From Hand Calculation to IT-based Estimating – Learning through Project

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Think&Achieve 2013
University of Tennessee-Chattanooga
on May 01, 2014

Presentation Outline

Background & Objective

- **The general status quo of Construction Cost Estimating class**
- **Knowledge and skills desired in construction estimating**
- **Assist students in efficiently mastering IT-based estimation**

Research Approaches and Results Analysis

- **Conducted research activities with specific sub-objectives**
- **Assessment plan**
- **Results**

Discussion and Conclusion

Background

- **General status quo of Construction Cost Estimating class**
  - We only cover the important concepts and hand-calculation methods due to time limit.
- **Knowledge and skills desired in construction estimating**
  - Both the basic concepts and the practical skills for performing construction estimates are substantially desired by industry;
  - Information technology (IT) based estimation is more and more important among industry.
- **Students could feel frustrated since they are NOT well-equipped with these IT tools**

Objectives

- **Help our students quickly adapt themselves to IT tools**

  - From critical thinking perspective: train students on how to efficiently solve problems using their knowledge through the complete problem solving process, including identifying critical points, analyzing the reasons, proposing potential solutions and choosing the optimal solution;

  - From the knowledge perspective: help students own a quick adaption to IT tools.

Approaches & Activities(1)

- The practical project based learning approach is used.
- The two different estimating methods are experienced on the same project by students.
- The differences (Advantages & Disadvantages) between the two methods are analyzed and compared by students.
- In-class discussions and questionnaires survey by students are used for Rethinking on Their Thinking.
- Critical Reflection is adopted to assess the students' learning outcomes.

Approaches & Activities(2)

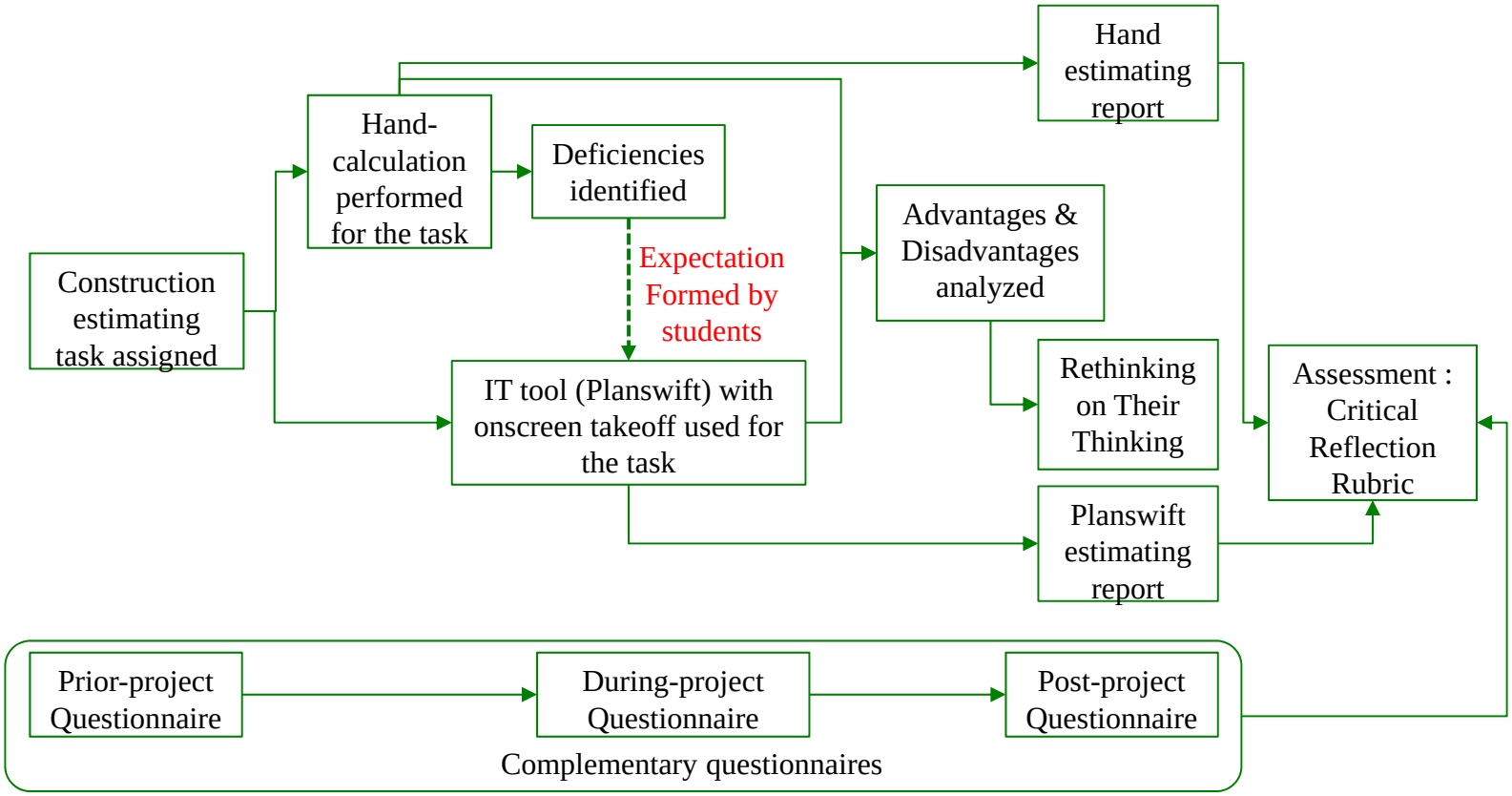

Fig.1 Specific project methodological procedure

Approaches & Activities(3)

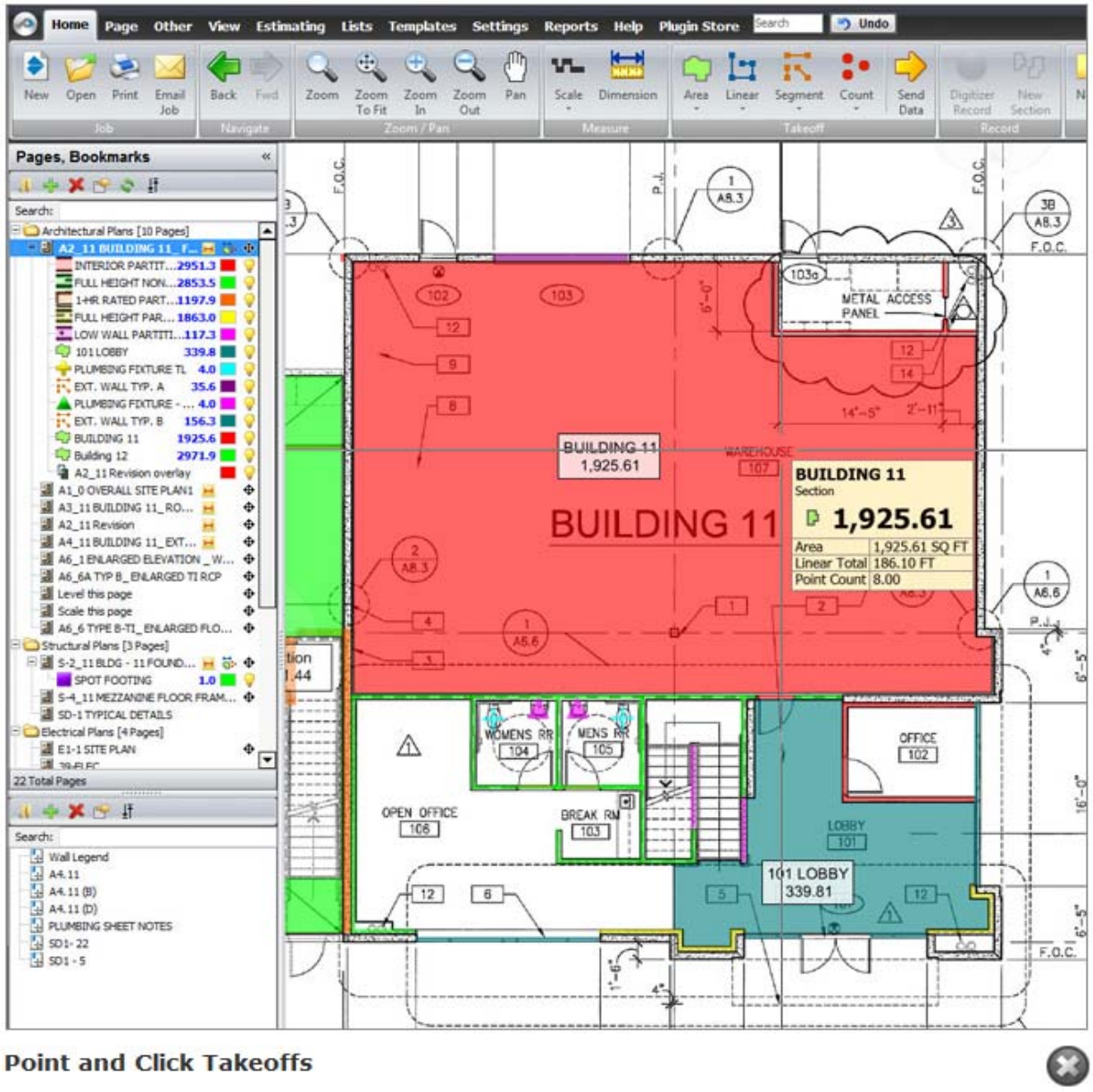

Fig.2 Planswift software

Approaches & Activities(4)

I. Questionnaires

1. Prior-project Questionnaire

a. How much do you know about the estimating concepts?
b. Which method do you know for estimating except hand-calculation?
c. Do you know IT-based estimating? If yes, what is the difference between IT-based estimating and hand-calculation?
d. Which method you think will be more accurate? Why?

2. During-project Questionnaire

a. What are the deficiencies of hand-estimating? How can we improve the hand-estimating?
b. What is the advantage of IT-based estimating? How can it improve the hand-estimating?
c. What are the similarities and essential differences between two estimating methods?
d. Have you met with some difficulties during estimating with two methods? How did you solve them?

3. Post-project Questionnaire

a. Do the estimating results match your prediction? If not, why?
b. Is IT-based estimating perfect? Why?
c. Are you more comfortable with IT-based estimating now? Why?
d. Do you better understand the estimating concepts? Why?

Approaches & Activities(5)

II. Critical Reflection Rubric for Engineering Undergraduates

Table 1 Critical Reflection rubric for engineering undergraduates table (Based on Ralston and Bays 2010; Paul and Elder 2001; Alfrey and Cooney 2009; etc.)

Elements (Aligning with the Think& Achieve outcomes)	**Characteristics**					**Scores and comments**
	1	2	3	4	5	
Information and Questions (15%)	Unclear information and does not include any questions with estimating project	Identifies pertinent information with irrelevant and/or few questions related to the project	Identifies key information with some complexities of relevant questions	Clearly identifies most information with most pertinent questions to the project	Clearly identifies all information with enough complexities of main questions and embedded aspects	
Problem solving (limitations, connections and possible solutions) (20%)	No perception of limitations; No connection with pertinent knowledge; No solutions	Little perception of limitations; Little connection with pertinent knowledge; One simple solution	Fairly understand limitations; Can connect with key knowledge; Two or more relevant potential solutions with insufficient accuracy	Understand limitations to large extent; Can connect with most of the required knowledge; Some accurate solutions but from limited perspectives	Thoroughly understand limitations; Can connect with all the required knowledge; Multiple accurate potential solutions from various perspectives	
The optimal solution selection and use (20%)	Selects solution that is invalid; The formulas, procedure and principles for the solution are wrong	Selects a reasonable solution but the justification is missing; The formulas, procedure and principles for the solution are inaccurate	Selects a reasonable solution with insufficient justification; The formulas, procedure and principles for the solution are with minor inaccuracy	Selects an optimal solution with sufficient justification; The formulas, procedure and principles for the solution are accurate	Selects an optimal solution with sufficient justification; The formulas, procedure and principles for the solution are accurate; Discusses the feasibility of other solutions	
Communication (Assumptions, solutions and implications) (20%)	Incompletely presents assumptions; Reports invalid solutions with arbitrary evidence; Fails to identify the implications	Simply presents relevant assumptions; Reports solutions without support of evidence; Recognizes the illogical implications	Fairly presents some relevant assumptions; Reports partial results using some evidences; Presents the insignificant implications	Completely presents key pertinent assumption; Reports solutions using effective evidences; Clearly presents Some significant implications	Completely presents all pertinent assumptions; Reports all solutions using effective evidences; Clearly presents all significant implications	
Innovative solutions (15%)	Fails to provide any innovative thoughts through creative thinking	Presents little innovative thoughts within limited perspectives based on pertinent experience	Presents some innovative thoughts within several perspectives based on experience but no perception of practice	Presents innovative thoughts within several distinct perspectives based on experience with perception of practice but no attempts	Presents revolutionary thoughts based on experience and attempts to put into practice	
Improvements (10%)	No perception of improvements	Little perception of improvements to integrate knowledge and skill through reflection on their thinking and learning	Attempts to seek improvements with the integration of relevant knowledge and skills through reflection on their thinking and learning	Spends some time to seek improvements to integrate knowledge and skill through reflection on their thinking and learning and discussion with peers	Spends much effort to seek improvements to integrate knowledge and skill through reflection on their thinking and learning , discussion with peers and consultation with education professionals	

Results (1)

- **Exampled estimating results**

Currently students must review drawings, take measurements, record them, make calculations and arrive at a total.

Hand calculations recorded on Excel spreadsheets.

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Project: Webb School New Science Building
CSI Division: 4
Specification Section:

Estimator: PB Student #1
Date: 9/26/2013 Page 1 of 1

Quantity Takeoff Sheet

Ref.	Description	Length	unit	Width	unit	Height	unit	Total	units	Notes	Carry FWD
	Brick										
	North Wall	59.8541667	ft			14.5	ft	868	sf		
	North Parapet	4.66666667	ft			34.6666667	ft	162	sf		
								39	sf		
	Under North Parapet	21.3333333	ft			9.94791667	ft	212	sf		
	North Parapet Columns	10.6666667	ft	2	ea	9.33333333	ft	199	sf		
	East Wall	87.8541667	ft			14	ft	1230	sf		
	East Parapet	4.66666667	ft			56	ft	261	sf		
								177	sf		
	Under East Parapet	42.6666667	ft			9.94791667	ft	424	sf		
	East Parapet Columns	10.6666667	ft	4	ea	9.33333333	ft	398	sf		
	South Wall	39.8541667	ft			14.5	ft	578	sf		
	South Parapet	4.66666667	ft			56	ft	261	sf		
								177	sf		
	Under South Parapet	42.6666667	ft			9.94791667	ft	424	sf		
	South Parapet Columns	10.6666667	ft	4	ea	9.33333333	ft	398	sf		
	West Wall	127.85	ft			15	ft	1918	sf		
	West Parapet							88	sf		
	Type B Windows (-)	-5.3333333	ft	14	ea	6	ft	-448.00	sf		
	Type C Windows (-)	-3.3333333	ft	13	ea	6	ft	-260.00	sf		
	Entrance Corridor Doors (-)	-6	ft	3	ea	9.33333333	ft	-168.00	sf		
	Outside Classroom Doors (-)	-3.3333333	ft	4	ea	9.33333333	ft	-124.44	sf		
		-5.3333333	ft	1	ea	9.33333333	ft	-49.78	sf		
	Mechanical Outside Door (-)	-4.3333333	ft	1	ea	9.33333333	ft	-40.44	sf		
	Precast Band (-)	-370.66667	ft			0.66666667	ft	-247.11	sf		
	Precast Coping (-)	-354.08333	ft			0.66666667	ft	-236.06	sf		
	Precast Sill (-)	-118	ft			0.44444444	ft	-52.44	sf		
	Precast Window Head (-)	-154	ft			0.66666667	ft	-102.67	sf		
	Precast Lintel (-)	-146.66667	ft			0.66666667	ft	-97.78	sf		
	Precast Accent (-)	38.48	sf	2	ea			-76.96	sf		
	Precast Window Accent (-)	0.44444444	sf	56	ea			-24.89	sf		
	Precast "SCIENCE" Sign (-)	14.6666667	ft	2	ea	3.33333333	ft	-97.78	sf		
	Precast Band Above "SCIENCE" Sign (-)	-32	ft			1.11111111	ft	-35.56	sf		
	Total SF							5753	sf	6334 sf	
	Bricks Needed							38833	ea	x6.75	
	Waste							3883.34644	ea	x 10% waste	
	Total Bricks Needed							42717	ea		
										Instructor's Calculation	GRADE
	Total Brick							43	M	47	M 91%

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Project: Webb School New Science Building
CSI Division: 4
Specification Section:

Estimator: EF Student #2
Date: 9/26/2013 Page 1 of 1

Quantity Takeoff Sheet

Ref.	Description	Length	unit	Width	unit	Height	unit	Total	units	Notes	Carry FWD
	Brick										
	sf * 6.75										
		6851.62	sf	6.75							
		6334 sf								instructor's calculation	Grade
	Total Brick							46248.4	m	47	98%
								46.2484			

Results (2)

Questionnaire results summary

- Students are gaining better perception in hand-estimating as the project moves on;
- Students are getting more comprehensive understanding (thinking) on estimating software by comparing their expectation and using experience.

Exampled questionnaire

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---Learning through Project

1. Prior-project Questionnaire

a. How much do you know about the estimating concepts?

I know how to do a detailed takeoff and assign prices based off RS Means.

b. Which method do you know for estimating except hand-calculation?

Basic understanding of takeoffs through BIM

c. Do you know IT-based estimating (i.e. software)? If yes, what is the difference between IT-based estimating and hand-calculation?

I know what it is, not necessarily how to use it.

d. Which method you think will be more accurate? Why?

IT Based. It is easy to overlook things when doing it by hand.

From Hand Calculation to IT-based Estimating
---Learning through Project

2. During-project Questionnaire

a. What are the deficiencies of hand-estimating? How can we improve the hand-estimating?

It can be easy to overlook things or count twice if you have not adequately marked things off. Plans are also big and bulky and easy to spill coffee on.

b. What is the advantage of IT-based estimating? How can it improve the hand-estimating?

It is colorful and easy to keep track of what you have done in an organized manner

c. What are the similarities and essential differences between two estimating methods?

They both get quantities, one uses a computer

d. Have you met with some difficulties during estimating with two methods? How did you solve them?

When estimating by hand, I didn't record how I got my numbers in enough detail to help my self on later projects and had to do them again.

Results (3)

Rubric-based evaluation results

Indicators	Prior-project	Post-project	Improvement	Weight
*Information and questions	2.33	2.67	15%	0.15
*Problem solving (limitations, connections and possible solutions)	2.50	3.17	27%	0.20
*The optimal solution selection and use	2.83	3.67	30%	0.20
*Communication (Assumptions, solutions and implications)	1.67	1.67	0%	0.20
*Innovative solutions	2.67	3.33	25%	0.15
*Improvements	2.67	3.00	12%	0.10
	2.42	2.90	20%	

Discussion and Conclusion

- **This funded project provides a great opportunity for students with dual benefits: improving their critical thinking capabilities and learning onscreen takeoff estimating technique.**

- **Questionnaire survey and in-class discussion help student think and rethink their work critically. It can be an effective way to enable a continuous improvement in students' critical thinking skills.**

- **Significant improvement (Average 20%) is witnessed in students' critical thinking in terms of the scoped indicators.**

Thank you !