

Probing the Unknowable: The Structure of Future Developments

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Accuracy of Forecasts

- ***Given a set of forecasts and the passage of time, we can check to see***
 - ***Which have occurred when expected***
 - ***Which have not happened but may yet***
 - ***What was omitted from the study***
- ***Omitted futures are***
 - ***Unknown but knowable, given the right tools***

Unknown and unknowable

The 1964 RAND Study

In the table, the first column with years represents the group's median opinion as to the date the development was expected, and the second is the quartile range of opinions.



Economically useful desalination of sea water	1970 1964-1980
Effective fertility control by oral contraceptive or other simple and inexpensive means	1970 1970-1983
Development of new synthetic ultra light materials	1971 1970-1978
Automated language translators	1972 1968-1976
New organs through transplanting or prosthesis	1972 1968-1982
Reliable weather forecasts	1975 1972-1988
Operation of a central data storage facility with wide access for generalized or special information retrieval	1980 1971-1991
Reformation of physical theory, eliminating confusion in quantum relativity and simplifying particle theory	1980 1975-1993
Implanted artificial organs made of plastic and electronic components	1981 1975-1988

The 1964 RAND Study

In the table, the first column with years represents the group's median opinion as to the date the development was expected, and the second is the quartile range of opinions.

Widespread and socially acceptable use of non narcotic drugs (other than alcohol) for the purpose of producing specific changes in personality characteristics	1983	1980-2000
Stimulated emission X and Gamma ray region of the spectrum	1985	1978-1989
Controlled thermonuclear power	1986	1980-2000
Creation of a primitive form of artificial life (at least in the form of self replicating molecules)	1989	1979-2000
Economically useful exploitation of the ocean bottom through mining (other than offshore oil drilling)	1980	1980-2000
Feasibility of limited weather control, in the sense of substantially affecting regional weather at acceptable cost	1990	1987-2000
Economic feasibility of commercial generation of protein for food	1990	1985-2003
Increase by an order of magnitude in the relative number of psychotic cases amenable to physical or chemical therapy	1992	1983-2017
Biochemical general immunization against bacterial and viral diseases	1994	1983-2000

Forecasts that Did not Appear in the RAND Study

- ***MRI and CAT scans***
- ***Housing bubble***
- ***Cold war collapse***
- ***Nanotechnology***
- ***Google***
- ***Green revolution***
- ***HIV/AIDs***
- ***Hubble and the Large Hadron Collider***

Omitted Forecasts: Conclusion

- ***The omitted development were:***
 - ***More important than most others that were included, as measured by***
 - ***Number of people affected***
 - ***Severity of effects***
 - ***Lasting consequences***
 - ***Door opening to further achievements***
- ***And they may have been unknowable***

Types of Future Ideas

➤ ***Anchored in history***

Extrapolative : Most forecasts most of the time

Extension of trends

Prior accomplishments

Lessons of history

Scheduled and planned

Work in progress

Scheduled meetings

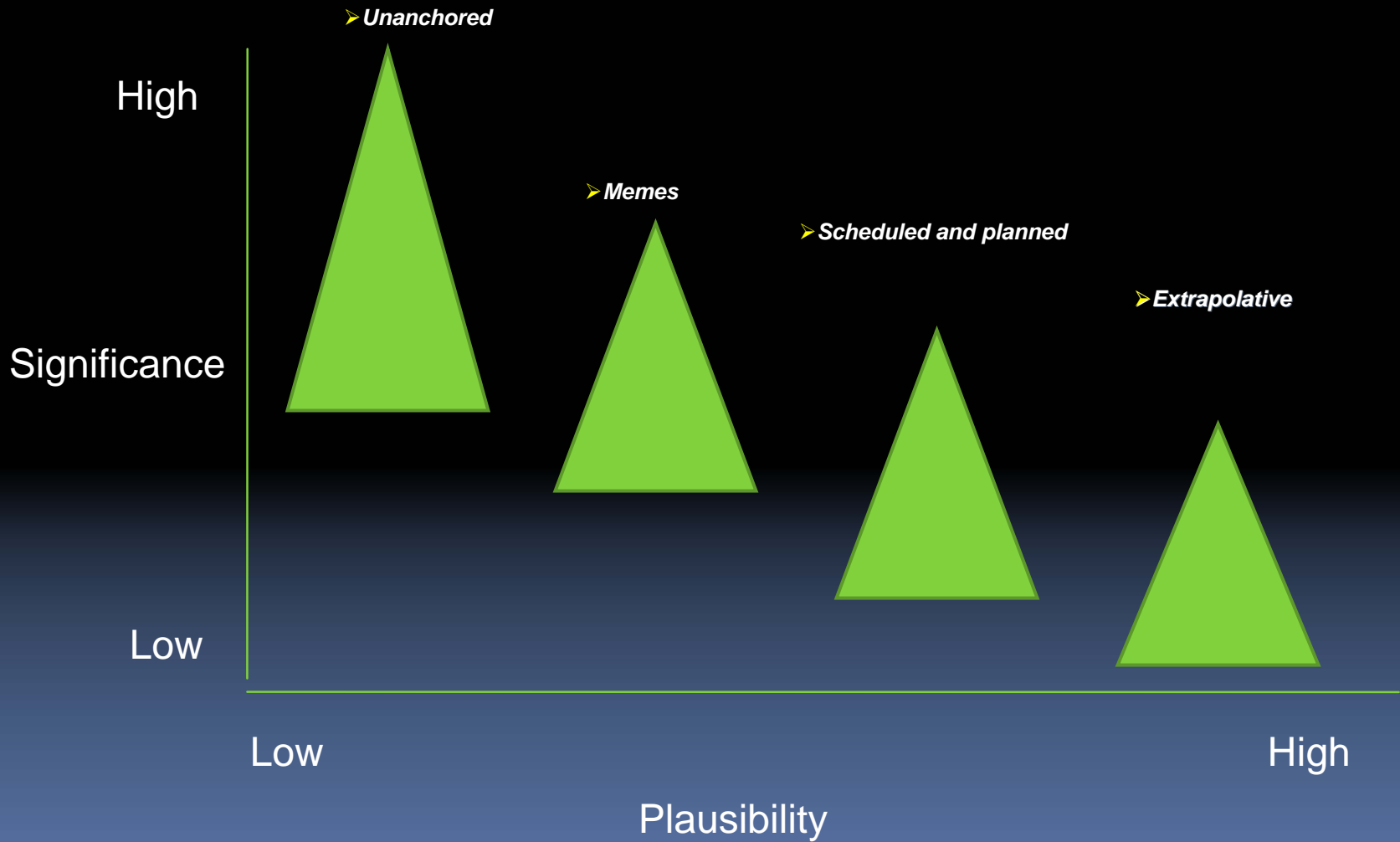
Memes

Science fiction

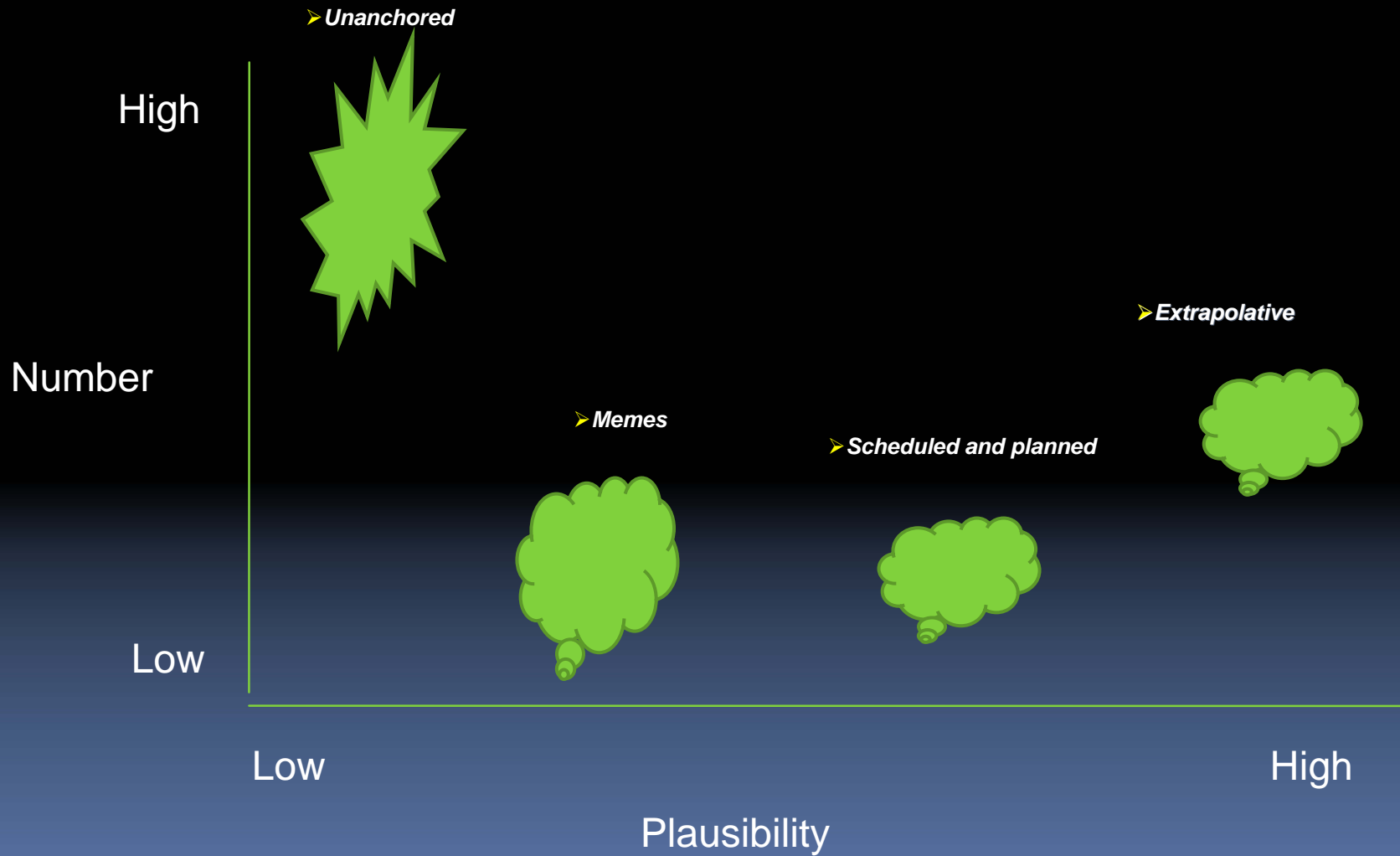
In the air

➤ ***Unanchored (unknown and unknowable)***

The Shape of Future Ideas



The Number of Future Ideas



Extrapolative: Strongly Anchored

- ***Linear, on trend, demonstrated in principle***
 - ***Road-able airplanes; cars that fly***
 - ***Personal genome analysis***
 - ***Individualized medicine***
 - ***Computers exceeding human brain power***
 - ***World population reaching 9 billion***
 - ***3D TV***
 - ***Improved weather forecasting***
 - ***Spread of robot assisted surgery***
 - ***Gender selection of progeny by parents***

Scheduled and Planned: Moderately Anchored

- ***Linear, on trend, feasible, announced***
 - ***Withdrawal from Iraq***
 - ***Mid-east peace negotiations***
 - ***Revised health care insurance plan***
 - ***Increased efforts at non-proliferation***
 - ***Massive job creating infrastructure programs***
 - ***Energy research programs***
 - ***Carbon sequestration experiments***
 - ***Improved security devices***
 - ***Massively destructive single person terrorism***

Memes:

Weakly Anchored

- ***Linear, on trend, feasible***
 - ***Positive remote detection of lies***
 - ***Flipping of the earth's magnetic poles***
 - ***Chemicals for improving intelligence***
 - ***Invisibility cloaking***
 - ***Large scale wireless electricity transmission***
 - ***Positive weather control***
 - ***Cheap fresh water from salt water***
 - ***Massively destructive cyber-attacks***
 - ***Large scale improvement in life expectancy***

Unanchored Developments: Characteristics

- ***Paradigm shifting***
 - ***Unexpected***
 - ***Earth shaking***
 - ***But must satisfy (or modify) natural laws***
- ***Parallels Kuhn's Structure of Scientific
Revolutions***
- ***Black Swan developments (Taleb)***

Wild Cards and Weak Signals

- ***Wild Cards***
 - ***Generally means “out of the box”***
 - ***But may be any type of low probability development***
- ***Weak signals are early indications of future developments of any type***

Implausibility of Unanchored Developments

<i>Before there was</i>	<i>Who could have forecasted</i>
<i>A chain reaction</i>	<i>Atomic power, (Prehoda: Hahn-Strassmann point)</i>
<i>A transistor</i>	<i>The demise of the vacuum tube</i>
<i>Penicillin</i>	<i>Antibiotics</i>
<i>Petroleum</i>	<i>Gasoline</i>
<i>Internet</i>	<i>Google</i>

Unanchored Developments: Examples- NOT FORECASTS

- ***Non-linear, non-extrapolative, unexpected, often seen as infeasible or undesirable, counter paradigmatic***
 - ***Controlled anti-gravity***
 - ***Faster than light particles***
 - ***Time travel to the past***
 - ***Controlled positive telepathy***
 - ***Discovery of the cause of the “big bang”***
 - ***Proof that we are indeed alone in the universe***
 - ***Gestation factories***

Unanchored Developments: Origins

- ***Non Linearity***

Very small changes in initial conditions mean great downstream changes.

- ***Avalanche: Straws do break camels' backs***

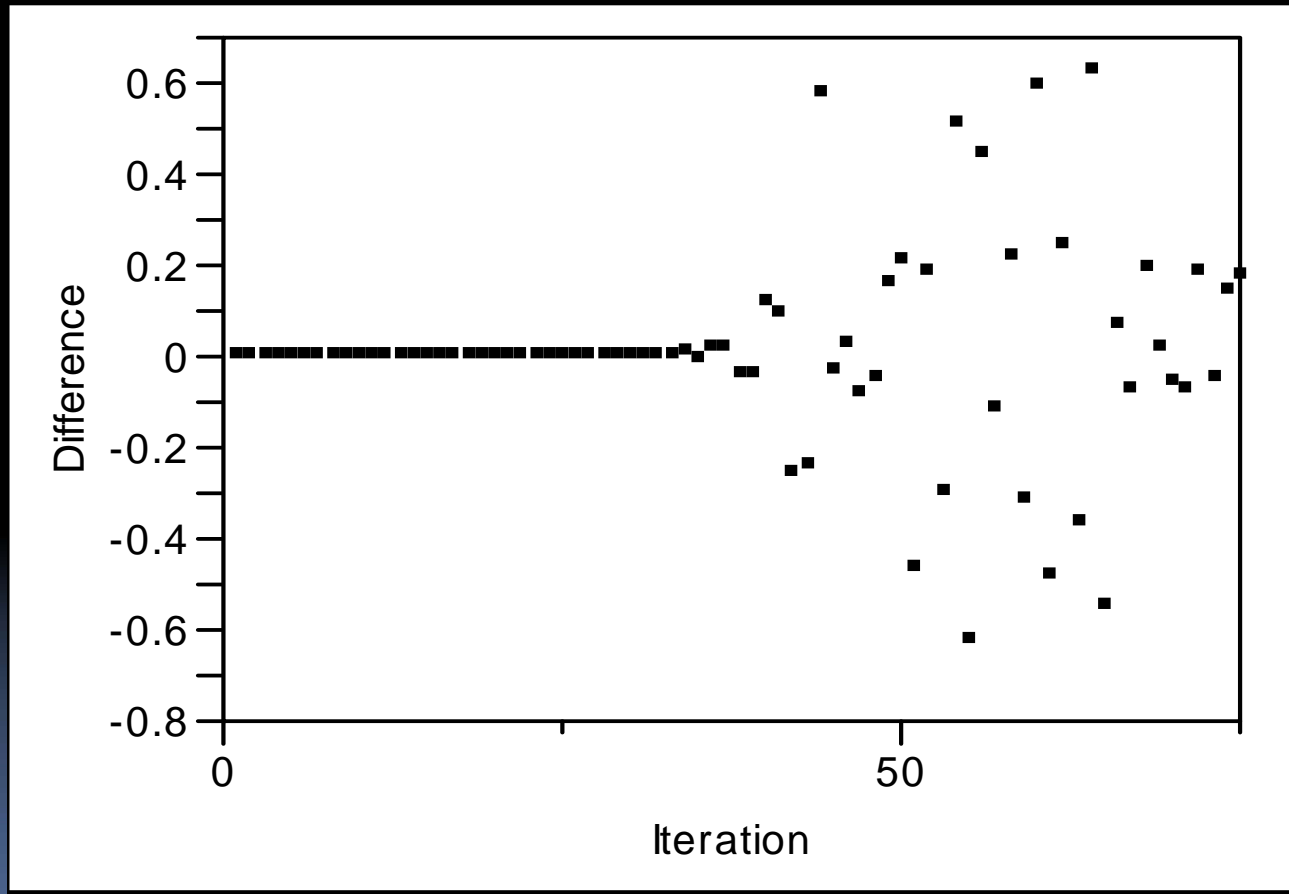
"... catastrophes, from earthquakes and avalanches to a stock market crash, can be triggered by a minor event. "
(Bak and Chen:)

- ***The genius idea***

- ***Accident, serendipity, unanticipated side effects***

Sensitivity: Initial Conditions

(one part in a million initial difference)



Proposed Classification of Unanchored Developments

<i>Points</i>	<i>State of Pre-knowledge</i>	<i>Paradigm shift potential</i>	<i>Impact Timing</i>
<i>5</i>	<i>No inkling, no precursors</i>	<i>New fundamental natural laws result</i>	<i>Essentially instant</i>
<i>4</i>	<i>Considered nonsense; bad science</i>	<i>Kuhnian revolutions across the board</i>	<i>Impacts in days</i>
<i>3</i>	<i>Considered impossible</i>	<i>Causes significant revisions to several disciplines</i>	<i>Impacts in years</i>
<i>2</i>	<i>Considered extremely unlikely</i>	<i>Affects a discipline or two</i>	<i>Impacts in decades</i>
<i>1</i>	<i>Considered plausible but centuries away</i>	<i>Raises questions for some disciplines</i>	<i>Impacts in centuries</i>

Classification

- ***A score of 15 describes the potential for an event that***
 - Has never been discussed*
 - Happens suddenly*
 - And the world will never be the same*

- ***A score of 3 describes the potential for an event that***
 - Has been discussed in small isolated groups*
 - Has consequences that happen gradually*
 - Will raise important questions for some disciplines*

Applications

- ***Imagine a database of several million entries, all improbable, all classified***

Useful in establishing research portfolios

A system simulation could be graded as to resiliency to accept unanchored developments of a given score

The database could be used to test robustness of policies; e.g. "this policy has been tested to class 12 unanchored developments, etc."