, IT'S FREE TO DOWNLOAD!

AND SHARE IT WITH YOUR SUPPLIER!