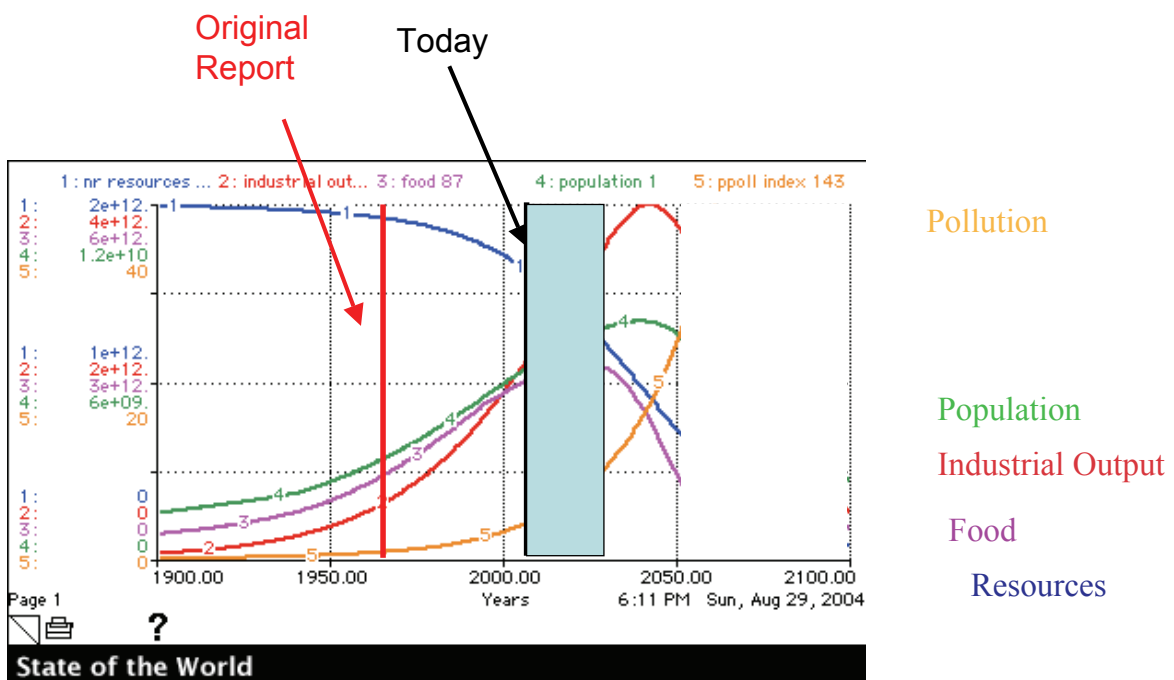


Causes and consequences of limits to growth in energy: 2010 - 2030

Dennis Meadows
Presentation to SES Fachtagung 2009
Zurich
28 August, 2009

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The Reference Scenario



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Main Insights from the Scenario

- In 1972 we expected another 40-50 years of growth without major problems.
- The timing for the end of growth is not known precisely, but all our scenarios showed it occurring in the period 2020-2050.
- Changes in technology are useful for buying a few years of time, but they do not avoid the necessity for an end to physical growth. Social changes are also required to achieve the most attractive futures.
- What we call problems are actually symptoms of physical growth pressing against the limits. Peak oil is not unique, except that it will occur earlier than many other problems.

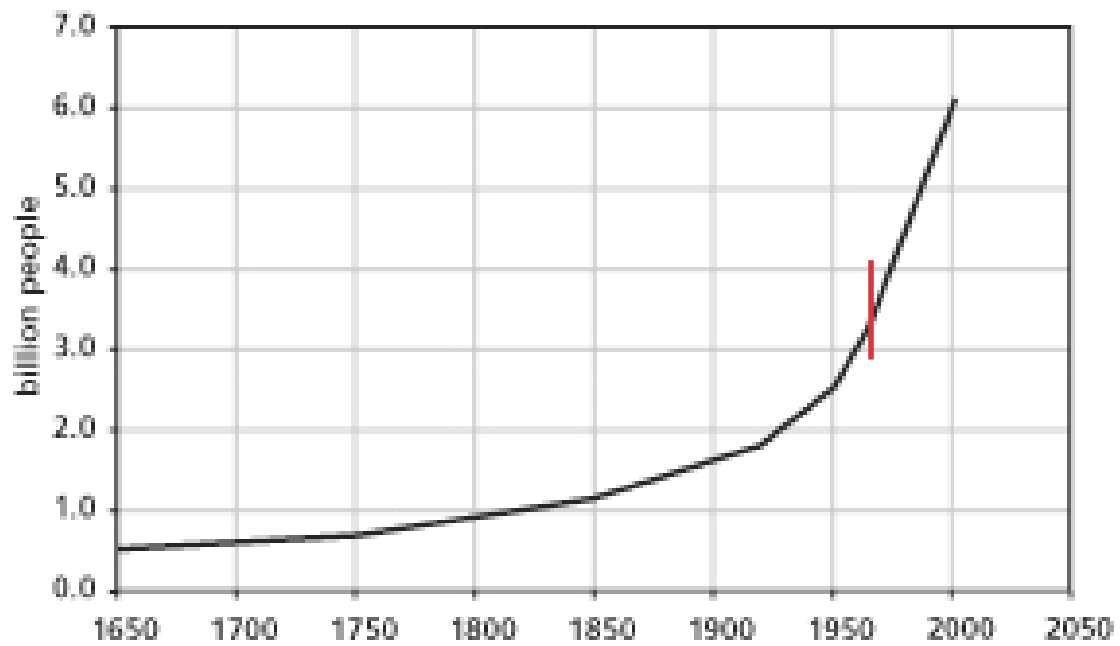
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Outline of My Remarks

- Physical growth has continued.
- Environmental problems will continue to grow until they stop the growth; one of the most important will be energy limits.
- It is too late to avoid those problems.
- Those problems have enormous implications for society
- To prosper over the coming decades will require all of us to adopt new habits in our goals and governance.

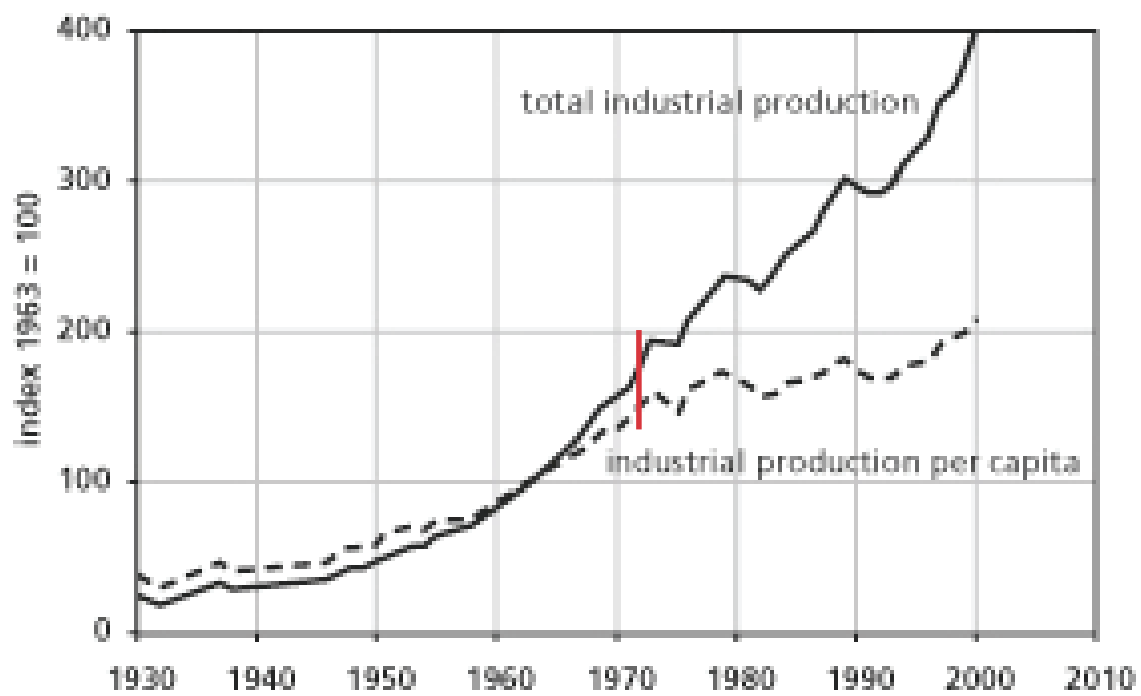
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World Population



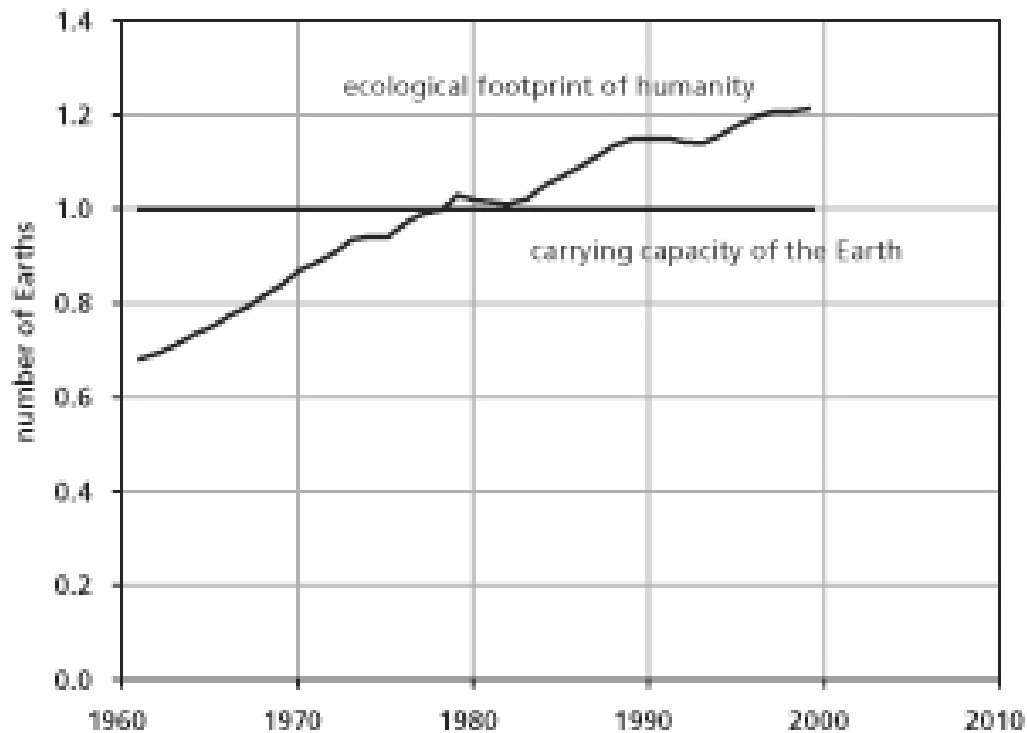
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Industrial Production



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One Indicator of Overshoot



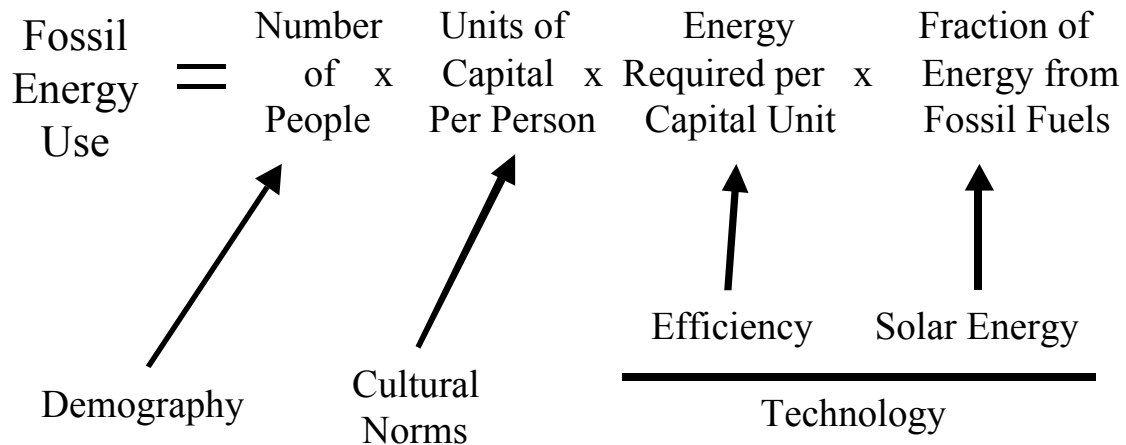
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The Environmental Obstacles to Growth

- Climate change
- Water scarcity
- Destruction of agricultural soils
- Pandemics
- Declining renewable resources
- Depleting nonrenewable resources
- Fossil fuels depletion

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Four Factors Determine the Amount of Fossil Energy Use



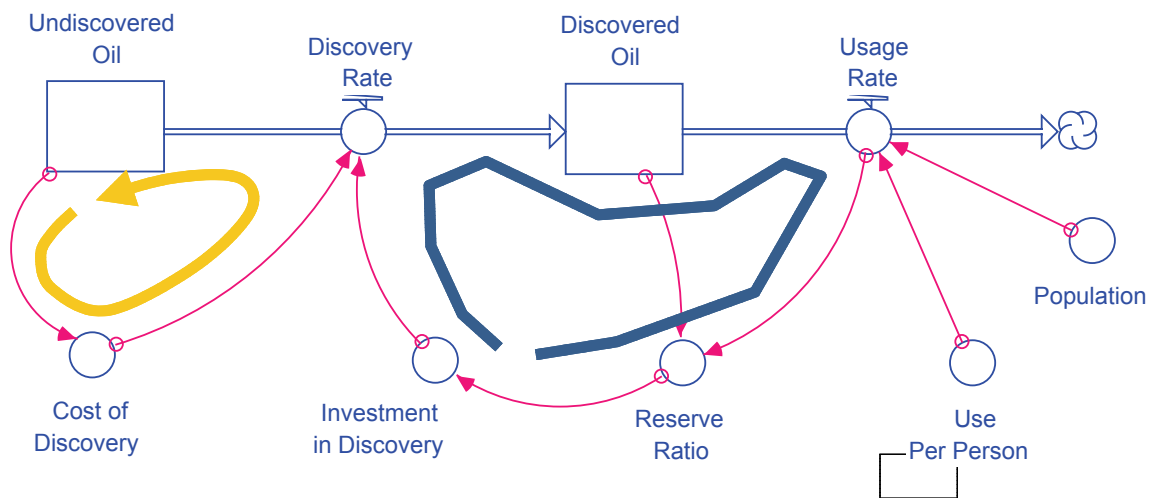
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We do not understand the dynamics of oil depletion.

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The Oil Discovery System



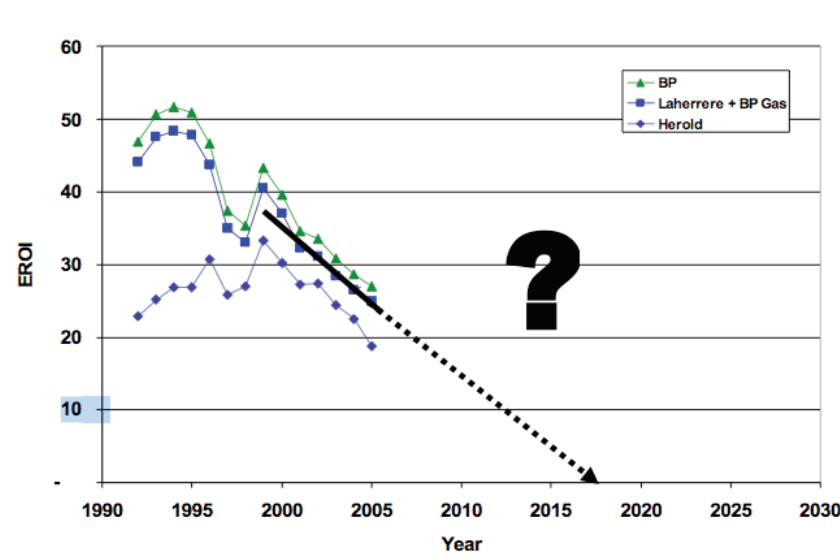
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The Easy Oil is Gone

- Oil discoveries peaked in 1960s.
- Every year since 1984 oil consumption has exceeded oil discovery. In 2006 discoveries = 9 billion barrels (bb), consumption = 31 bb.
- Of the world's 20 largest oil fields, 18 were discovered 1917 - 1968; 2 in the 1970s; 0 since.
- Oil production in 2007 was lower than in 2006.

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Energy Return on Investment



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Some Approximate Net Energy Yields

- US Oil 1930: 100; 1970: 30; 2005: 15
- Imported Oil: 30
- Coal: 10 - 80
- Nuclear: 10
- Firewood: 25
- Photovoltaics: 15-45
- Oil Sands: 2-3
- Ethanol from grain: 1.2

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Consequences of the Oil Peak

- We need to change the criteria we use in making choices
- We need to increase the time horizon for comparing costs and benefits of alternative actions.

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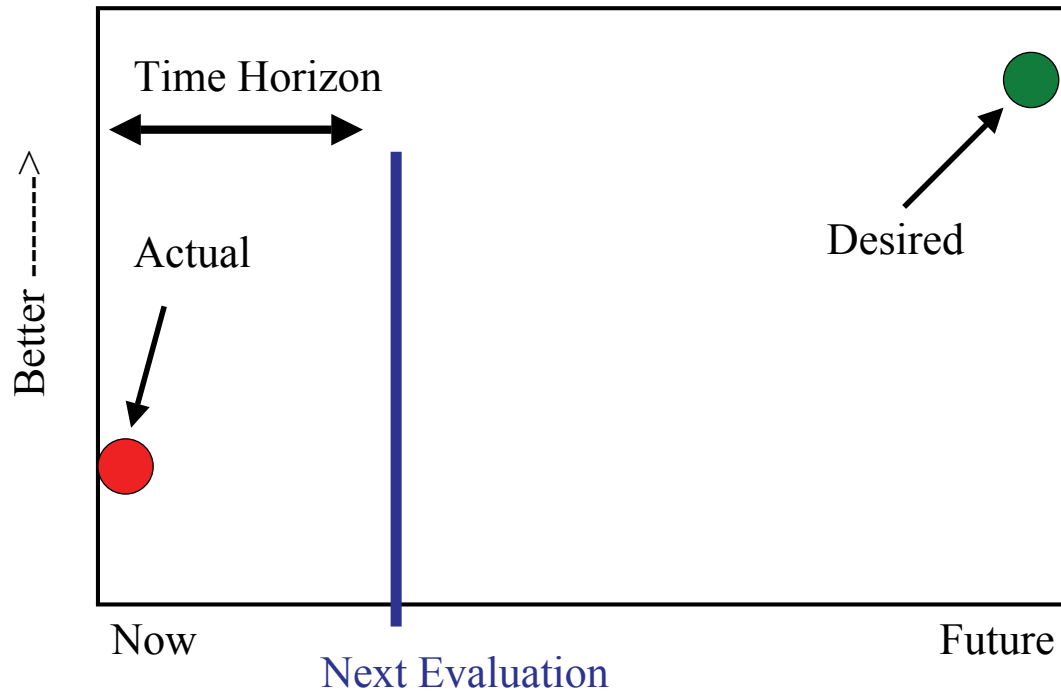
Relying on Present Net Value to Choose Assumes:

- All consequences of an action are known
- All consequences can be expressed in monetary units; they are commensurate
- We are the ones entitled to pick the interest rate
- Maximizing financial benefits is the goal of society
- Current mistakes can be corrected by paying some cost in the future

Every single one of these assumptions is false for the issue of climate change!!

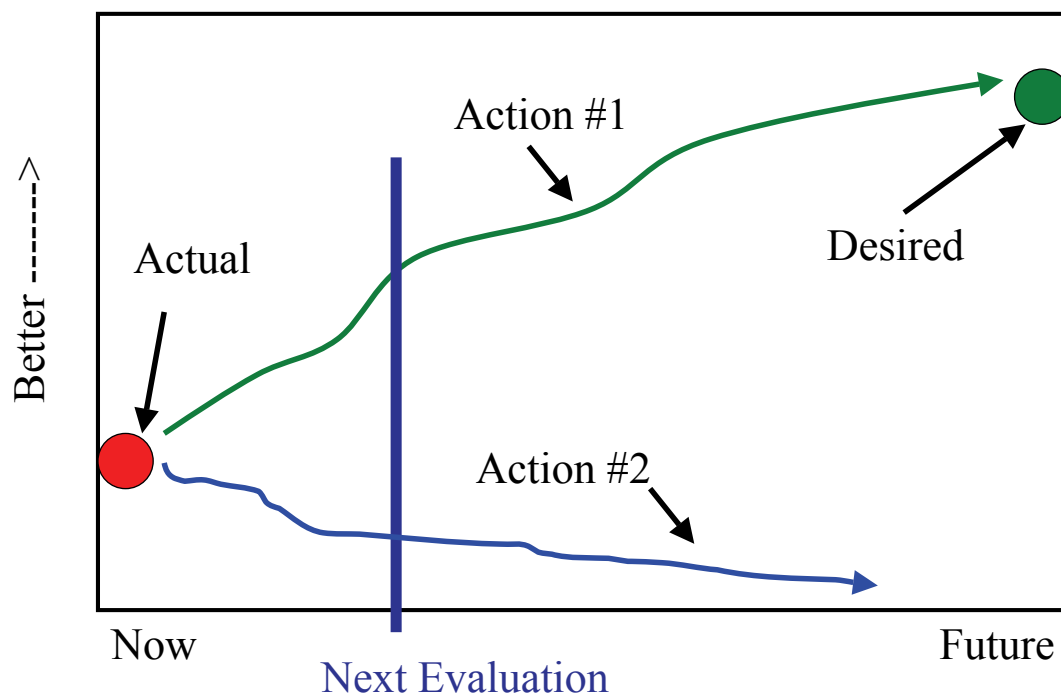
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A Problem



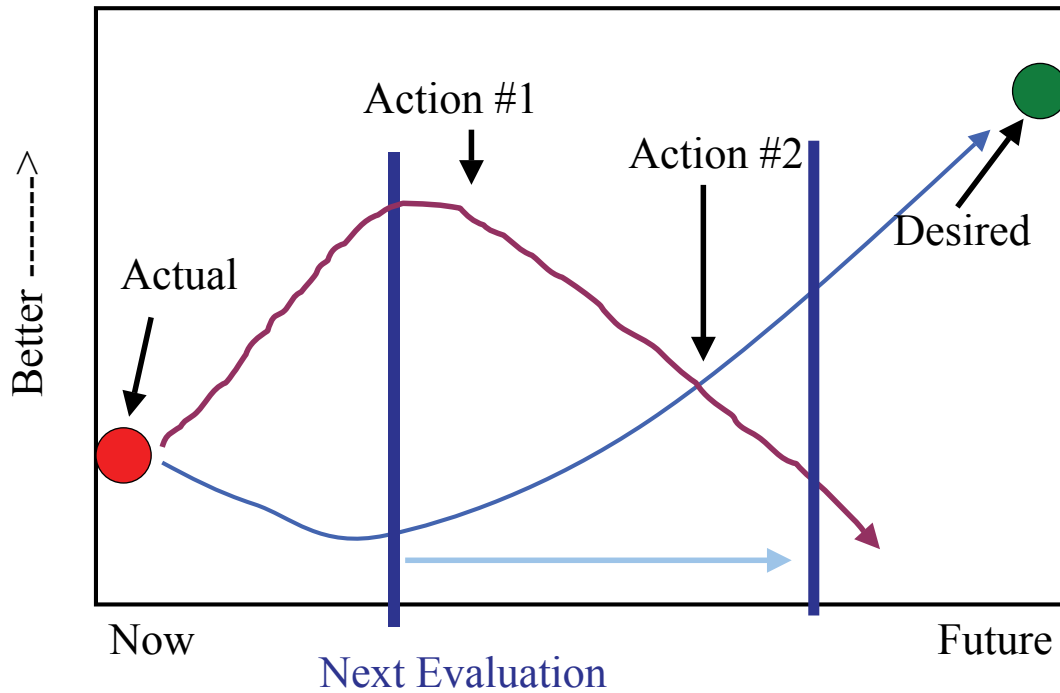
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Easy Problems



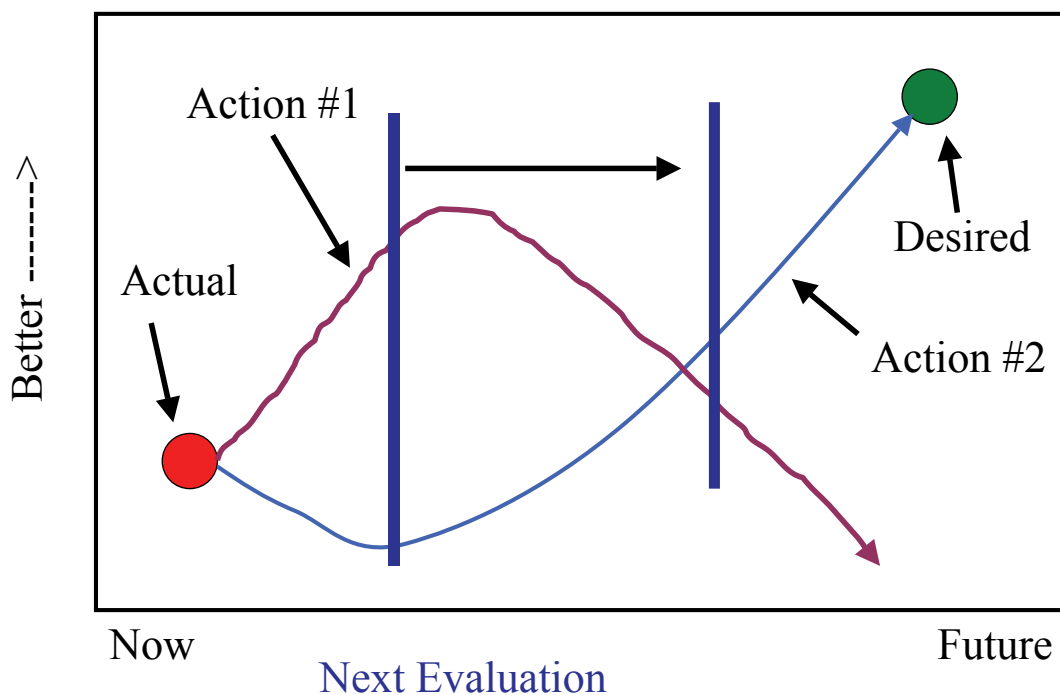
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Difficult Problems



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Difficult Problems Become Easy with Greater Time Horizon



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