Learn Chemistry

Commercial Skills for Chemists: Project Management

Student Pack

Developed by Professor Colin Pulham, University of Edinburgh and Kevin Parker, KKI Associates Ltd

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Student Pack

Project Management

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Project Management

- Overview
- Task Briefing
- Lecture Resources
- Other Materials

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Project Management – Task Briefing

- You are a group of technologists working for *Mega Chemicals plc*. Your work is to evaluate new technologies and recommend which ones *MegaChem* might wish to take to market. 5 new projects that *MegaChem* are interested in can be found on the following slides
- Your task, as a team, will be to produce project plans for two of the 5 new projects. The project plans will consist of:
  - Charts (Gantt and PERT or something similar) of the main tasks required to take the technologies through to eventual launch or application in the real world
  - An estimate of how long each task might take (in person-days) and how long the project as a whole might take (in years)
  - Identifying where the natural 'milestones', 'stage-ends' or review points in the project may be
  - An assessment of the main risks in the project, and what would cause you to cancel or stop it
- To help with your task you have access to lecture material, academic papers, a book, and a short video. There will also be a team training exercise that you should attend as a group

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The New Projects…

Here are the 5 projects MegaChem are interested in…..

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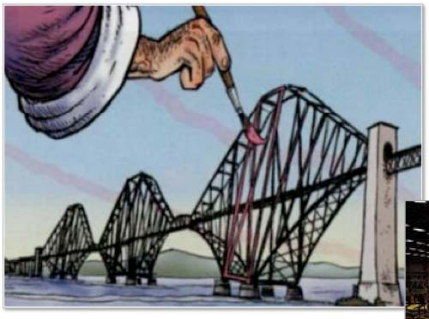
Project 1 Anti-corrosive pigment



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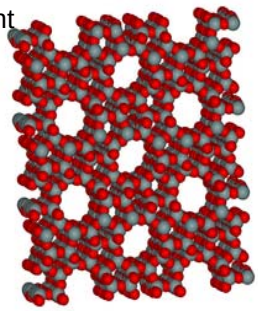
Project 1 – Anti-Corrosion Pigment

- We have discovered a better anti-corrosion pigment using zeolite to encage zinc chromate
- Corrosion costs $1trn in US alone!
- Zinc chromate is a well known effective anti-corrosive that is restricted in use because Cr^{VI} is toxic in the environment
- Because our pigment encages chromate anions, it provides the anti-corrosive benefits without the toxicity issues
- We recommend reviewing the opportunities for developing and commercialising this pigment



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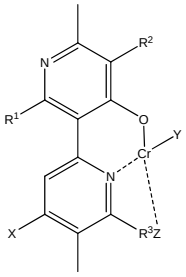
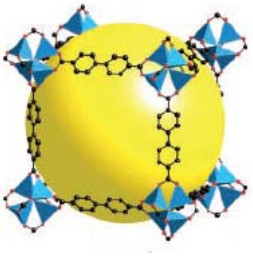
Project 2 Methane Oxidation Catalyst



Catalyst Facts:
Turn over Number:
15Million
Turn over Frequency:
1.5kat
Synthetic Cost:
18000$/kg



8.8x10^7 m^3 methane

1.2x10^5 T methanol

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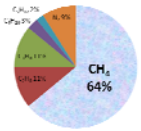
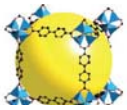
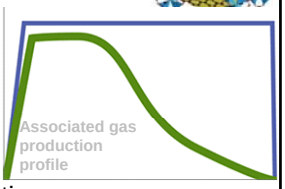
Project 2 – Methane Oxidation Catalyst

- We have a chromium catalyst that can convert methane t methanol at mild conditions
- Methane (natural gas) is difficult and expensive to transport over long distances, while methanol liquid is much cheaper and easier to move
- Commercial Opportunities could include
  - Major methane gas fields around the world
  - Potential to reduce flaring of associated gas
  - Exploit methane hydrates in arctic waters
- We need to assess and prioritise these opportunities







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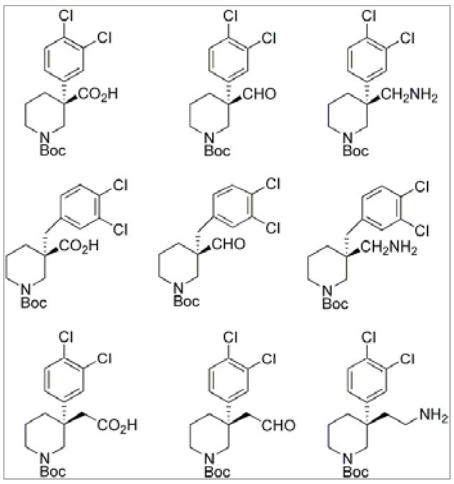
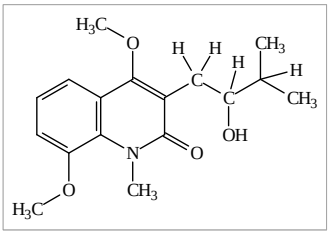
Project 3 New antibacterial synthesis





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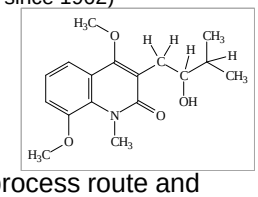
Project 3 New antibacterial synthesis

- We have a new route to synthesizing specific enantiomers of intermediates and drug candidate molecules
- Using specific enantiomers avoids some major potential side effects caused in drug trials by the presence of the opposite enantiomer
  - See 'thalidomide'
- In particular, we have a route to an enantiomer of lunacridine, which has potential anti-bacterial activity
  - Lunacridine could be the precursor of a whole new family of antibiotics, the first major discovery since 2000 (which was the first since 1962)
  - Constant demand for new antibiotics
  - World market around $15bn pa



- We would like to determine the value of the process route and the new antibiotic candidate

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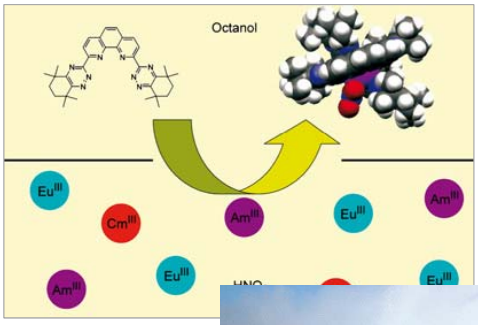
Project 4 New Separation Technique



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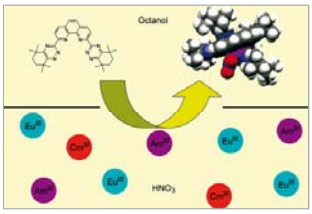
Project 4 New Separation Technique

- Lanthanides ('rare earths') and actinides are chemically similar and hard to separate
  - Lanthanide fission products are a problem in nuclear waste
  - Thorium is a contaminant in lanthanide mining
  - Lanthanides have interesting magnetic properties and important industrial uses
- We have discovered a new phenanthroline-derived ligand that can separate actinides (Th, Am, etc) from chemically similar lanthanides
- We plan to explore opportunities in both nuclear waste decontamination and clean-up of rare earth mines



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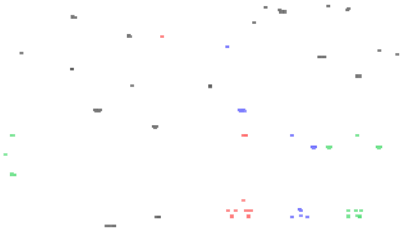
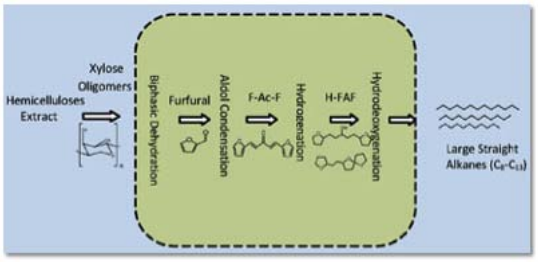
Project 5 Bio-diesel from Lignin





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Project 5 Bio-diesel from Lignin

- There are few current processes for making Jet Fuel from Biomass sources
  - Demand for Jet fuel around 5million barrels/day
- We have a multiple step process that converts lignin hemicellulose to C_8-C_{12} paraffins suitable for Jet Fuel
  - Lignins are major constituents in certain tropical and temperate plants
  - Other biomass process tend to make lighter paraffins not C_8-C_{12}
- We recommend further study of the economic and logistics of this process

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Lecture Material – Project Management

- The following slides are from a workshop on project management given to STEM students at a UK University in 2012
- You may read or use as much of this material as you like, working through the exercises if need be, to help you produce your assignments
- Part of this lecture is available on video at http://www.youtube.com/embed/Mb_MVYPpYXo?feature=player_detailpage

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Project Management

Kevin Parker, KKI Associates Limited

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Project Management

The talk starts off with an anecdote about a project where a number of 'obvious' things (such as proper costings, or informed market research) just hadn't been done…

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Project Management

…and it was a long time ago so I've erased the very start where I'd mentioned the name of the company involved

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Background - why project management?

'Who was in charge of the Project?
I suppose I was really'

(Five different interviewees)

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Project Management

- Is a discipline
  - Degrees and diplomas
- Is a process for achieving better results
- Is a transferable skill
- Is a way of working, not a software package or a Gantt chart

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Projects tend to…

- Have specific start/finish dates
- Have limited budgets
- Have set outputs and requirements
- involve many tasks and disciplines:
  - Telephoning or meeting funders/customers
  - Defining a technical specification
  - Contracts and intellectual property
  - Purchasing lab equipment
  - Carrying out a scientific research programme
  - Getting approval for foods or medicines
  - Building a factory

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Why was Project Management invented?

- Many techniques developed by US aerospace industry in 1950s-60s - 'Sputnik crisis'
- Spend more time and money on successful projects and reduce spending on unsuccessful projects
- Develop a system that is transparent in terms of progress and responsibilities
- Meet deadline and budget targets

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Examples of Poor Project Management

- Nimrod AWACS
- UK air traffic control system
- London Stock Exchange 'Taurus'
- Phillips V2000 video
- Apple (in the 1990s)
- British Leyland
- Many technology projects
- Most University collaborations
- Scottish Parliament

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Examples of Good Project Management

- Hewlett Packard, Canon, Xerox
- Theatre & film production companies (see LOTR ee)
- Building Industry
- Apollo Space Programme
- Desert Storm Logistics
- Pharmaceutical Industry
- McLaren, Williams, (Ferrari post Schumacher….)
- Sega, Nintendo, etc

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People that are good at PM….

- Have a process for deciding which projects to do
- Appoint Project Manager & agree objectives
- Break things into stages
- Manage by deadlines & deliverables not by annual budgets
- Communicate well inside project
- Know the risks in advance
- Will review & stop failing projects
- Use PM Methodologies (eg PRINCE2)

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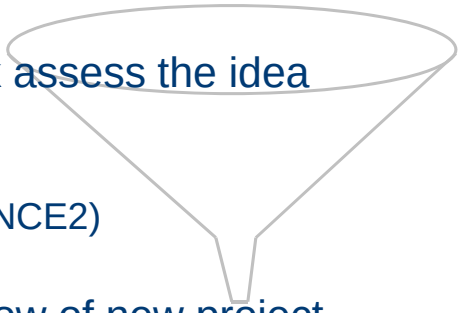
New Project Process

- How do we decide which projects to do?
- Idea generation and assessment
  - concept test
- 'Sanity check' or risk assess the idea
  - feasibility study
- Full project
  - PM process (eg PRINCE2)



- Result: a funnel or flow of new project ideas

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New Project Process

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Advantages of a process

- Know why you are doing a project
- Know what the risks are and why you would stop doing the project
- Know that if you stop a project there are others ready to take its place
- Encourage staff creativity

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Stage-Gate Process

- Generic process devised by Prof Robert Cooper (McMaster University)
- Used by many UK/US chemistry-based companies (e.g. P&G, Syngenta)
- Project goes through numerous phases from idea to launch
- Phases are made explicit, and specific things must be done to progress through them

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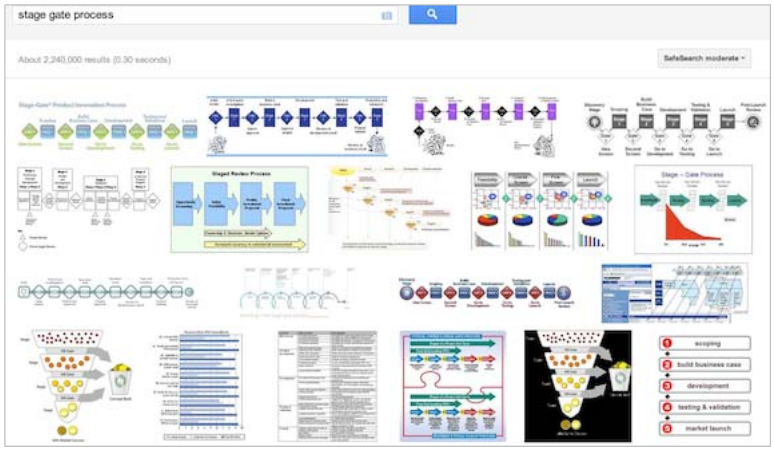
Many Stage-Gate Processes…



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What is PRINCE2?

- (**PR**ojects **IN C**ontrolled **E**nvironments)
- structured method for effective project management.
- used extensively by Government and private sector, UK and international.
- method in public domain
  - (www.prince2.com)
- 'Codified common sense' (lot of forms….)
- Similar to 'Stage-Gate'
  - Stage-Gate - R&D projects
  - PRINCE2 - Development, IT, Construction

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The principles of PRINCE2

- focus on objectives and reasons
- the project management team has clear roles and responsibilities
- project team reports to senior management group
- emphasis on dividing the project into manageable and controllable stages
- Explicitly recognise and address risks
- output-based planning approach
- Systematic approach to documentation

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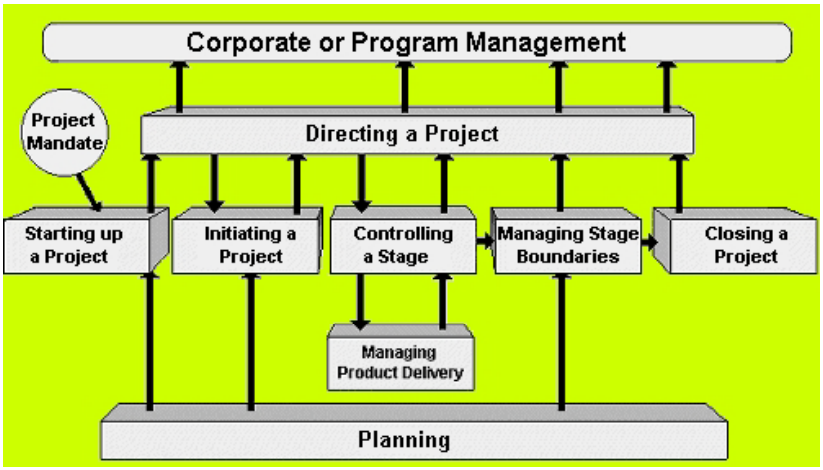
Overview



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Identifying Project Stages

- Introduce new stages where
  - Resource requirements increase
  - Nature of technology changes
  - Activities change in character (lab to plant)
- Address the areas of risk and uncertainty first..
- In general, do cheaper activities first and expensive ones later
- Keep testing the idea and the technology through the project
- Here are typical stage processes…

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Research & Idea

Starting a Project

- Idea Stage – express the main features of an idea
- Potential users/buyers
- Potential technical solution
- Potential resource Requirements

- Progress approved to proof of principle stage if idea looks
  - Interesting/profitable
  - Legal/achievable

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Proof of Principle

Proof of Principle

- Do sufficient technical/scientific work to show that the technology targets are achievable
- 'Back of fume cupboard' experiments

- Progress approved to feasibility study if science works and idea still looks
  - Interesting/profitable
  - Legal/achievable

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Feasibility Study

Feasibility Study

- Try to find all the potential problems/failure factors – 'devil's advocate' study
- Technical, commercial, regulatory
- Should generate set of targets, major risks and project flow chart

- Progress approved to technical development & market research if project still looks
  - Interesting/profitable legal/achievable etc

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Development Project

Development Project

- Technical work to develop saleable product/process
  - 'Scale-up' for new process
  - Packaging for products
- Quality, safety, specification cost targets

- Done in parallel with market research
- Progress approved to business plan if project still looks
  - Interesting/profitable legal/achievable etc

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Detailed Market Research

Detailed Market Research

- Intensive primary market research to determine customer needs, benefits targets
  - Qualitative and focus group studies
- Extensive quantitative research to estimate market size share, sales etc

- Done in parallel with development phase
- Progress approved to business plan if project still looks
  - Interesting/profitable legal/achievable etc

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Business Plan and Finance

Business Plan

- Detailed financial analysis of costs, income, timings, profits, cash etc
- Often based on budgets of future cash flow
- May involve discounted cash flow and net present value calculations

- Go to launch stage if project still looks
  - Interesting/profitable legal/achievable etc

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Summary of Managing Stages

- Each stage consists of a number of set activities.
- Budget tied to objectives not time period
- Each stage is multi-disciplinary - genetics, cell culture, IT, purchasing, etc
- Each stage usually costs more than the previous one
- At each stage-end, the team and senior, management complete a systematic review

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Stages in Clinical Trials

5-10 years drug discovery and pre-clinical work

Phase 1
Safety testing on 20-80 subjects

1 year £1m?

Phase 2
Efficacy testing on 100-300 subjects
2 years £2-20m?

Phase 3
Large trials 1000-3000 subjects
3-5 years £30-80m?

Launch and marketing costs
Phase 4 testing – post launch

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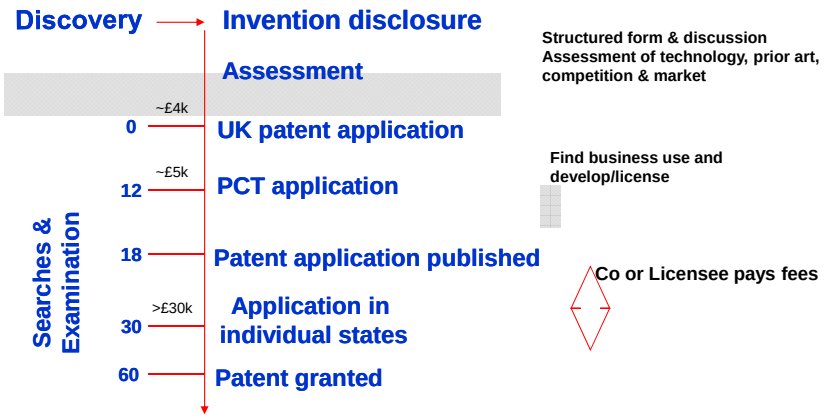
Stages in the patent application process



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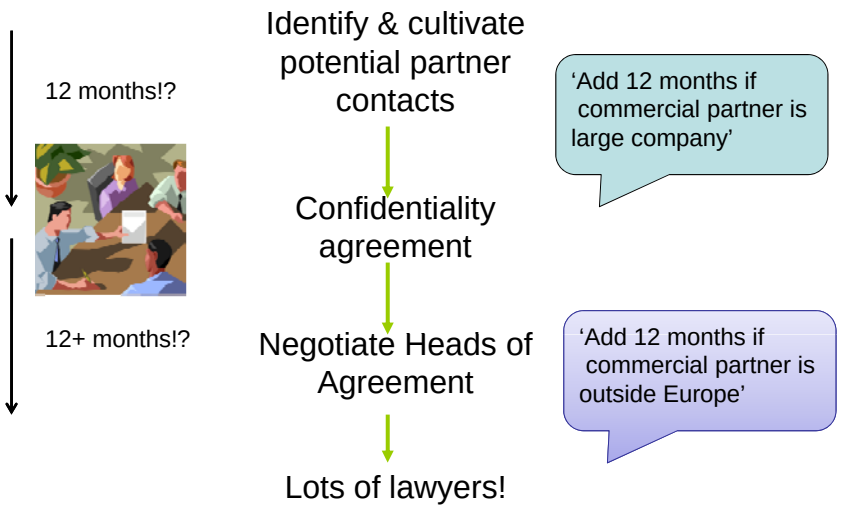
Stages in the Commercial Process



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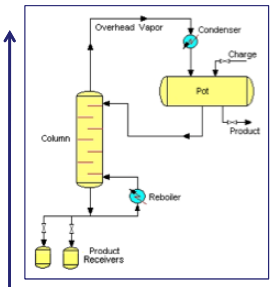
Stages and Issues in Scale-up



Remove synthesis stages (<4)

'you have to know kinetics as well as thermodynamics'

Stoichiometry of dosing

Mass transfer and solvent extraction

Surface area to volume ratio much smaller on large scale – less heat loss

Controlling exothermic reactions

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Some natural points to end a stage

- Going from computer modelling to physical prototyping
- When you need to go from lab-scale to pilot plant
- When you need a lot more money!
- When you have completed a feasibility or market research study
- Before and just after clinical trials, field trials, customer beta testing, etc

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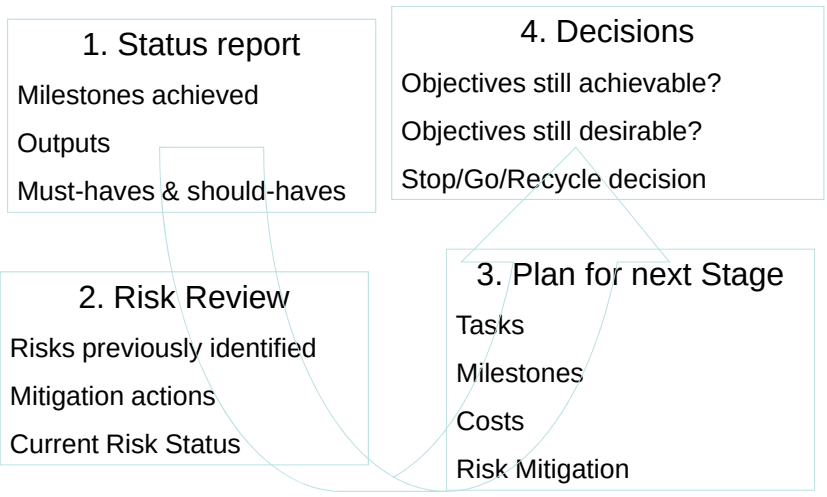
Stage End Processes



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Do the same for every project!

Reviewing the project

- Between each stage there is a STOP/GO/RECYCLE decision
- Taken by the project manager, and senior managers in charge of project finance
- Stop/Go decisions should be conditional on achieving pre-agreed objectives
- Team should always be willing to review and test the project's chance of success
- *Feasibility study should identify 'reasons to stop the project'*

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Encouraging Good Decisions

- Senior Managers should ensure
  - There should be no cheating!
  - Don't blame people when stopping projects for good reasons
- Separate Project funding from Annual Budgets
  - Concept stage: days/weeks
  - Feasibility study: weeks/months
  - Market research and business plan: weeks/months
  - Development: years

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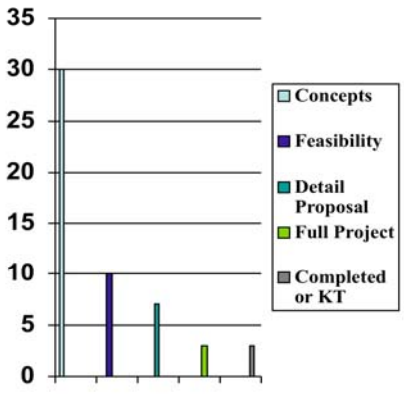
Typical Project Portfolio

- 30 project concepts
- 10 feasibility studies
- 7 detail planning and proposal stage
- 3 full projects in process
- 3 projects complete or in knowledge transfer



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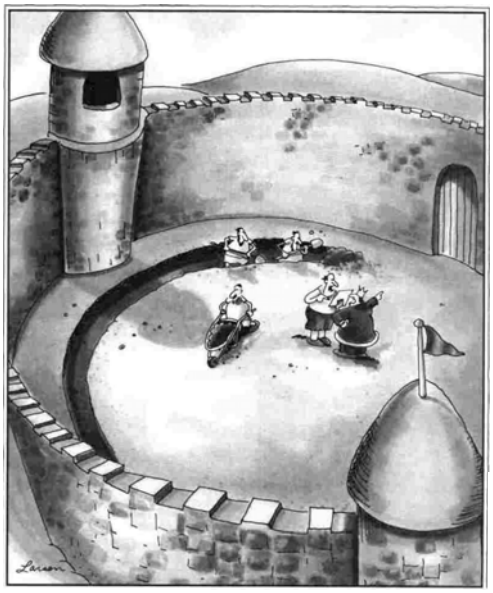
Planning and Running the Project



Suddenly an argument took place between the King and the moat contractor

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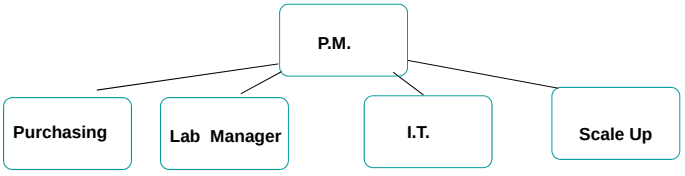
'Put Someone in Charge'

- Projects need an accountable leader - especially if interdisciplinary or cross-boundary



- Other resources can be brought in as required by the project leader
- Aim is to make it clear who is responsible for what in the project
- MOST IMPORTANT rule of project management!

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Project Planning

- Project Manager needs to break down activity into clear tasks and sub-tasks
- Ideally tasks or subtasks should be person-sized
- Everyone in project has a customer for their output and is a customer for someone else
- Everyone has a 'project contract' detailing targets, deadlines, budgets, etc

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Make your tasks SMART(er)

- Specific
- Measurable
- Agreed and Achievable
- Realistic
- Timed

and then

- Evaluate
- Review

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What the Project Team should know

- What is your principal task or sub-task on the project and why are you doing it?
- Who are you doing it for? why do they need it?
- When do they need it? Why?
- What targets or standards must be and should be achieved by the work?
- What are the main inputs you require to do the project and when do you need them?
- Who is providing them?
- Do they know why and when you need them?

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As Projects grow -

- Flow chart the tasks and Identify
  - What tasks must be carried out before another
  - What must be completed before another task can begin (FS dependency)
  - What must be completed before another can finish (FF dependency)
  - What must be started before another can finish (SF dependency)

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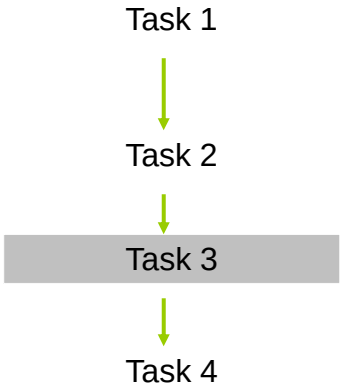
Managing Complexity

- Does your project look like this?



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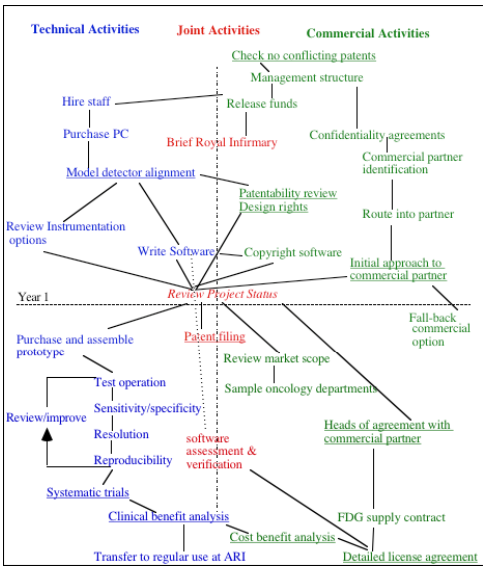
Managing Complexity

- Or this?
- 'Parallel Processing'
  - Speeds project but makes planning and scheduling complex



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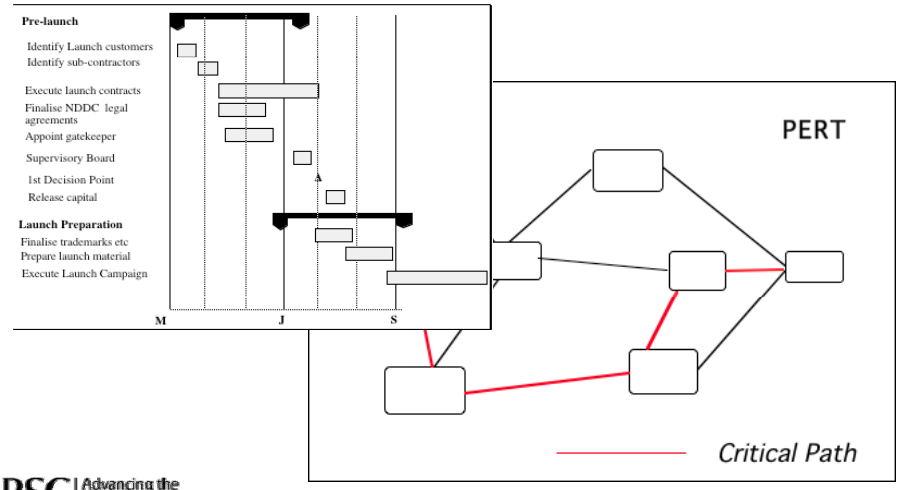
What happens when the flow chart gets complex?



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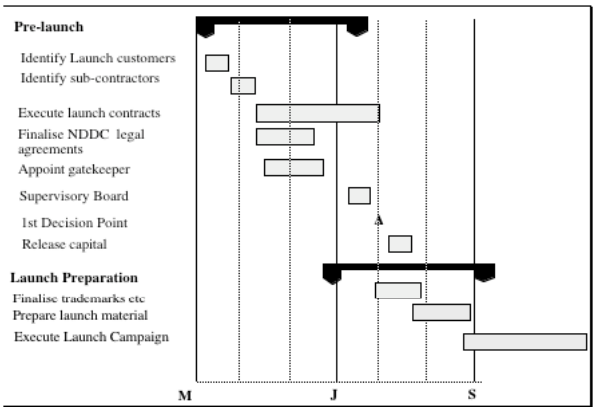
Project Scheduling Tools

- Gantt Chart



- Shows tasks against time

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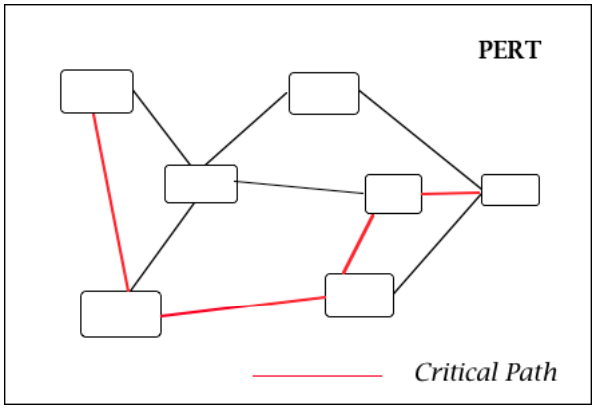
Project Scheduling Tools

- PERT Chart (Project Evaluation Review Technique)



- Shows task dependencies

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Project Scheduling Tools

- Available as PC software - Microsoft 'Project'
- Constructs PERT and Gantt charts from lists of subtasks and dependencies
- Calculates resource requirements (can be shared across projects)
- Calculates critical path activities
- Estimates likely finishing date

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A Quick look at PM software...

- MS Project (PC only)
- Merlin (Mac OSX)
- @Task (ASP -browser access)
- AEC Software FastTrack (multi-platform)

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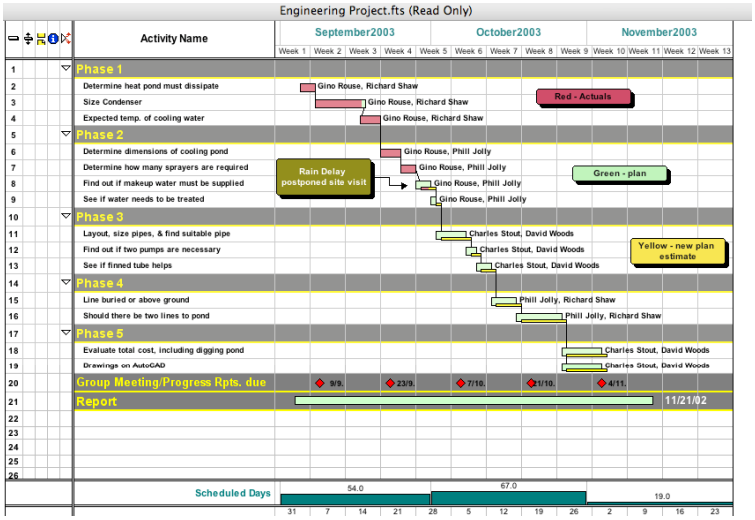
Software Examples - AEC



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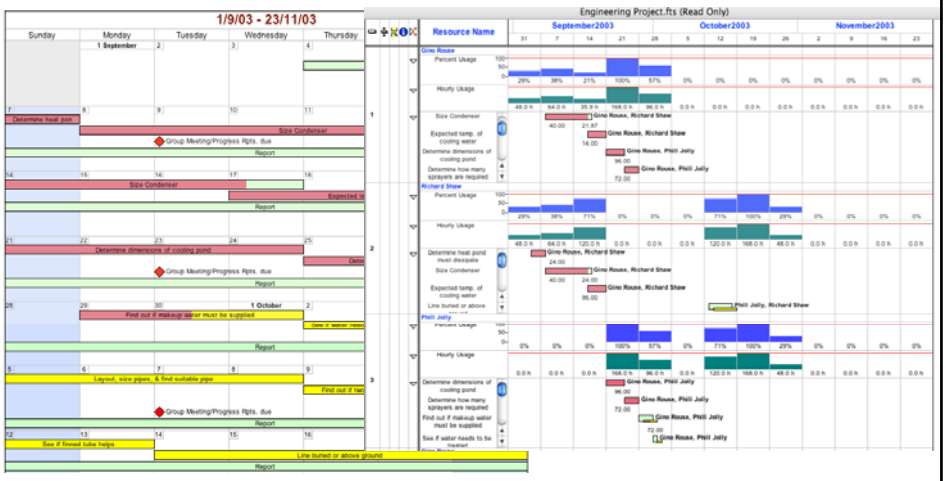
AEC Screenshots

Calendar View

Resource View



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Using PM Software

- Remember ‘Garbage In, Garbage Out’
- Must think through flow charts first!
- On simple projects - do you need software?
- On complex projects - full time job keeping chart up to date!
- Quite a useful tool for PM
- Useful in managing expectations of sponsors and non-experts!

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Assessing and Controlling Risk

What you have to ask yourself is:

'do I feel lucky today?'

C.Eastwood

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Tools for risk management

- Use people's experience
- Think about technical, cost, human, issues
- Identify things that would stop the project or make it not worth doing
- List each risk and how likely they are
- Identify and do things to reduce impact of risks
- Keep reviewing the list!

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Being systematic about risk

1. Identification of Issues affecting project

NB Enter Data in white boxes only!

Issue	Description	Effect on project	Mitigation (if any)	High Impact?	Highly Likely?	Do something about it?
Halliburton contracts	Staff at Halliburton with whom we negotiate are not the ones we'll be working with. For more info see	Difficulties in getting agreement signed will delay project and upset Shell	People at JRC are still keen on project	y	y	Go to options analysis
Royalty arrangements				Y	y	Go to options analysis
Auditability				Y	y	Go to options analysis
IP defense				Y	y	Go to options analysis
IP prior art				Y	y	Go to options analysis

2. Options for dealing with these issues

Issue	Option	Cost	Timescale	Likely Impact	Does this option look achievable and cost-effective?	Action?
Halliburton contracts	Employ US lawyer to help negotiations	$30k	3 months	should help finalise contract	y	y
	s					y
	t					y
	u					y
	v					y
	w					y
	x					y
Can we resolve this issue?						
Royalty arrangements						
Can we resolve this issue?						

A View from IBM

Table 3-3. Complexity Guideline

PROJECT TYPE[a]	ENVIRONMENT TYPE[b]	EFFORT MULTIPLIER
Old	Old	1.0
Old	New	1.4
New	Old	1.4
New	New	2.3

[a] Application, e.g., orbit determination, simulator. The project (or portion of the project) type is old when the organization has more than 2 years experience with it.
[b] Computing environment, e.g., IBM 4341, VAX 8810. The environment type is old when the organization has more than 2 years of experience with it on average.

Table 3-4. Development Team Experience Guideline

TEAM YEARS OF APPLICATION EXPERIENCE[a]	EFFORT MULTIPLIER
10	0.5
8	0.6
6	0.8
4	1.0
2	1.4
1	2.6

[a] Average of team member's years of application experience weighted by member's participation on the team. Application experience is defined as prior work on similar applications, e.g., attitude and orbit determination. Member's participation is defined as time spent working on the project as a proportion of total project effort.

Table 3-5. Team Size Guideline

TEAM LEADER: UM YEARS OF EXPERIENCE[a]		MAXIMUM TEAM SIZE EXCLUDING TEAM LEADER
Organization	Leadership	
4	3	7 ± 2
3	1	4 ± 2
2	0	2 ± 1

experience (requirements definition, analysis, development, maintenance, and

with the organization and its development methodology.
as a team leader or manager.

with no leadership experience should not be asked to manage a team with . A team of seven to nine members should be provided with a leader who has nce with the application, primarily within the organization.

3-6. Guideline for Development Team Composition

ENVIRONMENT TYPE[a]	PERCENTAGE OF SENIOR PERSONNEL[b]	PERCENTAGE OF ANALYSTS[c]
Old	25-33	25-33
New	33-50	25-33
Old	33-50	33-50
New	50-67	33-50

hment types are old when the development team has, on average, more than 2 years experience with them.
[b] Senior personnel are those with more than 5 years of experience in development-related activities.
[c] Analysts are those personnel who have training and an educational background in problem definition and solution with the application (project type).

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Classic Risks in Projects

- Medical technology - time for development and regulatory approval
- Environmental/renewables - who benefits and who pays
- ‘We’re in competition with Microsoft/BASF/Novartis and they have 200+ people working on the project
- Someone’s published it and we can’t patent
- 'Time to sell' to big customers
  - Finding the right person to approach!
  - Long lead time for chemical plant etc, decision making 5 years out

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Ending the Project

“The consultant told us to stop the project but we sacked him and got someone to give us the right answer”

Anon (at own request)

“Underlying PRINCE2 is this hidden principle:
Good project management means killing off bad projects”

Patrick Mayfieldhttp://pearcemayfield.typepad.com/prince2tm_practice_blog/

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How do you know its complete?

- List key things that will have happened before you can say project is complete
- Outputs achieved?
- Must-have targets achieved?
- Money spent?
- Objectives achieved and knowledge transferred?

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What if it doesn't work

- Use list of 'project killers' to close down projects that won't achieve objectives
- Identify genuine risk areas and distinguish from poor management
  - Don't shoot the messenger!
- Look for ways to scale down or modify project

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Final Steps

- If project didn't go well, review it to see how to do better next time!
- If project went well, review it so next PM knows what worked last time!

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Project Management – Other Resources

- Video: *What Makes a Good Commercial Invention?*
  - http://www.youtube.com/watch?v=ArJvmjGfNVg
- Video: *The Difference Between Features and Benefits*
  - http://www.youtube.com/watch?v=stv3ePGNBcE

Website: http://www.projectmanagement.com/

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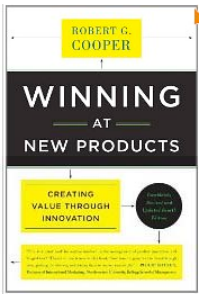
Project Management – Other Resources

- Paper: Great Mistakes in Technology Commercialisation
  - *Journal of Strategic Change, Volume 10, Number 7, pages 383-390, John Wiley & Sons, (November 2001)*
  - Download here:
    - http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/419/Great%20Mistakes.pdf

- Book: Winning at New Products, Robert G Cooper
  - Basic Books; 4th edition (28 July 2011)
  - ISBN-13: 978-0465025787



- PM Workshop Game
  'The Leaning Tower of Pasta'
  See next slides!

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These slides are not discussed in the video lecture. They are not essential for completing the task. However they may be very useful if your team doesn't work well together!

Which may become apparent in the 'Leaning Tower of Pasta' game!

Working in Teams

Most Projects involve working in teams

How do we do that?

- Typical team evolution
- Team Role Preferences
- Identifying preferred roles
- Building a successful team

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Lots about this on the internet!

Tuckman's model - forming storming norming performing

- forming - stage 1
  - High dependence on leader for guidance and direction.
- storming - stage 2
  - Decisions don't come easily within group. Factions & power struggles!
- norming - stage 3
  - Agreement and consensus among team, facilitation by leader. Roles and responsibilities are clear and accepted.

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Tuckman's model

- performing - stage 4
  - The team is more strategically aware; the team knows clearly why it is doing what it is doing. The team has a shared vision and is able to stand on its own feet with no interference or participation from the leader
- What it means
  - You are probably going to have arguments before you have a good team!
  - The trick is to address your differences constructively
  - Directly, not 'behind their back'
  - Critique the 'performance not the person' (see 'praise and critique' slides below)

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Tools for Team Building

- Psychological tests (M-Briggs, Belbin)
  - Preferred team roles (shaper, completer-finisher)
- Team building courses (Outward Bound etc)
  - Put team under shared stress
  - Teams need to 'storm' before 'perform'
- Working together
  - Contractors become employees

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Lots about this on the internet!

Preferred Team Roles

- Its good to have a mixture of
  - 'Plant' (good Ideas)
  - 'Shaper' (gets things going)
  - 'Completer-finisher' (details correct)
  - 'Worker' (does the work)
  - Team worker (encourages everyone)
  - 'Chair' (gets everyone's views heard)
  - 'Resource Investigator' (finds out how to do things)
- The Belbin Team Role Analysis
- *What do you think you are?*

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Lots about this on the internet!

Cross-cultural Issues

- Power-distance relationship
  - Korea vs New Zealand
- Individual vs Collective
  - China vs Japan
- Avoid or welcome uncertainty
  - Switzerland vs Spain
- Long or short termism
  - UK vs Germany
- Social Issues:
  - Working hours and after hours bonding
  - Body Language
  - Language barrier (even when all speak English)
- Preferred Team roles still apparent

- See Geert Hofstede 'Motivation, Leadership, and Organization: Do American Theories Apply Abroad?", **Organizational Dynamics, Vol. 9 no. 1, Summer 1980, 42-63.**

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Major Problem with UK Projects

- Little team culture
- No analysis of team roles
- No storming/norming etc
- Embarrassment?

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Motivating people …

- … is about
  - Positive Motivation
  - Absence of demotivation

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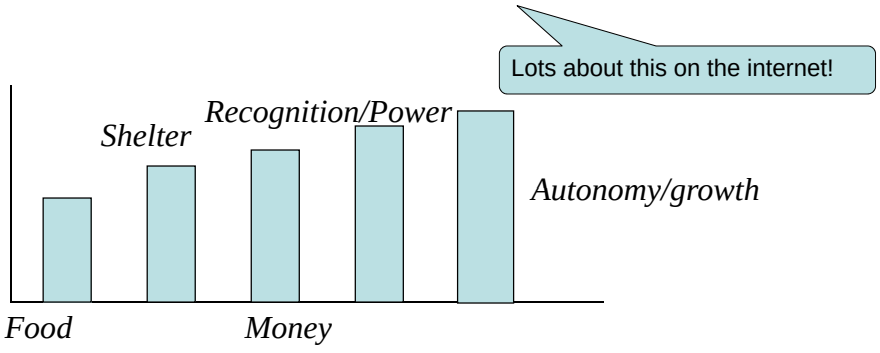
What Motivates People

- People have needs that work must meet
- Needs include
  - Structure, power, relationships, autonomy, recognition
- Needs are hierarchical (Maslow)



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Practical Ideas for Motivation

- Build team achievement
  - 'Projectise' putting ideas into practice
  - multi-disciplinary work
  - get some 'quick wins'
- Make individual jobs interesting
  - build entire car/stereo
  - remove controls but keep accountability
- Management Style
  - praise costs nothing!

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Praise and Critique

- When you praise someone how do you it?
- When you are praised how do you respond?
- When you critique do you act like an adult or a (critical) parent?
- When your work is critiqued do you respond like an adult or a (sulky) child?
  - See Berne 'Games people play'
- Beware of e-mail!

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Lots about this on the internet!

Transactional Analysis

- Reciprocal/complementary
  - Have you been able to write that report?
  - Yes, I'm just about to e-mail it (adult-adult)
- Crossed
  - Have you written that report yet? (adult?)
  - Get off my back, I'm doing it! (child)
  - Don't talk to me like that! (parent)
- Switching
  - When am I going to get that x@! report? (parent)
  - Its was in my workplan for next Tuesday, but if it's a priority would you like me to reschedule? (adult)

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Working with People Summary

- Clarify aims of project
  - Put someone in charge, Project Mandate
- Clarify all relationships
  - roles, responsibilities, motivation
- Look for ways to make tasks interesting
  - Appropriate delegation
- Build Team
  - Appropriate roles
  - forming storming norming performing
- Issues for own projects ?

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Dilbert on Motivation

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Final Summary and Close

- Project Management is a mixture of creativity and disciplined structures
- Many organisations use staged processes for managing new projects
  - e.g. Stage-gate, PRINCE2
- There are scheduling tools to help manage complex time-lines
  - Gantt, PERT charts, PM software
- PM is a team activity with a defined leader
- Not constrained by annual budgets, but by deadlines and deliverables
- We can optimise team performance by putting the right people in the right roles
  - Belbin team roles

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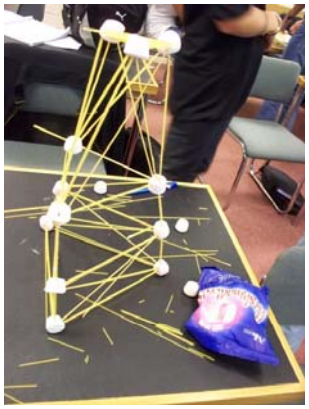
‘*The Leaning Tower of Pasta*’

Project Management Exercise

We are investigating the potential of complex polysaccharides and dehydrated starch-based renewables as highly insulating building materials*



**40% of the UK’s carbon footprint comes from heating and cooling buildings, but many insulating materials are petroleum-based*

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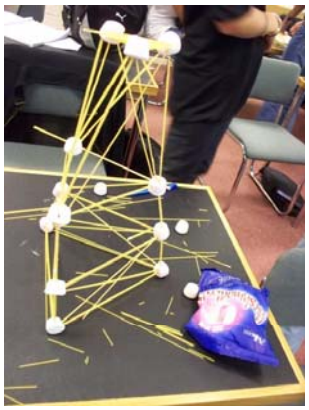
Project Management Exercise

- Build the tallest free-standing tower you can from the renewable materials provided*
- It must support a small weight
- Height to be measured to the point where weight is supported
- You have 45 minutes to beat the one in the picture



** Complex polysaccharides and dehydrated starch-based renewables*

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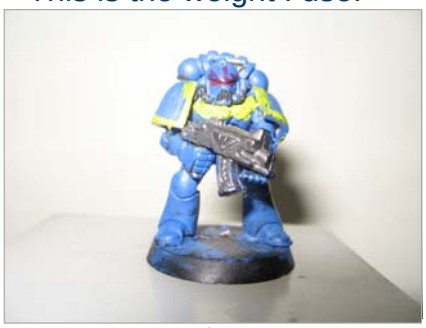
Project Management Exercise

- This is the weight I use!*



- Measure height to bottom of base

**Games Workshop 'classic' metal Space Marine ~ 10 grams*

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Post Exercise Analysis

- How tall did you make the tower?
- Was it stable?

- What are the problems with using pasta?
- What are the problems of using marshmallows?

- If you had to do it again what would you change?

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Post Exercise Analysis - Team Roles

- Who seemed to be doing what within the team?
  - Bossing others around?
  - Wanting to get started?
  - Coming up with ideas?
  - Encouraging others?
  - Quietly getting on with it?
  - Checking what was needed?

- Was there any conflict in the team?
- Was it resolved, and if so how?
- Google 'Belbin test' and see whether this illuminates what was happening!
- Would you do anything different next time?

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Research & Idea

Idea Generation

- Can you think of any better ways to build the tower?
- How would you overcome the problems of the materials?
- Can you think of any chemical ways of improving the materials?
  - How about using a chemical treatment?

- *Spend 10-20 mins coming up with some ideas*

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Research & Idea

Literature Survey

- 'Induced flexibility of dehydrated starch-based renewables with dihydrogen monoxide treatment' *(Pasta et al dente, 1999)*
- 'Increased adhesive properties of polysaccharide gels interacting with oxygen dihydride' *(Sticki & Messi 2003)*
- 'Stable lattice formation in starch-based renewables. Pioneering work facilitated by boiling hydronium hydroxide' *(Reef & Knott 2009)*

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Proof of Principle

Proof of Principle

- Devise and carry out a series of experiments to test your ideas of material improvement and tower construction techniques
- You are allowed 1 chemical substance to help with your research

  (dihydrogen monoxide)*

- *Spend 30 mins to 1 hour on these experiments*

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** Google for safety information*

Development Project

Development Project

- Plan and execute a new pasta tower project
  - Identify the tasks, estimate the time required and flow chart the project
  - Allocate roles
  - Plan for review meetings
  - Write safety procedures for potential hazards
    e.g. handling dihydrogen monoxide
  - Identify main risks and your 'Plan B'

- *Time allowed $^1/_2$ hour for planning, 1 hour to build!*

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Your New Technical Target

Current record holders – 42 inches,

Edinburgh University Architecture Students:

Anthony Richardson, Mario Kong, Lizzie Murphy and Rachel Slater

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Facilitator's Notes

- The 'Leaning Tower of Pasta' is based on a common team building exercise where groups are challenged to build the tallest tower they can from dried spaghetti and marshmallows. Architects use it as an exercise in structural design as apparently the strength of pasta is 'in scale' with the size of the building
- Here we are adapting it to illustrate the principles of managing a research and development project for chemists
- This activity can be used alongside the lecture material on project management. Together the lecture/workshop and the activity would make a full day
- In the ideas phase there are at least three potential solutions for making the tower stronger
  - Soaking the pasta in hot water for about 5 mins makes it rather more flexible – you can weave into criss-cross lattices which are quite stiff. They can warp as they dry though!
  - Boiling the pasta to get 'cooked' spaghetti lets you use it as 'rope' to lash dry pasta together – see http://en.wikipedia.org/wiki/Lashing_knot
  - You can make liquid 'glue' by softening the marshmallows in warm water. A bunch of pasta 3-4 strands upwards can be stuck together with this to form a very rigid rod

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Facilitator's Notes

Pasta woven into rigid lattice after softening (not boiling) in hot water

This can be further strengthened by lashing boiled pasta around the joints (like these below!)

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