CS207 #5, 25 Oct. 2013

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Hewlett 102

Sign in

Syllabus:

1. Why should software be valued?
2. Open source software. Scope. Theory and reality
3. Principles of valuation. Cost versus value.
4. Market value of software companies.
5. Alternate business models.
6. Intellectual capital and property (IP).
7. Life and lag of software innovation. Marketing. Allocation.
8. Sales expectations and discounting.
9. The role of patents, copyrights, and trade secrets.
10. Licensing.
11. Separation of use rights from the property itself.
12. Risks when outsourcing and offshoring development.
13. Effects of using taxhavens to house IP.

Renovate or Reconstruct:
the economics, tradeoffs and applications

Dr. Vishal Sikka
Member of the Executive Board | SAP AG
October 25, 2013

Tradeoffs in Software (and Other Systems)

A few fundamental tradeoffs governed by underlying economics impact software development decisions as well as areas beyond software.

Examples of these tradeoffs are:

- Renovating vs. Reconstruction
- Own vs. Rent
- Decentralized Teams vs. Shared Services

During the next two lectures we explore these tradeoffs.

SAP at a Glance

The World's Largest Provider of Enterprise Software

Founded in 1972, **Headquarters: Walldorf, Germany**

66,061 employees with 120+ nationalities | 14 Development centers (SAP Labs)

16.3B EUR Revenue (2012) | 94.73B USD Market Cap

251,000 customers in 120 countries

20% Large Enterprise, 80% Small & Medium Enterprises

5 Markets: Application, Analytics, Database & Technology, Mobile, Cloud

25 industries and 11 lines-of-business

13,200+ partners around the world

SAP Product Portfolio

20,500 R&D Employees

Thousands SW Products & Versions

60%+ SW Products in Maintenance

SAP R/2 (end of 1970s), SAP R/3 (1992) still in Customer Specific Maintenance

RTC today: Asset Management Oil & Gas 1.0

Products Diversity

Home Grown | Acquisition | 3rd Party

Programing Language | Architecture | Platform

Products Development Shifting

From Applications Centric to Applications + Technology & Platform

From On-Premise to Cloud

Fundamental Questions for Today

When do you **reconstruct** vs. **renovate**?

Is there a spectrum of choices here? What is the point of no return at which a system/structure is best shutdown/mothballed/left-for-dead?

To what extent can the models applicable to physical structures (like houses and hotels) apply as well to software systems?

Examples in Real Life – Single Family Homes

- Projects range from
  - tear down of existing structure and rebuilding a new home; quite common when land value is very high and residential areas are restricted i.e. limited expansion plans e.g. Palo Alto, Woodside
  - Improving select areas in the house e.g. the kitchen or adding a living area

- Tradeoffs include costs involved (economics), emotional attachments and at times legacy value of structure

Examples in Real Life – Commercial Buildings

- Note: interesting part of the video is from 1:46 mark http://www.youtube.com/watch?v=h3K3kEDEAN4
- Tradeoffs include costs involved (economics), changing customer preferences e.g. rising popularity of extended stay hotels, and at times historical value of building

Examples in Real Life – Software

Successes

Google's reconstruction of its search with the new engine "Hummingbird"

Twitter's reconstruction of its entire stack on JVM/Scala, move away from Ruby on Rails

Failures

Microsoft's Project Green announced in 2003 planned to bring four acquired ERP products (Great Plains, Navision, Axapta, and Solomon) to Microsoft technology and common code base

Oracle's Project Fusion announced in 2005, envisioned to bring together the capabilities of various acquisitions and a new platform

FAA's Next Generation Air Transportation Control System announced in 2004 to transition the Air Traffic Control system from outdated ground-based radar to satellite-based GPS

IBM initiative in the mid to late 1990s to turn some basic business application functionality-general ledger, say-into shared intellectual property that a range of ISVs could use to build applications.

The Objective

- Identify the key economic forces at work in making the decision to renovate or reconstruct
- Develop empirical relationships that can help make this decision
- Understand the key tradeoffs that are in play e.g. cost of borrowing, lifespans etc.
- Recognize the non economic factors which are also in play and their importance

Economic Forces and Assumptions

Reconstruction

- Cost of new system, plus costs for demolishing old system and temporary arrangements during reconstruction
- Savings in annual maintenance due to reconstructed
- Additional rent or value from reconstruction

Renovation

- Cost of renovation
- Expected prolonged life of renovation to delay reconstruction costs
- No significant savings in maintenance expected due to renovation
- Additional rent or value from renovation

Reconstruction vs. Renovation

Empirical Relationship – Conceptual Representation

Cost of reconstruction	**vs.**	**Cost of renovation**
Cost of new system + Cost of demolishing and disposing of the old system + Costs incurred for temporary arrangements during reconstruction - Discounted present value of new construction which is delayed by renovation		Cost of renovating the system + Net present value of extra cost in maintenance (which is saved if system is reconstructed) + Net present value of any extra rent (revenue) that can be attributed to a reconstructed system vs. the renovated system

Source:
Lionel Needleman, The Economics of Housing, 1965
Decision support model for semi-automated selection of renovation alternatives Yehiel Rosenfeld), Igal M. Shohet, 1999

Reconstruction vs. Renovation

Empirical Relationship – Mathematical Representation

Cost of reconstruction

$$C - k\left(\frac{1 - nr}{1 + i}\right)^n$$

vs

Cost of renovation

$$R + (M + D)\left(\frac{1}{i} - \frac{1}{i(1+i)^n}\right)$$

C = Total costs of reconstruction {cost of new system + cost of demolition of old system and any temporary arrangements}

k = Cost of new system

n = Expected prolonged life of renovated system

i = Interest rate

r = Depreciation rate of reconstructed system

R = Cost of renovation

M = Savings in annual maintenance cost due to reconstruction

D = extra rent (revenue) that can be attributed to a reconstructed system vs. the renovated system

Source:
Lionel Needleman, The Economics of Housing, 1965
Decision support model for semi-automated selection of renovation alternatives Yehiel Rosenfeld), Igal M. Shohet, 1999

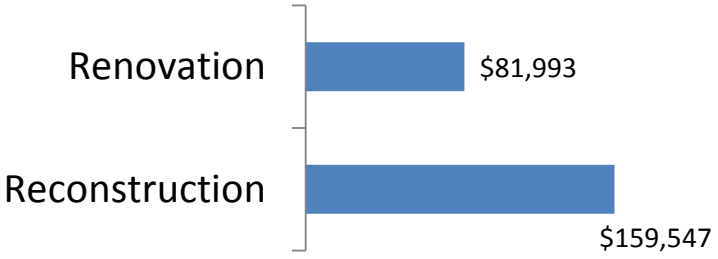
Application of Empirical Equation

Examples include residential building, hotel & software

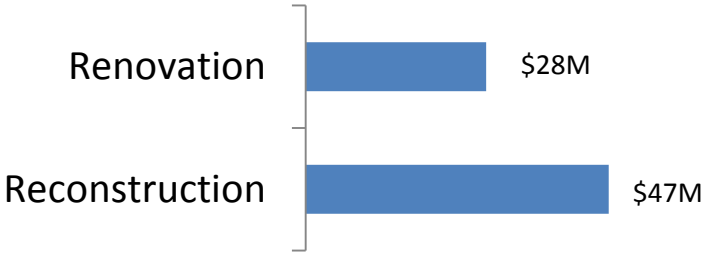
Each scenario evaluates renovate vs. reconstruct decision

Findings from empirical equation

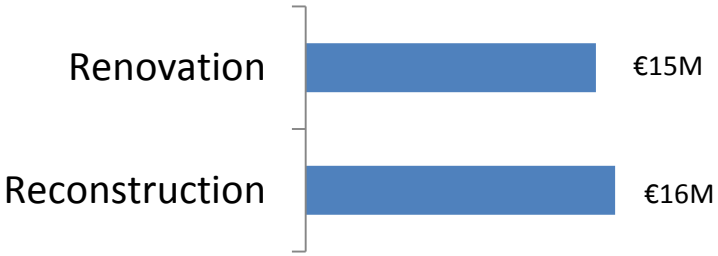
A typical 1960's Eichler in Palo Alto, 2000 sq. ft. of constructed space, owner considering adding 1000 sq. ft. of space for e.g. expanding the living area, adding a bathroom



An existing hotel with mid Priced rooms evaluating conversion to an extended stay. There is expected to be higher occupancy and rental value if reconstructed



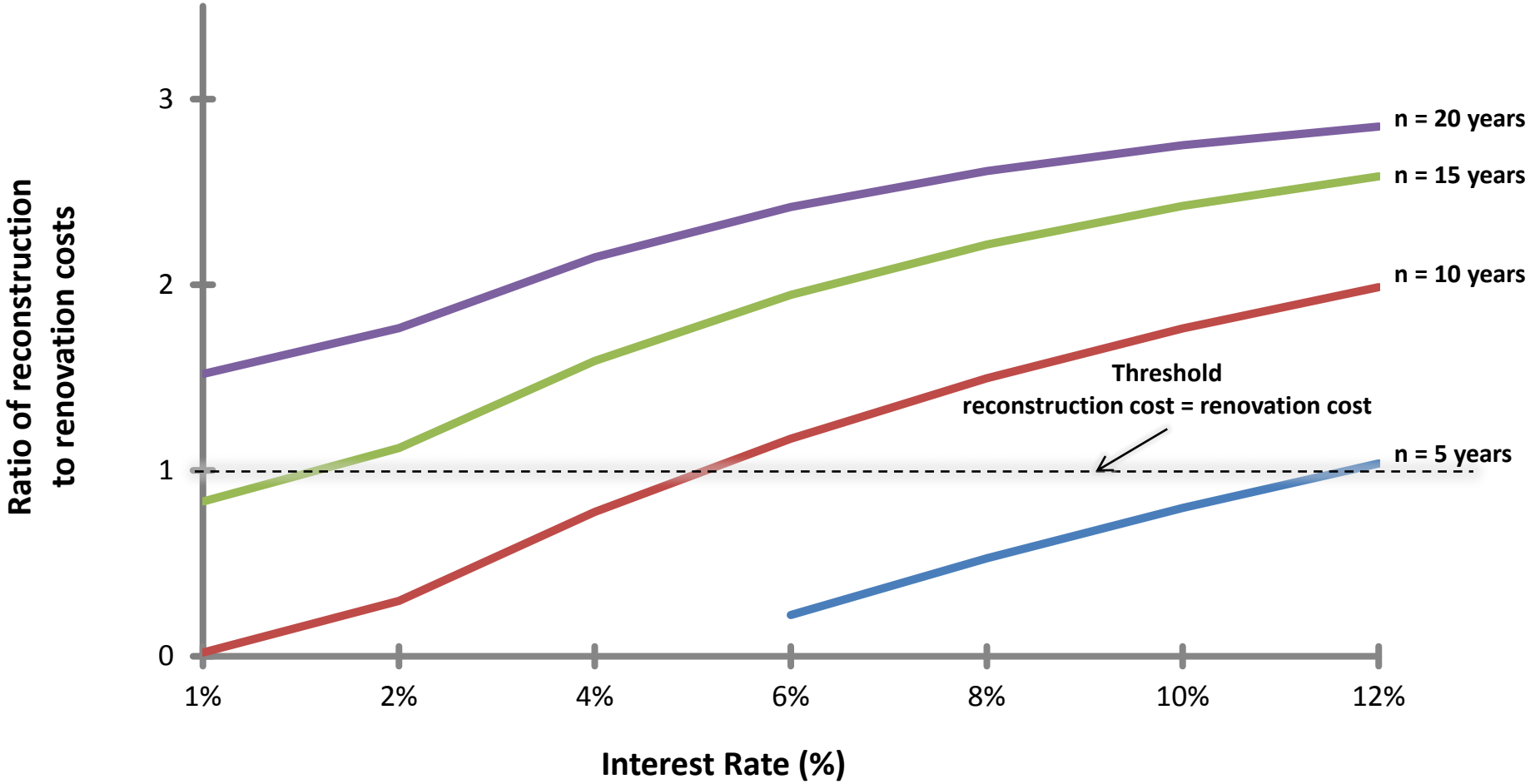
A cloud based SW solution with complete business functionality like finance, HR. However it faces severe limitations in its existing platform which make it expensive to operate, limited in its adoption as extensibility is not easy , poor performance.



Comparing the Results from Three Scenarios

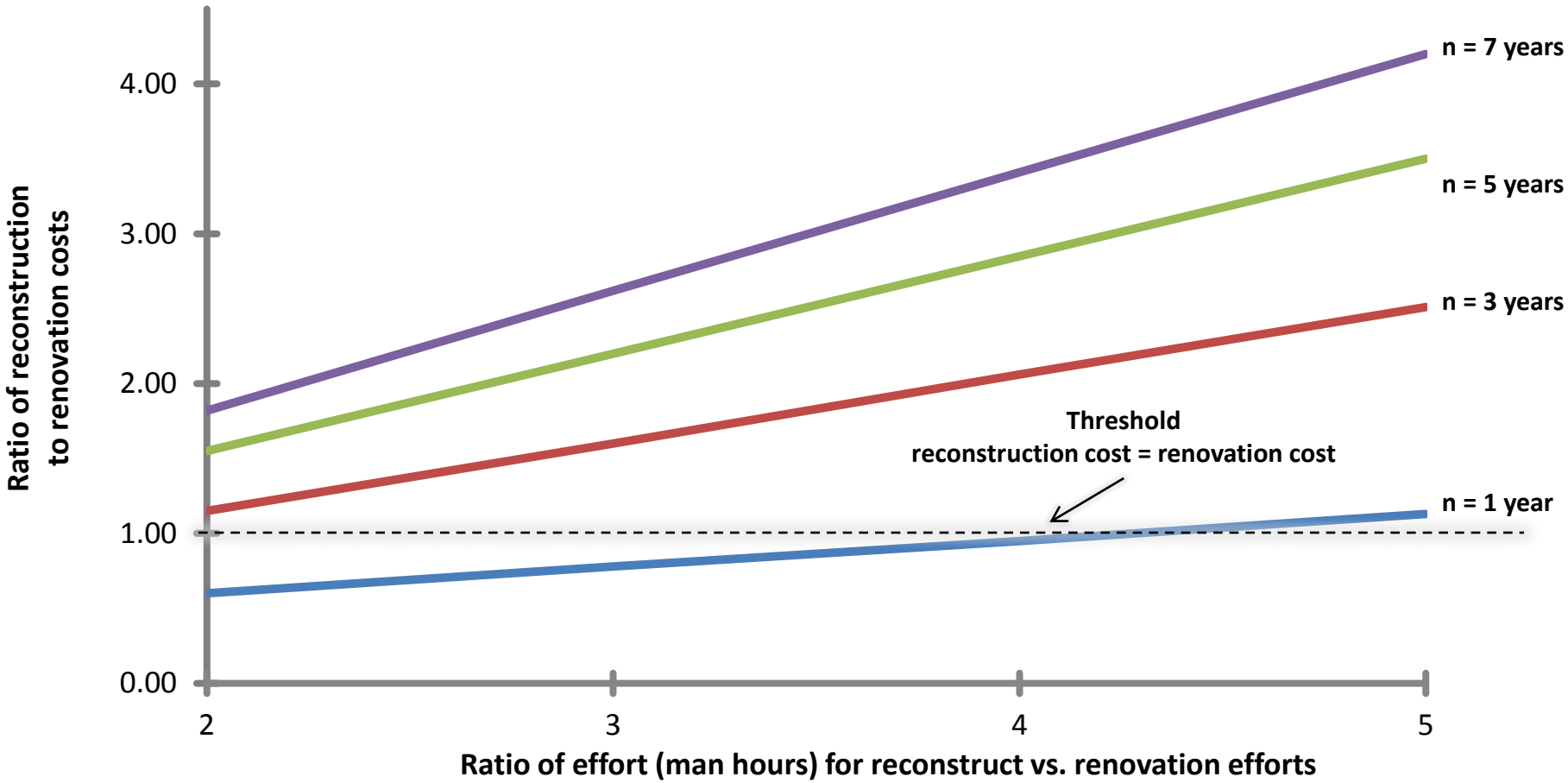
- Interest rate *i* and prolonged life of renovated asset *n* are two significant variables where a slight change in their values has an exponential impact on the reconstruction vs. renovation decision
  - For e.g. in case of residential scenario interest rate for home loans is higher than loans for commercial building
  - Increased life of renovated assets is much higher in building structures as compared to software since disruption cycles are shorter in technology
- Other variables like direct cost of reconstruction or savings in maintenance have more of a linear effect
- Although the empirical relationship was developed for structures it can be successfully applied for software systems effectively

Threshold with Variation in Interest Rate and Increased Life of Renovated Asset (Buildings)



- Interest rate (borrowing cost) and prolonged life (n) of renovated system are two key variables
- At lower interest rate reconstruction is more attractive option

Threshold with Variation in Interest Rate and Effort Needed (SW Scenario)



- Man hours needed and prolonged life (n) of renovated software system are two key variables
- Unless renovation efforts increase the life of the software system more than 5 years, reconstruction is a better option
- Interest rate does not matter as much because it is the internal hurdle rate of a company and usually that does not vary too much

Key Findings/Applications

In general renovation is better if

- It prolongs the effective service life of existing asset by at least 5+ years
- The value of existing asset is high
- The interest rates are high
- The direct/indirect cost of reconstruction is relatively high vs. renovation

Both reconstruction and renovation efforts need a few key common checks

- Effective execution is key, many examples of failures after a grand vision
- Conceptual integrity and timeless software principals, separate the content from container, architecture from implementation

Psychological Factors to Consider

- Organizational and market implications
- Emotional attachment to existing system, or “too much invested to fail”
- Hoarding is easier in software systems as indirect cost of maintaining unused codes is not directly apparent
- Tendency to over-engineer in software (*Second-system effect, Fred Brooks in Mythical Man Month*)

Conclusions

- Economic model of reconstruction vs. renovation for buildings can be a good starting point to think about the economics for software

- For Software
  - The frequent technology disruption cycles limit the usefulness of renovation efforts when compared to reconstruction
  - Value of rapid iterations vs. the nonlinear growth in cost of debugging/maintaining legacy code
  - Timeless architecture has the potential to get the best of both worlds (the benefits of reconstruction AND renovation)
  - Cannot ignore the psychological implications in making the decision for e.g. over-engineering reconstruction efforts (second system effect) or organizational impact of change

- More work is needed to bring quantitative thinking to software decision making

Next Lecture

- The shift from ownership model to collaborative consumption
- Owning vs. renting (sharing) assets, services and resources
- Exploring the new business models and their economics

Backup Slides

Reconstruction vs. Renovation
Empirical Relationship – Typical Variations

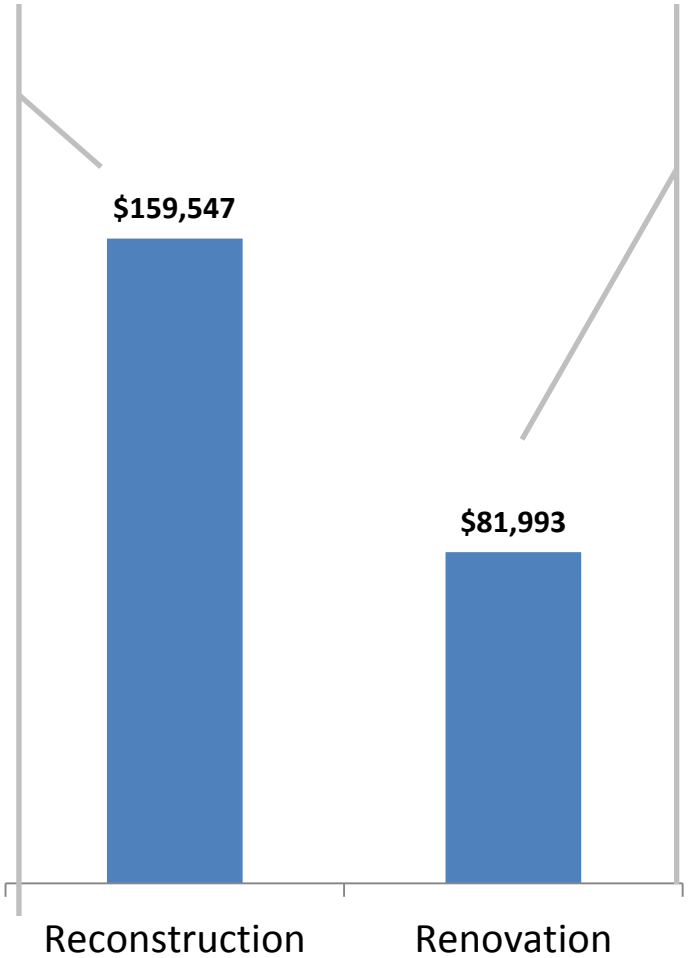
Condition	Modified expression
If n i.e. the expected prolonged life of renovated system is small then depreciation of reconstructed system is negligible hence r = 0	$C - k\frac{1}{(1+i)^n} \quad \boldsymbol{vs} \quad R + (M+D)\left[\frac{1-\ (1+i)^{-n}}{i}\right]$
The original expression assumes constant prices, if however replacement costs increase at annual rate of *z* then the expression is modified to account for these increasing prices	$C - k\,(1-nr)\frac{(1+z)^n}{(1+i)^n} \quad \boldsymbol{vs} \quad R + (M+D)\left[\frac{1-\ (1+i)^{-n}}{i}\right]$
If there is no additional rent expected due to reconstruction then D = 0	$C - k\frac{(1-nr)}{(1+i)^n} \quad \boldsymbol{vs} \quad R + M\left[\frac{1-\ (1+i)^{-n}}{i}\right]$

Example 1: Residential home scenario
Application of empirical equation

A typical 1960's Eichler in Palo Alto, 2000 sq. ft. of constructed space, owner considering adding 1000 sq. ft. of space for e.g. expanding the living area, adding a bathroom

Reconstruction Investment

Cost of new construction (c')	$400,000
Cost of demolition and disposing	$20,000
Temporary housing costs	$48,000
Total cost of reconstruction (C)	$468,000
Cost of reconstruction from empirical equation	**$384,547**
Value added to house due to reconstruction	$225,000
Net investment in reconstruction	**$159,547**



Renovation Investment

Cost of renovation (R)	$150,000
Savings in annual maintenance (M)	$720
Additional Rent (D)	N/A
Cost of renovation from empirical equation	**$156,993**
Renovation costs recovered	$50,000
Net investment in renovation	**$81,993**

Residential home scenario

Residential home scenario (typical 1960 Eichler in Palo Alto, 2000 sqft of constructed space) considering remodeling about 1000 sqft of space for e.g. expanding the living area, adding a bath

Input Variables

Initial home constructed size (sq ft)		2000
Planned renovation area (sq ft)		1000
New construction costs including permitting ($/sq ft)	$	200
Cost of renovation ($/sq ft)	$	150
Reconstruction duration (months)		12
Temporary housing (rental cost) during reconstruction ($/month)	$	4,000
interest rate (i) - home improvement loans		6%
prolonged life in years of renovated building (n)		15
depreciation rate of new construction (r) per year		3%

LHS of evaluation expression for reconstruction costs

Elements of cost for reconstruction	**Value**	
Cost of new construction (c')	$	400,000
Cost of demolishing and disposing	$	20,000
Temporary housing costs	$	48,000
Total cost of reconstruction (C)	$	468,000
Individual formula components (intermediate steps)		
1-nr		0.50
(1+i)^n		2.40
(1-nr)/(1+i)^n		0.21
c'(1-nr)/(1+i)^n	$	83,453
LHS: C - c'(1-nr)/(1+i)^n	**$**	**384,547**

RHS of evaluation expression for renovation costs

Elements of cost for renovation		
Cost of renovation (R)	$	150,000
Savings in annual maintenance due to new construction (M)	$	720
Rent due to new construction vs renovated old building (D)	$	-
Individual formula components (intermediate steps)		
(1+i)^-n		0.417265061
(1-(1+i)^-n)/i		9.712248988
(M+D)*(1-(1+i)^-n/i)		6,992.8
RHS: R+(M+D)*(1-(1+i)^-n/i)	**$**	**156,993**

Value added to price of house due to reconstruction		
Additional premium on prices due to new construction		15%
Typical value of a 2000 sq ft Palo Alto home		$1,500,000
Additional price due to reconstruction		$225,000
Net investment in reconstruction (cost - value addition)	**$**	**159,547**

Value added due to renovation		
Typical renovations costs recovered		50%
Renovation cost recovered	$	75,000
Net investment in renovation (cost - value recovered)	**$**	**81,993**

References and assumptions for residential scenario

Both reconstruction or renovation do not change the original footprint of the structure i.e. living space is same before and after, there may be modifications in that space though

Palo Alto (and most cities) allows maximum remodeling of upto 50% of existing structure before deeming it as new construction and thereby applying new standards and evaluations, so for this e.g. 1000 sqft was chosen

Demotion cost: http://online.wsj.com/article/SB10001424127887324407504578185762234289162.html

Average rental for a 2000 sq ft house in Palo Alto @$4000/month

Assumed reconstruction duration 12 months

Cost of new construction @ $200/sq ft (includes permits) for entire 2500 sq ft structure

Cost of renovation@125/sq ft for adding the new 1000 sq ft

Interest rate for home equity/improvement: http://www.bankrate.com/home-equity.aspx

Assuming a st line depreciation for a structure over 30 years (expected life of major structural elements excluding foundation)

Annual maintenance esp energy usage improves by 20 to 30% due to newer construction:
http://www.americanprogress.org/issues/2009/08/pdf/rebuilding_america.pdf

Typical monthly maintenance fee incl utility for 2000 sqft house is $300/month

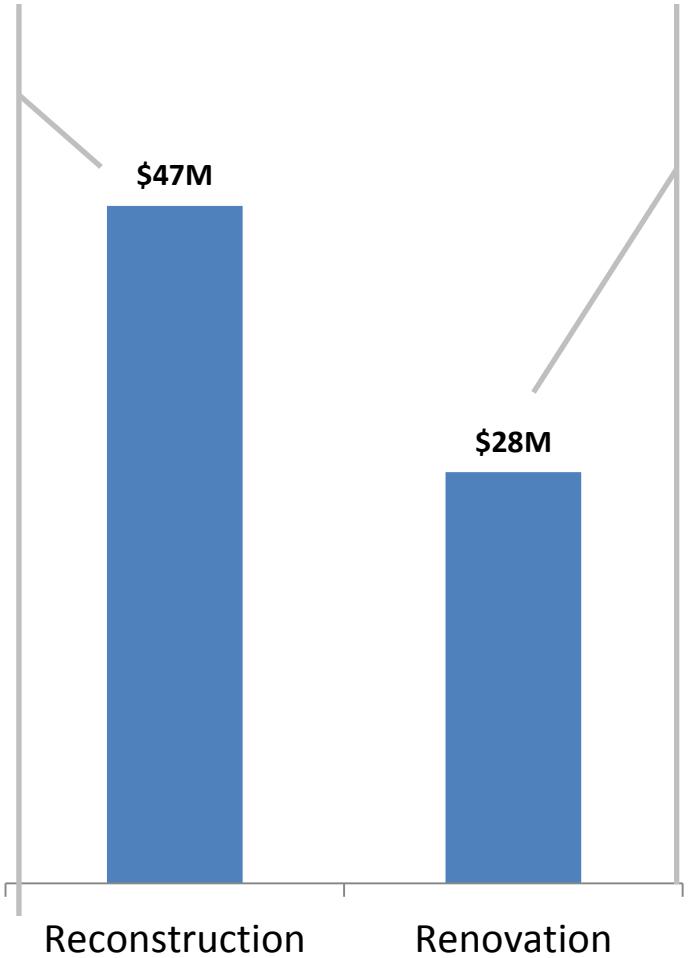
Palo Alto old and new home prices http://www.stucarson.com/PaloAltoNewVsOld

Recovery of renovation costs http://online.wsj.com/article/SB10001424127887324695104578419093371821934.html

Example 2: Commercial (hotel) scenario Application of empirical equation

An existing hotel with mid Priced rooms evaluating conversion to an extended stay. There is expected to be higher occupancy and rental value if reconstructed.

Reconstruction Investment	
Cost of new construction (c')	$52.72M
Cost of demolition and disposing	$100,000
Revenue loss during reconstruction	$2.7M
Total cost of reconstruction (C)	$55.47M
Cost of reconstruction from empirical equation	**$46.57M**
Net investment in reconstruction	**$46.57M**



Renovation Investment	
Cost of renovation (R)	$2.63M
Revenue loss during renovation	$675,000
Savings in annual maintenance (M)	$66,000
Additional Rent (D)	$3.01M
Cost of renovation from empirical equation	**$28.27M**
Net investment in renovation	**$28.27M**

Commercial (hotel) scenario

Input Variables

Number of rooms		150	
Room size including bathroom and kitchennte (sq ft)		550	
Lobby area (sq ft)		1,400	
Outside parking spots (9 ft x 18 ft)		175	
Cost of new construction including architect, contractor costs ($/sq ft)		300	does not include softgoods in rooms, bathrooms and lobby
Guest Room softgoods only renovation ($/room)	$	6,000	
Guest Room full renovation (additional to softgoods) ($/room)	$	9,000	
Guest Room bathroom renovation ($/room)	$	1,500	
Lobby softgoods only renovation ($/sq ft)	$	12	
Lobby full renovation (additional to softgoods) ($/sq ft)	$	84	
Outdoor parking cost ($/space)	$	140	
Reconstruction duration (months)		12	
average room rent (new construction) ($/room)		150	
average room rent (renovated construction) ($/room)		100	
average occupancy (new construction)		70%	
average occupancy (renovation)		50%	
energy costs per room per year	$	2,200	
energy saving due to new construction vs renovation		20%	
interest rate (i) - commercial loans		4.0%	
prolonged life in years of renovated building (n)		10	
depreciation rate of new construction (r) per year		5%	

Total hotel constructed area (building only) (sq ft)	83,900
Outside parking area (sq ft)	28,350
Total hotel area including parking lot	112,250

LHS of evaluation expression for reconstruction costs

Elements of cost for reconstruction	**Value**
cost of construction for structure including parking lot	$ 25,194,500
cost of furnishing rooms and lobby (softgoods)	$ 1,141,800
Cost of new construction (c')	$ 26,336,300
Cost of demolishing and disposing	$ 100,000
Opportunity cost lost in hotel revenues due to reconstruction	$ 2,700,000
Total cost of reconstruction (C)	**$ 55,472,600**
Individual formula components (intermediate steps)	
1-nr	0.50
(1+i)^n	1.48
(1-nr)/(1+i)^n	0.34
c'(1-nr)/(1+i)^n	$ 8,895,930
LHS: C - c'(1-nr)/(1+i)^n	**$ 46,576,670**

RHS of evaluation expression for renovation costs

Elements of cost for renovation		
Cost of renovation of rooms	$	2,633,900
Loss of revenue during renovation	$	675,000
Total cost of renovation (R)	$	3,308,900
Savings in annual maintenance due to new construction (M)	$	66,000
Higher rent (daily) due to new construction vs old building	$	8,250
Additional Annual Rent due to new construction vs renovated old building (D)	$	3,011,250
Individual formula components (intermediate steps)		
(1+i)^-n		0.675564169
(1-(1+i)^-n)/i		8.110895779
(M+D)*(1-(1+i)^-n/i)		24,959,254
RHS: R+(M+D)*(1-(1+i)^-n/i)	**$**	**28,268,154**

References and assumptions for commercial scenario

Hotel avg estimates and construction costs : http://www.fixr.com/costs/build-hotel

Assume typical guestroom area of approximately 25' wide x 16' long, plus 12' x 8' bathroom and 8' x 6' kitchen area = 548 SF, ceilings 8'-0" AFF, popcorn finish studio

Interest rates : http://www.nytimes.com/2013/02/13/realestate/commercial/new-york-developers-find-loans-easier-to-get.html?pagewanted=all

Hotel cost estimating guide: http://www.hvsdesignservices.com/2012%20Cost%20Est%20Guide_Updated_printable.pdf

Energy costs: http://www.energystar.gov/ia/business/challenge/learn_more/Hotel.pdf

Demolition costs: http://www.buildingjournal.com/commercial-construction-estimating-demolition.html

Assume it takes 3 months per floor for renovation