How to identify people who might radically change the way we think about an important subject

Donald W Braben
Department of Earth Sciences
University College London
d.braben@ucl.ac.uk

Copenhagen

28 October 2011

Some 20th century scientific discoveries

Max Planck:	Discovered that energy is quantised
Albert Einstein:	Photoelectric effect. Special and General relativity
Ernest Rutherford:	Founded nuclear physics
Niels Bohr	Conceived Bohr Model of the atom
Wolfgang Pauli:	Exclusion principle. Predicted existence of neutrinos
Erwin Schrödinger:	Founded wave mechanics
Werner K Heisenberg:	Founded quantum mechanics. Uncertainty principle
Alexander Fleming:	Discovered penicillin
Enrico Fermi:	Built first nuclear reactor
Oswald T Avery:	Discovered that DNA is the genetic molecule
Linus Pauling:	Seminal work on the nature of the chemical bond
Dorothy C Hodgkin:	Pioneered X-ray diffraction techniques
Max Perutz:	Discovered structure of haemoglobin
Francis Crick and James D Watson:	Discovered double-helix structure of DNA
John Bardeen, Walter H Brattain, and William B Shockley:	Invented the transistor
Dennis Gabor:	Invented holography
Charles H Townes:	Invented the maser (precursor to the laser)
Barbara McClintock:	Discovered how gene activity can be turned on or off
James Black:	Discovered how to design targeted pharmaceutical drugs
Sydney Brenner:	Pioneered molecular biology

The 20th-century Planck Club

A fictitious Club comprised of the scientists listed in Slide 2 together with about five hundred others of similar calibre – the Nobelocracy?

Their discoveries transformed the 20th century

Almost all its members were academics or similar

Few, if any, had to compete for their initial support - academic research before about 1970 was essentially unmanaged

Research Selection

Before ~ 1970, appointed academics usually had access to modest funds to use as they pleased

Thus, they could work on any problem of interest to them

Post ~ 1970, funding agencies required researchers to submit their proposals for competitive, peer-review based assessment

Success rates are low

Venture Research and The Planck Test

Definitions:

- **Venture Research: The type of research performed by 20th-century Planck-Club members**
- **The Planck Test: Assesses the probability that funding-agency-procedures would have led to the funding of Planck-Club members *when they were setting out***

Which agencies today would do well in such a Test?

If potential Planck-Club members are funded, are they given total freedom?

Will the universities (or industry) spawn a 21st-century Planck Club?

Peer Review

Assessments provided (often anonymously) by acknowledged experts

Generally accepted views:

- "peer review is like democracy: It's not the best but it's the best we know"
- peer review provides "the gold standard" of research excellence

Richard Feynman (1966) "Science is the belief in the ignorance of experts"

The above contradictions are generally ignored

Peer review:

- applied to completed works ~ OK
- used to assess future potential – little or no evidence of effectiveness

The latter process should have been given a different name – peer preview?

Peer Preview = Peer Review of proposals

Tactical considerations

Science differs from other activities:

- Its standards are ~ absolute
- The most significant discoveries have always been unpredicted and are rarely accepted immediately

However, peer preview:

- Is competitor review
- Is based on opinion and consensus
- Implicitly assumes that science is democratic
- Implies that majority opinion = scientific truth
- Allows competitors to make unattributed comments
- Has the power to veto proposals

Peer preview therefore constrains scientific freedom

Peer Preview
Strategic considerations

Works best when performed by experts in well-defined fields

Leads to focus on priority fields, which, as science is global, are much the same everywhere

Such policies are also ~ global, and thereby favour nations with the highest cash investments in R&D

Does poorly in the Planck Test

Despite all this, peer preview is at the very foundation of scientific enterprise today

Its demerits are rarely mentioned

Pioneers must be allowed to pioneer

Venture Research

Specifically and directly attempts to identify and support potential 21st century Plank-Club members

Success rates will necessarily be low, but applicants are never rejected

It selects and defines programmes through impartial scientific dialogue

Venture Research initiatives – public or private - should complement existing funding arrangements and not replace them

Venture Research Strategy

Aims to stimulate unpredictable major discoveries

Should have as few rules as possible

Some details:

- Fosters freedom and mutual trust, and avoids peer preview
- Funds should be "free"- that is available for use as required
- No boundaries
- No deadlines
- No milestones
- No priorities
- No specific objectives other than to understand or explore
- Researchers free to go in any direction at any time

Venture Research Selection (1)

Procedures must be defendable against the Planck Test

Extend invitations as widely as possible

Applicants write 200-word proposals focussing on concepts

Selections made by the same set of 2 or 3 scientists whatever the field

Such a team can handle ~ 1000 proposals a year

The team strives:

- to act as Nature's Ambassadors
- to apply the same criteria that Nature herself might be imagined to use in today's circumstances

More prosaically, the team strives to be as objective as possible

Venture Research Selection (2)

Applicants with proposals deemed evolutionary, developmental, or not obviously requiring total freedom are informed accordingly

The team invites comments and re-submissions at every stage

To use a tennis analogy: the team must ensure that the “ball” is always returned to the applicant’s court: it is the applicant’s responsibility to return it or not. Response is encouraged

Venture Research Selection (3)

Applicants with possible Planck-Club potential are invited for discussions

Discussions:

- Focus exclusively on concepts
- Give real-time feedback
- Are open ended
- Foster mutual trust
- Encourage a spirit of adventure

The team considers responses to such questions as:

- If you had infinite resources and freedom what would you do that you are not doing now?
- Might the proposed research radically change perceptions?
- Might your research be recommended for a Nobel prize?

Venture Research Selection (4)

When the team is convinced, it commits to the applicant's success

The team submits its recommendations to a panel of VIP scientists – comprising one each say from the major disciplines - the funding agency appoints to consider the team's recommendations

The panel may consult experts but they should agree to write open reviews

The panel and the team confer – applicants are not present – before the panel makes its final decision

Venture Research
Sponsored by BP: 1980 – 1990

- Cumulative expenditure over the decade ~ £15 million
- Supported basic, exploratory research in any field, anywhere
- Final number of research programmes: 26
- Proposals had almost invariably been rejected by national agencies
- Number of scientific “breakthroughs”: at least 14

- Strong subsequent industrial interest in their development
- Estimated value over the next decade ~ £1 billion

Some Venture Research Discoveries

Mike Bennett and Pat Heslop-Harrison:	Discovered a new pathway for evolution and genetic control
Terry Clark:	Pioneered the study of macroscopic quantum objects
Steve Davies:	Developed small artificial enzymes for efficient chiral selection
Nigel Franks, Jean Louis Deneubourg, Simon Goss, Chris Tofts:	Quantified the rules describing distributed intelligence in animals
Herbert Huppert and Steve Sparks:	Pioneered the new field of geological fluid mechanics
Jeff Kimble	Pioneered squeezed states of light
Graham Parkhouse:	Derived a novel theory of engineering design relating performance to shape and material
Alan Paton, Eunice Allen, Anne Glover:	Discovered a new symbiosis between plants and bacteria
Martyn Poliakoff :	Transformed Green Chemistry
Ken Seddon:	Transformed Green Chemistry
Colin Self:	Demonstrated that antibodies in vivo can be activated by light
Gene Stanley and José Teixeira:	Discovered a new liquid-liquid phase transition in water that accounts for many of water's anomalous properties
Harry Swinney, Werner Horsthemke, Patrick DeKepper, Jean-Claude Roux, and Jacques Boissonade:	Developed the first laboratory chemical reactors to yield *sustained* spatial patterns - an essential precursor for the study of multi-dimensional chemistry

UCL Venture Research

UCL announced its launch in December 2008

The UCL Provost provides support for approved Venture Research projects for at least three years

It is restricted to researchers working at UCL, but we hope that other universities will join

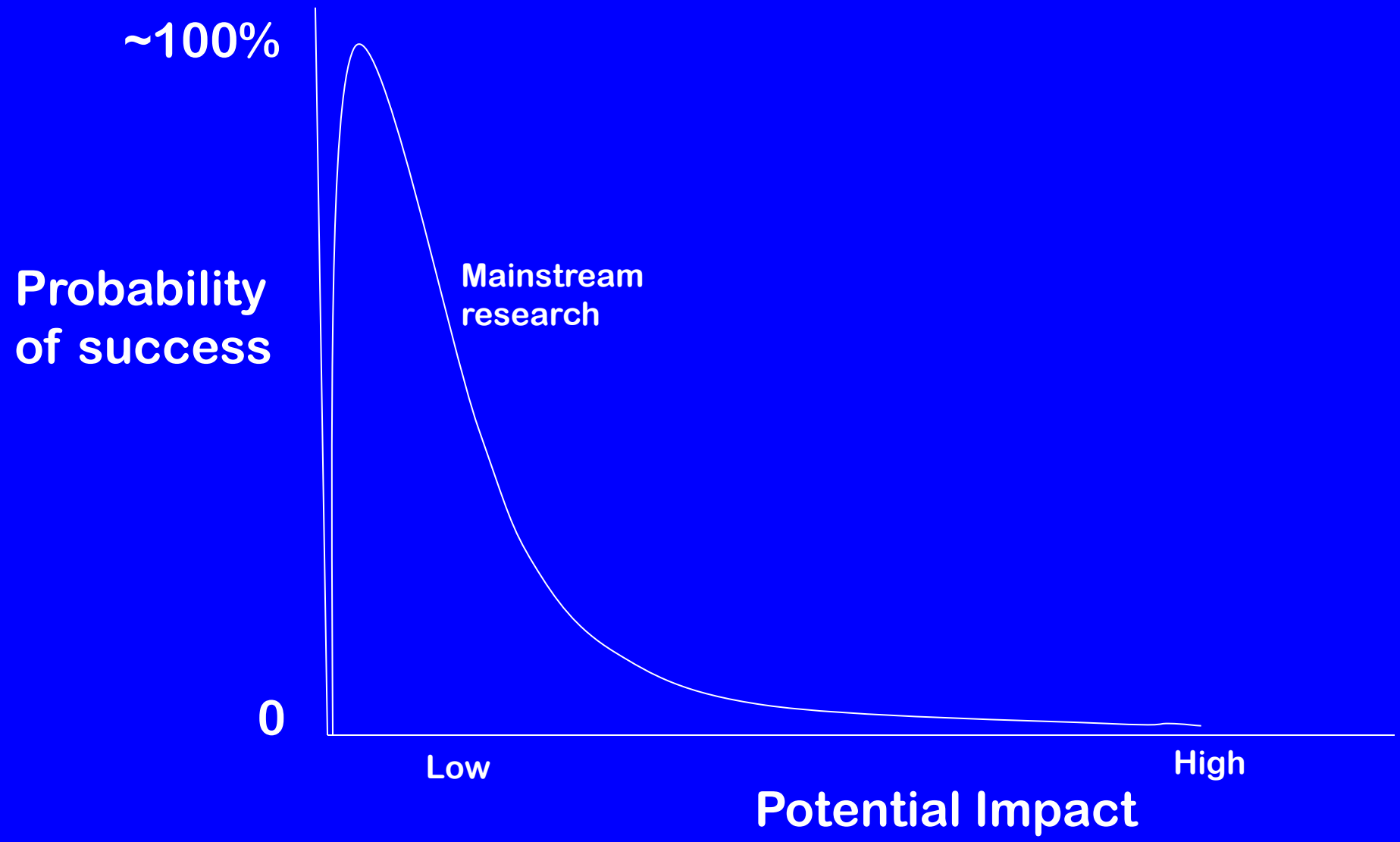
Each university would support from its own funds the cost of Venture Research projects it approves

UCL Venture Research Fellow (2009-12)

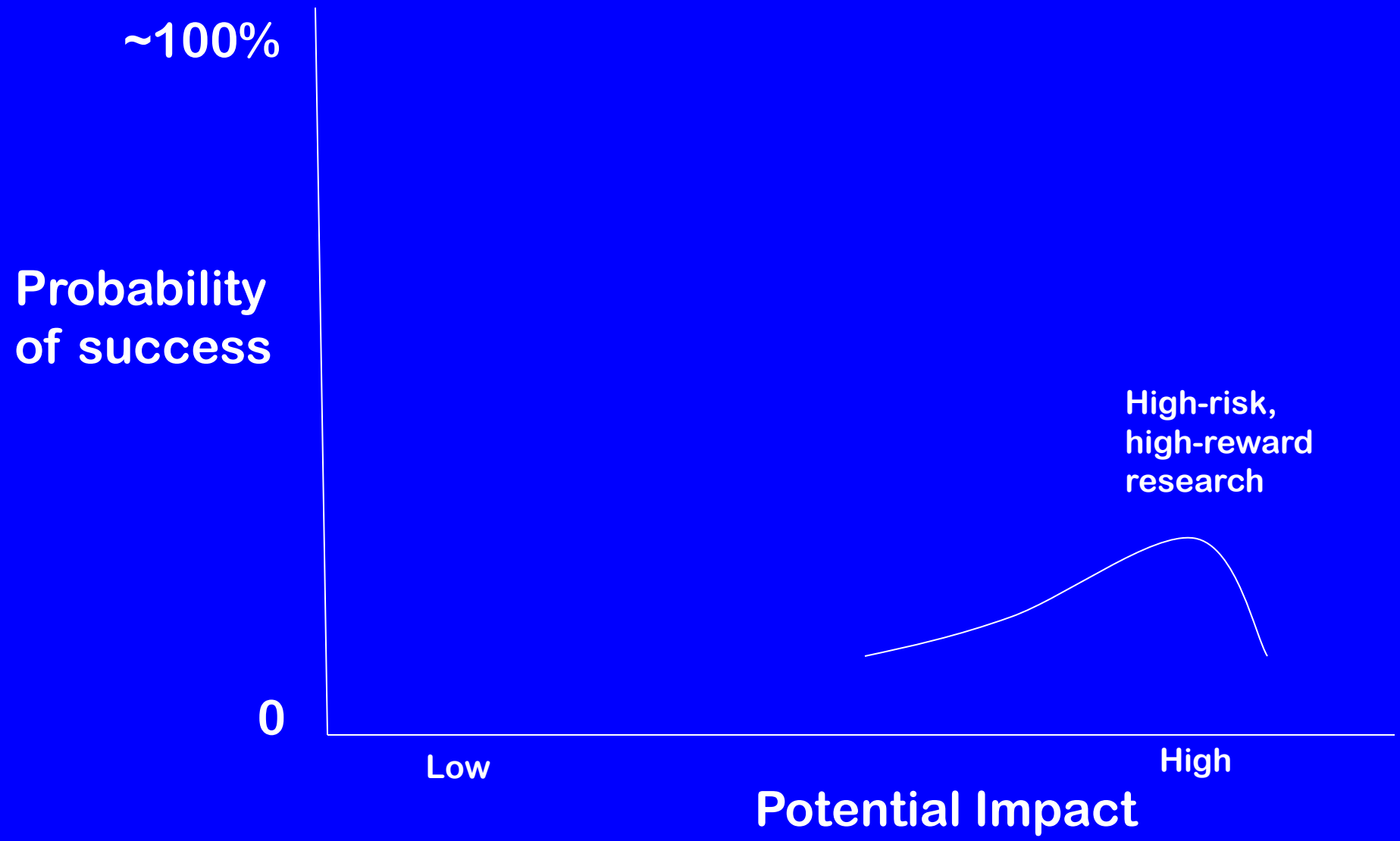
Nick Lane

Proposal title: Chemiosmosis and Complex Life

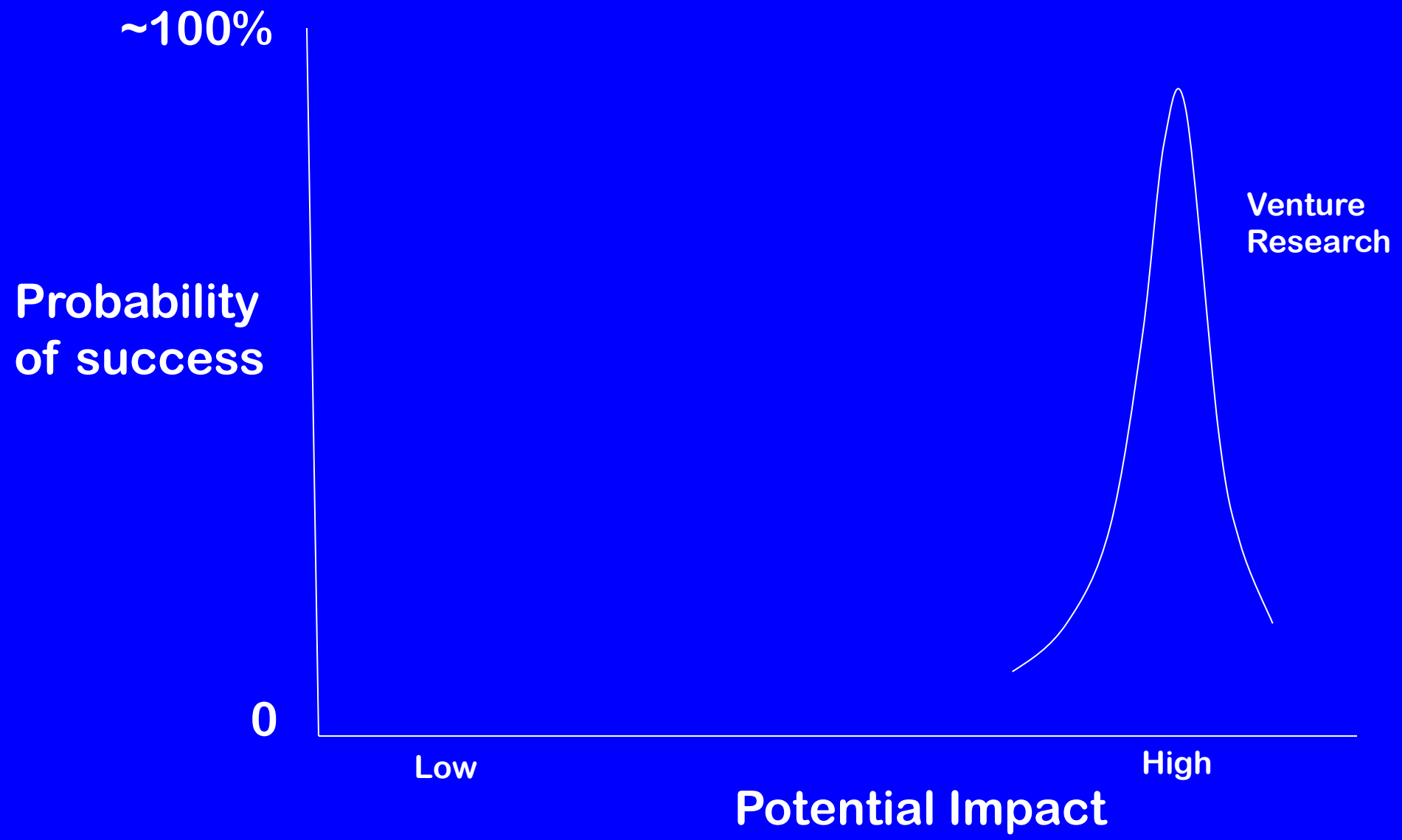
Schematic: A spectrum of research (1)



Schematic: A spectrum of research (2)



Schematic: A spectrum of research (3)



Scientific Freedom: The Elixir of Civilization

Donald W Braben, Wiley 2008.