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Intrinsic-Engineering-Value (IEV) Estimate of Software: A new Fundamental and Complementary Measure for Software Valuation.

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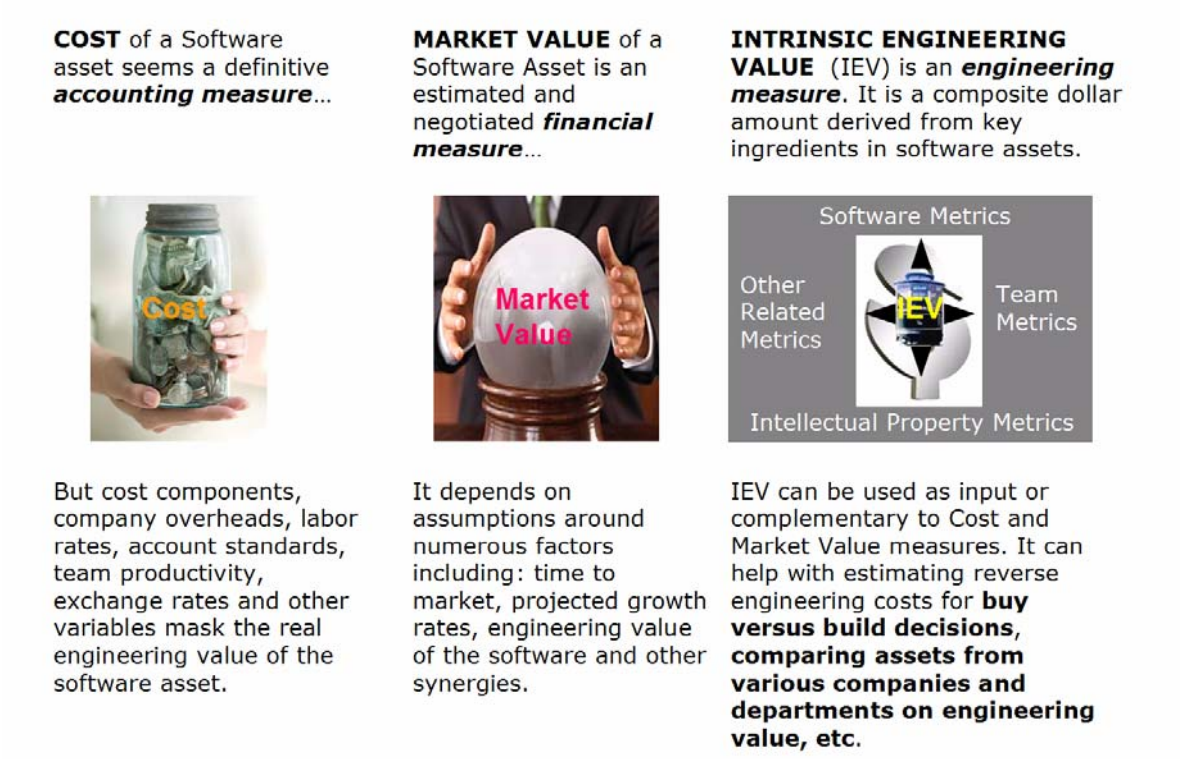
Introduction

The intrinsic Engineering Value (IEV) estimate of a software asset is a composite dollar value that is a function of several parameters that reflect the content of the software. IEV includes but is not limited to: software metrics (e.g. lines of code, number of classes); third party content (e.g. open source content); team metrics (e.g. years of experience); IP content (e.g. patents, propriety algorithms). Figure 1, summarizes how IEV contrasts and complements with commonly used measures such as the Cost and Market Value.

Figure 1: Cost and Market Value Measures versus IEV



During the course of a software company acquisition the technical diligence team may be asked, "***What do you estimate it would take us (the acquiring company) to build the software asset ourselves*?** Similarly, during the course of licensing a software asset to another company, the technical team may be asked, "***What do you estimate it took them (the licensing company) to build the software asset***? The objective of the research is to develop an IEV Model that can help answer these questions. For example, assuming a linear relationship between IEV and its parametric variables:

$$IEV = C_0 + \sum_1^n C_i X_i$$

Where, $X_1 .... X_n$ = Intrinsic Value Variables and $C_0 .... C_n$ are the coefficients or weights.

For a given class of software products, the objective of this Research is to identify the IEV variables and coefficients that can help estimate IEV.

In the May 2007 Pace DPS Research Day Proceedings, an idea paper with regard to the IEV was presented. This paper presents an overview of the Research Methodology for the computation of IEV and the details of the first phase of data collection.

Definitions and Terminology

The Webster Dictionary defines *Intrinsic* as- "belonging to the essential nature or constitution of a thing". In the *context of the software* asset the intrinsic aspects include software engineering metrics such as the number of lines of code, function points, number of Application Programming Interfaces, number of resources utilized and other variables that constitute a software asset.

The term *Value* has varied meanings in the Webster Dictionary including – "assigned or computed numerical quantity, something intrinsically valuable or desirable, estimate the monetary worth". In the context of this Research the Engineering value of the software asset represents a numerical measure that reflects the estimating of what it would take to build a software asset that is similar to the one that has been created.

Research Hypothesis

Software industry is a dynamic industry that is characterized by numerous mergers and business arrangements (licensing, joint ventures, etc). The Research hypothesis is that:

1. The IEV measure will be important for professionals involved with acquiring software assets from other companies.
2. The IEV measure will be important for professionals involved with licensing or partnering with other companies for software commercialization.
3. A set of variables that define the IEV for a particular class of assets can be identified.
4. The IEV measure is a more effective measure than other measures such a cost estimate based on lines of code.
5. The IEV model can be used as a predictive tool to estimate the intrinsic engineering value of software assets.

Research Methodology

The data for the Research effort is being collected in three phases.

Phase 1

The objective of this phase is to test the hypothesis that the IEV will be useful and identify preliminary variables that define the IEV. Four groups of software professional will be interviewed.

Group 1: This group will consist of business professionals involved with acquiring a software asset from a different company. The data required to access the need for IEV in this sample will be collected using interview questions shown in Table 1.

Table 1: Questions for the Members of the Business Team involved with Software Acquisition

1) What was or is your primary role in the Software Company Acquisition process?

- ☐ Financial Analysis
- ☐ Strategy and Business Development
- ☐ Product Offering Development
- ☐ _____

2) Do you have measure(s) that quantify the intrinsic engineering value of the software?

- ☐ Yes
- ☐ No

3) As part of the due diligence how important is it that the technical due diligence team quantify the intrinsic engineering value of the software asset being acquired?

- ☐ Not important
- ☐ Important
- ☐ Very Important

4) If intrinsic engineering value of the software is made available how useful would it be?

- ☐ Not useful
- ☐ Useful
- ☐ Very useful

5) If the Intrinsic Engineering Value is available how would you use it?

- ☐ Input to Pricing
- ☐ Comparison of Product offering across companies
- ☐ Input to good will estimation
- ☐ Input to book value estimation
- ☐ _____
- ☐ _____
- ☐ _____

General Comments and Suggestions: _____

Group 2: This group will consist of technical professional who were actually involved with acquiring a software asset from a different company. The data required for accessing the need for IEV and preliminary IEV variables will be collected using interview questions shown in Table 2 and sample IEV variable list shown in Table 3.

Table 2: Questions for the Members of the Technical Team involved with Acquisition.

1) Did you find the need to identify the intrinsic engineering value during the course of the acquisition analysis?

- ☐ Yes
- ☐ No

2) Are you aware of or use any quantitative model that can help estimate the intrinsic engineering value of the software?

- ☐ Yes
- ☐ No

3) If the intrinsic engineering value of a software asset could be estimated and modeled how useful would it be?

- ☐ Not Useful
- ☐ Useful
- ☐ Very Useful

4) If you were to quantify the intrinsic engineering value of a commercially available software product what are the TOP 5 variables you would choose?

- ☐ Variable 1: _____
- ☐ Variable 2:_____
- ☐ Variable 3:_____
- ☐ Variable 4:_____
- ☐ Variable 5:_____

5) If you were to quantify the intrinsic engineering value of a software asset that is still in development what are the TOP 5 variables you would choose?

- ☐ Variable 1: _____
- ☐ Variable 2:_____
- ☐ Variable 3:_____
- ☐ Variable 4:_____
- ☐ Variable 5:_____

General Comments and additional variables: _____

Table 3: Sample Intrinsic Value Variables

Code Metrics
Number of lines of code
Number of classes
Programming language

Functional Metrics
Number of function points
Number of use cases

Intellectual Property
Algorithm complexity
Number of Patents

Integration
Programming APIs
Sub-system integration APIs

Resources
Number of resources
Type of resources
Duration of resources

Type of Software
Component/SDK
Embedded software
Web application
32 bit client server application
Web services

Third Party Content
Open Source
Third Party Dlls

Group 3: This group will consist of business professionals involved with commercializing software innovations through licensing, joint ventures or other business arrangements. The data required to access the need for IEV with this segment of professionals will be collected using interview questions as shown in Table 4.

Table 4: Questions for the Members of the Business Team involved with commercializing Software innovations.

1) What was or is your primary role in the Software commercialization process?

- ☐ Financial Analysis
- ☐ Strategy and Business Development
- ☐ Product Offering Development
- ☐ _____

2) Do you have measure(s) that quantify the intrinsic engineering value of the software?

- ☐ Yes
- ☐ No

3) As part of your licensing, joint venture or other business arrangements how important is it to estimate the intrinsic engineering value of the software innovation you are trying to commercialize?

- ☐ Not important
- ☐ Important
- ☐ Very Important

4) If intrinsic engineering value of the software is made available how useful would it be?

- ☐ Not useful
- ☐ Useful
- ☐ Very useful

5) If the Intrinsic Engineering Value is available how would you use it?

- ☐ Input to Pricing
- ☐ Estimating potential partners reserve engineering costs
- ☐ Identifying high intrinsic value assets
- ☐ _____
- ☐ _____
- ☐ _____

General Comments and Suggestions: _____

Group 4: This group will consist of technical professionals who may be asked to assess the IEV for software assets. The data required for accessing the need for IEV and preliminary IEV variables will be collected using interview questions shown in Table 5 and sample IEV variable list shown in Table 3.

Table 5: Questions for potential members in <u>Technical Team that may be asked to assess Intrinsic Engineering Value.</u>

1) Did you find the need to identify the intrinsic engineering value or other cost measures (cost estimate, reverse engineering costs, etc)?

- ☐ Yes
- ☐ No

2) Are you aware of or use any quantitative model that can help estimate the intrinsic engineering value of the software if you were asked for an estimate?

- ☐ Yes
- ☐ No

3) If the intrinsic engineering value of a software asset could be estimated and modeled how useful would it be?

- ☐ Not Useful
- ☐ Useful
- ☐ Very Useful

4) If you were to quantify the intrinsic engineering value of a <u>commercially available software product</u> what are the TOP 5 variables you would choose?

- ☐ Variable 1: _____
- ☐ Variable 2:_____
- ☐ Variable 3:_____
- ☐ Variable 4:_____
- ☐ Variable 5:_____

5) If you were to quantify the intrinsic engineering value of a software asset that is still in development what are the TOP 5 variables you would choose?

- ☐ Variable 1: _____
- ☐ Variable 2:_____
- ☐ Variable 3:_____
- ☐ Variable 4:_____
- ☐ Variable 5:_____

General Comments and additional variables: _____
_____

Phase 2

This phase will involve refining the intrinsic value variables (x variables) for software assets that need to be commercialized. The refining process will include grouping of similar variables, developing a scale for the IEV variables and testing the significance of the IEV variables.

Phase 3

Bayesian, Logistical Regression and Multiple Regression were considered to establish IEV measure. Bayesian would be useful in answering a probabilistic question. For example, what is the probability that it the IEV is $2 million for software product A? However, it does not give an estimated, absolute measure.

Logistical Regression was considered because it takes in account categorical variables (e.g. software product A has a Patent -Yes or No). However, since software products have a combination of both absolute variables (lines of code, number of person years, etc) and categorical variables (type of code, patents, etc) it was recommend using multiple regression with some modifications by subject matter experts in regression.

A linear regression assumes a function of the form:
$y = C0 + C1 * x1 + C2 * x2 + ...CnXn$ and finds the values of C0, C1, C2, ..Cn

In this context of this Research
Y=IEV
X1…Xn= Software Engineering Metrics (Lines of Code, Person Years, Patents, etc)
The X variables and values are available. However, there is no historical IEV data or weights relative to the lines of code, patents, etc (C0..Cn values). This makes it impossible to solve the equation. Therefore, multiple Subject Matter Experts (SMEs) will be asked to provide the IEV to solve the regression equation. Table 6 and Table 7 illustrate a hypothetical preliminary model in this regard.

Table 6, contains the sample data. In this case, the IEV for a software asset (A, B, C, D, E, F and G) is established by various subject matter experts. For example, the IEV for Software product A is set by two SMEs (SME 1 and SME 2) and the IEV for Software product D is set by four SMEs (SME1, SME2, SME 3 and SME4). The X values which are software engineering metrics (Lines of code/LOC, number of patents and person year investments/PY) are fed into the regression model.

Regression analysis will be used to solve for the coefficients in the regression equation (sample in Table 7). The resulting parameterized model will be tested with new data to generate predictive IEV values and be compared to other software estimating methods for differential analysis.

Table 6: Sample Data Set

Software	SME Observations		IEV (Y)	LOC (X1)	Patents (X2)	PY (X3)
A	SME1	1	$ 600,000	100000	0	2
A	SME2	2	$ 800,000	100000	0	2
B	SME3	3	$ 1,200,000	10000	5	4
B	SME4	4	$ 900,000	10000	5	4
C	SME5	5	$ 1,500,000	50000	3	5
C	SME6	6	$ 1,500,000	50000	3	5
D	SME7	7	$ 1,300,000	95000	6	4
D	SME8	8	$ 1,200,000	95000	6	4
D	SME9	9	$ 1,000,000	95000	6	4
D	SME10	10	$ 1,200,000	95000	6	4
E	SME11	11	$ 600,000	20000	5	2
E	SME12	12	$ 400,000	20000	5	2
E	SME13	13	$ 500,000	20000	5	2
F	SME14	14	$ 600,000	20000	5	2
F	SME15	15	$ 525,000	20000	5	2
G	SME16	16	$ 600,000	35000	2	3

Table 7: Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.94772088
R Square	0.89817487
Adjusted R Square	0.87271858
Standard Error	132870.847
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.86873E+12	6.23E+11	35.28303	3.1228E-06
Residual	12	2.11856E+11	1.77E+10		
Total	15	2.08059E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-76743.3611	120042.0846	-0.639304	0.534639	-338292.5906	184805.8684	-338292.5906	184805.8684
X Variable 1	1.68502826	0.982208267	1.715551	0.111925	-0.455019676	3.825076196	-0.455019676	3.825076196
X Variable 2	-6505.80027	18379.02797	-0.35398	0.729496	-46550.26152	33538.66097	-46550.26152	33538.66097
X Variable 3	287878.114	31606.08706	9.108312	9.73E-07	219014.3669	356741.8605	219014.3669	356741.8605

Summary

In the May 2007 Pace DPS Research Day Proceedings, an idea paper with regard to the IEV was presented. This paper presents an overview of the Research Methodology for the computation of IEV and the details of the first phase of data collection. The data for Phase 1 will be collected in May-June 2008 and Phases 2 and 3 will be refined and developed based on the results in from Phase 1. Please send feedback and comments to the author at nvreddy@yahoo.com.