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Software Cost Estimation:

A Tool for Object Oriented Console Applications

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Software Cost Estimation Model

For

Object Oriented Software

Console Applications

Visual application = ~~Visual part~~ + Programming language part

The application dose not use any internal visual components provided by any language

This part is our objective

Agenda

- Introduction
- Related work
- The proposed Cost Estimation Model
- The measurements in the estimation process
- Experimental data used to test our method.
- Experimental result
- Results notes
- Conclusion & future work



Demo for

The Cost Estimation Tool for the proposed model

Introduction

The cost estimation model need to be:

- Reliable and accurate
- The accuracy can be improved by the calibration
- Accurate estimation of size is vital
- The proper size measure effect the model accuracy.



Reliable & Accurate Cost Estimation Model

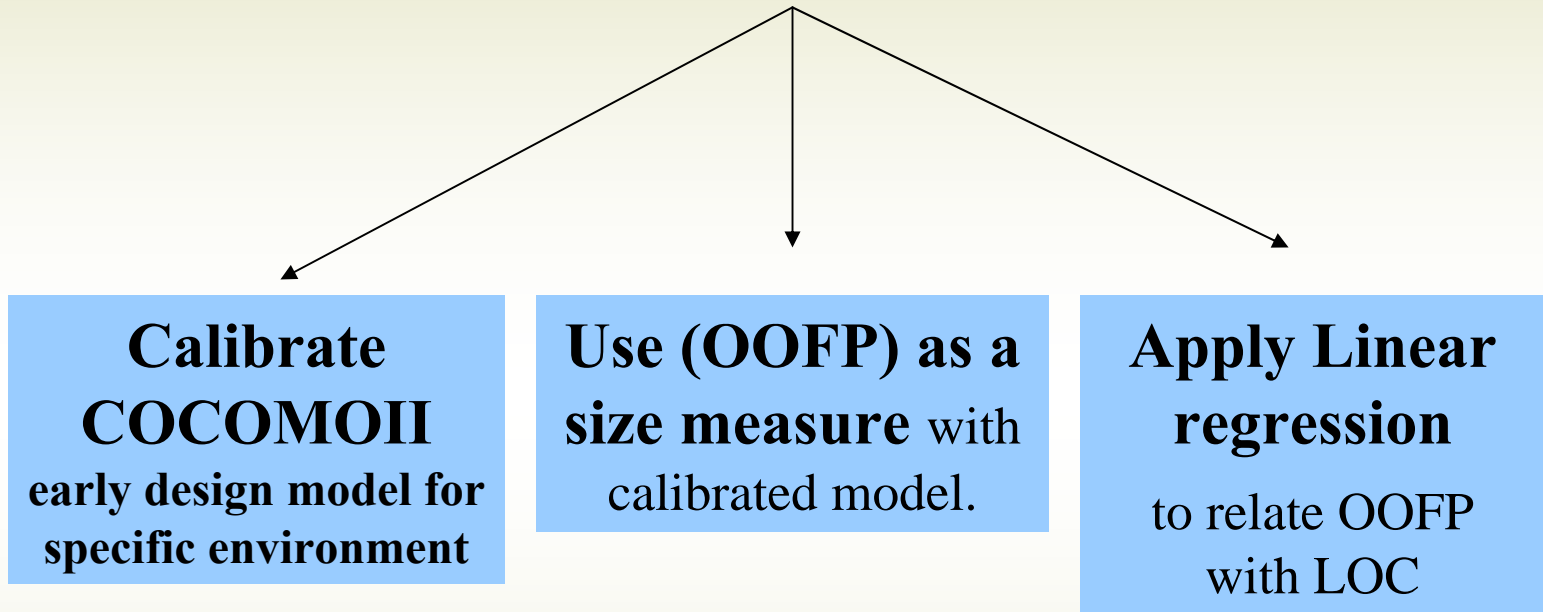


**Model
Calibration**

**Proper Size
Measure**

The proposed cost model

improve the accuracy through :



Related work

+ Several authors assert that

a model's predictive accuracy can be improved by **calibrating** (adjusting) its default parameters to a specific environment.

+ Thibodeau [1] calibrated nine models using three databases.

+ the IITRI [2] study with original COCOMO

+ In 1997 COCOMO II **Post-Architecture model** was calibrated by Bernheisel [3]

Related work

These studies showed estimating accuracy improved with calibration.






In this study

COCOMO II Early Design Model calibrated.

$$\text{Effort PM} = A * (\text{Size})^B * EM_1 * EM_2 * \dots * EM_7$$

Related work

A lot of researchers have proposed many methods for size measure such as:

-  function point (FP)
-  Object Point (OP)
-  Predictive Object Point (POPs)
-  Object Oriented Function Point (OOFPs)
-  Object Oriented Design Function Points (OODFP)

COCOMOII models use only the traditional FPs & OP.

Related work

The addition in this study:

We combine the **OODFP** with **calibrated COCOMOII** early design model.

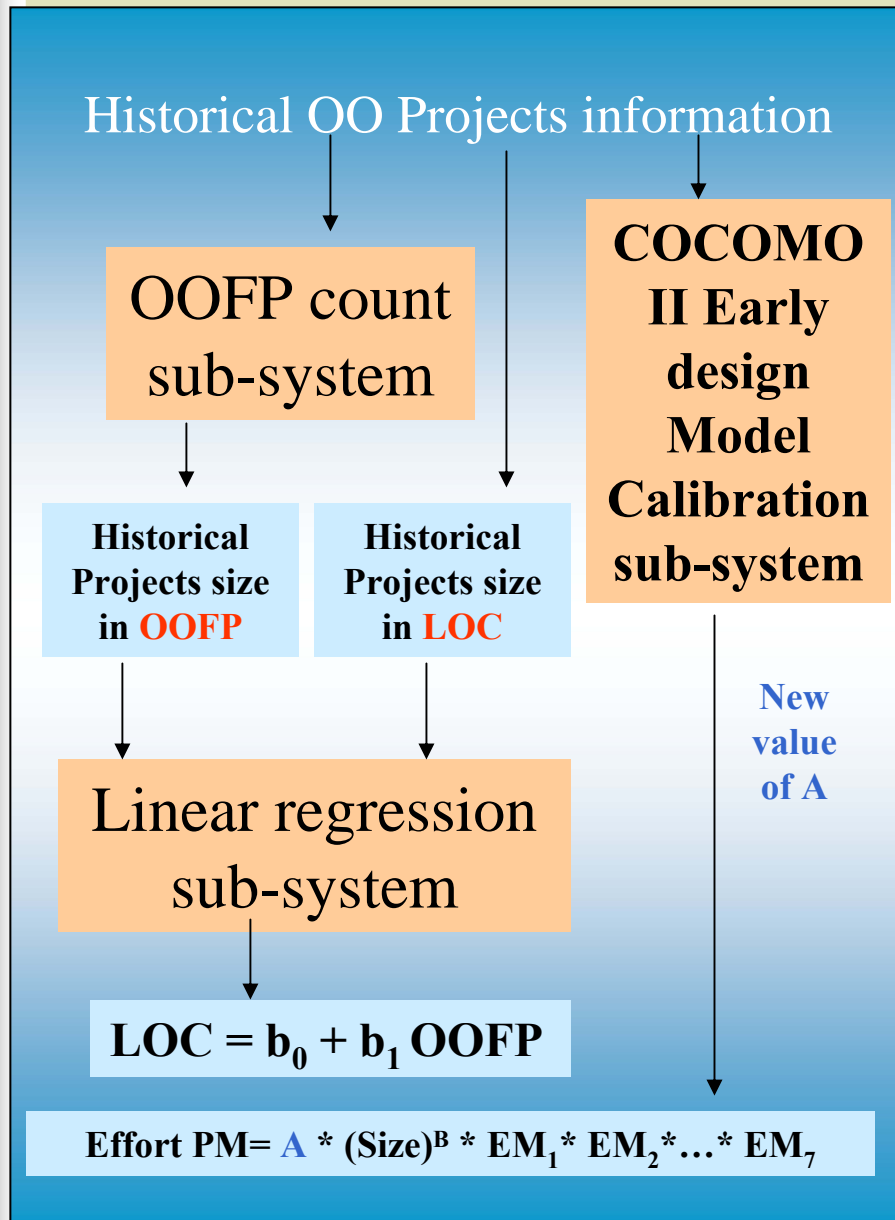
The Cost estimation tool will

- + Calibrate COCOMOII early design model according to the historical data.**
- + Automate OODFP counting procedure [4].**
- + Estimate the software size in LOC .**
- + Estimate the software effort and cost.**

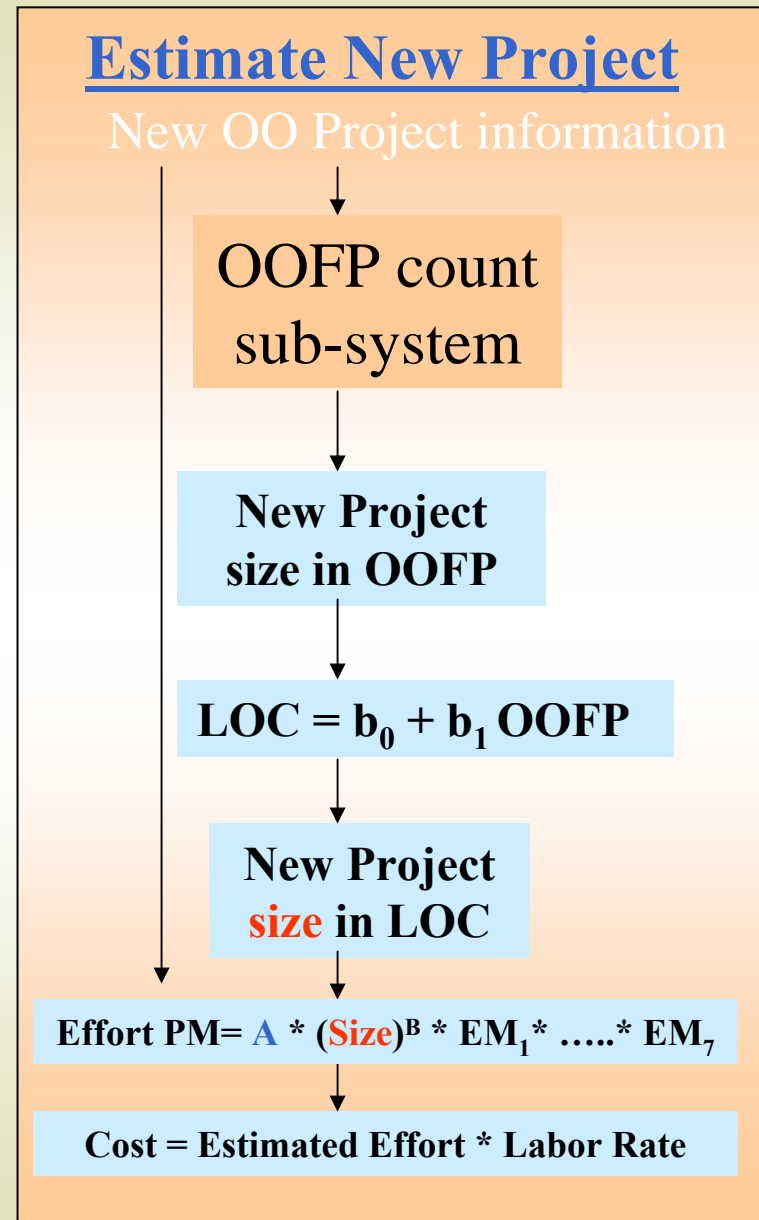


The proposed Cost Estimation Model

The proposed Cost Estimation Model



1



2

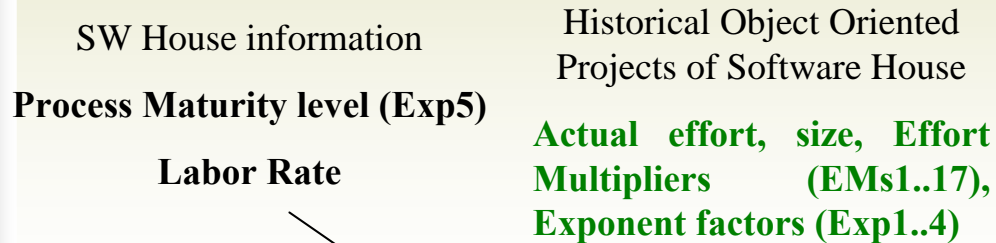


**the measurements in
the estimation process**

the measurements in the estimation process

1- COCOMOII Early design Model Calibration

$$\text{Effort PM} = A * (\text{Size})^B * EM_1 * EM_2 * \dots * EM_{17}$$



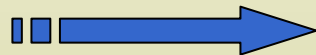
Calibration of
COCOMOII Early Design
Model Sub-system

Calibrated Cost Model

Algorithm

- ✚ Enter SW House information
- ✚ Enter Historical Object Oriented Project information
- ✚ $B = 1.01 + 0.01 * \sum \text{Exp}_{1..5}$
- ✚ $Q_i = (\text{Size})^B * \sum_{1..n} \text{EMs}/n$

New Value



$$A = (\sum_{i=1..n} \text{PM}_i Q_i) / (\sum_{i=1..n} Q_i^2)$$

the measurements in the estimation process

In object oriented software design:

Classes & Methods

- ✚ Data in a class can be mapped to a **logical file**.
- ✚ Each method mapped to a **transactional function**.

the measurements in the estimation process

Class Complexity

The complexity of an logical file (class) depends on the DETs and RETs

- + A DET is a simple data type such as int, char.
- + A RET is an Object reference, a complex data type

DETs= *number of simple data type + number of inherited simple data type*

RETs= *1+ number of complex data type + number of inherited Complex data type*

the measurements in the estimation process

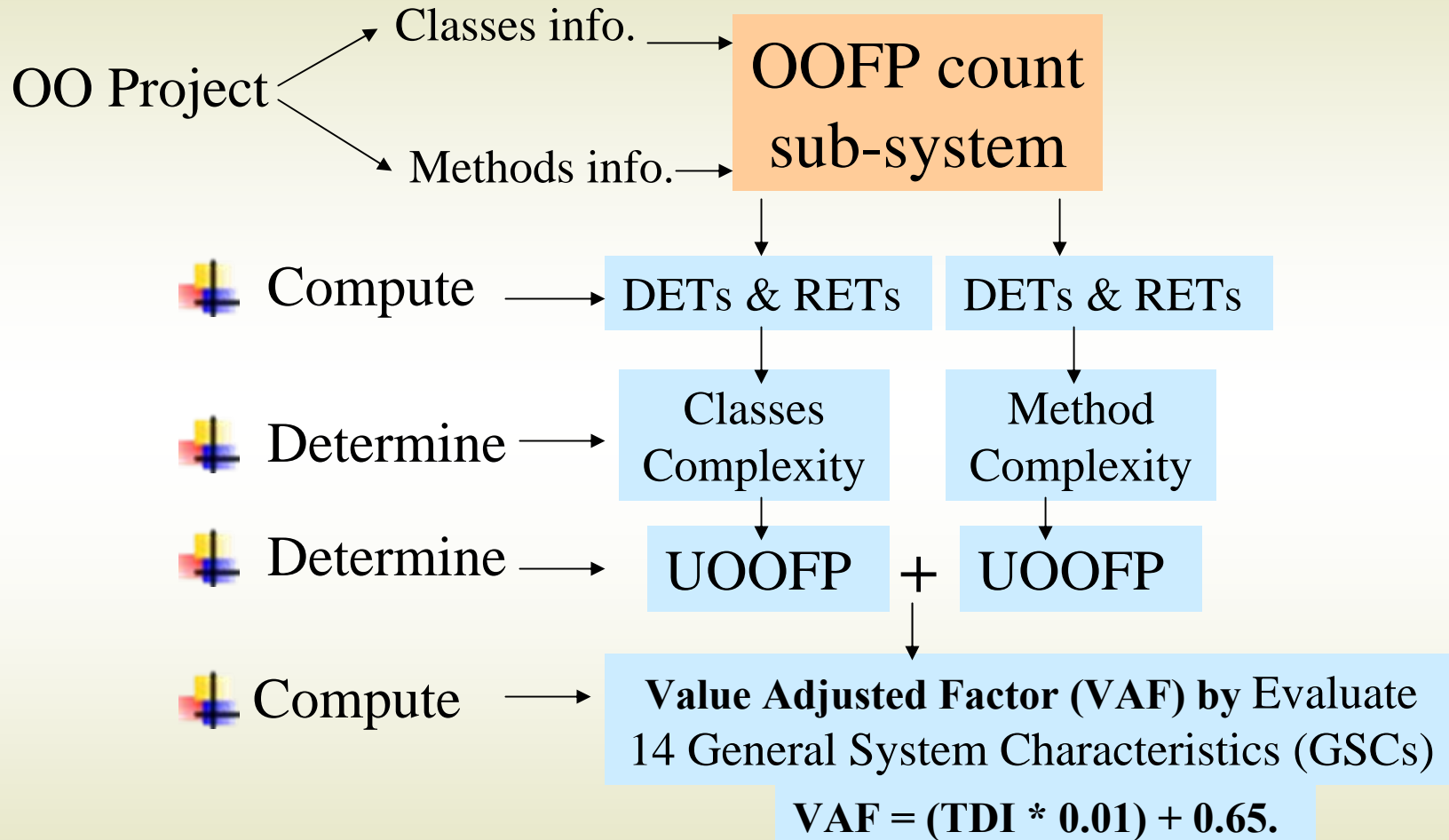
Method Complexity

The complexity of a transactional function (method) depends on the DETs and RETs

- ✚ A single valued association is considered as a DET
- ✚ Multi-valued association is considered as a RET.
- ✚ If a method does not have any arguments and return type, then its complexity is considered as one DET

the measurements in the estimation process

2-OOFP measurement calculation

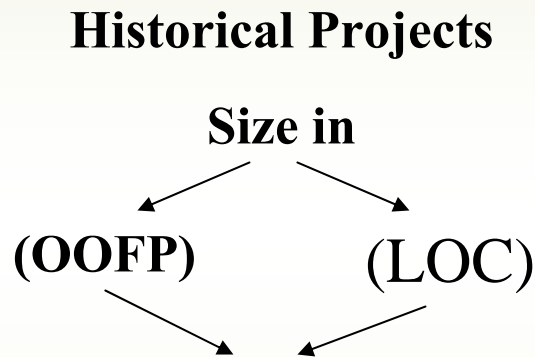


OOFP = VAF * UOOFP

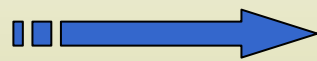
the measurements in the estimation process

3- Build a Regression Model to relate OOFP with Project's LOC

Algorithm



Linear regression
sub system



Regression Model

$$\text{LOC} = b_0 + b_1 \text{OOFP}$$



Calculate OOFP for (n) old projects



Read Actual LOC for (n) old projects



$$b_1 = \frac{\sum(\text{LOC}_i \text{OOFP}_i) - [(\sum \text{LOC}_i)(\sum \text{OOFP}_i)/n]}{\sum(\text{OOFP}_i^2) - [(\sum \text{OOFP}_i)^2/n]}$$



Compute the average of OOFP



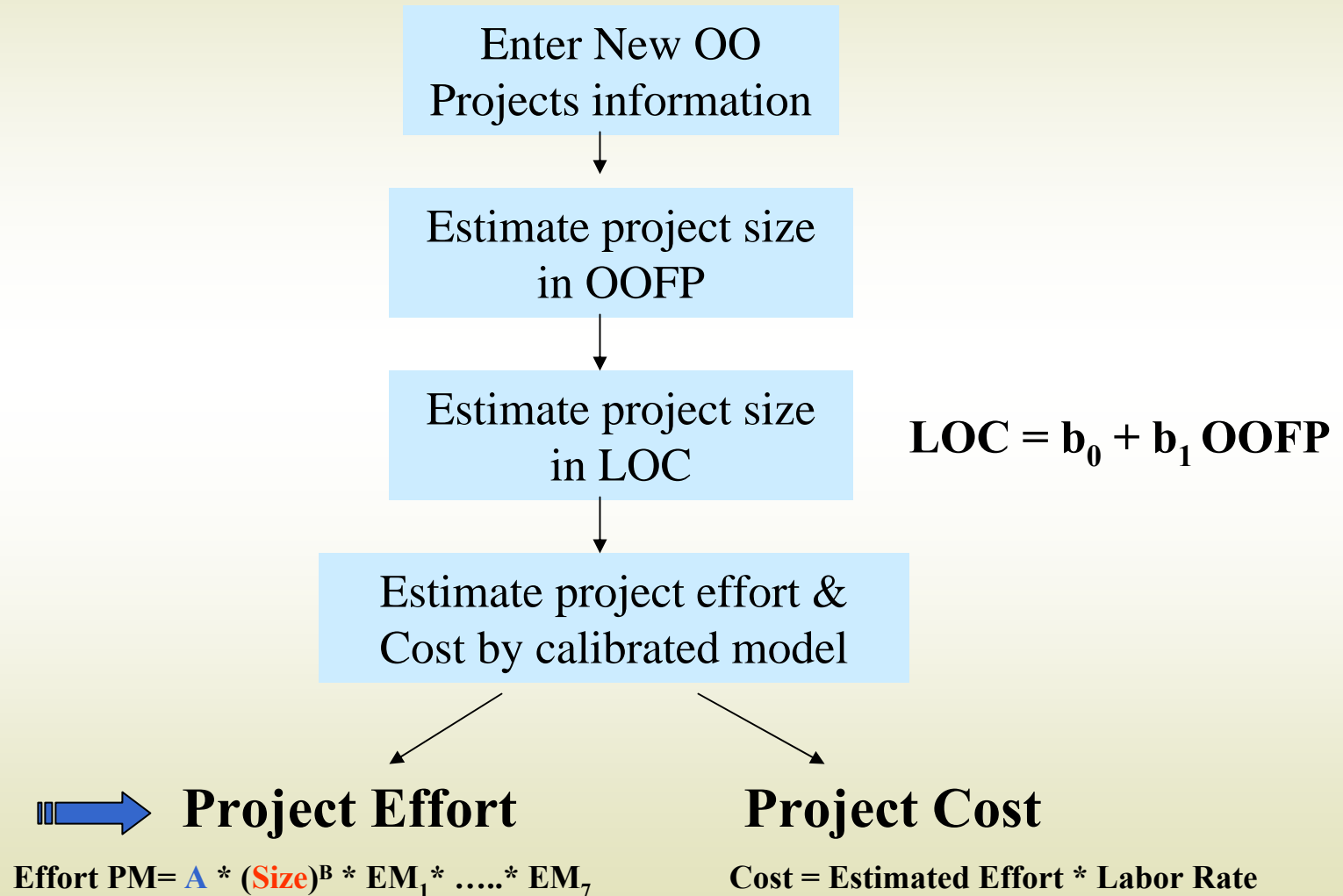
Compute the average of LOC



$$b_0 = (\text{AVG of LOC}) - b_1 (\text{AVG of OOFP})$$

the measurements in the estimation process

4- Estimate New Project





**Experimental data
used to test our method**

Experimental data used to test our method

In this project

- + The measurements (**Cost drivers**) & **14 General System Characteristics (GSCs)** were collected for ten completed OO projects from a specific software house, for which both an **OO design model** and the **final code** (LOC) were available.
- + All were developed in the same environment, using the same language (C++ - console application)



Experimental Result

[Show the results](#)

Results Notes

The factors affect the model accuracy :

- + The number of data points collected .
- + The accuracy of data collected
- + The re-estimation process could be done as the OO design become more stable.

Results Notes

- + the estimated values of the 7 effort multipliers.
- + The regression model need more than 10 data points to estimate the size of the project in LOC correctly.
- + Some collected data are abnormal, so it will effect on the calibration values and regression model parameters

Conclusion

- ✚ In this study we have propose a new cost estimation model for object-oriented software – written with C++ console application.
- ✚ It based calibration of COCOMOII – early design Model that is a well-known and validated cost model.
- ✚ The calibrated model use OOFP as size measure.
- ✚ The size of the project in line of code (LOC) estimated by using linear regression model built from historical project of the organization.

Conclusion

A cost estimation tool is constructed to automate the following:

- ✚ Calibrate COCOMOII early design model for specific environment.
- ✚ Calculate OOFP for a new projects and for all historical projects.
- ✚ Construct a linear regression model to relate OOFP of the project to LOC.
- ✚ Estimate the effort and cost for a new project

future work

+ I think it is better to improve the proposed model to estimate the cost for all OO C++ projects:

1- Console Application (No Generated code in the model)

$$\text{Effort PM} = A * (\text{Size})^B * EM_1 * EM_2 * \dots * EM_7$$

2- Windows Application (Visual component and Automatic generated code included in the model)

$$\text{Effort PM} = A * (\text{Size})^B * EM_1 * EM_2 * \dots * EM_7 \\ + ((\text{ALOC}) * (\text{AT}/100)) / \text{ATPROD}$$

ALOC is the number of automatically generated LOC

AT the percentage of total system code which is automatically generated

ATPROD is the productivity level for this type of code production.

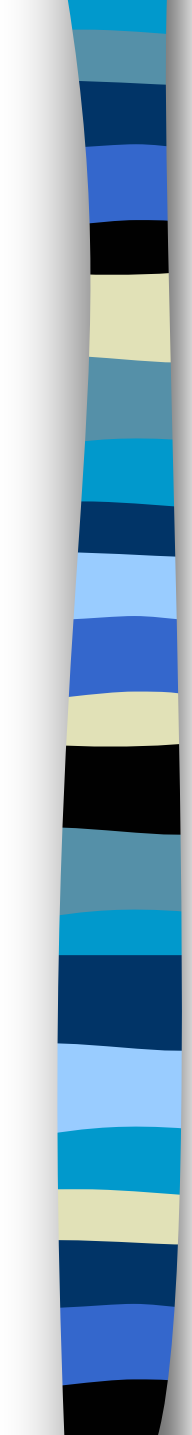
A vertical decorative bar on the left side of the slide, composed of various colored horizontal stripes including shades of blue, teal, yellow, and black. The stripes vary in width and color, creating a vibrant, multi-colored pattern.

Thank you



References

- [1] Thibodeau, Robert. *An Evaluation of Software Cost Estimating Models*. Huntsville AL: General Research Corporation, 1981.
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- [3] Bernheisel, Wayne A., "**Calibration and Validation of the COCOMO II.1997.0 Cost/Schedule Estimating Model to the Space and Missile Systems Center Database.**" Unpublished masters thesis. Dayton, OH, Air Force Institute of Technology. 1997.
- [4] Ram D. J. and S. V. G. K. Raju, "**Object Oriented Design Function Points**", IEEE , The First Asia-Pacific Conference on Quality Software (APAQS'00), October 2000, pp. 121



[5] Sneed, H., “**Estimating the development costs of object oriented software**”, in: Proceeding of 7th European software control and metrics conference, 1996 ,Wilmslow, UK.

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[8] Caldiera, G. , G. Antoniol, R. Fiutem, C. Lokan,” **Definition and Experimental Evaluation of Function Points for Object-Oriented Systems**”,IEEE, 5th. International Symposium on Software Metrics , March 1998, pp. 167