Assessing Intellectual Property

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Intangibles

- Product of knowledge *by*
- Cost of original >> cost of copies

1. Books		*authors*
2. Software	*Ever*	*programmers*
3. Inventions	*Even*	*engineers*
4. Trademarks	*Less*	advertisers
5. Knowhow	*Tangible*	managers
6. Customer Loyalty		long-term quality

Intellectual vs Intangible *property*

1. Intellectual property refers to creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce [WIPO].
   a. Industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source;
   b. Copyright, includes literary, artistic works, focusing on presentation; and software, including transformations of representation.
2. "Workforce in place" has much value

   but People can**not** be considered **property** *anymore*
3. Goodwill everthing else – mainly in

Σ^{1-3} = Intangible contribution to corporate value

- Tangible property including cash is the rest

IP is the Link to the workforce

To be effective a worker has to know what has to be done

- That knowledge consists of
  - The technology
    - Documentation, prior versions, quality control
  - The business methods
    - How technology in the product is marketed
    - The flow from buyers to improved products and methods
- Companies distinguish themselves by proprietary IP

1. Patents, sometimes Copyrights
2. Confidential Documents
3. Knowledge within its people - protected by NDAs
4. Software ---> new quantitative model

Trade secrets

Magnitude of intangibles

Implicitly estimated by share holders

Example: Value of a company *(SAP)*

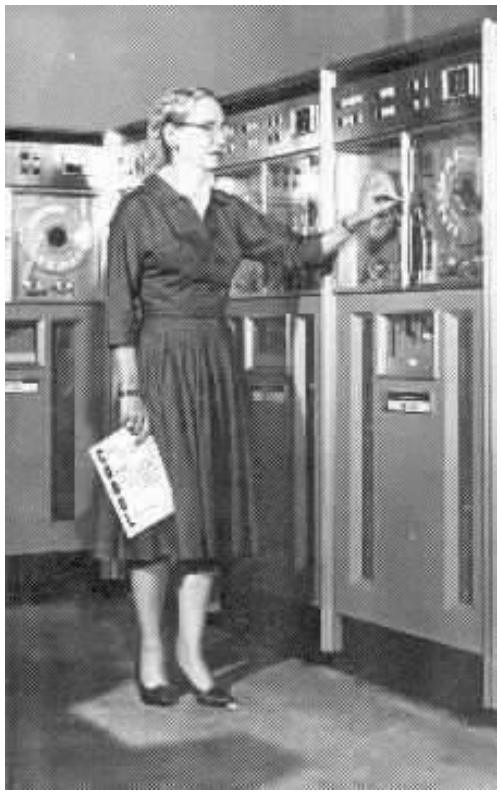
- Largely intangible – like many modern enterprises

1.	Market value = share price × no. of shares	€31.5B	100%
2.	Bookvalue – sum of all tangible assets Equipment, buildings, cash	€ 6.3B	20%
3.	**Intangible** value per stock market	€25.2B	80%

Intangible/tangible = 4 x

- How much of it is software ?

1987 Quote



"Some day, on the corporate balance sheet, there will be an entry which reads, 'Information'; for in most cases the information is more valuable than the hardware which processes it."

-- Grace Murray Hopper

The inventor of COBOL

Basis for SW value *NPV*

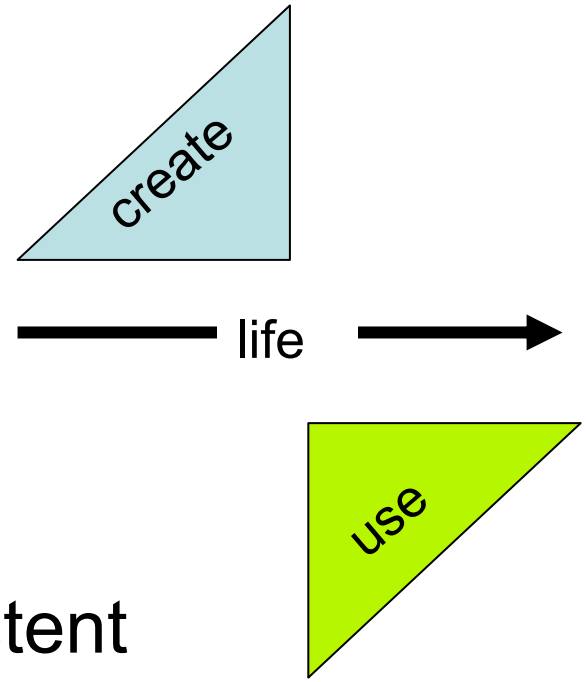
- Sum of future income
  - Sales = price * copy count
  - Maintenance fees if service subscription
- Minus sum of future costs
  - Cost of goods
  - Cost of marketing
  - Cost of doing business
  - Cost of maintenance
- Discounted to today
  - To account for risk

Independent of cost

Current State of Valuing SW

- Software producers traditionally care about
  - Cost of writing software
  - Time to complete products
  - Capabilities
- When the value is a concern
  - Business people
  - Economists
  - Lawyers
  - Promoters

} inconsistent



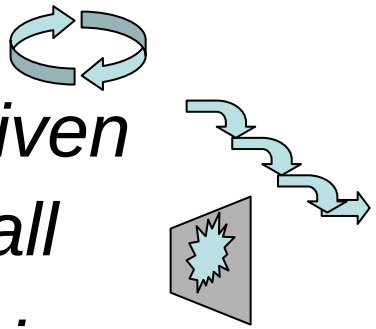
Why a Technical Concern

- Making decisions about creative tradeoffs
  - Elegance versus functionality
  - Rapid generation versus maintainability
  - Careful specification versus flexibility
- *Dealing with customers*

  Dijkstra model: *for self-satisfaction*

  Engineering model: *formal process driven*

  Startup model: *see if it sticks to the wall*



- Gain respect: *know what you are doing*

Why an Economic Concern

- Software is the driving force for generating income in many modern enterprises
  - Companies that sell software
    - or hardware with embedded software
  - Companies that sell other stuff on the web
  - Companies that sell financial services
    - There are no real, tangible piles of money there
  - Companies that rely on their supply-chain prowess
  - Multi-nationals that coordinate their operations

Why now

Worrying about economics is a sign of a maturing field:

Phases:

1. Get it to work
2. Getting adequate performance
3. Get it to be sufficiently reliable to be useful
4. Get it into routine production
5. Increase capacity
6. Make it safe
7. Make it affordable

Why me

- Much software is being exported as part of **offshoring** (offshore outsourcing)
- It is typically property – i.e., *protected*
- If it is not valued correctly – i.e., *too low*

1. Loss of income to the creators *in the USA*
2. And loss of taxes *to the US* treasury
3. Excessive profits *kept external to the USA*
4. Increased motivation for external investment

Software is slithery !

Continuously updated

1. Corrective maintenance

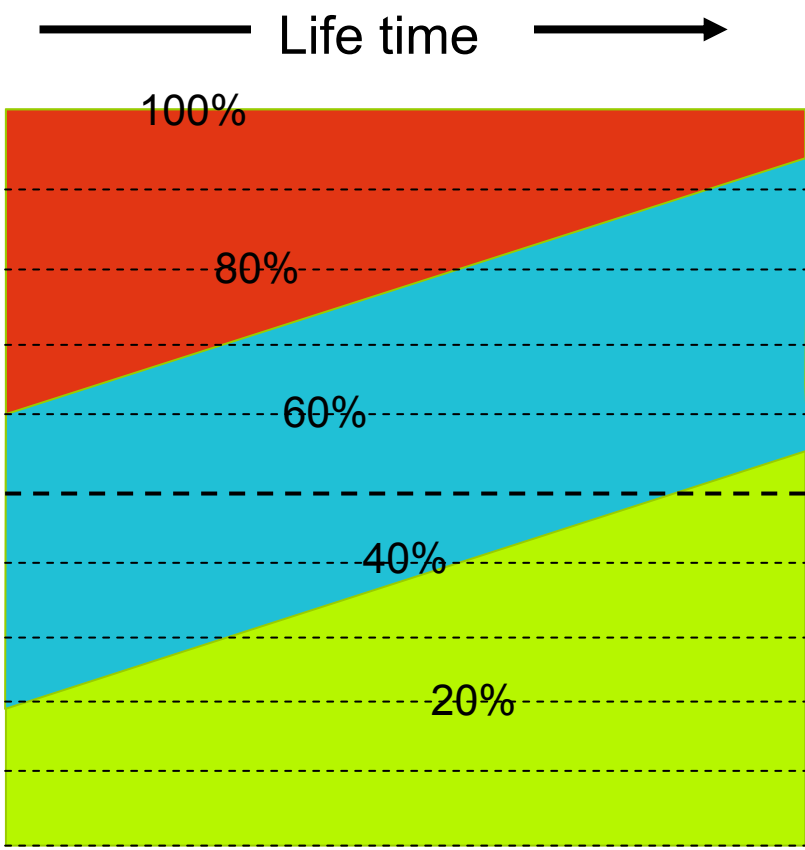
   bugfixing reduces for good SW

2. Adaptive maintenance

   externally mandated

3. Perfective maintenance

   satisfy customers' growing expectations



[IEEE definitions]

Ratios differ in various settings

IP sources

- Corrective maintenance
  - Feedback through error reporting mechanisms
    - Inadequate protection from virus etc.
    - Taking care of missed cases
    - Complete inadequate tables and dimensions
- Adaptive maintenance
  - Staff to monitor externally imposed changes
    - Compliance with new standards
    - Technological advances
- Perfective maintenance
  - Feedback through sales & marketing staff
    - Minor features that cannot be charged for

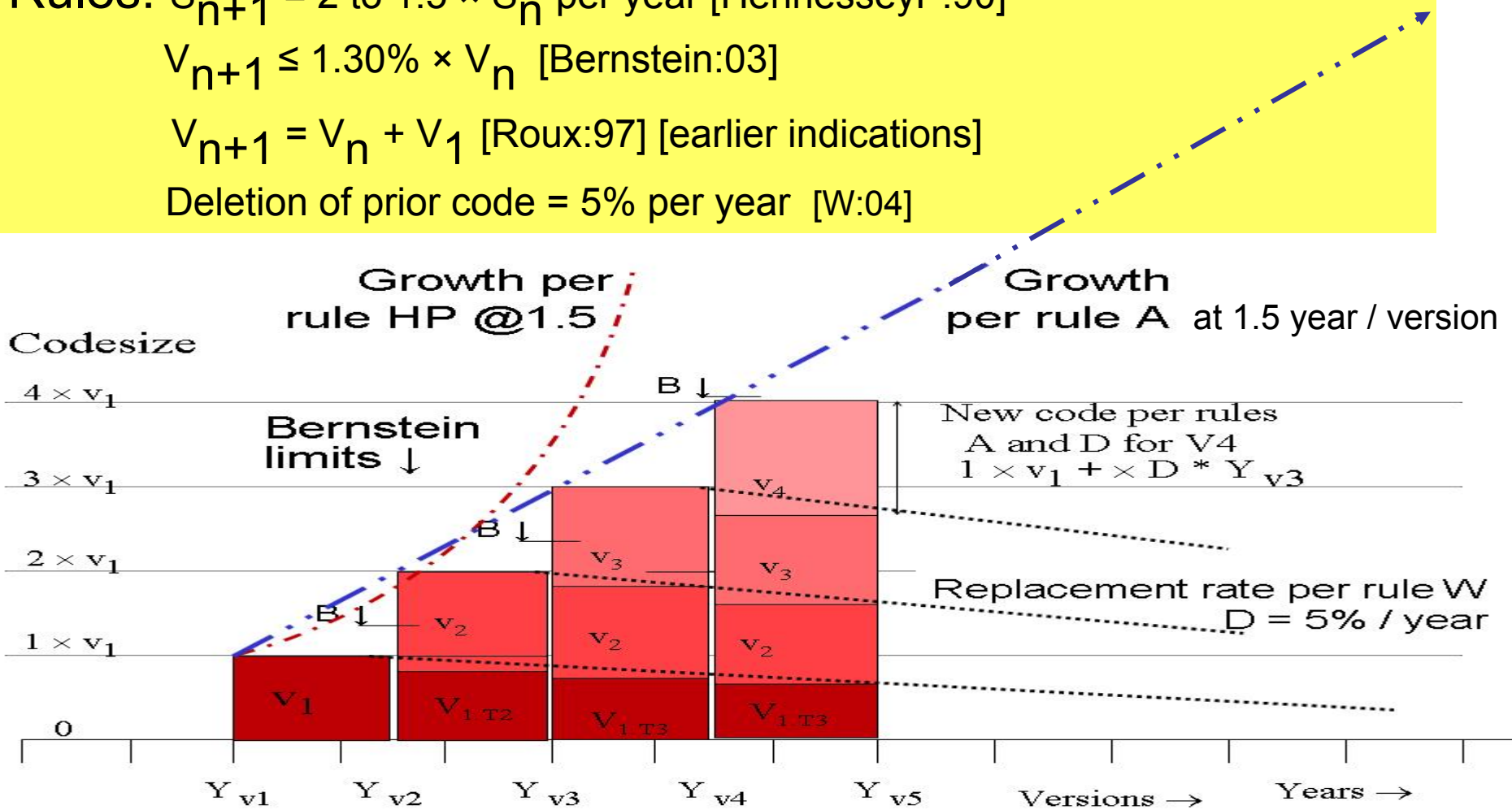
Effect: SW Growth

Rules: S_{n+1} = 2 to 1.5 × S_n per year [HennesseyP:90]

$V_{n+1} \leq 1.30\% \times V_n$ [Bernstein:03]

$V_{n+1} = V_n + V_1$ [Roux:97] [earlier indications]

Deletion of prior code = 5% per year [W:04]



Observations

- Software cannot grow exponentially [e]

no Moore's Law

Because

1. Cost of maintaining software grows exponentially with size [Brooks:95]
2. If [e & 1.] would need to hire staff at exponential $*^2$
3. Cannot have large fraction of changes in a version
4. Cannot impose version changes on users < 1 / year
5. Deleting code is risky and of little benefit

except in game / embedded code

Price *remember IP =f(income)*

- <u>Price stays ≈ fixed over time</u>

  like hardware Moore's Law

  Because

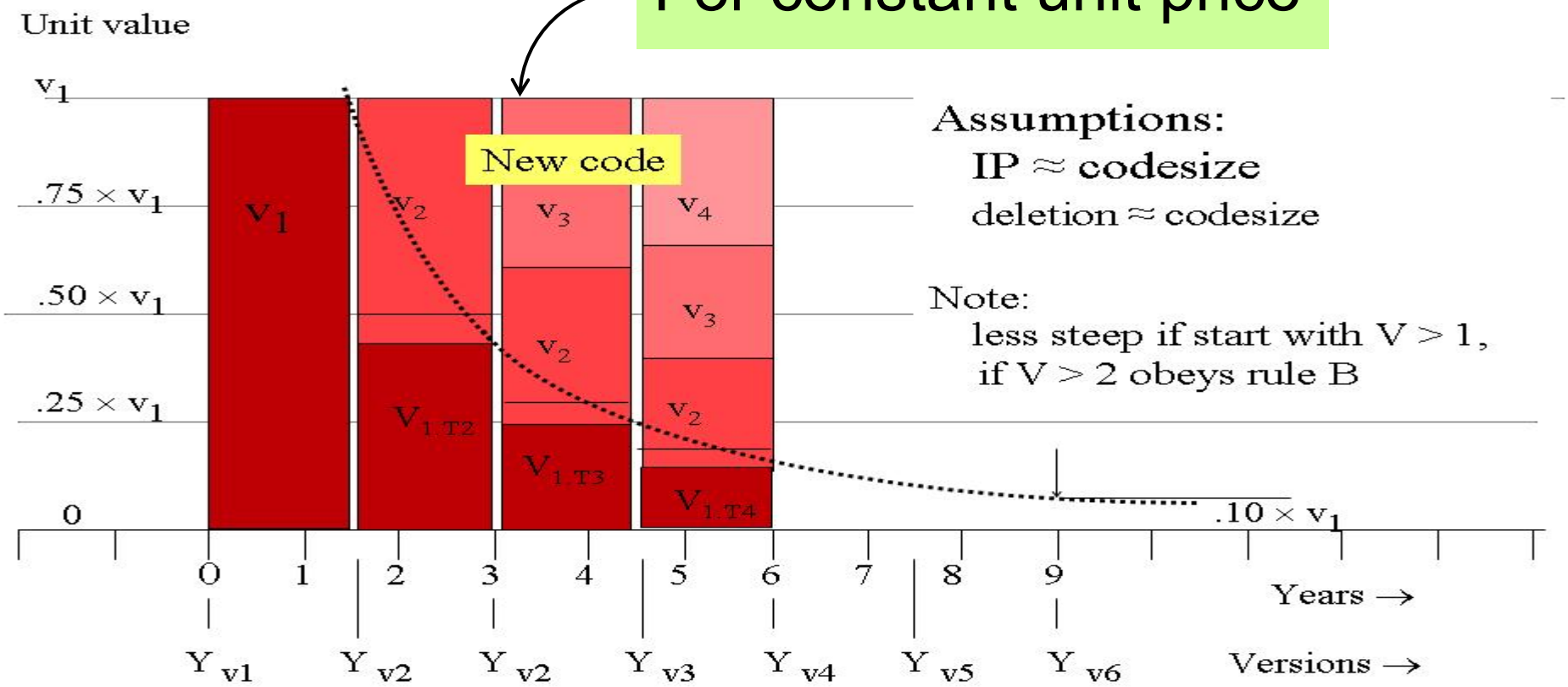
  1. Customers expect to pay same for same functionality
  2. Keep new competitors out
  3. Enterprise contracts are set at 15% of base price
  4. Shrink-wrapped versions can be skipped

- <u>Effect</u>

The income per unit of code reduces by 1 / size

Growth diminishes IP

For constant unit price



Assumptions:
IP ≈ codesize
deletion ≈ codesize

Note:
less steep if start with V > 1,
if V > 2 obeys rule B

Total income

Total income = price × volume (year of life)

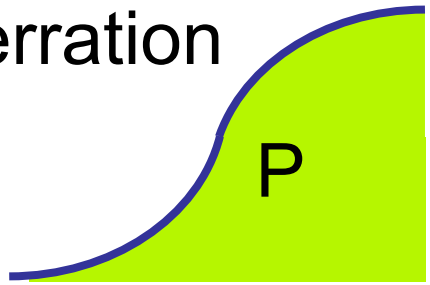
- Hence must estimate volume, lifetime

Best predictors are Previous comparables

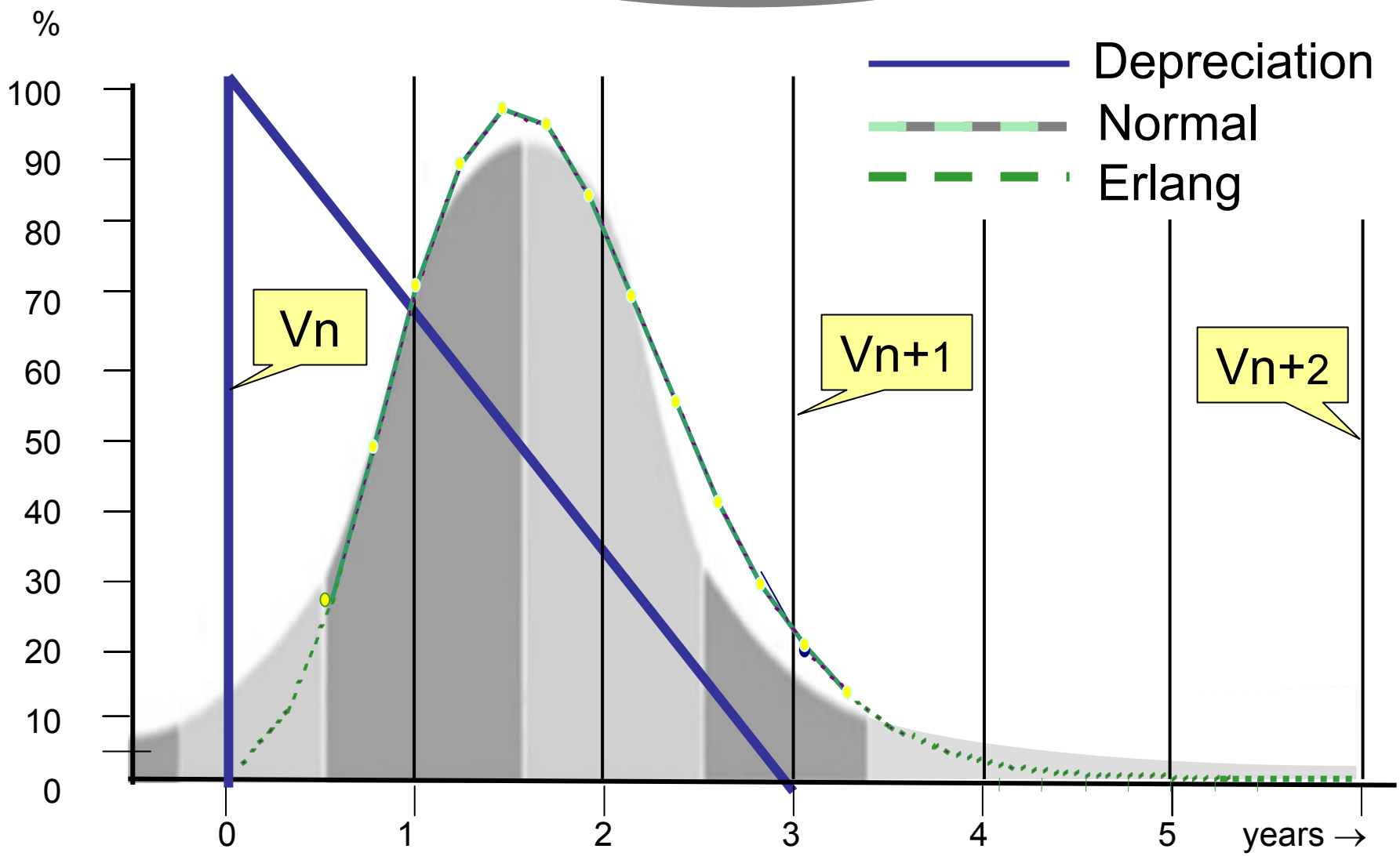
- Erlang curve fitting (m=6 to 20, 12 is typical)

and apply common sense limit = Penetration

- estimate total possible sales F × #customers
- above F= 50% monopolistic aberration



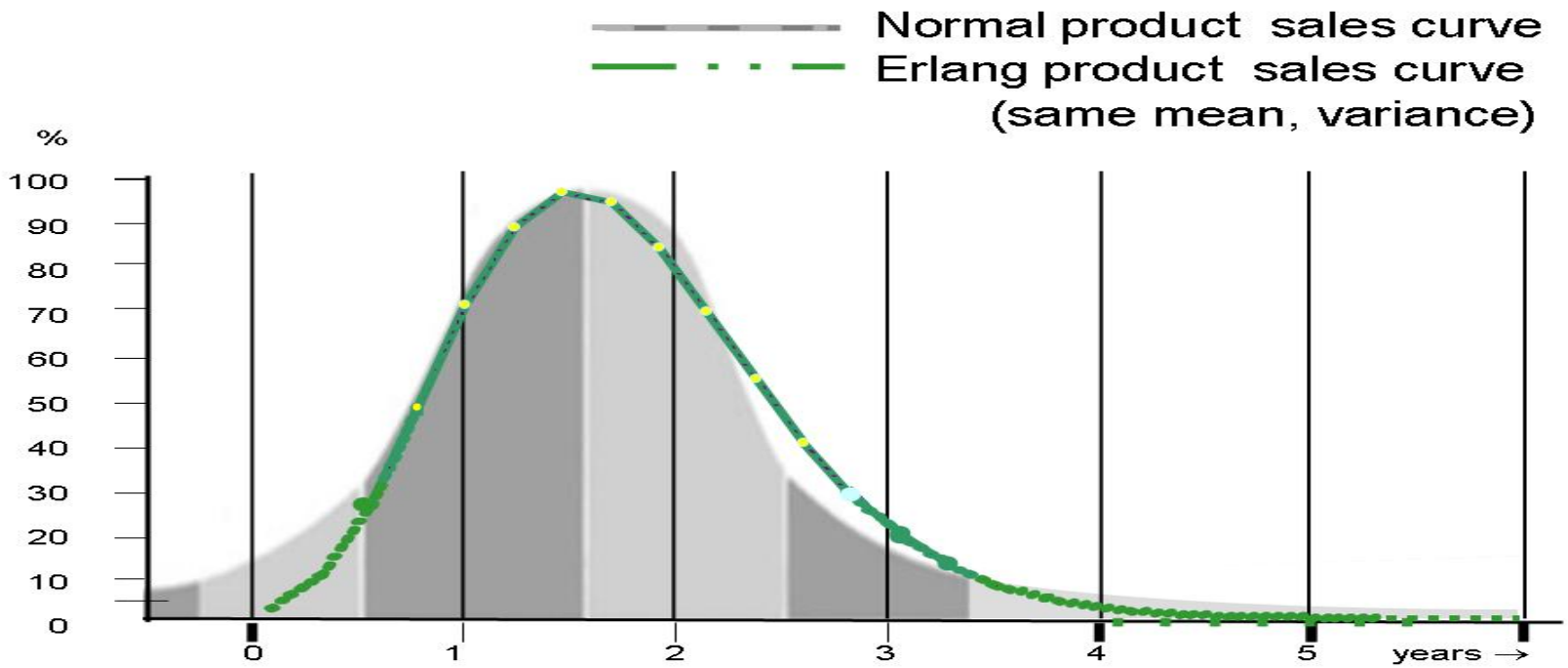
Sales curves used



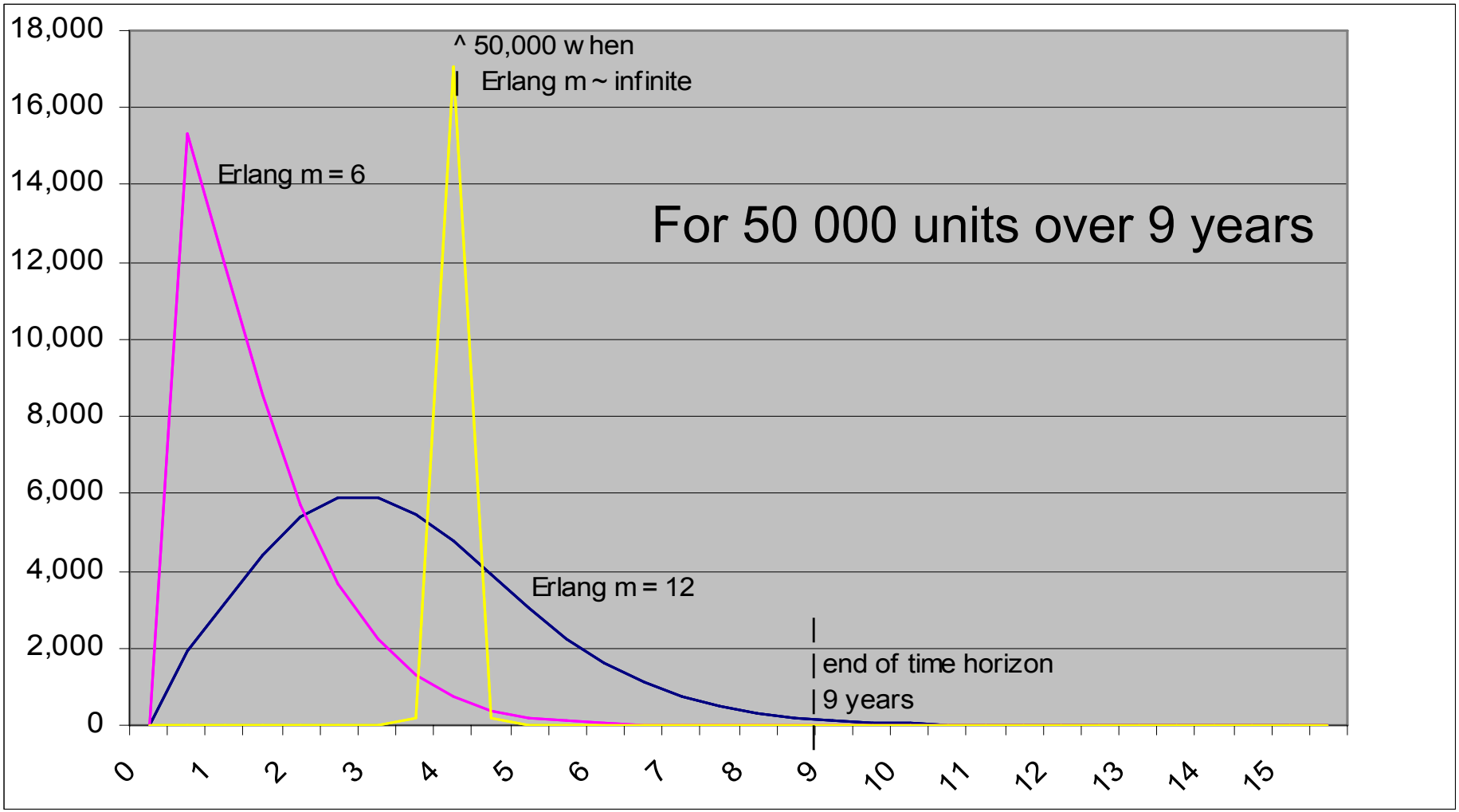
Sales models

1. Normal curve: simple, no defined start point
2. Erlang: realistic, more complex

both have same parameters: mean and variance



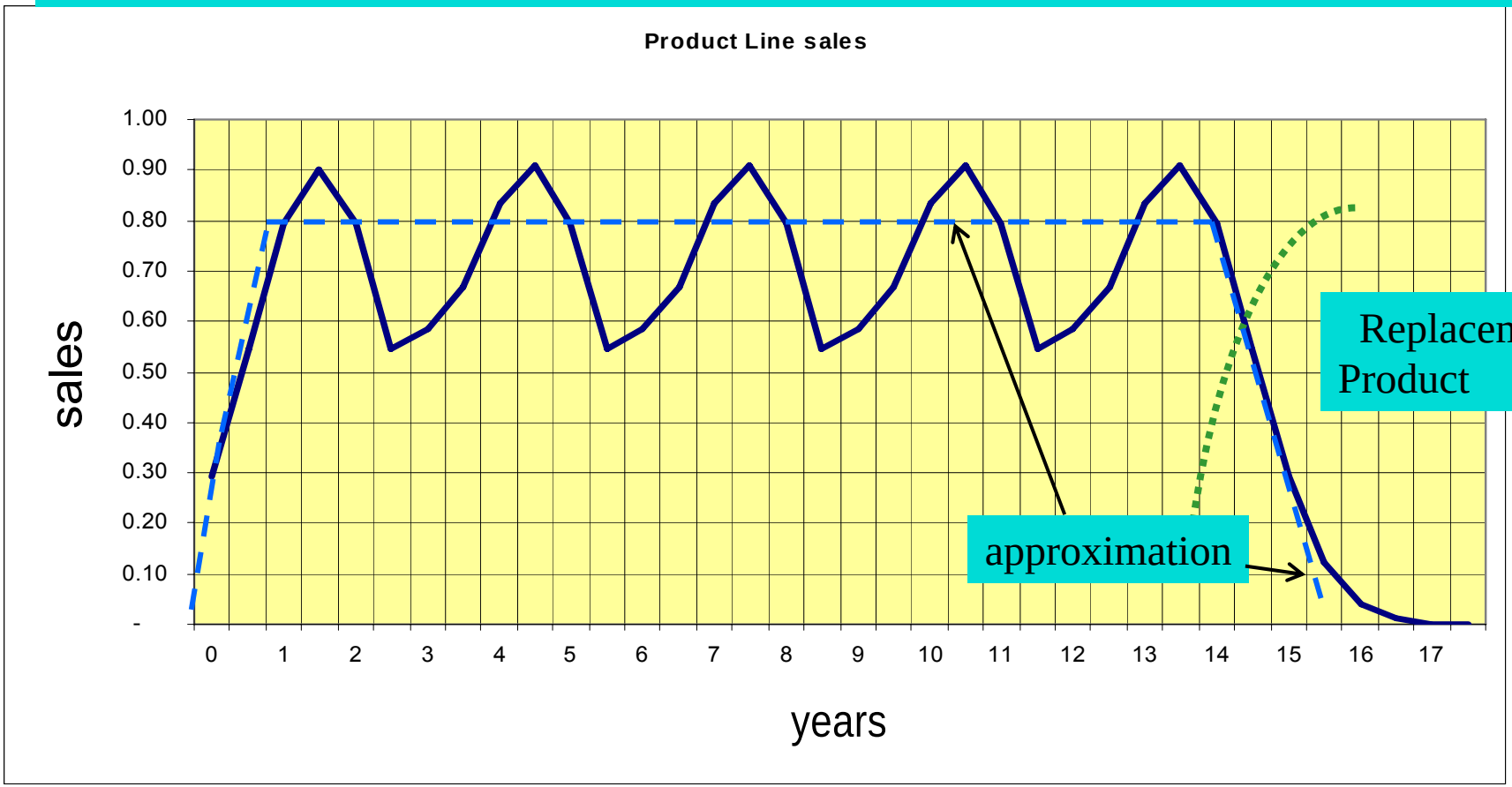
Erlang sales curves *m=mean/variance*



Ongoing Version Sales

Predicted product sales for 5 versions, stable rate of product sales

3 year inter-version interval, first-to-last product 12 years, life ~15 years



Software users & IP

Companies that

1. develop & sell software → *
   - Basis of IP: income from sales
2. purchase & license software for internal use
   - Do not generate IP with software
3. develop software internally for their own use
   - Basis of IP: relative SW expense × all income (Pareto rule)
4. combinations

Fraction of income for SW*

Income in a software company is used for

- Cost of capital *typical*
  - Dividends and interest ≈ 5%
- Routine operations -- not requiring IP
  - Distribution, administration, management ≈ 45%
- IP Generating Expenses (IGE)
  - Research and development, i.e., SW ≈ 25%
  - Advertising and marketing ≈ 25%

These numbers are available in annual reports or 10Ks

Discounting to NPV

Standard business procedure

- Net present Value (NPV) of

  getting funds 1 year later = F×(1 – discount %)

Standard values are available for many businesses

  based on risk (β) of business, typical 15%

Discounting strongly reduces effect of the far future

  NPV of $1.- in 9 years at 15% is $0.28

Also means that bad long-term assumptions have less effect

Example

Software product

- Sells for $500/copy
- Market size 200 000
- Market penetration 25%

➢ Expected sales 50 000

➢ Expected gross income $25M

Combining it all

factor	**today**	y1	y2	y3	y4	y5	y6	y7	y8	y9
Version	1.0	2.0		3.0	4.0		5.0	6.0		7.0
unit price	$500	500	500	500	500	500	500	500	500	500
Rel.size	1.00	1.67	2.33	3.00	3.67	4.33	5.00	5.67	6.33	7.00
New grth	0.00	0.67	1.33	2.00	2.67	3.33	4.00	4.67	5.33	6.00
replaced	0.00	0.05	0.08	0.12	0.15	0.18	0.22	0.25	0.28	0.32
old left	1.00	0.95	0.92	0.88	0.85	0.82	0.78	0.75	0.72	0.68
Fraction	100%	57%	39%	29%	23%	19%	16%	13%	11%	10%
Annual $K	0	1911	7569	11306	11395	8644	2646	1370	1241	503
Rev, $K	0	956	3785	5652	5698	4322	2646	1370	621	252
SWIP25%	0	239	946	1413	1424	1081	661	343	155	63
Due old	0	136	371	416	320	204	104	45	18	6
Disct 15%	1.00	0.87	0.76	0.66	0.57	0.50	0.43	0.38	0.33	0.28
Contribute	0	118	281	274	189	101	45	17	6	2
Total	1 032	≈ $ 1 million								

Result of Example

- Selling 50 000 SW units at $500 ≈ $ 1M
  not $ 25M

Once its in a spreadsheet, the effect of the many assumptions made can be checked.

When assumptions later prove unwarranted then management can make corrections.

To be wise, don't spend more than ≈ $500 000 to develop the software product.

Alternate business model

Consider maintenance and its income

"Service model"

- More assumptions – now include cost

1. Original cost $516 000 (used to estimate 2.)
2. Maintenance cost 15%/year of original cost
3. Maintenance fee 15%/year of original price
4. Lag = Δ (*t* cost , *t* income) = 2 years
5. Stop maintenance when cost > income

Effect of service model

factor	**today**	y1	y2	y3	y4	y5	y6	y7	y8	y9
Version	1.0	2.0		3.0	4.0		5.0	6.0		7.0
Org.cost $K	516									
Maint.cost	0	77	129	181	232	284	339	387	0	0
Aggregate	0	77	207	387	619	903	1239	1626	*not discounted*	
Disc.(lag)	0	102	171	239	307	376	444	512	0	0
income	0	240	946	1413	1424	1081	661	343	103	21
Net income	0	137	776	1174	1117	705	218	-170	103	211
Contribute	0	119	586	772	639	351	94	-64	32	6
Total	2537	≈ $ 2.5 million					but $ 1626 for maintenance			

Assume designed for maintenance

Good time to quit

Reduce income 1/3 each year

Cost of maintenance = 1626/(516+1626) = 61% of total

typical

Service model

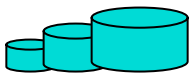
Analysis shows » profitability in service model

- To achieve such a beneficial model
  1. Management must value maintenance
  2. Marketing and sales must provide feedback
  3. Education and training must recognize the value of maintenance and maintainability
  - Often ignored today
    1. Academics don't teach it (3/850 pages [Pressman:01])
    2. Companies give maintenance tasks to novices
       - Experienced programmers should maintain their work

Offshoring

Outsourcing to Enterprises in Foreign countries

Two aspects:

1. Work migration: jobs are moved to lower-cost countries 
2. Support software etc. is moved to enable similar productivity in those countries 

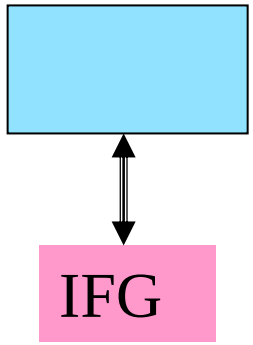
- Income is generated by people and (intellectual) capital

Hypothesis

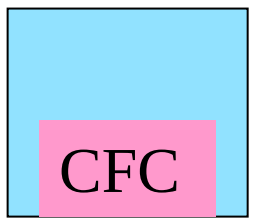
- Offshoring of jobs is effective because of concurrent Intellectual Property (IP) transfer
- Much of that IP is corporate property
- Transfer of corporate IP is poorly understood
  - IP as property is not well defined, hard to measure
  - There are many components to IP, coming from
    - *open source*, **R&D, marketing, reputation** as
    - Patents, copyright, trade secret (covered by NDAs)
- But can't ignore IP, it is a valuable, significant export

Types of Foreign Destination Entities

- **I**ndependent **F**oreign **C**ontractors
  - IFG may serve multiple customers
    - Share trade secrets with competitors
  - Owners need contracts to protect the IP
    - Hard to monitor and enforce

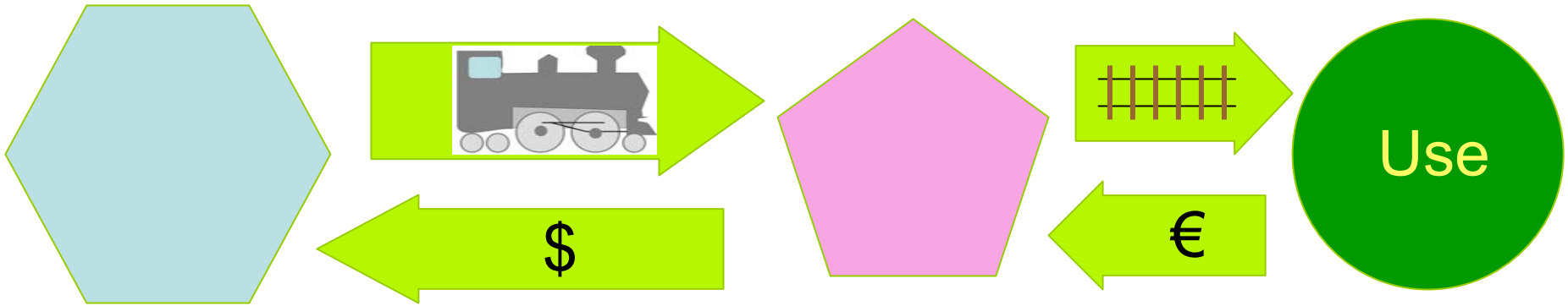


- Owned, **C**ontrolled **F**oreign **C**orporations
  - CFC provides much more control over IP
  - Ownership often in third-party countries
    - Avoids taxation of sales to other countries

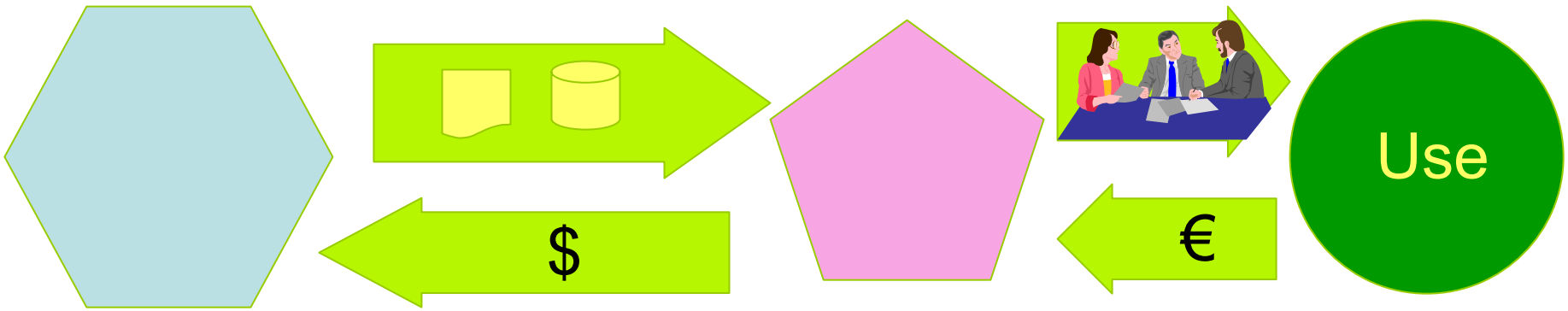


Export of (I) Property

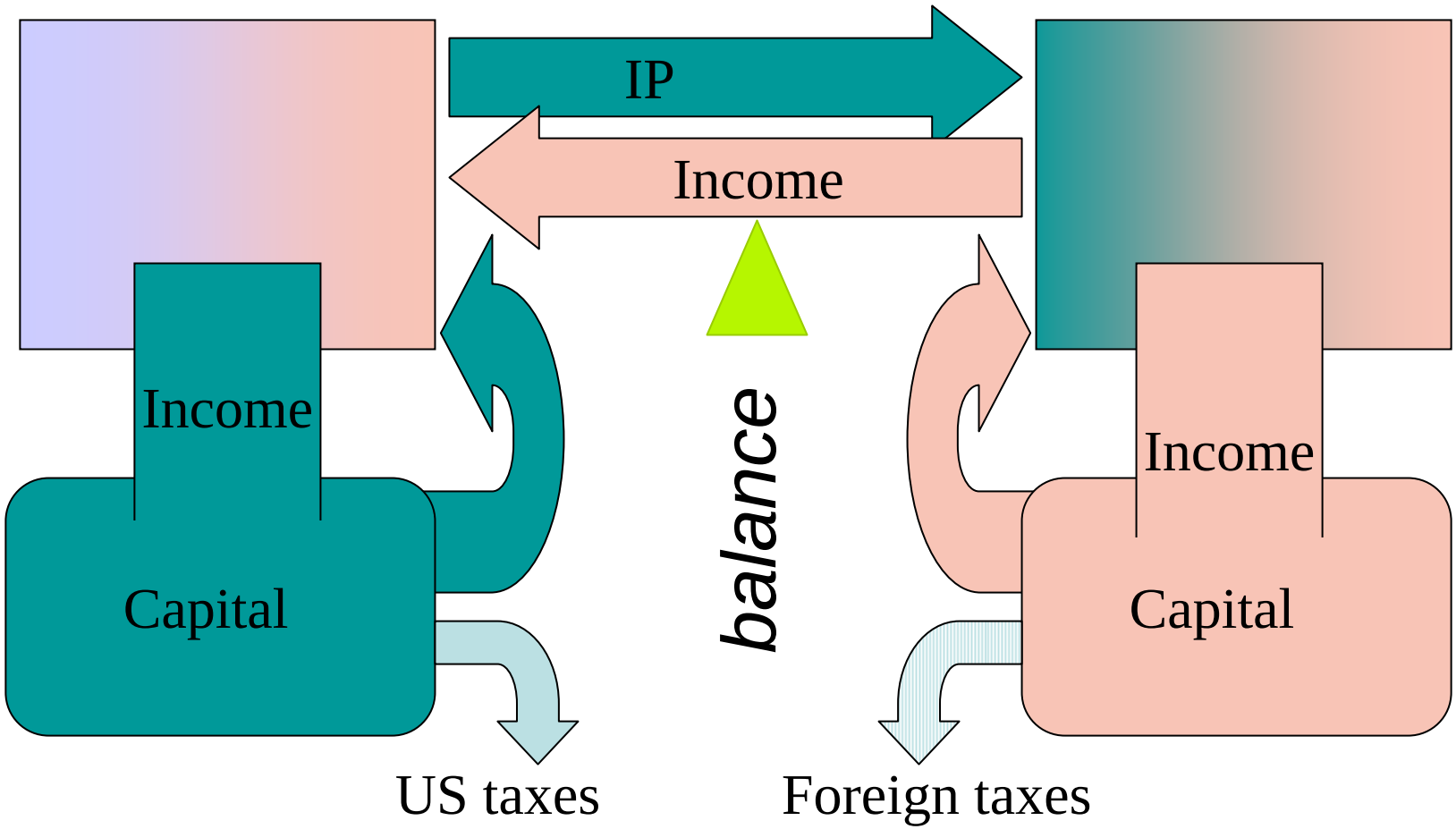
- Tangible value based on cost + margin ≈ price



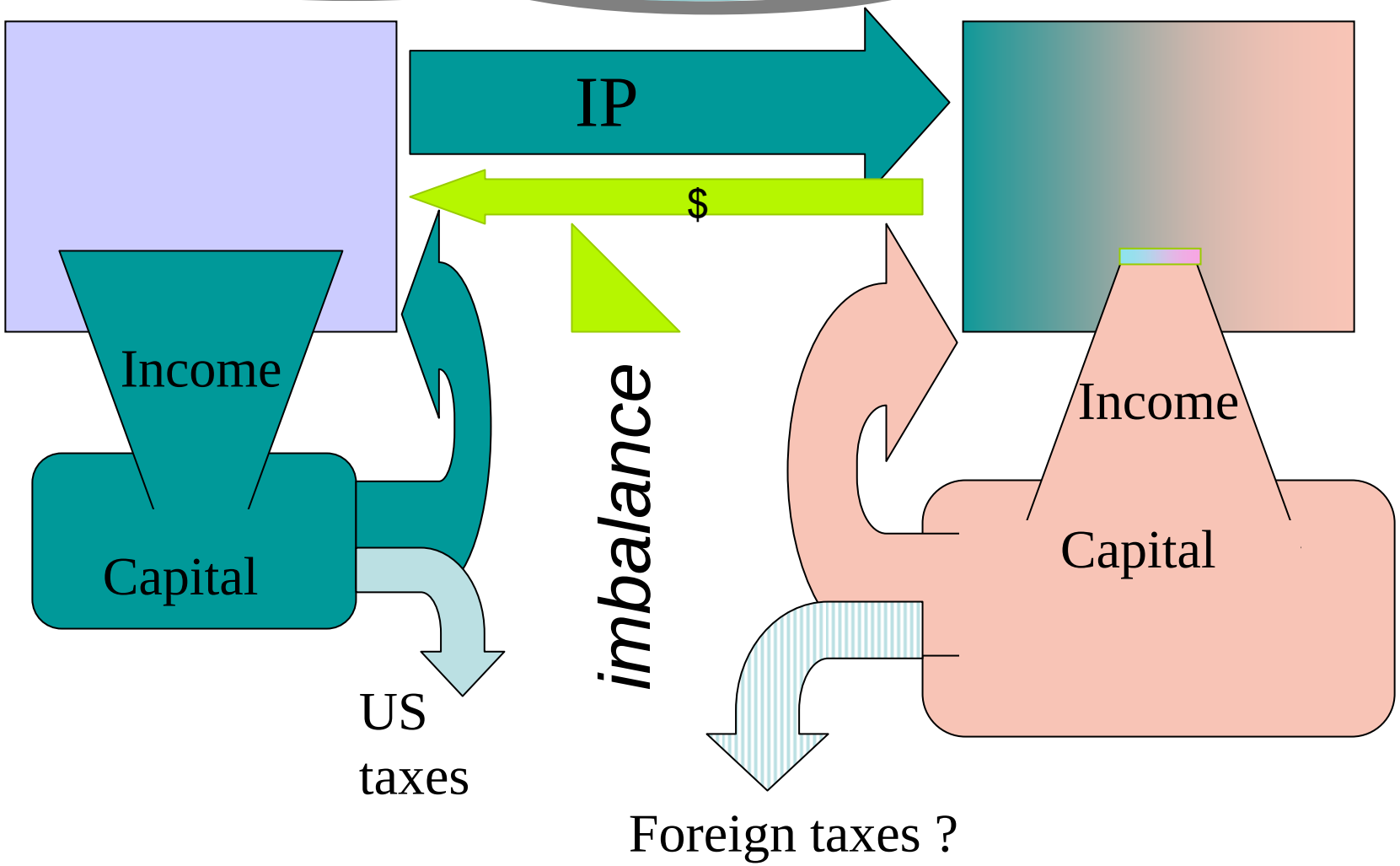
- Intangible value based on income potential, ≠ cost



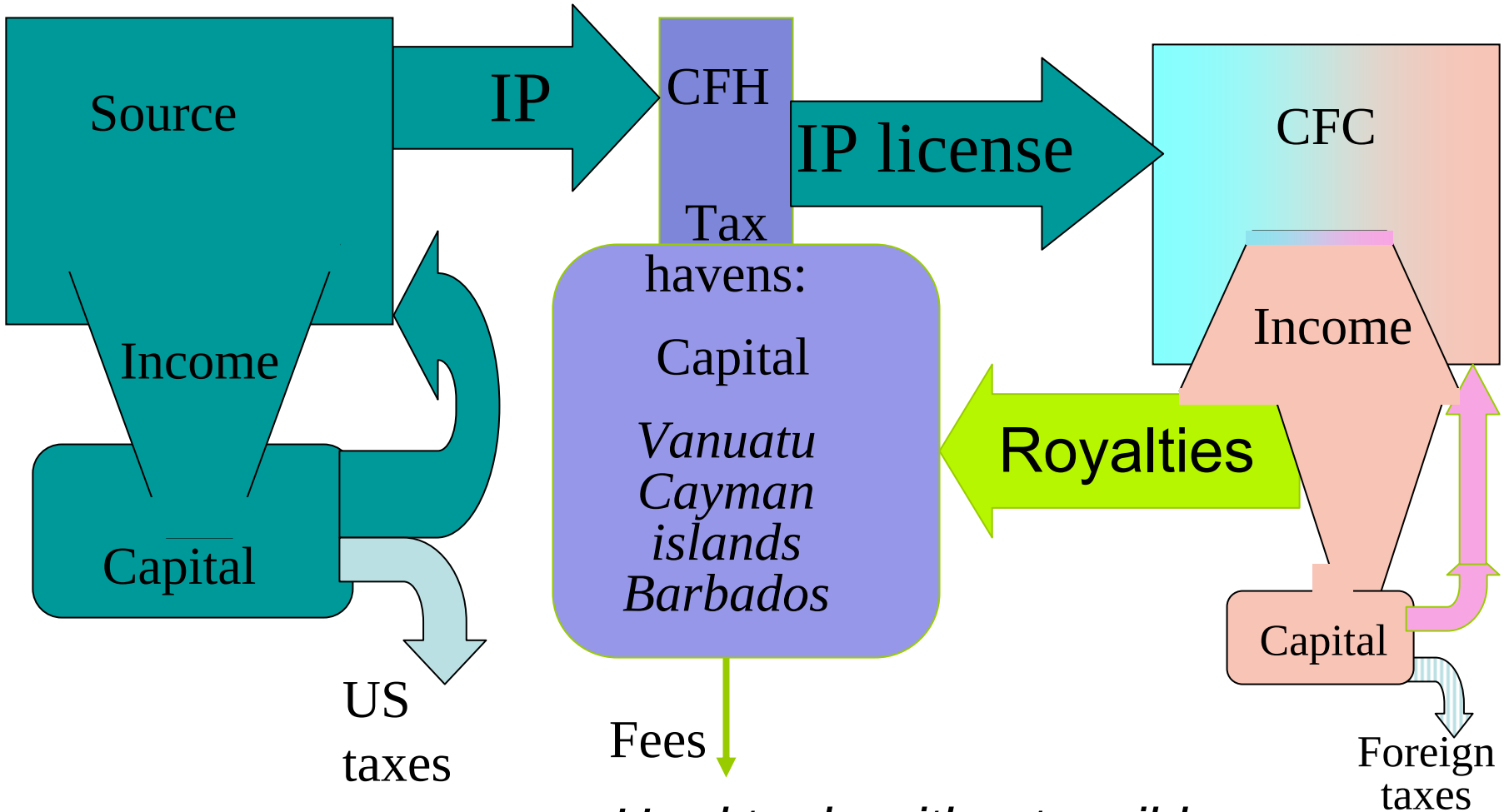
IP flow with fair return



IP flow without or poor return

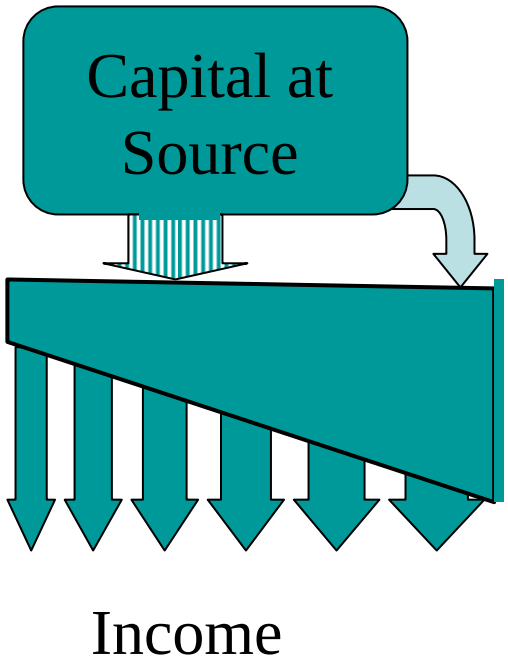


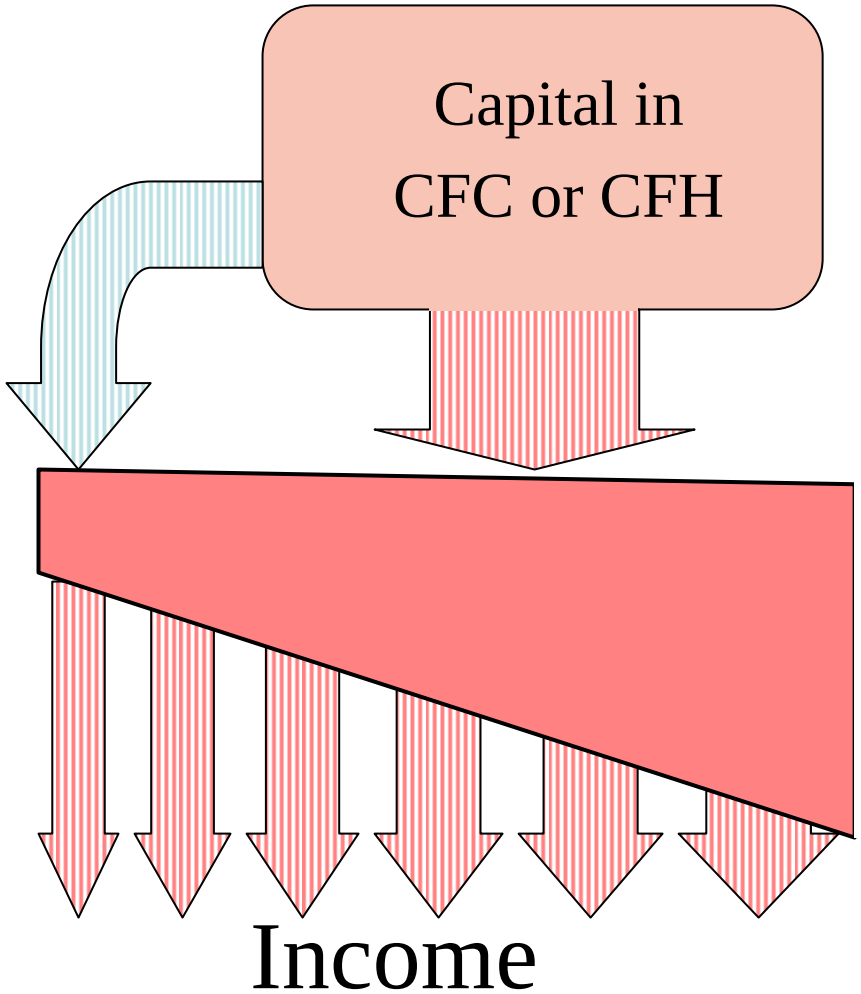
Capital flow with a taxhaven



Hard to do with a tangible

Capital creates more IP and Income





Extreme Case: Inversion

The foreign subsidiary (CFC or CFH) uses the capital to buy the U.S. Base (USB) company

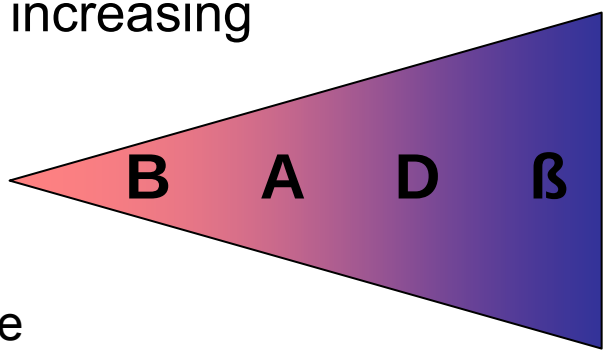
- CFC creates a second-level subsidiary (CUS) in the U.S.
- CUS merges with USB, considered a (368)(a)(2)(E) reorganization
- USB stockholders trade their shares for CUS shares, may be taxable
- USB is now a subsidiary of FS; and FS is not subject to U.S. tax
- Stockholder value is unchanged, but their control is diminished

- For sales to the U.S., royalty is now due to the IP owner
  - Tax deductible expense

← Symmetry →

Exports and Transfers go both ways

- There is innovation everywhere
- If the U.S. imports IP, the receiver should pay
  - Basic and fundamental research in the U.S. is declining
    - Growth was motivated by WW II experience [Vannevar Bush]
    - Many countries now fund fundamental research
  - The ratio of applied to basic research is increasing
    - Technological research is rarely Basic
    - Industrial research is mainly Applied
  - Development requires more resources
    - Industrial and management infrastructure
    - Demonstration and Beta (ß) sites - early adopters



Good in the U.S

Problems

- There is a lack of trustworthy data

1. $ 209M spent [US commerce department, 2003]
+ 4 663 jobs lost [U.S. labor dept, 1Q04]

2. $2 400M income [Business week, in 2003]
+ 50 000 jobs gained [Indian NAS&S Cos, Fy04/4]

- Attitudes are inconsistent

Greenspan 1: IP rights have assumed increasing importance [27Feb03]

Greenspan 2: Our economy is best served by full and vigorous engagement in the global economy – when defending reducing protection [11Mar03]

Convoluting non-owned ~~IP~~ issues

- Education: Services that transmit valuable,

  but non-*proprietary* knowledge to others.
  - If receiver pays, can take it anywhere
  - If the state pays, can it / should it be reimbursed?
- Publication: ~~IP~~ placed into the public domain
  - Who benefits?
    - The reader gets knowledge / The writer gets fame
    - Society becomes more egalitarian, effective

Future: Outsourcing and IP export

Increasing understanding and accounting for IP exports

(making them visible)

Political concern by populists & traditional conservatives *versus* strong lobbyists pressures and neo-conservatives

Taxation of IP exports

- will increase corporate profits in the U.S.
- reduce cash in foreign accounts, more for U.S. investment
- provide taxes that could be used to compensate
  - for R&D support provided by the government
  - for educational costs
  - for retirement benefits of workers whose IP was outsourced
- Is unlikely to stop offshoring substantially

- Amounts would be large in a number of cases

Related philosophical questions

Happiness or contentment

- Personal benefits of offshoring – short term
  - ↑ More cheap stuff --- a benefit of offshoring
  - ↓ Less employment --- a cost of offshoring

- Global benefits of offshoring -- long term
  - ↑ Greater income equality among countries
  - ↑ Balancing working conditions within countries

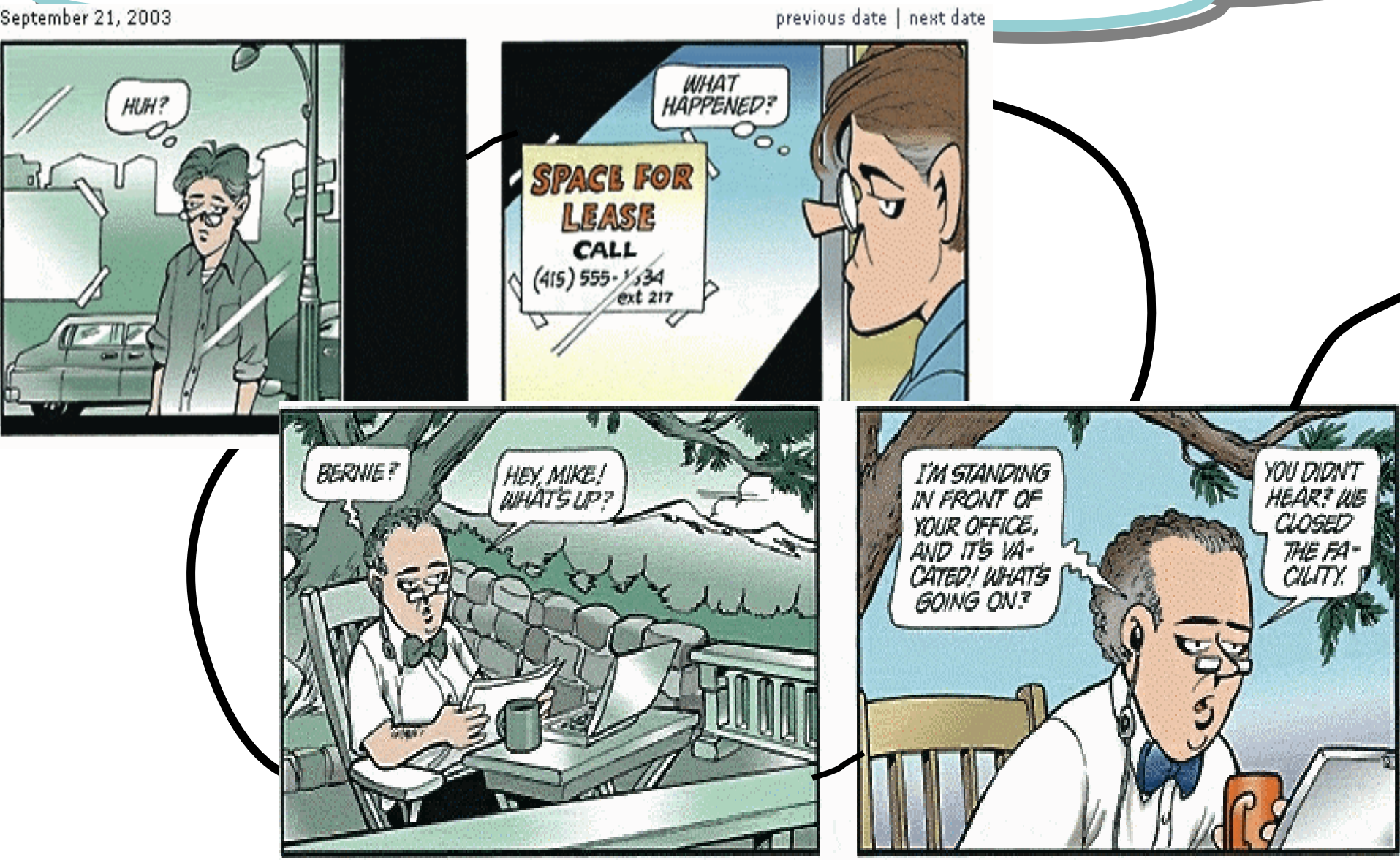
- Can a corporation or government be happy?

  Note that a corporation is legally treated as a person!

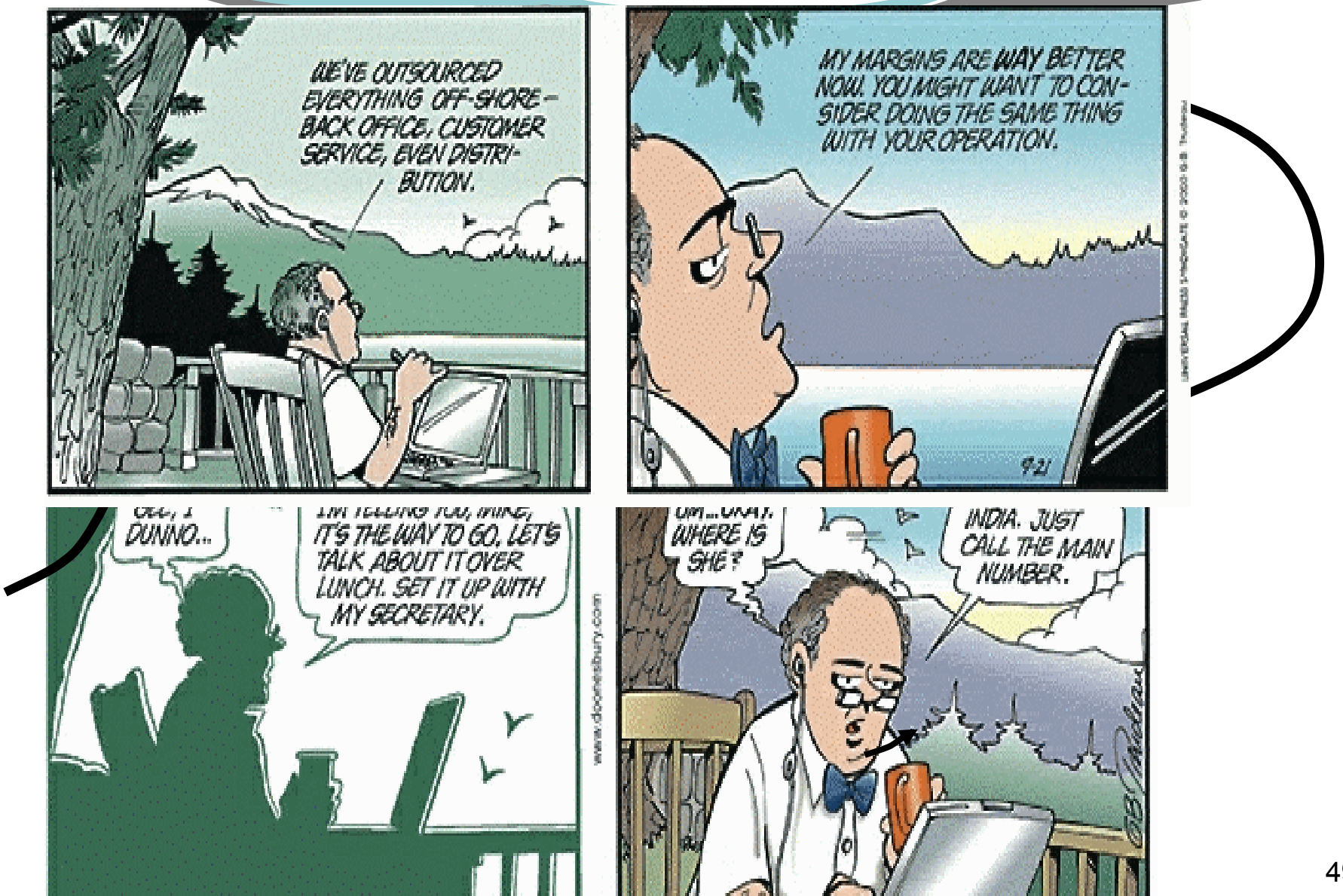
Knowing the Worth of Software

- Allows rational design decisions, as
  - Directing development efforts
  - Programming investment for maintenance
  - Understand limit to Software Life
- Allows rational business decisions, as
  - Choice of business model
  - Degree and method of outsourcing
  - Where and when to invest
  - How to assign programming talent
- Improve focus of education in software
  - Consider quality, not just quantity in assignments
  - Effectiveness of curriculum

Doonesbury 1/2



Doonsbury 2/2



To illustrate: a Sequence of Hx cases

- Moving from Sales to Transfer of property
  - Country-based vs. Global companies
- Moving from Tangible to Intangible
  - Visible & measurable, barely so, or not at all
- Intangible property with Intangible knowledge
  - Services versus Patents and Trade Secrets
- Outsourcing
  - Work and its enablers: human and intellectual capital

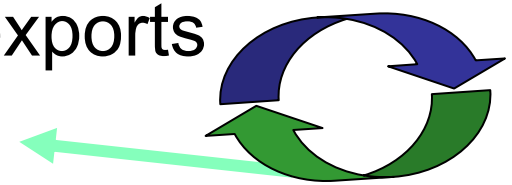
Definitions emerge as we proceed through 10 cases

Case 1: Tangible export only

U.S. Machine tools* producer **U**

* To simplify: tools are not innovative, could be be built anywhere

- **U** exports its products to foreign countries
  - Receives payments for those exports
  - Pays taxes on resulting profit



IP Note: **U** supplies documents for use of the machines. Those documents may be copyrighted.

But copyright does not protect intellectual contents, only protects outright copying.

Rarely valued.

Case 2: Tangible transfer

Global Machine tools producer **G**

- Exports machines to **G**'s CFC factory **F**, to be used in production of other products at **F**
  - **G** receives transfer payments **T** from **F** for those exports
  - Must show that the transfer price **T** is reasonable
    - Should match prices of external sales by **G**, or by other Co's
    - Unreasonably low transfer prices imply U.S. tax avoidance and hiding profits at a foreign base.
  - Pays taxes on resulting profit

But it's hard to be profitable without distinguishing abilities: IP

Case 3: Tangible + market value transfer

Renowned **r** Global Machine tools producer **R**

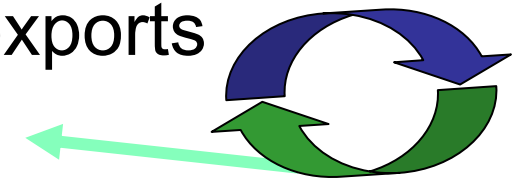
Reputation **r** is due to investment in quality and advertising

- Exports machines to its CSC factory **Q**
  - Gets higher prices **T+** for external sales because of **r**
  - **R** receives transfer payments for the internal exports
    - Transfer price includes **r** when based on its **T+** export prices
    - Harder to assess when there are no exports, and other companies in the business have different reputations
    - Reputation **r** is IP due to marketing & product quality
      fast effect - *long-term effect* .
  - Pays taxes on resulting profit

Case 4: Intangible export ≈ Case 1

U.S. Software tools creator and producer

- Exports software to foreign countries
  - Receives payments for those exports
  - Pays taxes on resulting profit



- *Problem: software is easily copied*
  - Protection desired, achieved by combination of

    Only issuing licenses -- *avoids property rights issues*

    Copyright laws and patents -- *requires govmnt cooperation*

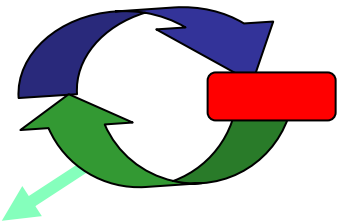
    Making copying hard -- *technology game*

    Restricting maintenance -- *works for critical packages*

Case 5: Intangible transfer ≈ Case 2

U.S. Software creator and producer

with foreign distribution

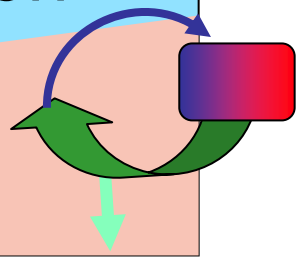


- Exports software products to foreign subsidiary, to be marketed and sold there
- Receives transfer payments for those exports
  - Must show that the transfer price is reasonable
    - By comparison with other sales by self, or by other co's
      - More difficult to assign value than tangibles.
  - Pays taxes on resulting profit

Case 6: Intangible manufacturing

U.S. Software producer with foreign distribution

- Exports software master to its subsidiary,
  to be copied*, marketed, and sold there



- Receives transfer payments for single export
  - Must show that the transfer price is reasonable
    - One instance allows thousands of sales,
      generates substantial ongoing income over its lifetime
    - Valuation requires projection of income over life
      - When is income realized? What is the life of the software?.
  - Pays taxes on resulting profit

** equivalent to manufacturing; writing software is considered R&D*

Case 7: Intangible transfer, joint creation

Software producer with foreign specialists

- Exports software master to its subsidiary, and **adapted, copied, marketed, and maintained** there
  - Source of foreign part of knowledge is remote
  - Assume cost of all R&D centrally accounted
- Receives transfer payments for those exports
  - Must show again that the transfer price is reasonable
  - Share R&D cost according to locale of revenue
  - Credit foreign R&D against foreign revenue
  - Pays taxes on U.S. assignable profit of foreign sales

Case 8: Shared intangible creation

Global Software producer "*a Knowledge Factory*"

- Develops globally, perhaps 24/7
  - Shares all knowledge globally at initiation
  - Assume that cost of all R&D centrally accounted

- Transfer payments should move both ways
  - Must show that the transfer prices are reasonable
    - Use of prior IP accounted for, or Buy-out
    - Allocation? cost, hours?
    - Compute balance
  - Pays taxes on U.S. balance of profit.

Case 9: Extreme offshoring

Company offshores everything

R&D, Production, distribution, service, feedback

- All IP has been exported
  - Value of export is value of entire company, except for tangibles (HQ building, cash, option income)
  - All income is offshore
  - Only profits needed for dividends are repatriated
  - No U.S. taxable income on continuing operations
  - Initial export of IP should be (have been) taxed?

Value of Intellectual Property

Value of IP is sum of future income it generates, reduced to the present

1. If investors determine a Market value

   IP = market value – book value (tangible)

   - Book value: Much detail in corporate reports
   - IP: no information, often 10 × bookvalue

2. Specifics require good predictions
   - Fractions of IP from sources:
     - R&D, personnel know-how, acquisitions, advertising
   - Life of IP