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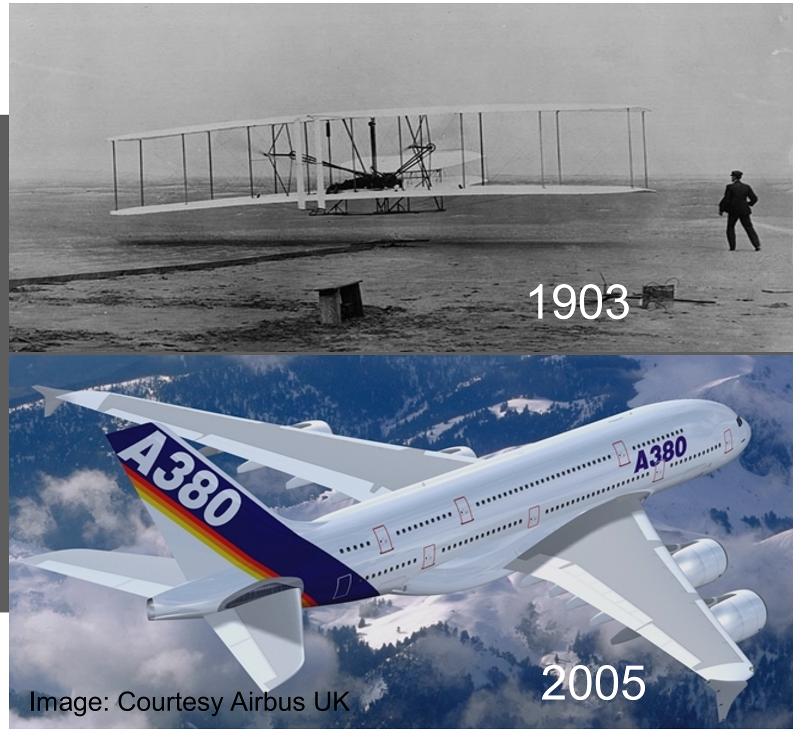

Design innovation:

Creating an environment for creativity

European workshop on aircraft design education

19-21 October 2005

OUTLINE

1. Innovation: Stepping outside of the box
2. Risk management and assessment
3. Innovation promoters
4. Innovation inhibiters
5. Concluding remarks

Design innovation:

Creating an environment for creativity

European workshop on aircraft design education

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Stepping outside the box

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- **Conventional versus unconventional thinking**

- **Conventional thinking**

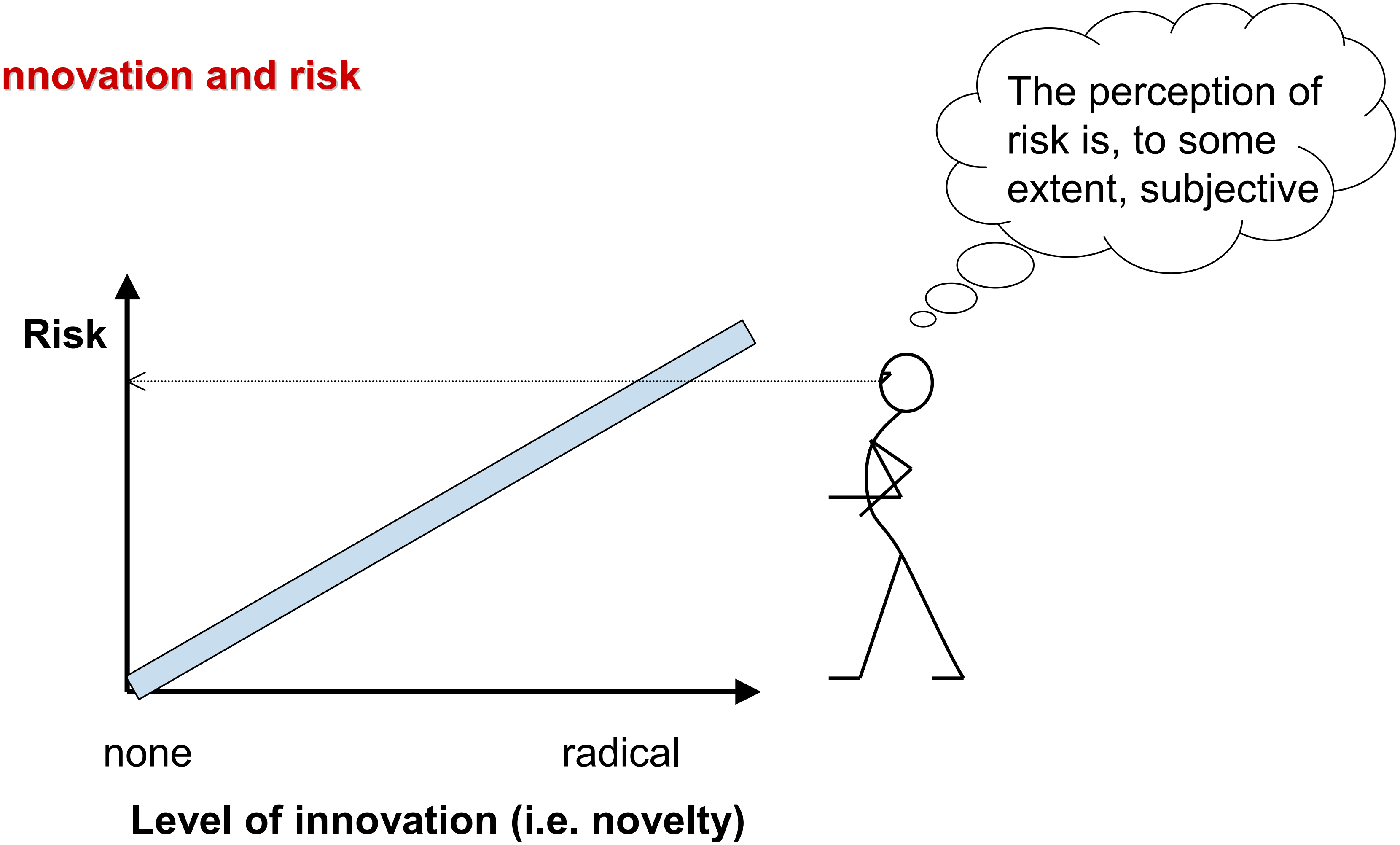
  Produces designs that are, more or less, evolutions of past designs

- **Stepping outside the "box"**

  Produces designs that are radical in concept – bearing little, or no, resemblance to that which came before, and are potentially high risk

Stepping outside the box

- **Innovation and risk**



Perceptions of innovation

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It is apparent to me that the possibilities of the aeroplane, which two or two years ago were thought to hold the solution to the [flying machine] problem, have been exhausted, and we must turn elsewhere

Thomas Edison, 1895

I have not the smallest molecule of faith in aerial navigation other than ballooning

Lord Kelvin, 1896

Aerial flight is one of that class of problems with which man will never be able to cope

Simon Newcomb, 1900

All attempts at artificial aviation are not only dangerous to life but doomed to failure from an engineering standpoint

The editor, London Times, 1905

It is complete nonsense to believe flying machines will ever work

Sir Stanley Mosley, 1905

Their Lordships are of the opinion that they [airplanes] would not be of any practical use to the Naval Service

British Admiralty, 1907

In its present state, and even considering the improvements when adopting the higher temperatures proposed …, the gas turbine could hardly be considered a feasible application to airplanes.

National Academy of Sciences, UK, 1940

Risk management and assessment

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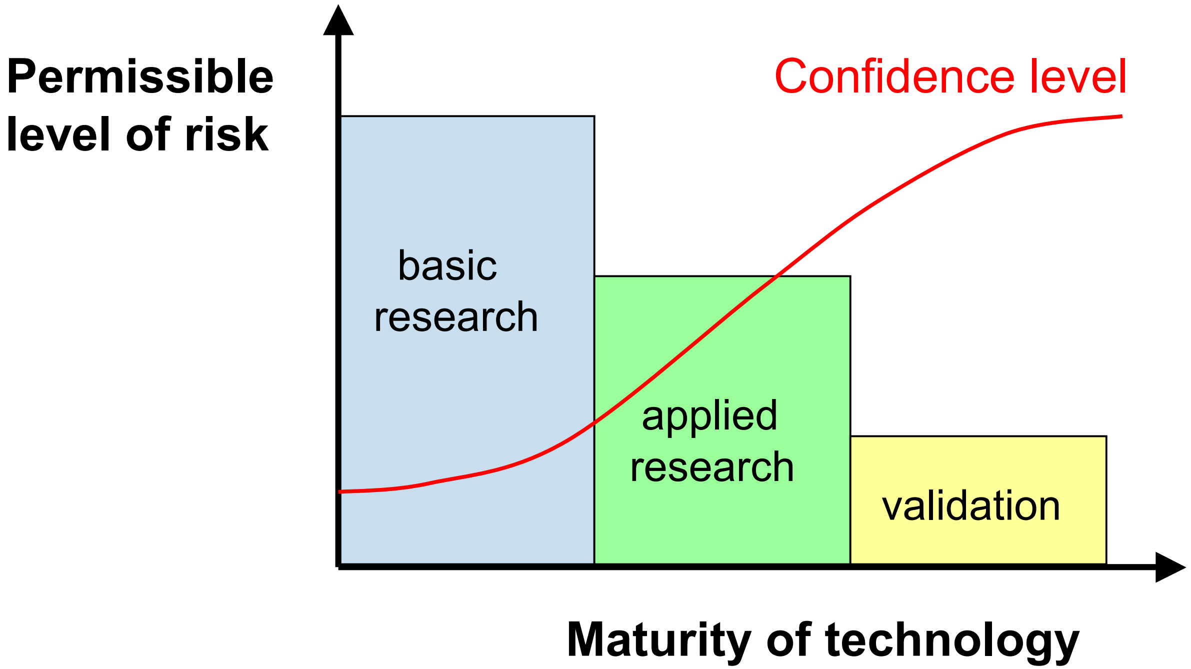
Permissible level of risk

- Adjusted to suit the research



Risk management and assessment

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- **Consequence of failure**

		Consequence of failure			
		Negligible	**Minor**	**Major**	**Catastrophic**
Risk level	**4**				big concern
	3				
	2				
	1	no concern			

Risk level = probability of failure

1 = small probability

4 = high probability

Risk management and assessment

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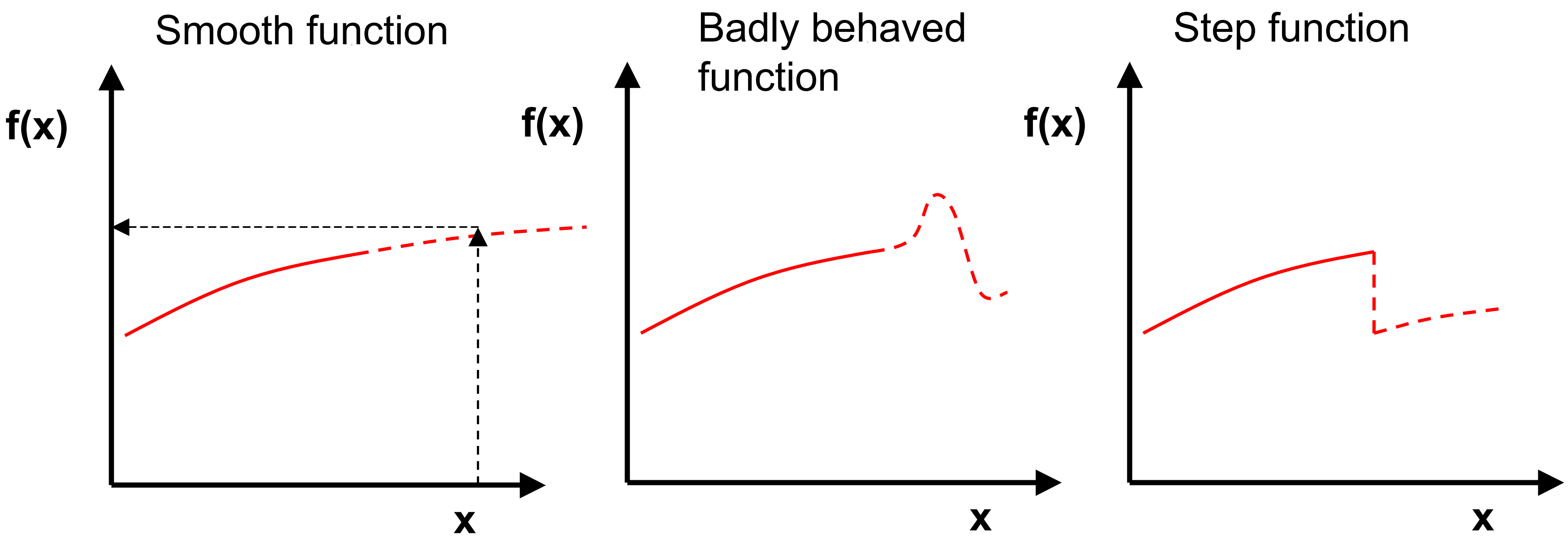
Consequence of failure

		Consequence of failure			
		Negligible	Minor	Major	Catastrophic
Risk level	4				
	3				
	2				
	1				

Judgement is made based on:

- Past experience
- Extrapolation of known results
- Conjecture (based on limited information)

Extrapolation & conjecture



Risk management and assessment

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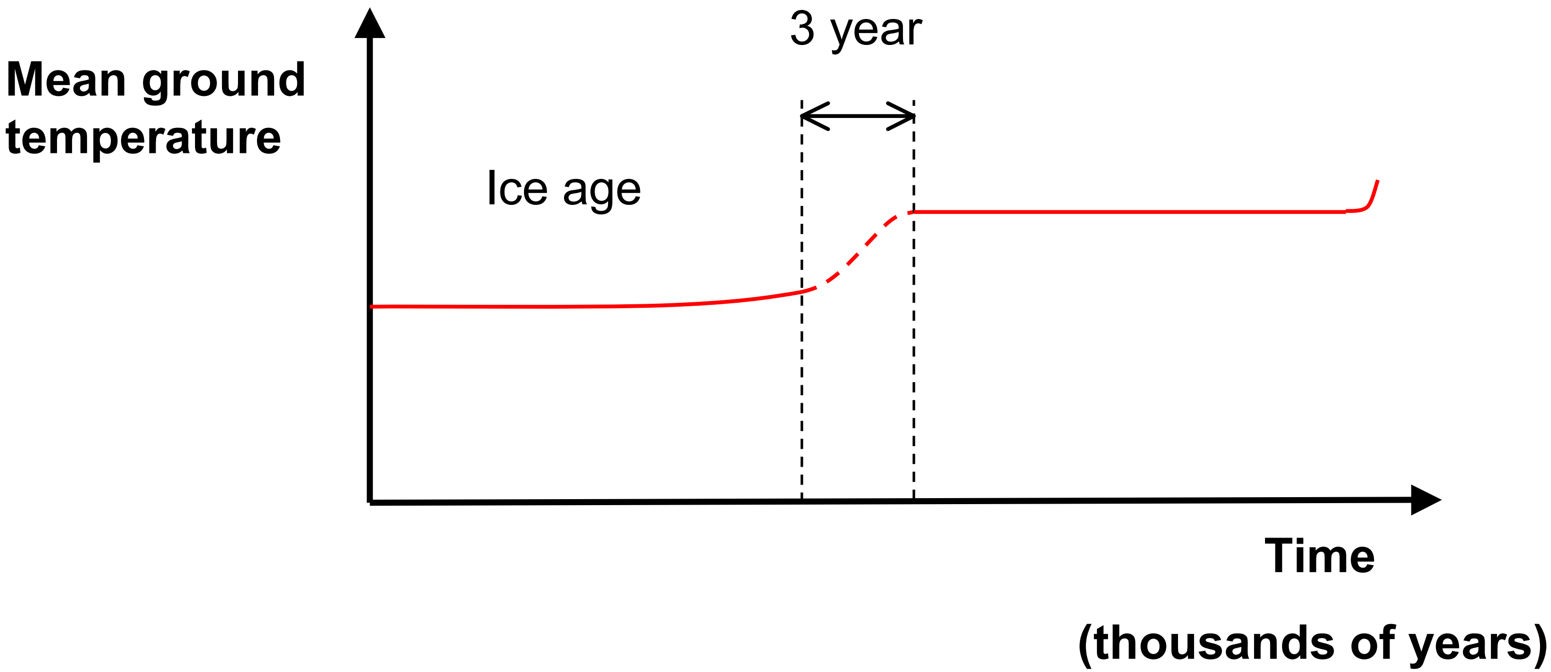
- **Extrapolation & conjecture: example of step change**



Source: Time, Issue 3 Oct 2005, reporting on work by Richard Alley, Pennsylvania State University

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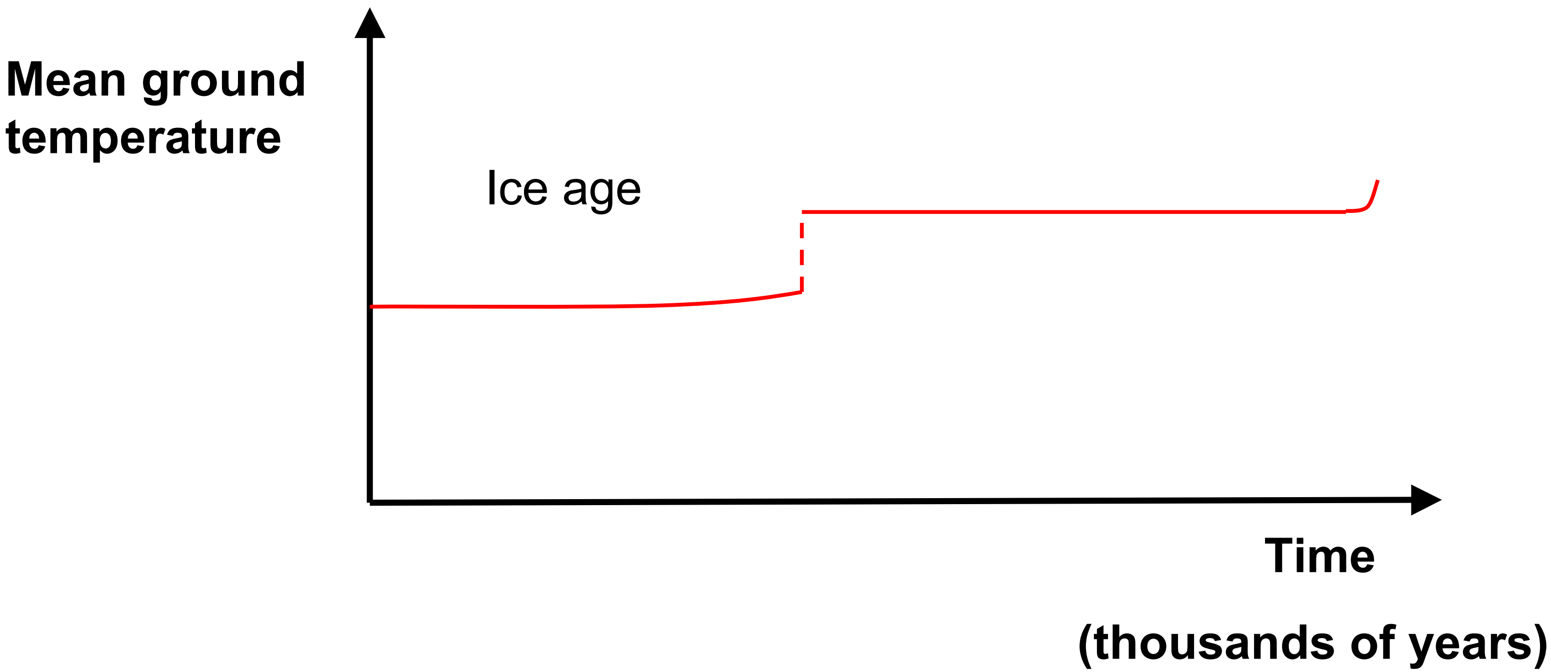
Extrapolation & conjecture: example of step change



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Innovation promoters

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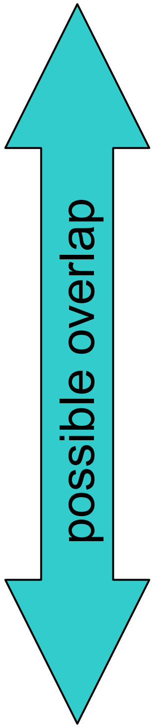
- **What drives or promotes innovation?**



1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Innovation promoters

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- **What drives or promotes innovation?**

1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Mechanisms & limitations

- e.g. war, hunger
- Can’t starve students
- Fail grades

Innovation promoters

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What drives or promotes innovation?

1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Mechanisms & limitations

- Cultural & ethnic diversity
- Academic disciplines

Examples:

a) Project teams with engineering & business students

b) Specialists in structures, aerodynamics, propulsion, systems, control, manufacturing, etc – all working together.

Innovation promoters

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What drives or promotes innovation?

1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Mechanisms & limitations

- Observations of the natural world – e.g. birds, insects
- Concepts from other disciplines – e.g. structural health monitoring developed for civil engineering

Innovation promoters

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- **What drives or promotes innovation?**

1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Mechanisms & limitations

Examples:

- RAeS light aircraft project
- Ansari X-Price (Peter Diamandis)

  Goal: to enter space twice in a fortnight

  Price: $10 million

Innovation promoters

- **Competition**

Fig (a) Takeoff: SpaceShipOne and WhiteKnight (June 2004)

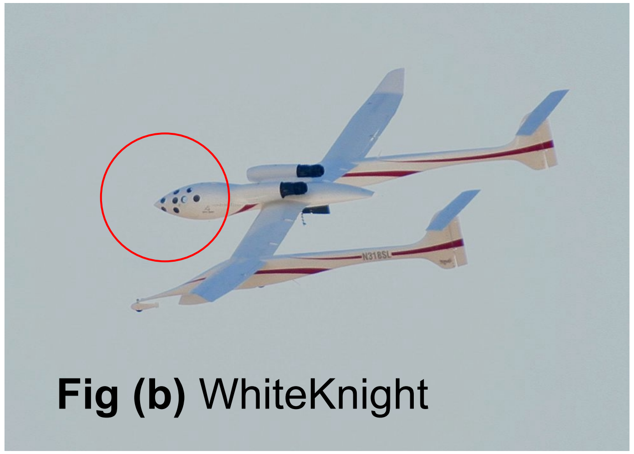

Fig (b) WhiteKnight

Fig (c) SpaceShipOne

Innovation:

- Fuel
- Re-entry technique
- Structures

Photographs: by Richard Seaman (www.richard-seaman.com).

Innovation promoters

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Competition

Mr. Diamandis' next challenge

Formula 1 rocket racers

Objective: To race rocket powered aeroplanes around a track in a F1 style league.

Fig Artist's impression of rocket powered racing aeroplanes

Image: The Economist, issue 8-14 October, 2005

Innovation promoters

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- **What drives or promotes innovation?**

1. Adversity
2. Diversity & collaboration
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4. Competition
5. Targets

Mechanisms & limitations

Example:

- Strategic Research Agenda (SRA)

Innovation promoters

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Targets

- The EC-sponsored ACARE (Advisory Council for Aeronautics Research in Europe) published its Strategic Research Agenda (Nov. 2002) to serve as “an overall guide for planning European research”.
- It supported the top-level objectives of the ‘*Vision 2020*’ report (2001), which identified as targets:
  - 50% cut in CO_2 emissions (per pax. km)
  - 80% cut in NO_x emissions
  - 50% reduction of noise.

Roughly implies a 50% cut in fuel consumption for new aircraft by 2020

Refs.: *Strategic Research Agenda*, EC, Nov. 2002.

European Aeronautics: A vision for 2020, Group of Personalities, EC, Jan. 2001

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Targets

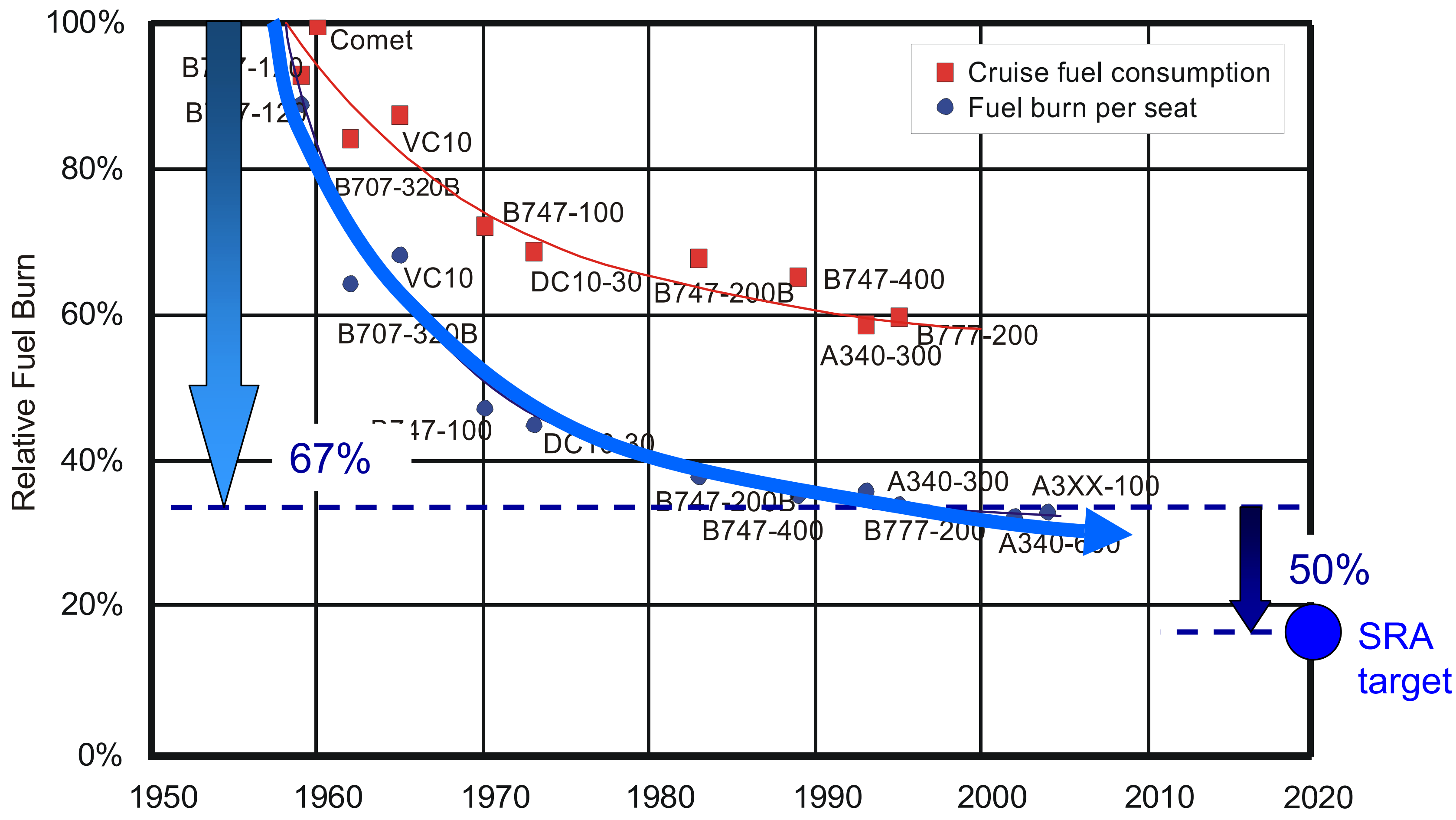
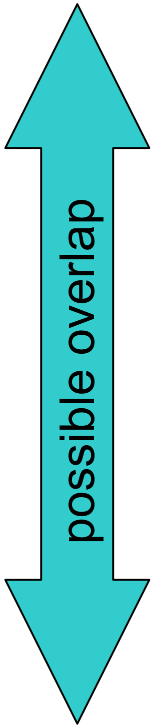


Fig Historical improvements in fuel efficiency

Ref. Adapted from Birch, *Aero. J.* Aug. 2000

Innovation inhibiters

- **What discourages or inhibites innovation?**



1. Lack of drivers / promoters
2. Over emphasis on tools / methods
3. Fear of failure
4. Unwarranted criticism
5. Poor definition of success

Innovation inhibiters

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What discourages or inhibites innovation?

1. Lack of drivers / promoters
2. Over emphasis on tools / methods
3. Fear of failure
4. Unwarranted criticism
5. Poor definition of success

Mechanisms & limitations

- Lack of:

1. Adversity
2. Diversity & collaboration
3. Observation & curiosity
4. Competition
5. Targets

Innovation inhibiters

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Mechanisms & limitations

Examples:

- Students become fixated on "gee-whiz" software
- Detailed studies built on weak foundations (i.e. inconsistent with initial data or results)
- Lack of a creative environment

Innovation inhibiters

Creative environment

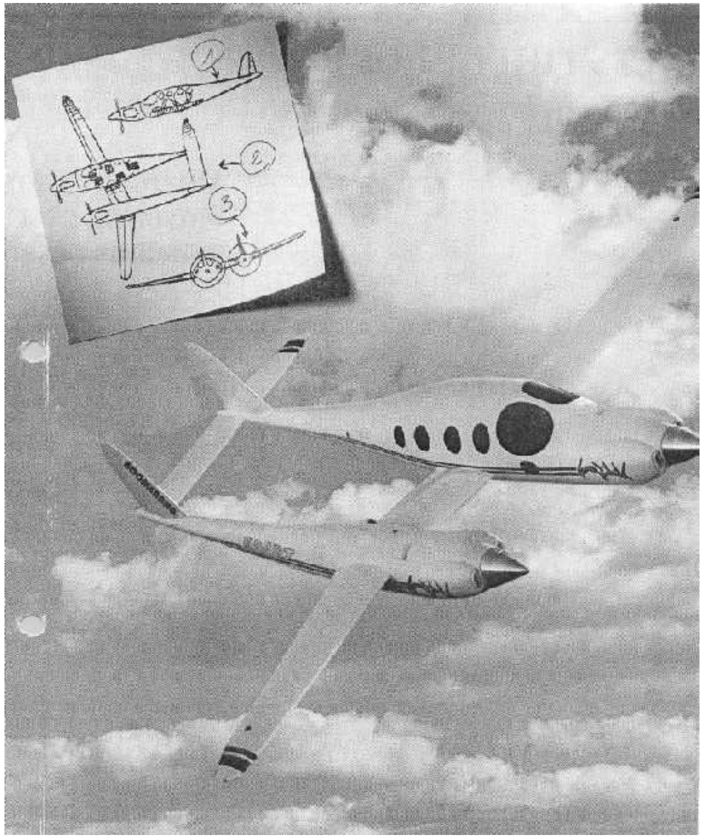

Fig The Boomerang aeroplane (conceived 1993; flown 1996)

“We spent an awful lot of money on how to analyse, but we do not spent much money on creating an environment for creativity. Much of what people do, called design, is really better called analysis. So [aircraft] design is something different. … You need to be able to visualise load paths and visualise the flow over an airplane and [know] just what it needs to do.”

Burt Rutan, ca 1996

Innovation inhibiters

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Mechanisms & limitations

An issue for:

- Universities, industry, research centres, and
- Funding agencies

Innovation inhibiters

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5. Poor definition of success

Mechanisms & limitations

Example:

- Ted Smith

  A Yale University management professor, on reading Smith's paper proposing an overnight parcel delivery service, noted:

  "The concept is interesting and well-formed, but in order to earn better than a C, the idea must be feasible."

- Smith later started FedEx

Innovation inhibiters

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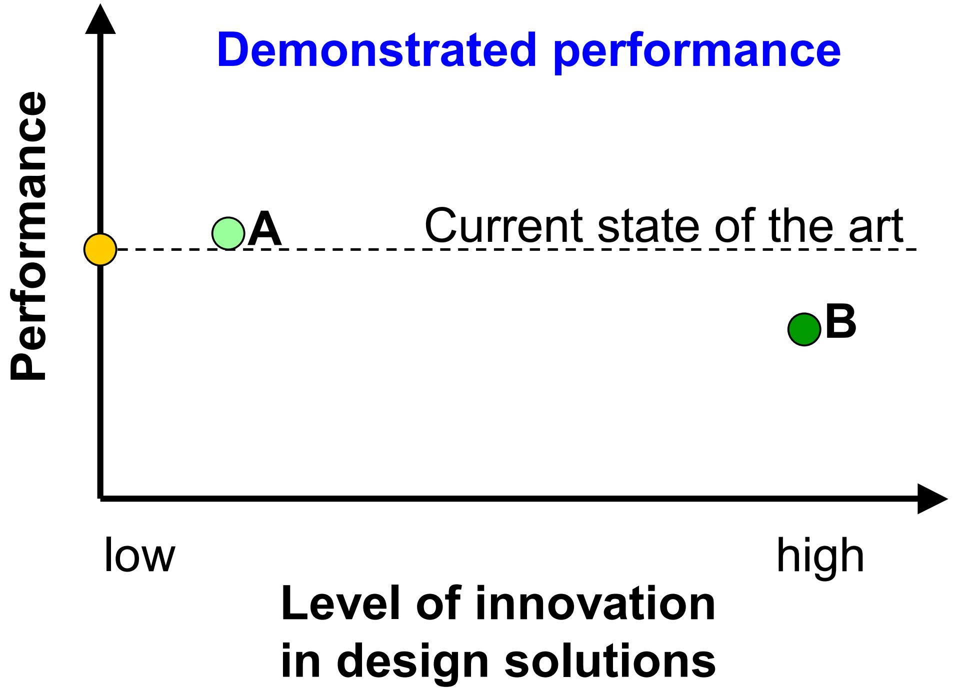
Mechanisms & limitations

Success may be measured by asking:

- Does it work?
- Is it fit for purpose?
- Have the performance targets been met?

Innovation inhibiters

- **Measure of success (performance target)**
  - Consider, for example, the objective of designing and demonstrating – by flight test – a highly manoeuvrable AUV. And two solutions emerge.



Innovation inhibiters

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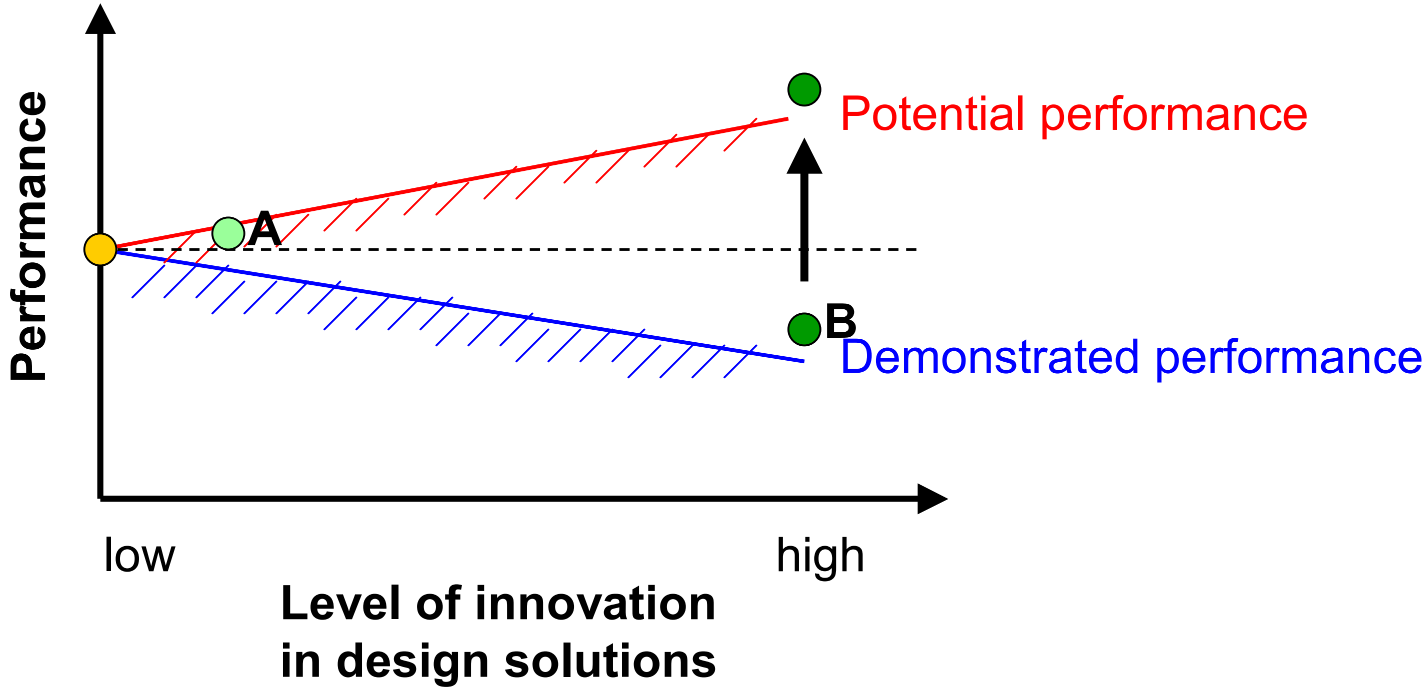
- **Measure of success (performance target)**
  - Develop a metric for success taking into account both demonstrated and potential performance



Concluding remarks

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Concluding remarks

On predictions

In 1908, Wilbur Wright said, “I confess that in 1901, I said to my brother Orville that man would not fly for 50 years… Since then I have distrusted myself and avoided all predictions.”

On innovation

Merits for success – especially for student projects – must be carefully established so as not to inhibit innovation.

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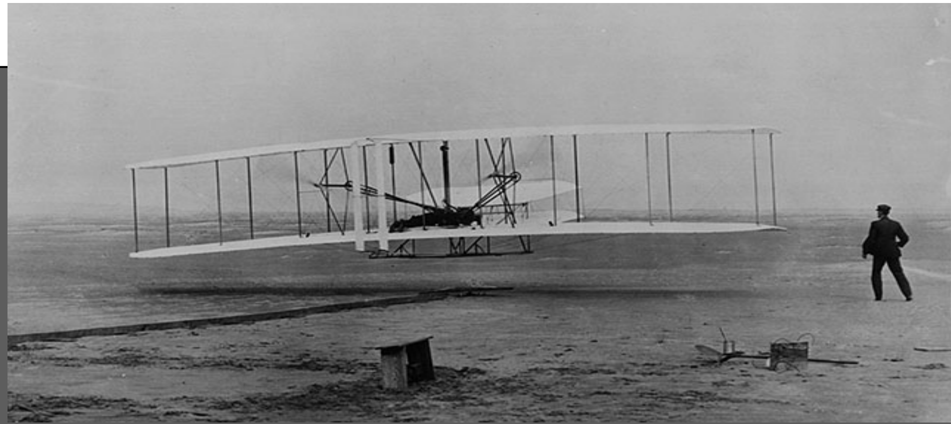

Dr Trevor Young
19-22 October 2005

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The Economist, issue 8-14 October, 2005

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