

Title: First Principles - Building an Einstein Factory

Date: Oct 22, 2005 10:00 AM

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Abstract: Howard Burton, the Executive Director and chief architect of Perimeter Institute, describes the process and pitfalls of constructing a home for budding Einsteins from scratch in Waterloo. <kw> Einstein factory, Howard Burton, Perimeter Institute, Einstein, sociological factors, Mike Lazardis, IAS, research, culture, making a difference, government support, </kw>





New Title – Rigorous Version:

A description of the formation and founding motivations of Perimeter Institute complete with a retrospective, ad hoc and highly conjectural analysis of what Albert Einstein might think of its existence were he alive today, combined with a concluding assessment of the relevant likelihood of the Institute producing “The Next Einstein”.



New Title: Intelligible Version

“Perimeter
Institute – What
Would Einstein
say?”

Structure of the Talk:

Beginning: Introduction and
Structural Preamble

Middle: Brief History of
Perimeter Institute – 4
Relevant Factors

End: Conclusions –
Einsteinian Assessment of
4 Factors (total score) plus
speculation on “The Next
Einstein”.

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END OF
BEGINNING

A Brief History of PI

Setting the Stage I

The Passing of the Buck
and the
Foundations of
Quantum Theory

*“Any one who is not
shocked by
quantum
mechanics has not
fully understood
it.”*

Neils Bohr

“Contemporary physicists come in two varieties. Type 1 physicists are bothered by EPR and Bell’s Theorem. Type 2 (the majority) are not, but one has to distinguish two subvarieties, Type 2a physicists explain why they are not bothered. Their explanations tend either to miss the point entirely or to contain physical assertions that can be shown to be false. Type 2b are not bothered and refuse to explain why.”

David Mermin

“I am a professional
theoretical physicist
and I would like to
make a clean theory.
And when I look at
quantum mechanics I
see a dirty theory.”

John Bell

“I think it is safe to say that no one understands quantum mechanics. Do not keep saying to yourself, if you can possibly avoid it, ‘But how can it possibly be like that?’ because you will go down the drain into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that.

Richard Feynman

“Philip Candelas and I were waiting for an elevator, our conversation turned to a young theorist who had been quite promising as a graduate student and who had then dropped out of sight. I asked Phil what had interfered with the ex-student’s research. Phil shook his head sadly and said, “He tried to understand quantum mechanics.”

Steven Weinberg

A Brief History of PI

Setting the Stage II

Sociological Factors:

*Job Market and Local
Intolerance*

“Science is a
wonderful thing if
one does not have to
earn one’s living at
it.”

Albert Einstein

The Story Begins

Meeting Mike

The Story Begins: Starting to Think:

- *Name*
- *Precedent – IAS*
- *Making a Difference*

Institute for Advanced Study – Princeton, New Jersey



Abraham Flexner



IAS History

- Founded in 1930 through the efforts of Abraham Flexner and the largesse of Louis Bamberger and Catherine Bamberger Fuld
- Flexner was an innovative educator who had written penetrating critiques of American Universities and American Medical Schools

IAS History

“It should be a free society
of scholars. Free
because mature
persons, animated by
intellectual purposes,
must be left to pursue
their own ends in their
own way.”

Abraham Flexner

IAS Original Faculty

- 1) James Alexander
- 2) Albert Einstein
- 3) John von Neumann
- 4) Oswald Veblen

Making a Difference

In 1999, the IAS had been in operation for 66 years and many other physics and mathematics institutes existed throughout the world.

What was appropriate for us, in Waterloo, now?

Making a Difference:

- 1) Research: Achieve international excellence in fundamental physics while directly addressing sociological factors in physics – foundational issues (“hard questions”) often not addressed, too rigid sociological constraints between sub-disciplines
- 2) Cultural/Operational: Underappreciated importance of basic research in society

Trips and Discussions (2000):

- 1) IAS
- 2) (K)ITP
- 3) Santa Fe Institute
- 4) Max Planck Institute
- 5) ICTP (Trieste)
- 6) IHES (Paris)
- 7) Schrödinger Institute (Vienna)

And many more....

Conclusion 1 - Research

Create an atmosphere
where foundational
issues can be
rigorously addressed
from a variety of
perspectives, both
orthodox and
unorthodox

Some very impressive results in 20th century physics from those out of the mainstream of their day

- 1) Alan Guth – cosmological inflation
- 2) John Schwartz & Michael Green – Superstring Theory
- 3) Albert Einstein – SR, Light quanta and other stuff

Some very impressive results in 20th century physics from those in the mainstream of their day

- 1) Albert Einstein – general theory of relativity
- 2) Richard Feynman – quantum electrodynamics
- 3) Weinberg, Glashow, Salam – electroweak unification

A random sample of people who feel that
being out of the mainstream is somehow
indicative of their genius

- 1) Fred Schmo
- 2) Mary Blow
- 3) John Doe

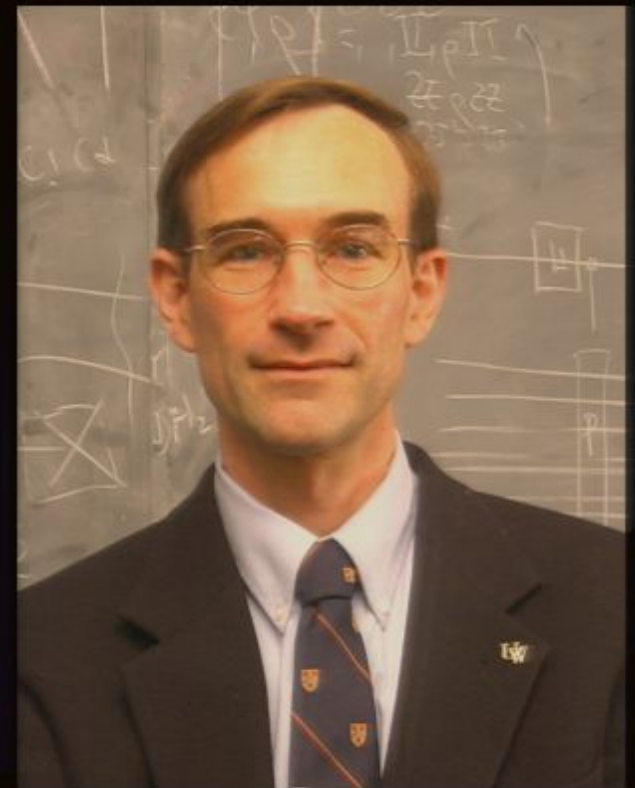
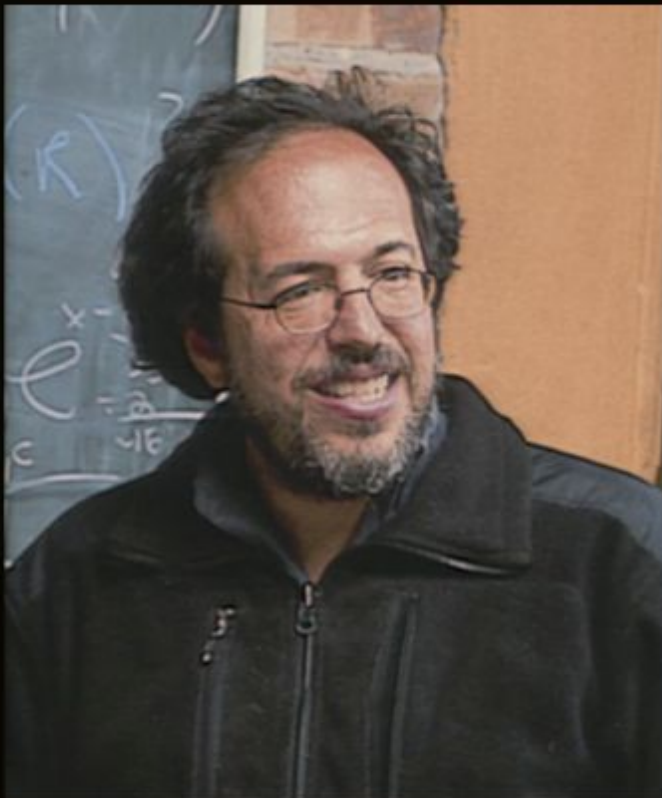
- *i.e. BE CAREFUL! Marrying
orthodox and unorthodox
approaches in theoretical
physics is a tricky balancing
act!*

Conclusion 2 - Research

Achieve a balance
between formal,
mathematical
approaches and
those more directly
relevant to
experiment

Research Areas

- 1) Quantum Gravity and Unification
- 2) Foundations of Quantum Theory
- 3) Quantum Information Theory
- 4) Elementary Particle Physics
- 5) Cosmology
- 6) Possible Other Related Areas



Conclusion 3 – Cultural/Operational
(Somehow)
obtain and
maintain strong
government
support

Conclusion 4 – Cultural/Operational
Develop a dynamic
& internationally
cutting-edge
outreach program

Mission Statement:

Perimeter Institute for Theoretical Physics is an independent, resident-based research institute devoted to foundational issues in theoretical physics at the highest levels of international excellence. We strive to create a lively and dynamic research atmosphere where many approaches to fundamental questions, both orthodox and unorthodox, are pursued simultaneously and where a balance between formal and phenomenologically-oriented research is established. We are further determined to interact constructively with the surrounding academic community whenever possible, particularly with regards to the inclusion of graduate students, and are equally determined to promote a world-class outreach program to disseminate the mysteries and wonder of the physical world to the general public throughout Canada and beyond.

Initial Report from PI's SAC

PI is a remarkably bold experiment. Its mission is tightly focused on research; on fundamental physics; and on the development of a highly interactive, tightly knit community of colleagues. It is distinguished by a major financial commitment, which is directed towards a small but highly influential scientific field. PI is unencumbered by many of the restrictions and traditions that accompany public universities in Canada and hence free to experiment in the widest possible sense. PI has the potential to become the most important new, privately funded, institute in theoretical physics since the founding of the Institute for Advanced Study seventy years ago. The challenge is to achieve that potential over the next few years, and the SAC will make every effort to help the Institute achieve this ambitious goal.

END OF THE MIDDLE

What would Einstein Say?

Conclusion 1 - Research

Create an atmosphere
where foundational
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from a variety of
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orthodox and
unorthodox



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On orthodoxy/authority:

“As punishment for my contempt of authority, Fate has made me an authority myself.”

On orthodoxy/authority:

“With fame I
become more and
more stupid, which
is of course a very
common
phenomenon”

On orthodoxy/authority:

“The most
aggravating thing
about the younger
generation is that I
no longer belong
to it.”

On orthodoxy/authority

“I am generally regarded as a sort of petrified object, rendered blind and deaf by the years. I find this role not too distasteful, as it corresponds very well with my temperament.”

On the merits of foundational inquiry

“I want to know how God created this world. I am not interested in this or that phenomenon, in the spectrum of this or that element. I want to know his thoughts, the rest are details.”

Conclusion 1

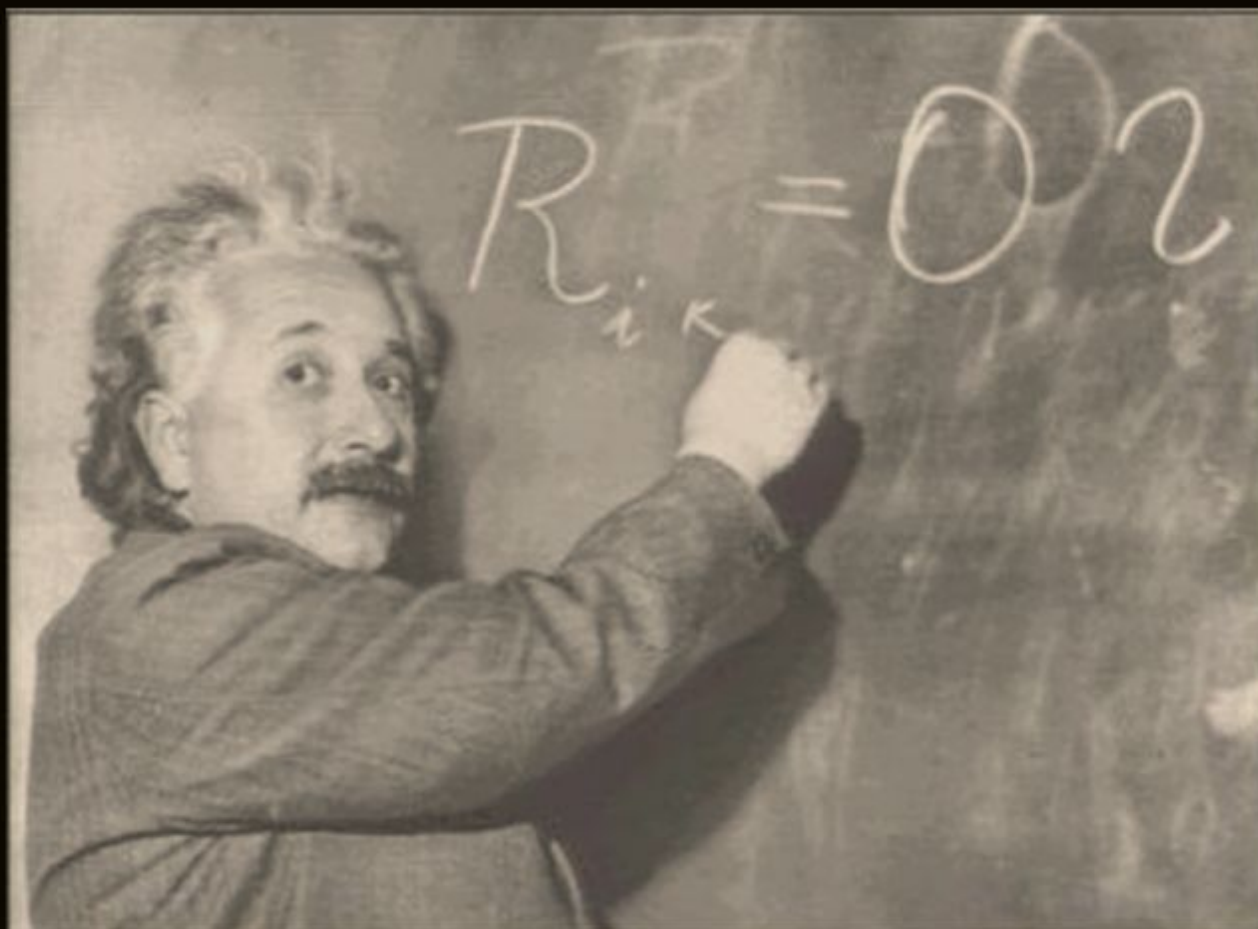
Foundational
Research/Iconoclastic
Balance

Score:

24/25

Conclusion 2 - Research

Achieve a balance
between formal,
mathematical
approaches and
those more directly
relevant to
experiment



Einstein and the Ricci Tensor

On physical intuition:

“...the physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations; for he himself knows best, and feels more surely where the shoe pinches...”

On the domain of physics:

“In regard to his subject matter...the physicist had to limit himself very severely: he must content himself with describing the most simple events that can be brought within the domain of our experience...”

On the domain of physics

“What we call physics comprises that group of natural sciences which base their concepts on measurements, and whose concepts and propositions lend themselves to mathematical formulations.”

On mathematics vs physics

“As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.”

On the quest for the ultimate theory and associated difficulties

“The unified field theory has been put into retirement. It is so difficult to employ mathematically that I have not been able to verify it somehow, in spite of all my efforts. This state of affairs will no doubt last many more years, mostly because physicists have little understanding of logical-philosophical arguments.”

Conclusion 2

Pursuit of
Formal/Experimental
Research

Score:

23/25

Conclusion 3 – Cultural/Operational
(Somehow)
obtain and
maintain strong
government
support



On politics:

“Politics is more
difficult than
physics.”

On politics:

“The state to which I belong as a citizen plays not the slightest role in my personal life. I regard a person’s relationship with the state as a business matter, akin to one’s relationship to a life insurance company.”

On politics:

“One must divide one’s time between politics and equations. But our equations are much more important to me, because politics is for the present, while our equations are for eternity.”

Conclusion 3

Government support for
Perimeter Institute

Score:

13/25

Conclusion 4 – Cultural/Operational
Develop a dynamic
& internationally
cutting-edge
outreach program



On learning:

“The important thing is not to stop questioning. Curiosity has its own reason for existing.”

On teaching:

“I never had the chance to teach youngsters. A pity. I would actually have liked to teach high school.”

On teaching:

“It is the supreme
art of the teacher
to awaken joy in
creative
expression and
knowledge”

On contemporary education:

“It is in fact nothing short of a miracle that modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry...”

On music:

“Music does not influence research work, but both are nourished by the same sort of longing, and they complement each other in the release they offer.”

Conclusion 4

Development of an innovative
and comprehensive
outreach program

Score:

22/25

Total Score:

82/100

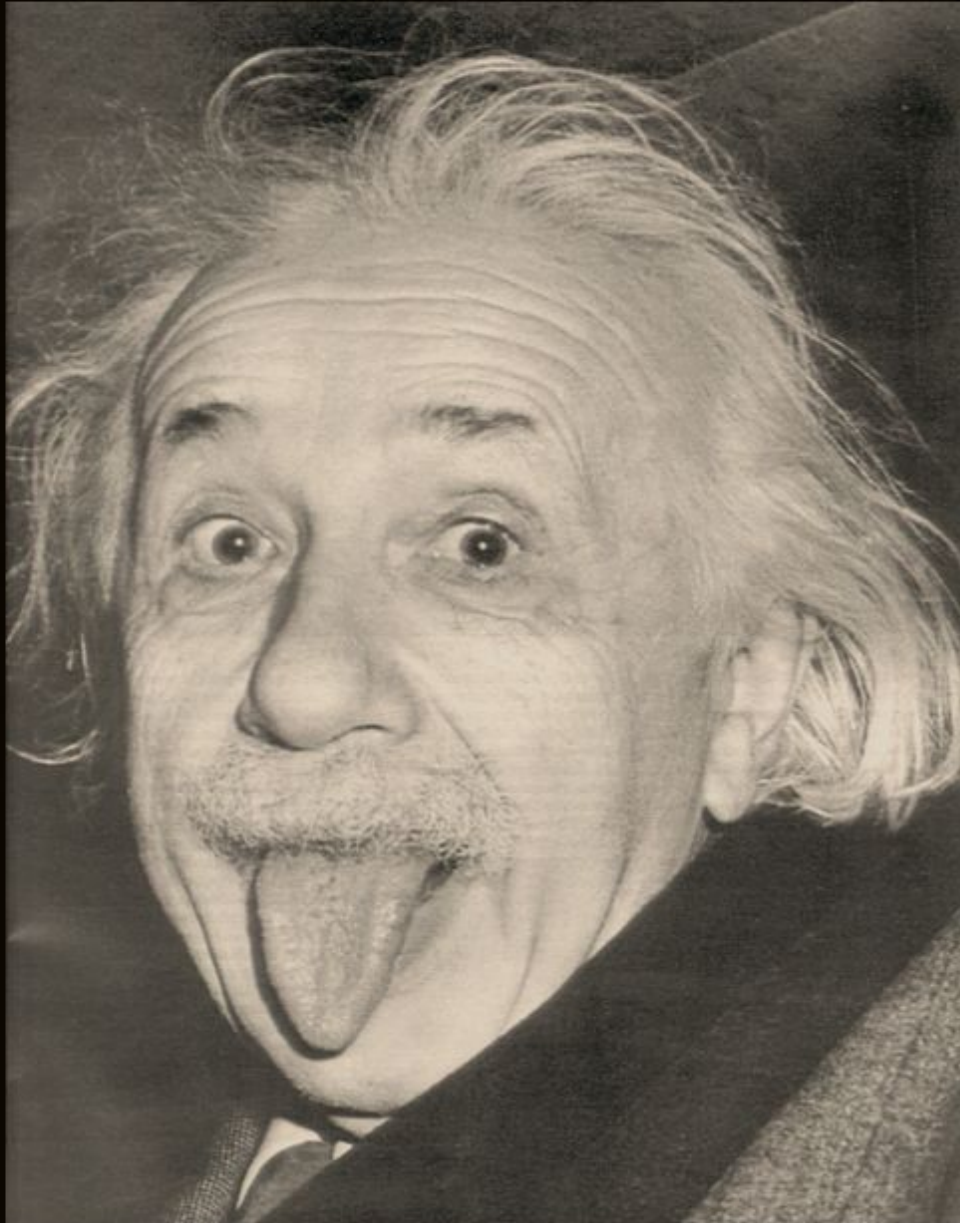
The Next Einstein?

“I have no special talents. I am only passionately curious.”

“I never think of
the future. It
comes soon
enough.”

“Prediction is very
difficult,
especially about
the future.”

Neils Bohr



END OF END