

Algorithmic game theory

Martin Balko

10th lecture

December 14th 2023



Mechanism design basics

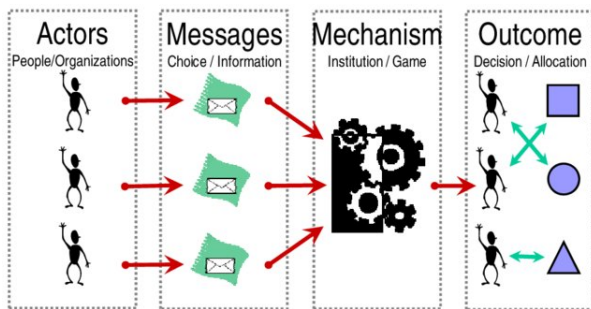
Mechanism design

Mechanism design

- Designing games toward desired objectives.

Mechanism design

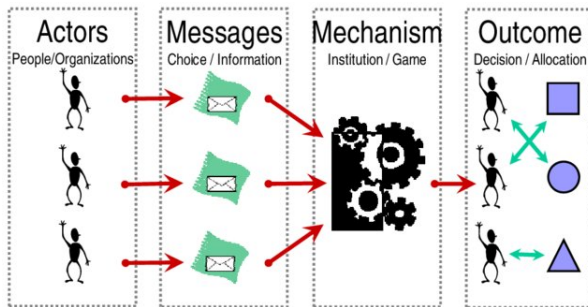
- Designing games toward desired objectives.
- **We try to design rules of the game** so that strategic behavior by participants leads to a desirable outcome.



Source: Innovations in Defense Acquisition: Asymmetric Information and Incentive Contract Design

Mechanism design

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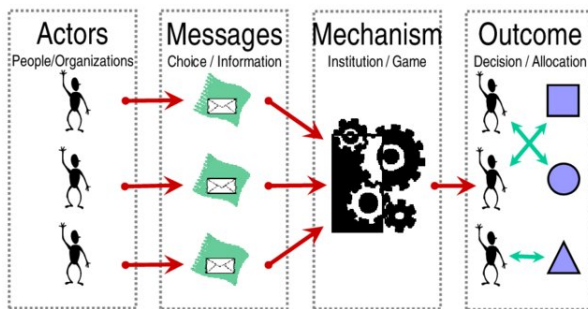


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- We start with **single item auctions**.

Mechanism design

- Designing games toward desired objectives.
- We try to design rules of the game so that strategic behavior by participants leads to a desirable outcome.



Source: Innovations in Defense Acquisition: Asymmetric Information and Incentive Contract Design

- We start with **single item auctions**.
- We then extend these desired properties to a more general setting of **single-parameter environments** using so-called **Myerson's lemma**.

Single item auctions



Source: <https://www.widewalls.ch>

Vickrey's auction

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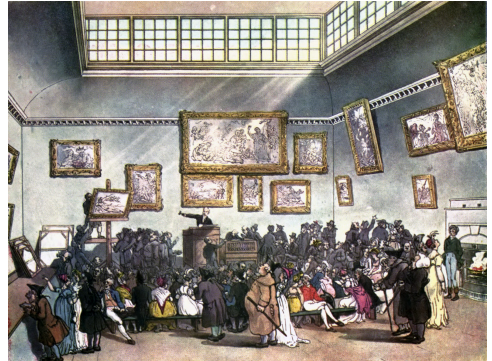
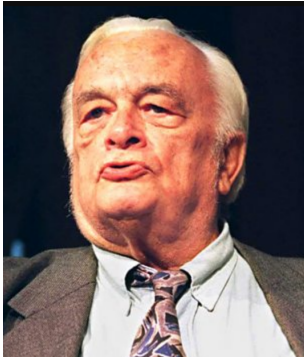


Figure: William Vickrey (1914–1996).

Sources: <https://en.wikipedia.org> and <https://ichef.bbc.co.uk/>

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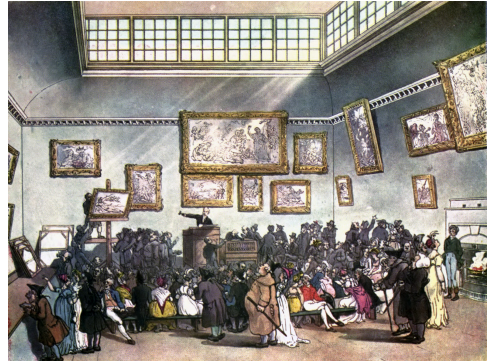
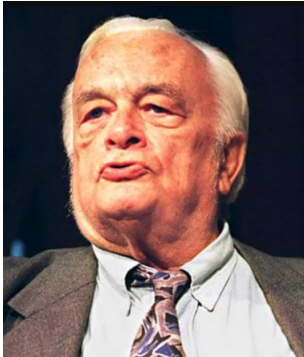


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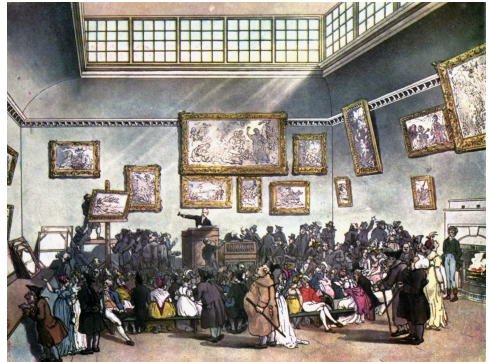
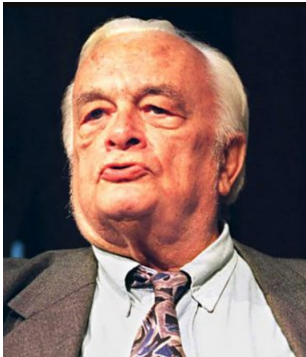


Figure: William Vickrey (1914–1996).

Sources: <https://en.wikipedia.org> and <https://ichef.bbc.co.uk/>

- Vickrey's auction is used also in, for example, **network routing**.
- Vickrey posthumously received a **Nobel prize** in Economic Sciences.

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Source: <https://proceedinnovative.com>

Myerson's lemma

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- A powerful tool for designing DSIC mechanisms.

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Figure: Roger Myerson (born 1951) receiving a Nobel prize in economics.

Myerson's lemma

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Myerson's lemma

In a single-parameter environment, the following three claims hold.

- (a) An allocation rule is **implementable if and only if it is monotone**.
- (b) If an allocation rule x is monotone, then there exists a **unique payment rule p** such that the mechanism (x, p) is DSIC (assuming that $b_i = 0$ implies $p_i(b) = 0$).
- (c) The payment rule p is given by the following **explicit formula**

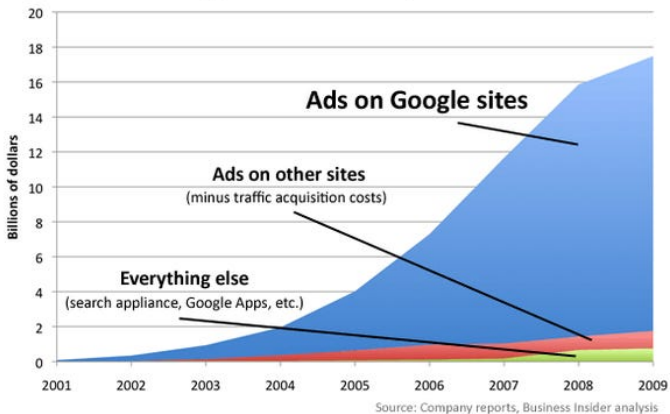
$$p_i(b_i; b_{-i}) = \int_0^{b_i} z \cdot \frac{d}{dz} x_i(z; b_{-i}) dz$$

for every $i \in \{1, \dots, n\}$.





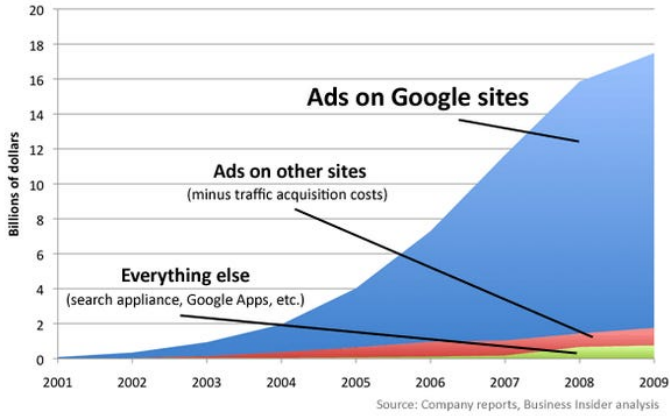
Google Revenue By Source



Source: <https://businessinsider.com>



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