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A STUDY OF OBJECT ORIENTED SOFTWARE METRICS

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Abstract

Object Oriented Software metrics play very important role in Object Oriented software development to improve the quality of software design. Various metrics are available to measure the different attributes of object oriented software. Different metrics are available which can be applied at different levels. In this paper thirty object oriented metrics are studied and described.

Key Words: Object Oriented Metrics, Class, Method, Attribute, Inheritance, Polymorphism, Information Hiding, Exception, Coupling and Cohesion.

I. Introduction

Developing high quality software is always an aim of any software engineering approach. Object Oriented Software Engineering provides new dimensions to software development and captures almost all of the areas of software development. OOSE provides new approach to software development that opens new windows to increase the quality of the software. OOSE makes the software more maintainable and reusable. Metrics are units of measurement. The term "metrics" is also frequently used to mean specific measurements taken on a particular item or process. Software engineering metrics are units of measurement that are used to measure different attributes of software product, process and people. Metrics plays a very important role in software development. Now almost all software development is done in object oriented environment. As traditional metrics are not suitable to evaluate object oriented software therefore new metrics are developed by various researchers to measure various attributes of Object Oriented software. Object Oriented software metrics are used to measure various attributes such as size, complexity, coupling, cohesion, inheritance and polymorphism.

2. TERMS USED IN OBJECT ORIENTED METRICS

Following are some key terms of object oriented software metrics.

Class

A class is a template that is used to create a set of similar objects.

Attribute

An attribute is a unique data member of class that is available to all the objects of that class.

Method

A method is a member function of class that is available to all the objects of that class. It need not be unique.

Object

An object is an instantiation of some class that stores the values of attributes defined by class and use methods to manipulate attributes. An object is identified by its existence.

Coupling

It is defined as the degree of interrelationships between two classes. Two classes are coupled when method declared in one class use methods or instance variables defined by the other class.

Cohesion

It is defined as degree to which methods within a class are related of each other. Cohesion of a class is its tightness.

Message

Message is defined as a request that an object makes to another object to perform an operation.

Encapsulation

It is wrapping of collection of items into a single unit. A class encapsulates data and function into a single unit.

Information Hiding

It the hiding of detail of one object from another object.

Inheritance

It is a relationship between classes through which one class can derive features of other class. It is used for reusability.

Polymorphism

Polymorphism allows the implementation of a given operation to be dependent on the object that contains the operation.

Method Overriding

If the derived class has method that has same name and signature as method of base class have then method of derived class overrides the method of base class.

3. LIST OF METRICS STUDIED

Following thirty object-oriented metrics are studied in this paper.

S.NO.	Metric	Level	Type
1	NOA	Class	Size
2	ANOA	System	Size
3	NOM	Class	Size/Complexity
4	ANOM	System	Size/Complexity
5	WMC	Class	Complexity
6	RFC & RI-C'	Class	Size/Complexity
7	DIT	Class	Inheritance
8	NOC	Class	Inheritance
9	MIF	System	Inheritance
10	AIF	System	Inheritance
11	RR	System	Inheritance
12	SR	System	Inheritance
13	IIF	System	Inheritance
14	NMO	Class	Polymorphism
15	PF	System	Polymorphism
16	CBO	Class	Coupling
17	DAC	Class	Coupling
18	MPC	Class	Coupling
19	CF	System	Coupling
20	LCOM	Class	Cohesion
21	TCC	Class	Cohesion
22	LCC	Class	Cohesion
23	ICH	Class	Cohesion
24	MHF	System	Information Hiding
25	AHF	System	Information Hiding
26	OHEF	Method	Information Hiding
27	AHEF	Attribute	Information Hiding
28	PPF	System	Generality
29	NCBC	Class	Robustness
30	EHF	System	Robustness

Table 2: List of object oriented metrics

Class level metric means that metric can be applied on individual class.

System level metric means that metric can be applied on whole software.

Method level metric means that metric can be applied on individual method of class.

Attribute level metric means that metric can be applied on individual attribute of class.

4. EXAMPLE USED TO EVALUATE METRICS

Object Diagram

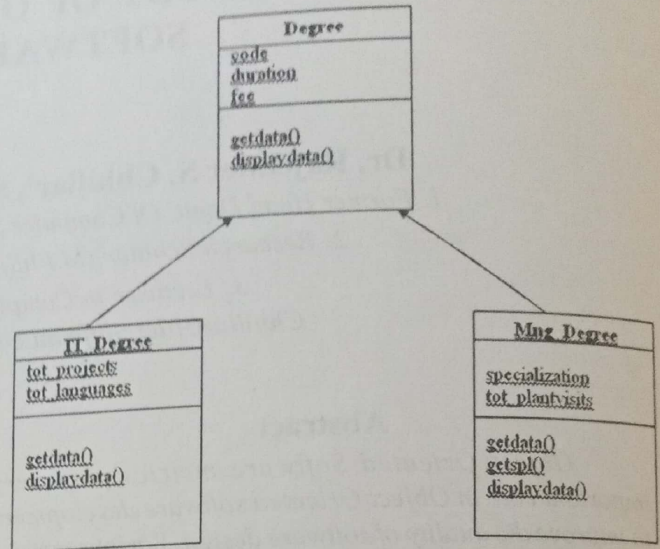


Figure 1: Object Diagram used to evaluate metrics

Classes shown in above Object Diagram are declared as follows (in C++ language)

```

class Degree
{
private:
    char code[10];
    int duration;
    float fee;
public:
    void getdata();
    void displaydata();
};

class IT_Degree: public Degree
{
private:
    int tot_projects,tot_languages;
public:
    void getdata()
    void displaydata();
};

class Mng_Degree: public Degree
{
private:
    char specialization[10];
    int tot_plantvisits;
public:
    void getdata();
    void getspl();
    void displaydata();
};
    
```

5. DESCRIPTION OF OBJECT ORIENTED METRICS

In this section various object oriented metrics are described using an example given in section 4.

1. Number of Attributes per Class (NOA) [1]

It is a size metric that defines size of a class in terms of number of attributes defined in the class.

NOA = Total number of attributes defined in the class

Example

NOA of Degree class =3

NOA of IT_Degree class =2

NOA of Mng_Degree class =2

Interpretation

As total size of an object in terms of memory is sum of memory consumed by all the attributes of class therefore larger number of attributes increased the object size.

2. Average Number of Attributes per Class (NOA)

$ANOA = \frac{\text{total number of attributes defined in all classes in the software}}{\text{total number of classes in the software}}$

Example

$ANOA = (3+2+2)/3 = 2.33$ attributes

3. Number of Methods per Class (NOM) [1]

It is a size metric which defines size of a class in terms of number of methods defined in the class. Method includes Function, Procedure, Property accessor (each property accessor is counted separately), Constructor, destructor and event handler.

NOM = total number of methods defined in the class

Example

NOM of Degree, IT_Degree and Mng_Degree class is 2, 2 and 3 respectively.

Interpretation

As a negative factor

High value of NOM complicates testing due to the increased object size and complexity and it also indicate that methods may be more application Specific therefore reducing the possibility of reuse.

High value of NOM is also indicator of difficulty in extensibility.

As a positive factor

A large number of methods also indicate that the derived class can inherit large number of methods.

4. Average Number of Methods per Class (ANOM) [8]

It counts the average number of methods defined in a class.

$ANOM = \frac{\text{total number of methods defined in all classes}}{\text{total number of classes}}$

Example

In Object Diagram-1

$ANOM = (2+2+3)/3 = 2.33$ methods

5. Weighted Methods per Class (WMC) [1,4,6]

WMC = sum of complexity of all methods of class

If complexity of each method =1 then $WMC=NOM$.

The complexity of method can be measured using traditional Cyclomatic Complexity metric.

WMC includes only those methods that are defined in class not inherited.

Example

WMC of Degree, IT_Degree and Mng_Degree class is 2, 2 and 3 respectively.

(by considering complexity of each method is 1)

Interpretation

High value of WMC is not desirable because complex methods are more difficult to maintain and test.

WMC can be used, as predictor of time and effort is required to develop and maintain the class.

A study of 30 C++ projects suggests that an increase in the average WMC increases the density of bugs and decreases quality. [Misra & Bhavsar :Relationships Between Selected Software Measures and Latent Bug-Density: Guidelines For Improving Quality. Springer-Verlag 2003]

6. Response For a class (RFC and RFC') [1,4,6]

RFC = number of methods defined in class and directly called by methods of the class that can be executed in response to a message received by an object of that class.

RFC is the original definition of the measure. It counts only the first level of calls outside of the class. **RFC** measures the full response set, including methods called by the callers, recursively, until no new remote methods can be found. If the called method is polymorphic, all the possible remote methods executed are included in R and R'.

RFC = number of methods defined in class and called recursively through entire call tree that can be executed in response to a message received by an object of that class.

Example

Class `IT_Degree` has two methods `getdata()` and `displaydata()` which call methods `Degree::getdata()`, `Degree::displaydata()` therefore response set (RS) of `IT_Degree` class is
`RS={IT_Degree::getdata(),IT_Degree::displaydata(),U Degree::getdata(),Degree::displaydata()}`
 Because response set of `IT_Degree` class have 4 methods therefore its **RFC** = 4.

Interpretation

High value of **RFC** is not desirable because it makes the testing and debugging of the class more complicated since it requires a greater level of understanding for testing.

High **RFC** means more complexity of class.

A worst case value for possible responses will assist in appropriate allocation of testing time.

A study of 30 C++ projects suggests that an increase in **RFC** increases the density of bugs and decreases quality. [Misra & Bhavsar :Relationships Between Selected Software Measures and Latent Bug-Density: Guidelines For Improving Quality. Springer-Verlag 2003]

7. Depth of Inheritance Tree (DIT) [1,4,6]

DIT of a class is defined as

DIT = max path length from root to node in inheritance tree

Example

DIT of `Degree`, `IT_Degree` and `Mng_Degree` class is 0, 1

and 1 respectively.

Interpretation

As a positive factor

High value of DIT means more methods can be inherited.

As a negative factor

The high DIT of a class in the hierarchy makes it more complex.

Deep trees indicate greater design complexity since more methods and classes are involved.

A study of 30 C++ projects suggests that an increase in DIT increases the density of bugs and decreases quality. [Misra & Bhavsar :Relationships Between Selected Software Measures and Latent Bug-Density: Guidelines For Improving Quality. Springer-Verlag 2003]

A Visual Studio .NET documentation recommends that `DIT <= 5` because excessively deep class hierarchies are complex to develop.

8. Number of Children (NOC) [1,3,6]

NOC of class is defined as

NOC = number of immediate derived or sub classes of a class

Example

NOC of `Degree`, `IT_Degree` and `Mng_Degree` class is 2, 0 and 0 respectively.

Interpretation

As a positive factor

High value of NOC indicates high reuse.

As a negative factor

A very high value of NOC is also indicator of improper sub classing and improper abstraction of the parent class.

A class with many children may also require more testing.

Depth is generally better than breadth, since it

promotes reuse of methods through inheritance.

9. Method Inheritance Factor (MIF) [1,7]

MIF is a system level metric and is computed as

MIF = (sum of number of methods inherited in classes), (sum of number of methods declared and inherited in classes)

Example

Number of methods inherited in `Degree`, `IT_Degree` and `Mng_Degree` class is 0, 2 and 2 respectively.

$$MIF = (0+2+2)/(2+4+5) = 4/11 = 0.36$$

Interpretation

Higher the value of MIF more is the method inheritance.

0 value of MIF indicates there is no method reusability, the reason may be there is no inheritance or all methods are private i.e the scope of methods don't permit inheritance.

Both too high and low value if MIF is not desirable because a low value indicates lack of method inheritance and a too high value may indicate improper use of inheritance or scopes.

10. Attribute Inheritance Factor (AIF) [1,7]

AIF is a system level metric and is computed as

AIF = (sum of number of attributes inherited in classes), (sum of number of attributes declared and inherited in classes)

Example

$$AIF = (0+0+0)/(2+2+3) = 0$$

It indicates that there is no attribute inheritance.

Interpretation

Higher the value of AIF more is the attribute inheritance.

0 value of AIF indicates there is no attribute reusability.

Generally low value of AIF is desirable lower as compare to MIF. High value of AIF means review of scopes of attributes is required because it may introduce side effects in the software.

11. Reuse Ratio (RR) [11]

It is computed as

$$RR = \frac{\text{(total number of superclasses)}}{\text{(total number of classes)}}$$

Example

$$RR = 1/3$$

12. Specialization Ratio (SR) [11]

It is computed as

$$SR = \frac{\text{(total number of subclasses)}}{\text{(total number of superclasses)}}$$

Example

$$SR = 2/1$$

13. Internal Inheritance Factor (IIF) [7]

It measures the amount of internal inheritance in a system. Internal inheritance means inheriting class of same system. External inheritance means inheriting class of different system. It is computed as

$$IIF = \frac{\text{(total number of classes that inherit class of same system)}}{\text{(total number of classes that inherit something)}}$$

Example

Number of classes that inherit class of same system = 2
 Number of classes that inherit something = 2

$$SR = 2/2 = 1$$

It means there is no external inheritance there is complete internal inheritance.

Interpretation

A system with low IIF reuses external classes.

If IIF = 1 then it indicates that there is no external inheritance.

14. Number of Methods Overridden by a Subclass (NMO) [1]

NMO = no of methods in subclass that overrides method of base class

Example

For IT_Degree and Mng_Degree class NMO=2 as both overrides getData() and displaydata() methods of Degree class.

15. Polymorphism Factor (PF) [1,7]

This metric is a polymorphism metric used to measure polymorphism by measuring the degree of method overriding in the class inheritance tree.

$PF = \frac{\text{number of actual method overrides}}{\text{maximum number of possible method overrides}}$

where
max. no. of possible method overrides of a class = number of new methods in the class * descendant count of the class

Example

Number of actual method overrides in Degree class=0
Number of actual method overrides in IT_Degree class=2
Number of actual method overrides in Mng_Degree class=2
Maximum number of possible method overrides of Degree class=0

Maximum number of possible method overrides of IT_Degree class=2*1=2

Maximum number of possible method overrides of Mng_Degree class=2*1=2

Therefore
 $PF = 4/4 = 1$

Interpretation

Too polymorphic code is difficult to understand.

16. Coupling Between Object Classes (CBO) [1,4,6]

Two classes are coupled when method declared in one

class use method or instance variables defined by the other class.

CBO = number of classes to which a class is coupled
Coupling due to inheritance are not included while calculating CBO.

Example

CBO for all classes is 0.

Interpretation

High value of CBO is undesirable because it is against modular design and prevents reuse.

17. Data Abstraction Coupling (DAC) [1]

DAC = number of ADT's defined in a class

ADT is a user defined data type which can be used without having the knowledge of how it is created. This coupling occurs when attribute of one class is object of another class.

Example

DAC of all classes is 0.

Interpretation

High value of DAC is undesirable.

18. Message Passing Coupling (MPC) [1]

MPC = number of message sent to another class
If two different methods of a class access the same method of another class then it is counted separately in MPC.

Example

MPC of IT_Degree and Mng_Degree class is 2.

Interpretation

High value of MPC is undesirable.

19. Coupling Factor (CF) [1,7]

$CF = (\text{Actual couplings}) / (\text{Maximum possible couplings})$
If N = total number of classes then maximum possible couplings = N(N-1)

Example

$CF = 0/6 = 0$

Interpretation

Always a low value of CF is desirable.

20. Lack of Cohesion in Methods (LCOM) [1,4,6]

It measures the dissimilarity of methods in a class on the basis of attributes used by methods of class. Always a low value of LCOM is desirable.

LCOM of a class is computed as
 $LCOM = (\text{number of pair of methods that have no common attribute}) - (\text{number of pair of methods that have common attribute})$

>0 value of LCOM indicates that there is lack of cohesion.

Example

LCOM of Degree class = 0-1 = -1

As displaydata() method display the same data as inputted by getData() method.

It indicates there is no lack of cohesion in result class.

Interpretation

LCOM should be 0 or <0.

LCOM is not desirable there must be maximum cohesion for good quality design.

21. Tight Class Cohesion (TCC) [1]

It measures the percentage of pairs of public methods to the class that use common attributes (directly). It is computed as follows

$TCC = (\text{number of pair of public method that use common attribute}) \times 100$
(number of pair of public methods)

Example

For Degree class
 $TCC = 100\%$

Interpretation

High value of TCC is desirable
If TCC = 0 it means no public method pair have common attribute.

If TCC = 100% it means all public method pair have common attribute.

22. Loose class Cohesion (LCC) [1]

It measures the percentage of pairs of public methods to the class that use common attributes (directly or indirectly). It is computed as follows

$LCC = (\text{number of pair of public method that use common attribute}) \times 100$
(number of pair of public methods)

Example

For Degree class
 $TCC = 100\%$

Interpretation

High value of LCC is desirable

If LCC = 0 it means no public method pair have common attribute (directly or indirectly).

If LCC = 100% it means all public method pair have common attribute (directly or indirectly).

23. Information based Cohesion (ICM) [1]

ICM of a class is defined as

ICM = number of times other method of same class are called

Example

ICM of Degree, IT_Degree and Mng_Degree class = 0

24. Method Hiding Factor (MHF) [1,7]

MHF is information hiding metric that measures the method encapsulation. It count average amount of method hiding among all classes in the system. It is a system level metric. In computation of MHF, inherited methods are not included.

Visibility of a method is computed as

$V(M) = \text{number of classes where a method is visible}$
Visibility of a method is calculated against other classes.

MethodVisibility = Sum of V(NM) of all methods of all class / (total no. of classes-1)
total number of methods

Example

MHF=1 - MethodVisibility

Example

MHF=0

It means there is no method hiding. Because all methods are public.

Interpretation

If MHF=1 (100%) it indicates full method hiding that is no method is visible outside its class it means all methods are private.

High value of MHF indicates low functionality of class and it also indicates that less number of methods that are available for reuse therefore reduces reusability.

If MHF=0 it indicates no method hiding that is all methods are visible to other classes it means all methods are public.

A study of 30 C++ projects by Mishra and Bhavsar show that increased MHF decreases bug-density and increase quality. [Mishra & Bhavsar: Relationships Between Selected Software Measures and Latent Bug-Density: Guidelines For Improving Quality. Springer-Verlag 2003]

A study of 8 small C++ projects by Abreu and Melo shows that increased MHF decreases defect density and rework effort to find and correct defects.

25. Attribute Hiding Factor (AHF) [1,7]

AHF is information hiding metric that measures the attribute encapsulation. It count average amount of attribute hiding among all classes in the system. It is a system level metric. In computation of AHF inherited attributes are not included.

Visibility of an attribute is computed as

$V(A) = \text{number of classes where attribute is visible} / \text{Attribute Visibility} = \text{Sum of } V(A) \text{ of all attributes of all class} / (\text{total no. of classes}-1)$

total number of attributes

Example

AHREF of all attributes of Degree class = 1/1 = 1

AHF=1 - Attribute Visibility

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AHF=1
Because all attributes are private so there is full attribute hiding.

Interpretation

If AHF=1 (100%) it indicates full attribute hiding that is no attribute is visible outside its class it means all attributes are private. 1 is ideal value of AHF.

If AHF=0 it indicates no attribute hiding that is all attributes are visible to other classes it means all attributes are public.

26. Operation Hiding Effectiveness Factor (OHEF) [7]

OHEF measures how good is the scope setting of a class operations or methods. It is calculated as follows

OHEF = number of classes that access operations number of classes that can access operations

Example

OHEF of Degree::getdata() method = 3/3=1

OHEF of Degree::displaydata() method = 3/3=1

Interpretation

OHEF is similar to MHF. MHF measures the degree of method hiding whereas OHEF measures the goodness of method hiding.

When OHEF = 1 then scope settings are perfect. When OHEF approaches to 0 then, it indicates that scope settings are not perfect.

27. Attribute Hiding Effectiveness Factor (AHEF) [7]

AHEF measures how good is the scope setting of a class attributes. It is calculated as follows

AHEF = number of classes that access attributes number of classes that can access attributes

Example

AHREF of all attributes of Degree class = 1/1 = 1

It means scope setting of attributes is perfect.

Interpretation

AHEF is similar to AHF. AHF measures the degree of attribute hiding whereas AHEF measures the goodness of attribute hiding.

When AHEF = 1 then scope settings are perfect.

When AHEF approaches to 0 then, it indicates that scope settings are not perfect.

28. Parametric Polymorphism Factor (PPF) [7]

PPF = (number of parameterized classes)/(total number of classes)

Example

PPF=0 because there is no parameterized class.

Interpretation

Parameterized classes are generic classes therefore PPF measures the generality of classes.

29. Number of Catch Blocks per Class (NCBC) [2]

This metric measures the robustness of class by measuring the amount of exception handling used in class. It is computed as follows

NCBC = (number of catch block in a class) / (total number of possible catch blocks in a class)

Interpretation

Higher the value of NCBC more robust is the class. If there is no catch block in the class then NCBC=0

30. Exception Handling Factor (EHF) [2]

It is a system level metric, which is computed as follows

$EHF = \frac{\text{number of exceptions classes}}{\text{total number of possible exception classes}}$

CONCLUSION AND FUTURE WORK

This study analyze various object oriented metrics using a example, given by various researchers and explain how Volume 2 No. 4

these metrics can be applied on object oriented software to evaluate size, complexity, inheritance, polymorphism, coupling, cohesion, information hiding, generality and robustness. Different metrics can be applied at different levels (method, attribute, class and system). All the metrics presented in this paper can be easily automated. Interpretation of metrics provides the impact of its computed value on software. Some metrics high/low values have positive as well as negative effect on software therefore they are interpreted from both aspects. For example high value NOM increases the complexity and makes the class more application specific but also indicates the more methods can be inherited by the derived class. The further work can be carried out to analyze the metrics more minutely to find the desirable value or range of desirable value of each metric for different kind of softwares and relationship between different metrics.

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ACQUIRING QUALITY AND PRODUCTIVITY THROUGH ERP IMPLEMENTATION

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Abstract

The "3C Crisis" i.e. Customer, Competition and Change is being felt in a big way in a country like ours. We are passing through this present era of "3C Crisis". Customer-satisfaction and adaptation to emerging high-tech is becoming the current trend of competitive world of business organisations. It is a well-known fact that technological advances of any nature bring a significant change in the society.

The emergence of ERP (Enterprise Resource Planning) and its evolution through BPR (Business Process Re-engineering) and EERP (Extended ERP) plays a significant role in this direction. Customer satisfaction with respect to all these has also been outlined.

This paper is aimed at addressing all the necessary issues related to ERP such as evolution of ERP, basic structure of ERP, BPR, EERP, and risk factors of ERP. ERP experimentation in India has also been explored. Further important tips for making ERP implementation a grand success have also been implemented.

Keywords: ERP, BPR, TQM, EERP, Risk factors.

1. Introduction

ERP is emerging very significantly as a very important discipline in its own. ERP has been a part of our operating culture since early businesses. Earlier planning and control were done manually and today, because of diversified businesses and complex products, it requires advanced technology like computers to crunch large volumes of data faster and generate information that makes it easier to run business. In the present times of Information Technology (IT), this discipline has got worldwide attention.

In order to meet this new challenge, India is experimenting with the new management philosophies and tools like:

- ◆ Business Process Reengineering (BPR)

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- ◆ Enterprise Resource Planning (ERP)
- ◆ Total Quality Management (TQM)
- ◆ Just In Time (JIT)

2. Emergence of ERP

An ERP is not a magic rod that provides a solution for all the problems in the organisation. It is a powerful tool and like any tool, its utility is entirely a function of the way it is used. Therefore, it requires a lot of hard work. It is not just top management commitment but involvement of every team member of the project will deliver the appropriate and intended results.

ERP is mainly an Information and Communication Technology (ICT) driven philosophy that was lacking critically in the early businesses. The poor decision-making process in the absence of right information at the right time resulted into lower utilisation of men, machine, material & money. In the light of IT tools, ERP may be treated as a set of software covering major business areas like: Finance, Materials, Manufacturing, Distribution, Logistics, Sales, etc all so tightly integrated with one another that any business activity recorded at one place is immediately reflected in all other places.

One formal definition of ERP according to a professional organisation APICS is: "An accounting oriented Information System for identifying and planning the enterprise wide resources to take, make, ship account for Customer Orders". ERP can be availed of by multiple users for multiple users for multiple users at multiple places.

A logical structure of ERP is necessary to ensure that it covers all parameters in a logical way and a detailed micro plan can be derived from macro plans at the aggregate level. The fundamental structure of ERP is shown in Fig. 1.

FRONT-END

Strategic Planning
Tactical Planning
Customer Expectation Targets

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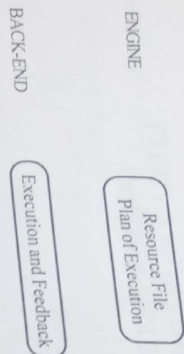


Figure 1: Fundamental Structure of ERP

- This structure indicates many important issues such as:
- ERP should always start from the top. Vision and the long-term objectives should drive ERP.
 - ERP should have well defined methods of desegregation of vision and strategic plans into more specific tactical plans and detailed execution plans.
 - ERP should support execution of plans and have a strong feedback mechanism.

3. BPR and EERP

"BPR is the fundamental rethinking and radical redesign of processes to achieve dramatic improvement in critical, contemporary measures of performance such as cost, quality, service and speed."

BPR focuses more on the transformation aspect of the business processes using innovative business concepts. ERP focuses on the automation aspect of the business processes using ICT to achieve the same objective. As per one of the experts in the corporate world, the following benefits may be listed towards customer's major five expectations.

Table 1: Capability of BPR and ERP Towards Customer

Customer Expectations	Benefit From BPR	Benefit From ERP
1 Quality/Reliability	Explicitly	Implicitly
2 Cost	Explicitly	Implicitly
3 Delivery Times	Explicitly	Explicitly
4 Flexibility (Customer, delivery)	Implicitly	Explicitly
5 After Sales Service	Implicitly	Explicitly

Certain questions need to be given a cool thought which top management may also ask:

- Whether to transform the business processes first through BPR and then adopt ERP or
- First adopt an ERP solution with world-class proven practices, and then keep on doing re-engineering or
- Adopt them together, business process module wise, one after other, till complete business is covered.

ERP started as a Materials Requirement Planning (MRP), a tool to enable factory supervisors to plan for raw materials and semi finished products required for the manufacturing process, batch or continuous. After a few years Manufacturing Resource Planning (MRP II) was born. Now the concept has expanded to cover non-manufacturing activities too, like purchase, distribution, finance and human resources; and gained an appropriate title, Enterprise Resource Planning (ERP).

Now a new term Extended ERP (EERP) is coined by Gartner Group which enables companies to move from thinking and planning in terms of an internal enterprise model to an external value network model. EERP will enable companies to improve three areas:

- Cost
 - Speed
 - Quality
- which can ultimately provide a competitive business advantage.

4. ERP Experimentation in India

ERP solutions include many features like human resource management modules, supply chain management, product data management, electronic data interchange, engineering change management, multi-currency and multi-location plants facilities, which is allowing many drastically transformed business processes to be adopted quickly.

The principal difference between ERP and BPR has also been outlined along with the line of operations applicable to each of the two. Expectations of ERP implementation have also been explored. Ways of enhancing the productivity and quality through ERP implementations have also been thrashed out. Risk factors as well as certain realities have also been discussed.

In the last more than two decades of we have experienced in planning technology starting from Materials Requirements Planning (MRP) to Manufacturing Resources Planning (MRP II) to Enterprise Resources Planning (ERP), Business Process Re-engineering, and so on. As a result of significant change in Information Technology of the present era, the name has metamorphosed: from ERP to ERP II or Extended Enterprise Resource Planning (EERP) to simple Enterprise System (ES).

ERP has been around in the world for over two decades but in the Indian sub-continent it has appeared only in the last three to four years. Why it is considered more efficient

than the earlier traditional application systems is because it takes into account all aspects of business. The ensuing data becomes part of a composite whole. Few of the popular expectations are:

- Increased productivity on all fronts
- Total automation and disbanding of all manual processes
- Improvement of all key performance indicators
- An improvement in processes
- Elimination of all manual record keeping
- Real time information systems available to concerned people on a need basis
- Finally total integration of all operations
- Reduced manufacturing cycle times
- Lower costs
- Freer access to data
- Greater flexibility in work processes

Major ERP players in the market are SAP, Baan Infosys, Oracle Corporation, Ramco, QAD India, Informix, Sybase, SAP AG, PeopleSoft Inc, JD Edwards & Co., etc.

5. ERP Risk Factors

The probability of ERP deployment delays and over-budgets is increasing. The current risk factors include:

- Increased stress caused by greater transparency
- Individual fear of loss of authority
- Bandwagging the expectation and fears is a very necessary part of the implementation process.
- Job redundancy
- Skills deficiency.
- Technology limitations
- High user expectations
- Loss of importance as information is no longer an individual prerogative
- Change in job profile
- An organisational fear of loss of proper controls and authorisation
- Information systems departments being downsized or outsourced.

- The future risk factors will arise, such as:
- Accelerated market consolidation.
 - Object and component revolution.
 - Network distributed architecture.

6. Acquiring Quality and Productivity

ERP requires fundamental shifts in assumptions, beliefs, and day-to-day behaviours throughout the organisation. In an organisation, the biggest leap is the necessity for

each person to have a basic understanding of the overall organisational system rather than just their piece of it. If issues related to increased workload are not managed effectively, and resistance is driven underground, the resulting problems can be very costly to the organisation in terms of quality and productivity.

ERP is very difficult to achieve but not impossible at all if we carry out a lot of spade work in a systematic manner in the desired manner. The following are few requirements for ERP to deliver expected results:

- Get adequate support from senior management
- Plan and manage the implementation effectively, and
- Identification of information and workflow
- Analysis of information needs
- Realise the business benefits
- Recognise the cultural implications
- Simplification and rationalisation of activities
- Policies to be decided on the basis of the redesigned activities
- Systems and procedures for various activities
- Standardisation of procedures
- Integrated MIS
- Data integrity and consistency
- On-line information availability
- Secured access
- Plan for high impact and high resistance

7. Making ERP Implementation a Grand Success

A few of the realities that any organisation must keep in mind are:

- Changing the organisation involves 3 levels--strategic, business process and change and consequential organisation change
- Changing the organisation requires a mindset change. Without a willingness to change, it would be a classic case of an old organisation plus new technology leading to an expensive old organisation
- In most companies in India, many process related key performance indicators have not been measured till now--either because the company did not feel it necessary or lacked the tools to do so. Measuring such indicators brings in new culture
- The generic nature of the ERP packages is such that there would be processes peculiar to some sectors and organisations, which may have to be kept out of the process
- Some of the processes are better done manually

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TOUR OF NEURAL NETWORK WITH ITS UNIQUE PARAMETERS & APPLICATIONS

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Abstract

With the ever-increasing demand of hi-tech systems that are capable of performing otherwise extremely exhaustive tasks involving computations of high complexity, the popularity of Artificial Neural Networks is growing ten folds per day because of its ability to emulate human beings & perform such tedious tasks with utmost ease & efficiency. In this paper we study the basics of neural networks & then venture into its wide application domain that touches all spheres of life. We present an overview of the various ANN applications with examples. From the aforementioned study we've concluded that the input parameters & the corresponding weights chosen play the most important role in designing any ANN application, they're the key players in the game. We present here the ANN introduction, its applications along with their key points & conclusions.

(I) INTRODUCTION

For many centuries, one of the goals of human kind has been to develop machines. We envisioned these machines as performing all cumbersome & tedious tasks so that we might enjoy a more fruitful life. Artificial neural networks are present day examples of such machines that have a great potential to further improve the quality of our life.

A neural networks ability to perform computation is based on hope that we can reproduce some of the flexibility and power of human brain by artificial means. Basically a neural network is machine that is designed to model the way in which the brain performs a particular task or function of interest. The network is usually implemented by using electronic components or is simulated in software on a digital computer.

We may also define neural network as "a massively parallel distributed processor made up of simple processing units called neurons which have a natural propensity to store experiential knowledge & making it available for use. It resembles brain in 2 respects:

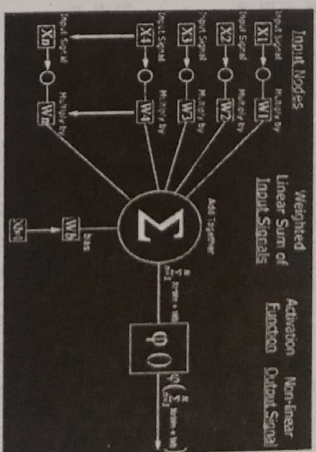


Figure 1- model of a neuron

- 1) Knowledge is acquired by network from its environment through a learning process, called learning algorithm.
- 2) Inter neuron connection strengths, called synaptic weights, are used to store the acquired knowledge.

Now a neuron is an information-processing unit that is fundamental to the operation of a neural network. The figure below shows the model of the neuron, which forms the basis for designing artificial neural networks.

As can be seen from the diagram, there are 3 basic elements of the neuronal model:

- 1) A set of SYNAPSES or CONNECTING LINKS, each of which is characterized by a weight of its own.
- 2) An ADDER for summing the input signals, weighted by respective synapses of the neuron.
- 3) An ACTIVATION FUNCTION for limiting the amplitude of the output of a neuron.

The model also contains an externally applied BIAS, which has the net effect of increasing or lowering the net input of the activation function.

The property of neural network that is of primary significance is the ability of network to learn from its environment, & to improve its performance through

training. A neural network learns about its environment through an interactive process of adjustments applied to synaptic weights & bias level. After completing the learning process successfully the network is ready to be employed for independent functioning.

In the foregoing paragraphs we discussed briefly the introduction of neural networks. Due to the fact that neural networks offer numerous distinguished advantages & benefits it is being currently used in all vistas of life. It has not a sphere of life untrouced, thus we shall now proceed to discuss some of the most common applications of the neural networks. For details refer [1].

III) Neural Network Applications

Neural Networks can be applied to a wide variety of problems. It touches almost every sphere of life. The applications have been divided into some broad application domains. These are discussed below:

MEDICAL APPLICATIONS :-

1) **Locate common characteristics in large amounts of data:**

Locating common characteristics in large amounts of data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks. Examples of classification applications in medicine include dividing research populations or data into groups for further study. For example, data from studies of body movement could be classified into different patterns to aid with physical therapy.

An example: Classification of Hand Movements:

Key points: EEGs of 6 normal subjects were recorded during sequences of periodic left or right hand movement. Left or right was indicated by a visual cue. The question posed was, "Is it possible to move a cursor on a monitor to the right or left side using the EEG signals for cursor control?" For this purpose the EEG during performance of hand movement was analyzed and classified on-line. A neural network in form of a learning vector quantization (LVQ) with an input dimension of 16 was trained to classify EEG patterns from two electrodes and two time windows.

Conclusion: After two training sessions on 2 different days, 4 subjects showed a classification accuracy of 89-

100%. For two subjects classification was not possible. These results show that in general movement specific EEG-patterns can be found, classified in real time and used to move a cursor on a monitor to the left or right.

Conclusion: On-line EEG classification is necessary when the EEG is used as input signal to a brain computer interface (BCI). Such a BCI can be help for handicapped people.

2) **Better-forecast results based on existing data.**

Forecasting results based on existing data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks. Examples of function approximation applications in medicine include the prediction of patient recovery and automated changes to device settings. For example, data from studies of potential recovery level of patients can provide realistic estimates to patients while helping facilities cut costs by better allocating resources.

An example: Functional recovery of stroke survivors: Objective is to predict the place of discharge or discharge Functional Independence Measure (FIM) score for stroke survivors with moderate disability using neural network modeling.

Key points: One hundred forty-seven consecutive stroke survivors admitted for rehabilitation with admission FIM scores between 37 and 96 were used as the training and internal test set. Seventeen other randomly selected stroke survivors were used as the external test set. A neural network model was developed using a small set of clinical variables and the admission FIM score. A working and accurate model was developed to predict the discharge FIM score.

Conclusion: The model was able to predict the 17 external test cases with an accuracy = 88%, sensitivity = 83%, specificity = 91%, positive predictive value = 83%, and negative predictive value = 91%. Neural network modeling is useful in the prediction of functional recovery and helps in discharge planning and allocation of rehabilitation resources.

3) **Predict the progression of medical data over time.**

Predicting the progression of medical data over time is a type of time-series prediction problem. Neural networks

can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in medicine include the prediction of cell growth and disease dispersion. For example, data from studies of muscle stimulation patterns of arm movements can be used to control mouse movements on a computer screen.

An example: Control of Arm Movements Application: A new approach to the control of point-to-point, single joint arm movements by an artificial neural network (ANN) controller is presented.

Key points: The ANN controller was used to learn and store the optimal patterns of muscle stimulation for a range of single joint movements. These stimulation patterns were obtained from an optimal control strategy that minimizes muscle activation or muscular effort. Feed forward, recurrent feedback, and time delay topologies of neural networks were considered for this application.

Conclusion: A comparison showed that the feedforward network combined with recurrent feedback and input time delays can most effectively capture the optimal temporal profiles of muscle stimulation. This neural network controller further demonstrated remarkable ability to generalize the learned optimal control to a class of scaled movements. This study showed that neural networks were promising as an open-loop pattern generator for muscle stimulation signals in movement restoration by functional electrical stimulation. Refer [2].

BUSINESS APPLICATIONS :

1) **Detect common characteristics in large amounts of data :** Detecting common characteristics in large amounts of business data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks. Examples of classification applications in business include dividing research populations or data into groups for further study. For example, data can be extracted from databases to determine potential business ventures for investors. Refer [3].

An example : Searching for "interesting" Business Applications: this study searched through a database of WWW businesses and classified them as "interesting" and "not interesting" for determining future business ventures.

Key points : With generalized models, the new data sets were classified at 84.75% on average correctly. An approach for searching and pre-selecting WWW offers to be considered for the Internet Database (IDB) was presented. First aim was to classify WWW offers into categories "interesting" and "not interesting". For this purpose, several multi-layer perceptrons, generalized feed-forward networks and modular networks were tried. All networks performed quite well. The winner, an MLP with 3 hidden layers and 50 PE's per hidden layer, exhibited reasonable generalization capability as well. When exposed to new data sets it classified 84.75% on average correctly.

Conclusion : In order to improve these current results we intend to use larger data sets to train the network.

2) **Determine relationship between business factors to forecast effects of changes**

Forecasting the relationship between multiple factors in business data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks. Examples of function approximation in business include predicting changes to prices and costs. For example, data from studies can potentially help predict bankruptcy predictions for credit risk or sales forecast.

An example: Bankruptcy Prediction for Credit Risk: This sample study highlights important and widely studied topic since it can have a significant impact on bank lending decisions and profitability.

Key points: Inspired by one of the traditional credit risk models, the neural network approach provides a significant improvement in the out-of-sample prediction accuracy (from 81.46% to 85.5% for a three-year-ahead- forecast). The prediction of corporate bankruptcies is an important and widely studied topic since it can have significant impact on bank lending decisions and profitability. This work presents two contributions. First we review the topic of bankruptcy prediction, with emphasis on neural-network (NN) models. Second, we develop an NN bankruptcy prediction model. Inspired by one of the traditional credit risk models developed by Merton (1974), we propose novel indicators for the NN system.

Conclusion: We show that the use of these indicators in addition to traditional financial ratio indicators provides a significant improvement in the (out-of-sample) prediction

accuracy (from 81.46% to 85.5% for a three-year-ahead forecast).

3) Forecast trends based on previous data

Forecasting the relationship between multiple factors in business data is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in business include forecasting revenue and expense cost. For example, data from business studies can predict labor, cost, material utilities, or other cost over time.

An example: Predicting Expense Cost: This study is used to predict the total contingency cost allowance for variations on a construction project is described. By determining cost factors for engineering and business decisions you could provide better estimations towards the manufacturing process.

GENERAL SCIENCE :

1) Identify characteristics in images or video feeds

Identifying characters in images or video feeds in general science is a type of image processing problem. Neural networks can be used to solve image-processing problems, typically through Principal Component Analysis (PCA) type network. Examples of image processing in general science include identifying agents in images. For example, image data from general science studies can model the detection of lethal agents using Terahertz images.

An example: Detecting Lethal Agents from Images: Using NeuroSolutions, the study used non-invasive means to detect and characterize lethal agents using spatial imaging of their characteristic transmission or reflection wavelength spectrum in the Terahertz (THz) electromagnetic range.

Key points: The application was put to use in two forms in this study: Lethal Agent detection in an Envelope and character Bomber. A non-invasive means to detect and characterize concealed lethal agents employs spatial imaging of their characteristic transmission or reflection wavelength spectrum in the Terahertz (THz) electromagnetic range. Artificial neural network (NN) analyses of these THz spectral images provide specificity of agent detection at reduced false alarm rates. Both multilayer perceptron and radial basis function NN architectures are used to analyze these spectral images. Positive

identifications are generally made, with radial basis functions NNs generally yielding superior results.

2) Group scientific data based on key characteristics

Grouping of general science data based on key characteristics is a type of clustering problem. Neural networks can be used to solve clustering problems, typically through Self-Organizing Map (SOM) type network. Examples of clustering in general science include the detection of key characteristics in robotic movement and forestry separation. For example, data from studies concerning machine learning can be applied to help robots improve their operational capabilities.

An example: Neural Networks in Mobile Robot Motion: This study deals with a path planning and intelligent control of an autonomous robot which should move safely in partially structured environment.

Key points: The study is based on two neural networks: 1) Determine "free" space using ultrasound range finder data and 2) "Finds" a safe direction for the next robot section of the path in the workspace while avoiding the nearest obstacle. It deals with a path planning and intelligent control of an autonomous robot, which should move, safely in partially structured environment. This environment may involve any number of obstacles of arbitrary shape and size; some of them are allowed to move. In future this technique can be implemented for safe motion of our experimental mobile vehicle in indoor conditions.

Conclusion: This algorithm can be used not only for the robot motion in known environment but for unknown one, as well. This technique will be suitable also for the motion of mobile devices in complex environment comprising also mobile obstacles.

3) Predict the progression of scientific data over time

Forecasting the relationship between multiple factors in general science data is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in general science include forecasting flood predictions. For example, data from general science studies can model the river flow to provide real-time prediction of peak downstream.

An example: Real-time River Flood Prediction: Artificial Neural Networks (ANNs) are being used increasingly to

predict and forecast water resources variables. ANNs have been used for the prediction or forecasting of water resources variables are reviewed in terms of the modelling process adopted.

Key points: The modeling steps investigated include selection of performance criteria, data division and preprocessing, determination of model inputs, selection of network architecture, optimization of connection weights and validation. The main areas of concern include (i) the utilization of the validation data during the training process, either by using them to optimize the network inputs, geometry and parameters as part of a trial-and-error procedure, or by using them to decide when to stop training, (ii) the use of a fixed number of iterations as the stopping criterion, especially when the results obtained are used to compare the performance of models with different inputs, architectures and internal parameters, (iii) the arbitrary choice of model inputs, network architecture and internal model parameters and (iv) the scaling of the input data to the extreme ranges of the transfer function in the output layer. One complicating factor is the fact that ANN modeling is a very active research area, and new network architectures and optimization algorithms are being proposed on an ongoing basis. For details study [4].

Conclusion: The dissemination of the vast amount of information that is being generated into a form that is useful for practitioners is one of the greatest challenges facing researchers in the field of ANN modeling.

Manufacturing and Controls

1) Locate common characteristics in large amounts of data

Detecting common characteristics in large amounts of manufacturing/control data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks. Examples of classification applications in manufacturing/control include dividing research populations or data into groups for further study. For example, data can be extracted from mechanical logs to determine the maintenance proficiency level of operators.

An example: Improving plant operator maintenance proficiency: Using NeuroSolutions, this study successfully modeled machine breakdown, but revealed that the operator's impact upon machine breakdown rates

can be considerable.

Key points: Specifically, an artificial intelligent classification model is proposed as a means of classifying plant operator maintenance proficiency into one of three bandings. These are good, average and poor. The results of such work will form the basis of new prescriptive guidelines, for incorporation into the new certificate of training achievement (CTA) scheme, available to inexperienced construction plant operators.

2) Predict the relationship between multiple factors

Forecasting the relationship between multiple factors in manufacturing/control data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks. Examples of function approximation in manufacturing/control include predicting changes to device settings. For example, data from studies can potentially help predict milling strategy, for prediction of surface quality and for the optimization of technological parameters in milling.

An example: Neural-Network-Based Numerical Control for Milling Machine: this sample study highlights using neural networks to generate part-programs for milling, drilling and similar operations on machining centers, on the basis of 2D, 2.5D or 3D geometric models of prismatic parts, without operator intervention.

Key points: The neural network consists of networks for prediction of milling strategy, for prediction of surface quality and for the optimization of technological parameters in milling. The device, which can be retrofitted to a CNC controller, can be trained from a set of typical parts and will then generate new NC part-programs.

3) Predict the progression of scientific data over time

Forecasting the relationship between multiple factors in manufacturing/control data is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in manufacturing/control include machine diagnosis or even controlling a device. For example, data from manufacturing/control studies can forecast driving patterns to support navigation.

An example: Learning Driving Patterns to Support Navigation: Experience is a significant source of knowledge for any human activity. Knowledge about past failures may help to avoid similar failures in the future, while repeating or even improving successes. Driving is a complex and dynamic activity, and the extensive previous experience provides great help when some important decision has to be made quickly.

Key points : Driving patterns are sequences of events in the traffic system repeating over time. We developed a framework of the driving warning system based on the learned driving patterns. The learning part of the proposed system builds and maintains the model of the traffic system. The system also predicts the most likely future events. The predicted event is compared with the actual event and if/when driver's behavior becomes significantly different from "usual", appropriate warnings may be generated. We developed a hardware system for data acquisition from navigation sensors. We used off-the-shelf components and a standard software development environment to create an inexpensive but reliable platform for our experiments. We tested prediction capabilities of multi-line perceptrons, recurrent and time-delay neural networks.

Conclusion : This system was able to successfully predict future events for previously used routes and to detect when an unexpected event has been experienced. An interesting avenue for further research would be to integrate short-term and long-term predictions into a composite system. Such a system may use generated long-term predictions to create a context in which short-term predictions would be made. This may improve the quality of the short-term predictions, and provide a basis for confidence estimation required for warning generation. Such a method may ensure the short response time with a reasonable prediction performance and a reliable warning generation. Refer [4].

Investment and Trading :

1) Locate common characteristics between available assets

Detecting common characteristics in large amounts of financial data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks. Examples of classification applications in finance include dividing research populations or data into groups for further study.

For example, data can be extracted from databases to determine whether a stock is on the verge of a breakout.

An example : Classifying level of return on stock market index: This sample study highlights the usage of neural networks in classifying the "level of return" on a stock index. The forecasting performance of a group of classification models is superior to that of a group of level estimation models.

Key points : The classification models included in the study are aimed at forecasting the sign (direction) of index return whereas the level estimation models take the conventional approach to estimate the value of the return. The classification models perform better than their level estimation counterparts in terms of hit rate (number of times the predicted direction is correct). More interestingly, the classification models are able to generate higher trading profits than the level estimation models. The classification models included in the study are aimed at forecasting the sign (direction) of index return whereas the level estimation models take the conventional approach to estimate the value of the return.

Conclusion : The classification models perform better than their level estimation counterparts in terms of hit rate (number of times the predicted direction is correct). More interestingly, the classification models are able to generate higher trading profits than the level estimation models. This is a clear message for financial forecasters and traders.

2) Forecast effects of changes to portfolio or trading approach

Forecasting the relationship between multiple factors in financial data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks. Examples of function approximation in financial include predicting changes to prices and costs. For example, data from studies can potentially predict the next day's closing price for stocks, Forex or even futures data. Detailed study can be done with reference to [5].

An example: Next Day's closing price & Sensitivity Analysis: This study using "Sensitivity about the Mean" to determine the key indicators to be used in the neural network model in Trading Solutions. The study was able to reduce the number of indicators in the model thus making it more efficient and more accurate.

Key points: This paper focuses on the data input selection based on the relative contribution of elected technical indicators while observing the strength of prediction and thereafter selecting a final set of inputs. Three different ANN architectures are compared along with relative weights of key technical indicators. Both the ability of each ANN model to predict stock market trends and a comparison of the contribution of indicators is determined. It was much easier to determine which of the inputs contributed most to the required output by performing the Sensitivity Analysis on all the inputs. In this case, the smaller model was the most efficient and the most accurate.

Conclusion: It was observed that the neural network model built with the best contributing indicators performed well, but more research is required to compare it to other NN architecture variations and other time series forecasting models. One of the future endeavors could also be to implement other inputs like seasonality and effect of political uncertainty to get a more realistic snapshot of the market behavior.

3) Predict prices or best trading actions based on previous performance

Forecasting the relationship between multiple factors in financial data is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in finance include forecasting revenue and expense cost. For example, data from financial studies can forecast the Forex (currency) markets with a higher return.

An example: Forecasting the Forex Market: This sample study highlights that a neural network model is applicable to the prediction of foreign exchange rates. The neural network model in this study outperformed all other models by having the highest Annualized Return of 29.68% in

comparison to the other models averaging 15.65%. In addition, the neural network model had the highest percent of winning trades with 57.24% and the other models having an average of 47.75%.

Conclusion: In this paper we've discussed the various application areas of ANN keeping in mind their key points and limitations & conclusions. We noticed that though many areas of ANN applications are common but they all have one differentiating parameter - inputs given. The inputs & their weights assigned are responsible for widening the scope of ANN & thus making them applicable in any area of general day-to-day life. But the selection of both these parameters is the most challenging task for the parameters needs to be representative of entire problem domain. They should be unique for each problem, reliable, & most important should be able to generate output ie their numerical conversion must be possible.

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HOW SECURE IS YOUR BLUETOOTH

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Abstract

Bluetooth use low power and generally do not require a license for spectrum use. Bluetooth systems are primarily intended to provide its users with access to their sensitive personal data. The communication medium being free airspace, possibility of interference and eavesdropping are quite high. Security thus attains core importance for all Bluetooth systems. Today's wireless world means that data is being sent invisibly from device to device and person to person. Bluetooth wireless technology has, from its inception put an emphasis on security while making connections among devices. There has been some confusion and misinformation surrounding security and Bluetooth wireless technology.

This paper is an attempt to study various security issues about Bluetooth so that one can able to find the reliability level of the security of confidential data. The paper also highlights various protocols used in Bluetooth and how to implement these protocols in a more efficient way.

INTRODUCTION

BLUETOOTH:-

Bluetooth is a wireless LAN technology designed to connect devices of different functions such as telephones, notebooks, computers (desktop and laptop), cameras, printers, coffee makers, and so on. A Bluetooth LAN is an ad hoc network, which means that the network called piconet. A Bluetooth LAN can even be connected to the Internet if one of the gadgets has this capability. A Bluetooth LAN by nature cannot be large. If there are many gadgets that try to connect, there is chaos.

Bluetooth technology has several applications. Peripheral devices of a computer can communicate with the computer through this technology (wireless mouse or keypad). Monitoring devices can communicate with sensor devices in a small health care centre. Home security devices can use this technology to connect different sensors to the main security controller. Conference attendees can synchronize their palmtop computers at a conference.

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Security features in Bluetooth :

Security begins when a user decides how a Bluetooth device will implement its connect ability and discoverability options. The different combinations of connect ability and discoverability capabilities can be divided into three security levels.

Security within Bluetooth has three major areas namely: authentication, authorization and encryption.

Authentication is used for proving the identity of one piconet member to another. The results of authentication are used for determining the client's authorization level. Encryption is used for encoding the information being exchanged between Bluetooth devices. Usually a PIN is provided for providing trust between two devices.

An initialization key is generated when Bluetooth devices meet for the first time and is used for securing the generation of other more secure 256-bit keys which are generated during next phases of the security chain of events. We can also add unique word in the initialization phase for unique identity of the devices. An initialization key is derived from an unencrypted 128-bit random number IN_RANDOM, an L-byte PIN code and a Bluetooth device address. A combination key is always dependent on two devices and therefore derived from information of both devices. It is used in the next phase for challenge response authentication in which a claimant's knowledge of a secret link key is checked. During each authentication a new 128 bit unencrypted random number is exchanged. The claimant returns a 32-bit result (SRES, signed response) to the verifier. The verifier also calculates the same SRES value and compares it to the received SRES. If the SRES value match, the authentication is completed successfully. The SRES value can be continuously varied in case information is more critical for providing higher level of security. Usually this type of variation demands extra bandwidth and adds time delays on the cost of high level of security. Bluetooth security can be enhanced by using some standard third party certificate based encryption methods at software level as extra security in addition to Bluetooth

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built in security. Devices may use digital signatures to add extra level of authorization security.

Bluetooth security

Bluetooth SIG claims that Bluetooth offers better security than its competitors such as IrDA, WLAN etc. security features like authentication and encryption are built into the protocol stack. This enables a negotiation as to the level of security to be used before actual data packets are transmitted. Apart from security offered by protocol stack, applications are further free to decide and implement upon their own security requirements independently and thereby enhance security.

The Bluetooth's Generic Access Protocol (GAP) has defined the following three different security modes for a Bluetooth device:

- Mode 1- Non secure
- Mode 2- Service level enforced security
- Mode 3- Link level enforced security

In security mode 1 a Bluetooth enabled device does not initiate any security procedures. This mode is used in devices with no critical applications.

In security mode 2, the channel has to be established at L2CAP level, otherwise the device will not be able to initiate any security procedures. This mode is suitable for running applications that require different security requirements in parallel.

Mode 3 requires device to initiate security procedures before link set up at the link Manager Protocol (LMP) level. This mode of security enforces a common security level for all applications.

Device Trust Level

Devices could also be classified into the following two nodes, based on their behavior:

- " Trusted Mode
- " Untrusted Mode

A device operating in a trusted mode has a clearly defined relationship. It goes through a set of strict procedures of authentication, upon completion of which, it is provided with unrestricted access to all the services.

A device operating in an untrusted mode has access to

only a limited number of services, and there is no need for such a device to go through strict security procedures. A device in untrusted mode may have a relationship with its respective connections only, however it is not reliable.

Key Management

Varieties of keys are used in the Bluetooth system to ensure transmission security. Important among these are the link key and encryption key. Link key is used in generating an encryption key and also in authentication process. Encryption key is used to encrypt the data packets to be transmitted. The same encryption key is used to decrypt it at the receiving end.

Link Key

The link key, a 128-bit random number, is used in authentication process and in deriving encryption key.

A link key could be used as temporary key or as a semi permanent key. Such usage defines its life span. A temporary link key is specific to only one session while the semi permanent link could be used for more than one session, i.e. they can be reused. Also temporary keys are usually applied for point to multipoint connections in a scenario where a master is broadcasting the same information to several slaves.

Master Key (K_{master})

Master key is a temporary key used if the master device needs to transmit several slave devices simultaneously. If use of master key is decided, link key for the respective connection is overridden. Master key is generated using key generating algorithm E22 with two 128-bit random numbers. As with all other link keys, output of E22 algorithm too is 128 bits. The reason for using key-generating algorithm in the first place is just to make sure that the resulting random number is random enough. A third random number is then transmitted to slave. With the key generating algorithm and current link key, both master and slave cooperatively compute on overlay. The new link key (master key) is then sent to slave, bitwise XORed with overlay. With this, the slave can calculate master key. This procedure must be performed with each slave the master wants to use master key.

Initialization Key (K_{init})

Initialization key is a result of pairing. This key is used in the initialization process to protect the initialization pa-

rameters during transmission. Initialization key is needed when two devices with no prior engagements and security negotiations need to communicate. During initialization process, the PIN code is entered on both devices. The initialization key itself is generated by E22 algorithm, which uses the PIN code, Bluetooth device address of the claimant device and a 128-bit random number generated by the verifier device as inputs. The resulting 128-bit initialization key is used for key exchange during generation of a link key. After the link key is exchanged, initialization key is discarded.

Unit Key (K_a)

Unit key is generated using key generating algorithm E21 when a Bluetooth device is in operation for the first time. After it is created, it will be stored in the non-volatile memory of the device and is rarely changed. Unit key could be used as a link key between two devices. During initialization process, application decides which party should provide its unit key as the link key. If one of the devices has restricted memory capabilities (i.e. cannot remember any extra keys), it uses unit key as link key.

Combination key (K_{ab})

This key is generated from a pair of Bluetooth devices for which a link has to be setup. This is useful when a higher security level is required. Combination key is generated during initialization process if the devices have decided to use one. However use of combination key requires more memory resource than unit key. Both devices generate it at the same time. First, both the units generate a random number. With the key generating algorithm E21, both devices generate a key, combining the random number and their Bluetooth device addresses. After that, the devices exchange securely their random numbers and calculate the combination key to be used between them.

Encryption Key

Encryption key is generated from the current link key, a 96-bit Ciphering offset number (COF) and a 128-bit random number. The COF is based on the Authenticated Ciphering Offset (ACO), which is generated during the authentication process. When the link manager (LM) activates encryption, the encryption key is generated. It is automatically changed every time the Bluetooth device enters encryption mode.

PIN Code

The length of Personal identification Number (PIN) code

used in Bluetooth devices can vary between 1 and 16 octets. This is how it works.

The regular 4-digit code is sufficient for most applications, but higher security applications may need longer codes. This number could be fixed one or selected by the user. User can change if he wishes to and this adds more security to the system. PIN code could be entered into one device, but it is safer to enter it in both units.

Bluetooth Protocol Stack

Following the lines of popular OSI reference model, the architecture of Bluetooth device has been segmented into different protocols, the collection of which is termed as protocol stack. Based on the functionality of the protocols, they have been classified into the following:

- " Bluetooth Core Protocols- the Base band ,LMP
- " Telephony Control Protocol-TCS Binary
- " Cable Replacement Protocol-RFCOMM
- " Adopted Protocol-PPP,UDP/TCP/IP

Implementation of Protocols in Bluetooth

Link Manager Protocol (LMP)

LMP messages are used for link setup, link configuration, link control and security mechanisms like authentication, encryption and other procedures. It discovers remote LMs and communicates with them via Link Manager Protocol (LMP). To provide this service, LM uses services of the underlying Link Controller (LC).

Logical Link Control Adaptation Protocol

The Bluetooth logical link control and adaptation protocol (L2CAP), is situated above base band layer and beside link manager protocol in the Bluetooth protocol stack. L2CAP provides connection oriented and connectionless data services to upper layers. It is applicable only to ACL links as SCO links run directly through base band. L2CAP performs Multiplexing, Segmentation, reassembly and groupings.

Service Discovery Protocol

Service Discovery Protocol (SDP) defines how a Bluetooth client's application shall discover available Bluetooth server's services and their characteristics. The protocol defines how a client can search for a service, based on specific attributes without client knowing anything of the

available services. Service discovery process is triggered when the client enters an area where a Bluetooth server is operating. SDP also provides functionality for detecting whether a service is available or not. Service discovery is performed without the need to consult a third device, nor is there a need to register new services with a central authority.

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SIX SIGMA - A QUALITY PRODUCT DEVELOPMENT SYSTEM

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ABSTRACT

In today's fast paced global economy, time to market constraints are demanding that companies produce their products more quickly and with higher quality. Developers need to create innovative products in less time; even through the product may be very complex. Organizations worldwide are under continuing pressures to control costs, maintain high levels of safety and quality, and meet customer's expectations. A six-sigma approach can directly affect the needs, if it is conducted wisely. Organizations need to give smarter six sigma solutions assessments that are linked to bottom line benefits. Six- sigma is a powerful breakthrough improvement business strategy that enables companies to use simple and powerful statistical methods to define, measure, analyze, improve and control processes for achieving and sustaining operational excellence. This paper will show how the goals for six sigma can be achieved and surpassed through the complimentary usage of six sigma.

KEY WORDS: SIX SIGMA, DMAIC, DPMO, MBB, BB, GB, TQM, CTQ.

INTRODUCTION

As the competition continues to get tougher, there is much pressure on the product development, manufacturing and service organization to become more productive and efficient. The marching trend of the new economic order has generated a new capsule of six sigma is a unified approach to process excellence. The roots of six- sigma as measurement standard can be traced back to Carl Frederick Gauss (1777-1885) who introduced the concept of the normal curve. Six sigma as a measurement standard in product variation can be traced back to the 1920's when Walter Shewhart showed that three sigma from the mean is the point where a process requires correction [1]. Six sigma was originally developed by Motorola in the 1980's and has since been implemented by a number of world

class organization such as GE, Honeywell, ABB, Sony, Ford, etc. with the purpose of reducing variability in processes, reducing quality costs, improving process capability and enhancing process throughput yield [2]. Six sigma born when Motorola published its six sigma quality program in 1987. in the early end mid 1980's with chairman Bob Galvin at the helm, Motorola engineers decided that the traditional quality levels measuring defects in thousands of opportunities didn't provide enough granularity. Instead, they wanted to measure the defects per million opportunities. Motorola developed this new standard and created the methodology and needed cultural change associated with it. Six sigma helped Motorola realize powerful bottom line results in their organization-in fact; they documented more than \$16 billion in savings as a result of our six-sigma efforts [3]. Mike J. Harry developed six-sigma the program gained publicity when Motorola won the Malcolm Baldrige quality prize [3].

CONCEPT OF SIX- SIGMA

Sigma () is character of the Greek alphabet, which is used, in mathematical statistics to define standard deviation. The standard deviation indicates how tightly all the various examples are clustered around the mean in a set of data. Six-sigma is a business method for improving defects and their causes in business process activities. It concentrates on those outputs, which are important to customers. The method uses various statistical tools to measure business processes. In technical terms, six sigma means that there are 3.4 Defects per million events or opportunities (DMPO). The main goal is continuous quality improvement.

SIX SIGMA PRINCIPLES

For effective introduction, development and implementation of six sigma program in any organization, one should consider the following key ingredients which will drive the application of six sigma principles successful.

Strong leadership and top management commitment

Many previous quality initiatives, such as TQM, have been faced with a major difficulty, which has been leadership attitude of 'Do as I say---- not as I do'. Such initiatives also faded because the company leaders focus [4]. In order to overcome this problem, company leaders have to ensure that six-sigma initiative has momentum for process improvement and hence it must be sustained over long term. Good support from management is imperative in the re-structuring of organization and achieving cultural change and motivation of employees towards quality and the six-sigma strategy to the business. The leaders have to be strong advocates of six-sigma.

Cultural Change

The successful introduction of six-sigma requires adjustments to the culture of the organization and a change in the mind-set of its employees. Employees have to be motivated towards the introduction and development of six-sigma program through various reward and recognition schemes. There can also be a problem of employees dismissing six-sigma as the latest fad or hype. To overcome this problem and also to allay the fears that employees may have, there has to be early and effective communication to all employees on the why and how of six-sigma.

Training

Training is a crucial factor in the successful introduction and development of six-sigma program. It is important to communicate both 'why and how' of six-sigma as early as possible, and provide the opportunity to people to improve their comfort level through training classes [5]. There is usually a hierarchy of expertise, which is identified by the belt system.

Understanding the six-sigma methodology, tools, techniques and metrics

A healthy portion of the six-sigma training involves learning of the theory and the principles behind the methodology, i.e. DMAIC cycle.

SIX-SIGMA IMPLEMENTATION

It is reasonable to carry out the six-sigma implementation as a six-phase process. Phases from one to four are to establish six-sigma, and phases from five to six are for realization of six-sigma look at the six-sigma implementation

model below.

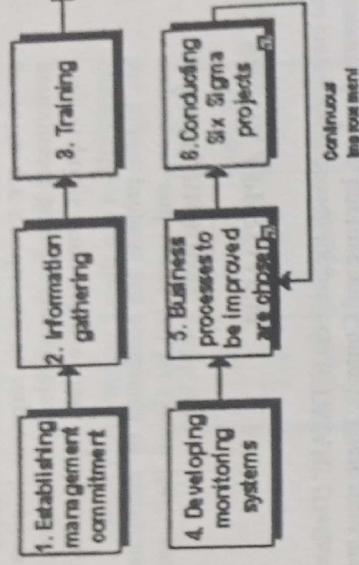


Figure - 1 Six-Sigma Implementation Model - General Level

1. Successful performance improvement must begin with senior leadership. Start by providing senior leadership with training in the principles and tools they need to prepare their organization for success. Using their newly acquired knowledge, senior leaders direct the development of a management infrastructure to support Six Sigma. Simultaneously, steps are taken to "soft-wire" the organization and to cultivate an environment for innovation and creativity. This involves reducing levels of organizational hierarchy, removing procedural barriers to experimentation and change, and a variety of other changes designed to make it easier to try new things without fear of reprisal.
2. Systems are developed for establishing close communication with customers, employees, and suppliers. This includes developing rigorous methods of obtaining and evaluating customer, employee and supplier input. Base line studies are conducted to determine the starting point and to identify cultural, policy, and procedural obstacles to success.
3. Training needs are rigorously assessed. Remedial skills education is provided to assure that all employees possess adequate levels of literacy and numeracy. Top-to-bottom training is conducted in systems improvement tools, techniques, and philosophies.
4. A framework for continuous process improvement is developed, along with a system of indicators for monitoring progress and success. Six Sigma metrics focus on the organization's strategic goals, drivers, and key business processes.
5. Business processes to be improved are chosen by management, and by people with intimate process

knowledge at all levels of the organization. Six Sigma projects are conducted to improve business performance linked to measurable financial results. This requires knowledge of the organization's constraints.

6. Six Sigma projects are conducted by individual employees and teams led by Green Belts and assisted by Black Belts.

SIX SIGMA APPROACH

The six-sigma approach for projects is 'DMAIC' (Define, Measure, Analyze, Improve and Control). These steps are the most common six-sigma approach to project work. The elements of the DMAIC cycle are explained below.

a) Define Phase

This phase involves

- * Who are the customers and what are their needs and expectations?
- * Understand the customer CTQ (critical to quality) and transform them into project CTQ'S.
- * Develop a project team charter (who is doing what, determine project goals, what are the key deliverables, benefits of going the project, costs issues etc.)
- * Gather data from customers to understand what exactly they want from us (customer surveys, benchmarking data, quality function deployment, etc.)
- * What is the process? Use tool such as high-level process mapping to map out core processes.

b) Measure phase

This phase involves

- * How is the process measured and how is it performing?
- * Decide what to measure and how do we measure it?
- * Measure current performance of the process (throughput yield, DPMO, capability, etc.)
- * Do we have a capable measurement system?
- * What is the variability contributed by the measurement system to the total variation?

c) Analyze phase

This phase involves

- * Identify the root causes of defects or failures?
- * Understand the data (using simple statistical tools

- such as histogram, scatter plot, etc.)
- * Use of simple tools regression analysis, control charts, etc. to analyze the data.
- * Select the 'vital few' causes from the trivial many for improvement phase.

d) Improve phase

This phase involves

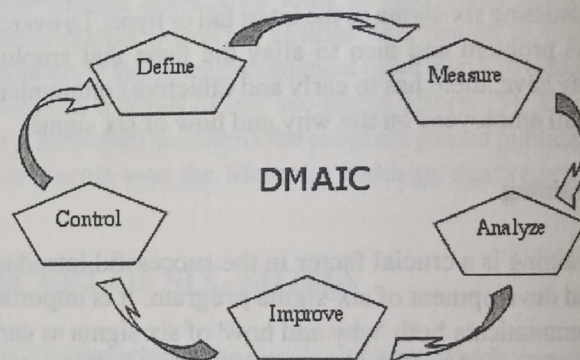
- * How can the causes of defects or failures removed?
- * Identify the key variables, which causes problems.
- * Document solution statements.
- * Test solutions and measure results.

e) Control phase

This phase involves

- * How can the improvements be maintained or sustained?
- * Document the new methods.
- * Select and establish standard measures to monitor performance.

Figure 2- DMAIC Cycle



ORGANISATIONAL INFRASTRUCTURE

In addition to top management support, there also needs to be an effective organization infrastructure to support the six-sigma undertaking. Teams do a great deal of work in six sigma. The various roles played and positions held by the team members are explained under the belt system.

CHAMPIONS AND SPONSORS

Six Sigma champions are high-level individuals who understand Six Sigma and are committed to its success. In larger organizations Six Sigma will be led by a full time, high-level champion, such as an Executive Vice-President. In all organizations, champions also include informal

leaders who use Six Sigma in their day-to-day work and communicate the Six Sigma message at every opportunity. Sponsors are owners of processes and systems that help initiate and coordinate Six Sigma improvement activities in their areas of responsibilities.

MASTER BLACK BELT

This is the highest level of technical and organizational proficiency. Master Black Belts provide technical leadership of the Six Sigma program. Thus, they must know everything the Black Belts know, as well as understand the mathematical theory on which the statistical methods are based. Master Black Belts must be able to assist Black Belts in applying the methods correctly in unusual situations. Whenever possible, only Master Black Belts should conduct statistical training. For example, Black Belts may be asked to provide assistance to the Master during class discussions and exercises.

BLACK BELT

Candidates for Black Belt status are technically oriented individuals held in high regard by their peers. They should be actively involved in the process of organizational change and development. Candidates may come from a wide range of disciplines and need not be formally trained statisticians or engineers. However, because they are expected to master a wide variety of technical tools in a relatively short period of time, Black Belt candidates will probably possess a background including college-level mathematics and the basic tool of quantitative analysis. Coursework in statistical methods may be considered a strong plus or even a prerequisite. As part of their training, Black Belts receive 160 hours of classroom instruction, plus one-on-one project coaching from Master Black Belts or consultants.

GREEN BELT

Green Belts are Six Sigma project leaders capable of forming and facilitating Six Sigma teams and managing Six Sigma projects from concept to completion. Green Belt training consists of five days of classroom training and is conducted in conjunction with Six Sigma projects. Training covers project management, quality management tools, quality control tools, problem solving, and descriptive data analysis. Six Sigma champions should attend Green Belt training. Usually, Six Sigma Black Belts help Green Belts define their projects prior to the training, attend training with their Green Belts, and assist them with their projects after the training.

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SLIDING SCALES FOR SIX SIGMA

TABLE - 1

Sigma Performance Levels one to Six-Sigma

SIGMA	YIELD	DPMO
1 σ	31.0%	690,000
2 σ	69.2%	308,000
3 σ	93.3%	66,800
4 σ	99.4%	6,210
5 σ	99.97%	230
6 σ	99.99966%	3.4

As the Sigma scale describes defects in parts per million, the desire to achieve six sigma either side of the nominal target inside the specification relates to very tight production characteristics or equivalently a very low incidence of cares outside the specification 'defect'. In fact, under the consumption of normality, a product or process operating at six sigma quality would have a 99.999998% yield, or defects at 0.002 parts per million (two parts per million). At more typical three-sigma quality level, the yield will be 99.73% or 2700 defects per million opportunities (DPMO) for most of their processes and a four or five sigma level in some of the mission-critical process. Consumptions of sigma level, yields and the corresponding defect rates are shown in Table 1.

The higher the number of sigma's, the more consistent the process of delivering a good product or services to the customers. A six-sigma level of performance means that we can fit in six standard deviation or sigmas between the process center and the nearest specification limit.

LINKING SIX SIGMA TO CUSTOMERS

Six-Sigma should begin and end with the customers. Projects should begin with determination of customer requirements. The process of linking six sigma to the customers can be divided in two main steps:

- a. Identifying the core processes, defining the key outputs, and defining the key customers that they serve.
- b. Defining the customers' requirements.

LINKING SIX SIGMA TO HUMAN RESOURCES

Human resources based action need to be put into effect to promote desired behavior and results. Some studies show that above 60% of the top performing companies practicing six sigma link their rewards to their business strategies. At GE, for instance for any manager to be considered for promotion, they have to be six sigma trained. Likewise, up to 40% of top management bonuses are tied to their specific six sigma success.

LINKING SIX SIGMA TO SUPPLIERS

Many organizations that implement six- sigma find it beneficial to extend the application of six sigma principles to management of their supply chain. For successful business it must be effective and seamless chain of supply to satisfy market demand. This alignment of the business towards the customer is one of principle foals of six sigma. Traditionally the approach was to have many suppliers in order to keep costs down. However, the trend now is to build strong partnerships and win-win relationships with suppliers. This has led to improvement in their product quality and brining the supplier closer to the customer.

CONCLUSION

Six sigma provides a comprehensive and flexible system for maximizing business success. It has system for maximizing business success. It has been considered as a

revolutionary approach to product and process improvement through the effective use of statistical methods. This paper illustrates the key ingredients one should considered before a six-sigma program is initiated in their organization. All these ingredients are en entail for the successful application of six sigma principles to any business process. If any of these ingredients were missing during the introduction and development of six-sigma program, it would be then the difference between a successful implementation and a waste of resources, energy money and time.

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SYSTEM-ON-CHIP OPPORTUNITIES AND CHALLENGES

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Abstract

As integrated circuits have become more and more complex, the ability to make post-fabrication changes will become more and more attractive. This ability can be realized using programmable logic cores. Currently, such cores are available from vendors in the form of a "hard" layout. An alternative approach is to use a "soft", or synthesizable programmable logic core that can be synthesized using standard library cells. One such emerging technique is the System-on-a-Chip (SoC) design methodology. In this methodology, pre-designed and pre-verified blocks, often called cores or intellectual property (IP.), are obtained from internal sources or third-parties, and combined onto a single chip. These cores may include embedded processors, memory blocks, or circuits that handle specific processing functions. The increasing demand to provide more and more functionality in faster embedded devices requires bus protocols to implement complex methods for component interaction, in order to deal with high-level constraints commonly found in most SoC systems. This paper outlines ways in which programmable logic cores can simplify SoC design, and describes some of the challenges like thermal management issues and energy and power consumption reduction technologies.

Introduction

The drivers for the technology improvements are the applications that are very heterogeneous in nature. They range from high-performance multicomputer clusters to portable appliances for wireless communication and embedded applications. The applications complexity will further increase which sets ever-increasing demands on the systems on which they are executed :

- Video and audio applications in personal portable communication devices
- Entertainment applications in game, music, and video players

- Computer networking applications with high data rate requirements
- Television production and broadcasting applications to process (e.g. compress, encrypt, decrypt, and decompress) high-definition video in real-time.

In order to fulfill the requirements for performance, size, energy consumption, and reliability, the complete system must be more often implemented in a single chip, also called System-on-Chip (SoC). Leading-edge systems-on-chip (SoC) being designed today could reach 20 Million gates and 0.5 to 1 GHz operating frequency. In order to implement such systems, designers are increasingly relying on reuse of intellectual property (IP) blocks. Since IP blocks are pre-designed and pre-verified, the designer can concentrate on the complete system without having to worry about the correctness or performance of the individual components.

Programmable Logic IP Cores in SoC Design

No matter how seamless the SoC design flow is made, and no matter how careful an SoC designer is, there will always be some chips that are designed, manufactured, and then deemed unsuitable. This may be due to design errors not detected by simulation or it may be due to a change in requirements. This problem is not unique to chips designed using the SoC methodology. However, the SoC methodology provides an elegant solution to the problem: one or more programmable logic cores can be incorporated into the SoC. The programmable logic core is a flexible logic fabric that can be customized to implement any digital circuit after fabrication. Before fabrication, the designer embeds a programmable fabric (consisting of many uncommitted gates and programmable interconnects between the gates). After the fabrication, the designer can then program these gates and the connections between them.

Energy Management for Soc Design

One of the biggest problems in complicated and high-performance SoC design is management of energy and/or power consumption. Dynamic power consumption is the major factor of energy consumption in the current CMOS digital circuits. The dynamic power consumption is affected by supply voltage, load capacitance and switching activity. The approach to control supply voltage, load capacitance and switching activity dynamically and statically in system architecture and algorithm design levels have been designed. In the future CMOS technology, leakage power consumption becomes dominant, because the threshold voltages are scaled as the transistor size shrinks. The techniques for reducing leakage power in system architecture design is being summarized. The contents include the followings (1) power and energy consumptions in SoC design, (2) tradeoff between energy and performance, (3) techniques for reducing dynamic power consumption.

Power and Energy Consumptions in Soc

The energy consumption of a system, E, can be defined as the summation of both spatial and temporal power consumption of circuits
 Local Power Dissipation

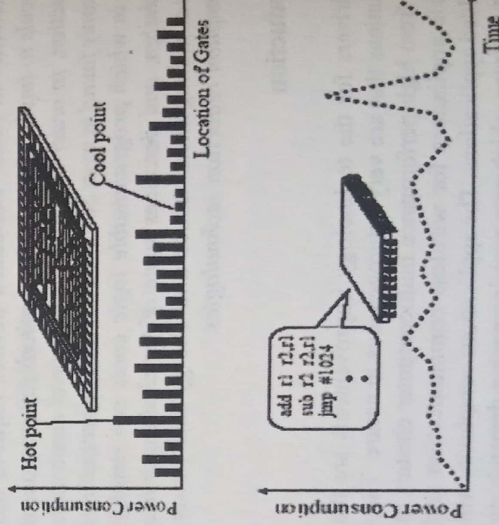


Fig-3 Power Dissipation vs. Energy Dissipation

$$P = P_{dynamic} + P_{leak} = \sum_{g \in G} S.A(g) \cdot CL(g) \cdot V_{DD}(g)^2 + P_{leak}(g)$$

$$E = \int_0^t P dt$$

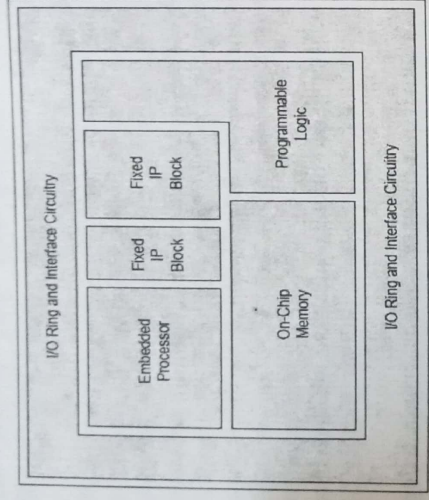


Fig-1

Thermal Management System

Increases in circuit density and clock speed in modern VLSI designs have brought thermal issues into the spotlight of high-speed integrated circuit design. Local overheating in one spot of a high-density circuit, such as CPUs and high-speed mixed-signal circuits, can cause a whole system to crash due to resulting clock synchronization problems, parameter mismatches or other coefficient changes due to the uneven heat-up on a single chip.

Architecture of the system

The architecture of the thermal management circuitry is divided into two portions: the thermal management circuit blocks and the system integration blocks. The former represent the designed thermal management system, and the latter represent the interface to the target system. The designed thermal management system could be applied to different SoC designs. The block diagram of the dynamic thermal management circuit is shown in figure given below. The thermal management circuit blocks are the white boxes with shadows; the gray boxes represent the system integration blocks.

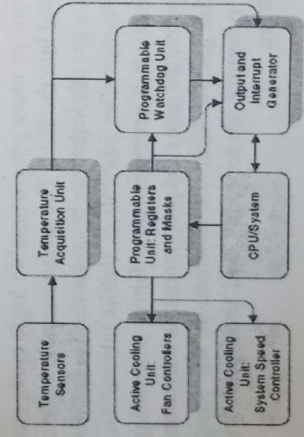


Fig-2

P : Power consumption of the target system

$P_{dynamic}$: Dynamic power consumption of the target system

Pleak : Leakage power consumption of the target system

SA(g) : switching activity of gate g (expected number of 0->1 transitions per second)

CL(g) : load capacitance of g

$V_{on}(g)$: operation voltage of g

t : Execution time of an application program

We treat the energy consumption, E, as an objective function to be optimized, because the energy consumption is close related to the heat and reliability of chips, battery life time of portable devices, and the number of nuclear and gas turbine power stations required. The main approach is detecting a spatial and temporal hot spot and reducing the power consumption of the spot. Since the power consumption, P, dynamically changes according to the behavior of the software running on a chip and a location of the logic gate on the chip as shown in figures above, both the software and the hardware should be taken into account for reducing the energy consumption of a SoC chip. As one can see from equations given above, we can reduce the energy consumption of the SoC chip by lowering SA(g), CL(g), VDD(g), Pleak(g) and t. However, lowering these parameters sometimes causes an increase of the execution time, a degradation of computational quality, system reliability and design flexibility. The key point of the energy reduction in SoC design is considering design tradeoffs among energy consumption, performance, computational quality, system reliability and design flexibility. The goal is minimizing the energy consumption under the constraint of performance, computational quality, system reliability and/or design flexibility.

There is a third source of power consumption, short-circuit power, which results from a short-circuit current-path between the power supply and ground during switching. Short-circuit power is projected to be constant around 10% of total power consumption.

Techniques For Lowering Operating Voltage

Since energy dissipation is quadratically proportional to supply voltage lowering the VDD has a strong impact on the energy reduction.

However, the following drawbacks should be taken into account;

1. loss of compatibility to external voltage standards,
2. performance degradation, and

Volume 2 No. 4

3. reliability issues (very low voltage).

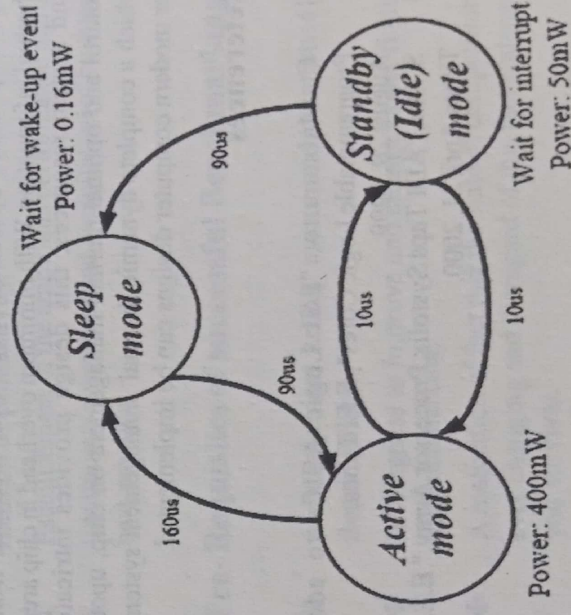
The following three ways for lowering the operating voltage without sacrificing the performance of the system.

1. Parallelize tasks so that the performance does not degrade even in a low voltage operation. We refer this approach as static voltage scaling.
2. Use the maximum available supply voltage for gates on a critical-path and use a lower supply voltage for the other gates. We refer this approach as multiple voltage assignment.
3. Lower the clock frequency and operating voltage when the maximum performance is not needed. We refer this approach as dynamic voltage scaling

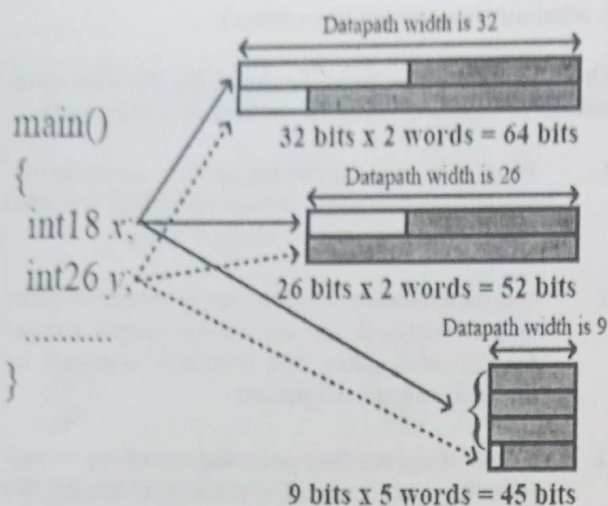
Techniques For Reducing Switching Activity

Lowering the switching activity is a very promising way of decreasing the power consumption. There are numerous researches on this issue. In this section, we introduce system level approaches for reducing the switching activity. System level switching activity reduction can be categorized as follows:

- Turn off unused HW modules.
- Adjust datapath, the bit width of buses and operational units in a system



Dynamic Power Management Example Fig-4



Conclusion

System On Chip (SoC) describes an evolving paradigm for the timely design of integrated circuits (ICs) that contain tens to hundreds of millions of transistors implementing a large variety of different functions. Programmable logic adds another dimension that designers must come to grips with before the full potential of these cores can be realized. The innovative temperature offset monitoring provides a mechanism for system-on-chip designs to monitor the temperature offset across the system and enhance stability. With proper handling of this information, the system not only prevents failure but also enhances performance by controlling each subcomponent's operation speed with feedback from thermal information. With minimum overhead in chip area and system resources, this design provides intricate control and optimal thermal management on chip, upon which a complete dynamic thermal management system for modern computer designs can be implemented.

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THE NEED OF BENCHMARKING IN COMPETITIVE ENVIRONMENT

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ABSTRACT

In the era "faster, cheaper and better", companies are focusing on improvement the product Development process. New Business strategies, new organizational approaches, New Business Process and new enabling technology Approaches that "striving to be the best of best" This mistake significantly reduces or eliminates any potential profit the product may have and greatly increases the sales development time.

The Benchmarking process gave us objective information that was used in decision-making processes, and it removed a lot of the opinion and related emotion that comes from not having substantiated information. Identifying and implementing world best practices, the key things that are done to deliver customer satisfaction. The importance of follow up strategy can be understood from the areas creating trouble can be detected.

- Many new insights can be obtained.
- The Benchmarking process can be made more efficient.

Spread of Benchmarking Culture Quality, speed and innovation are some of the deciding factors of competitive advantage. While innovation demands originally, speed and quality can be achieved by more efficient and effective use of existing resources.

KEYWORD : Continuous improvement, Customer satisfaction, Strategy, Collecting data, Evaluating progress.

INTRODUCTION

There are many benefits of benchmarking. The following list summarizes the main benefits:

- ☛ Provides realistic and achievable targets
- ☛ Prevents companies from being industry led

- ☛ Challenges operational complacency
- ☛ Creates an atmosphere conducive to continuous improvement
- ☛ Allows employees to visualize the improvement which can be a strong motivator for change
- ☛ Creates a sense of urgency for improvement
- ☛ Helps to identify weak areas and indicates what needs to be done to improve.

Objectives of Benchmarking

Following are the main objectives of the benchmarking:

1. Achieving competitive strength
2. Understanding customer requirements developing abilities to meet them
3. Designing , developing and implementing realistic measure of productivity
4. Establishment of the ambitious performance goals.
5. Continuous awareness and exploitation of business best practice

Pre- Requisites of successful Benchmarking

- ❖ A management keenly aware and committed to Benchmarking.
- ❖ Willingness to improve and change as per finding of Benchmarking.
- ❖ A realization of fact that the state of competition is ever changing and disregard of this fact endangers you survival.
- ❖ Willingness and honesty in sharing information with benchmarking partners.
- ❖ Dedicated adherence to the Benchmarking process.

- ❖ Willing to seek and adopt new ideas, creativity and innovativeness for around improvement of existing process

Steps In Benchmarking - Five Key Stages

There are five key stages in benchmarking:

- 1. Proto-planning**
 - a) Decide what you wish to benchmark
 - b) Decide against whom you need to benchmark
 - c) Identify outputs required
 - d) Determine data collection methodologies
- 2. Data collection**
 - a) Secondary/background research
 - b) Primary research - from the benchmark
- 3. Analysis**
 - a) Of the gaps
 - b) Of the factors that create the gaps (enablers)
- 4. Implementation**
 - a) Implementation planning
 - b) Roll-out of new modus operandi (changes)
- 5. Monitoring**
 - a) Collecting data
 - b) Evaluating progress

Customer Satisfaction Quality Level Matrix.

The fig shows the right bottom side of the matrix the reliability of the picture tube of the

TV set has been mentioned, which indicates that this particular feature of the product has highest importance for the customers but the quality of this is poor as compared to competitor's. So it indicates that product quality needs to be improved.

Challenge Questions

1. Into what market will the product be launched?
2. What customer segments will purchase the product?
3. For what applications will the customer use the product?
4. Into what geographic segments will be sold?

5. What are the benefits for the customers?

UNDERSTANDING THE CUSTOMER

Understand Customer Needs

Is the Company processes, policies and culture truly oriented toward understanding customer needs and satisfying those needs (versus, for example, developing the latest technology or providing the most features)

Promote Customer Understanding

Does the Company promote customer contact through programs such as rotation through sales/marketing or customer support functions or by visiting customers or going out to the field and observing how products are actually used and maintained by customers?

Follow Up Strategy

The Assumption that every thing is going well on its way can produce dangerous results.

So there should be a follow up strategy after implementing the action plane. The importance of follow up strategy can be understood from the following clues:

- ❖ Deficiencies in various activities can be sought out.
- ❖ Areas creating trouble can be detected.
- ❖ Many new insights can be obtained.
- ❖ The Benchmarking process can be made more efficient.

One should be Careful about one thing that before preparing the follow up strategy. All steps of Benchmarking should be reviewed carefully.

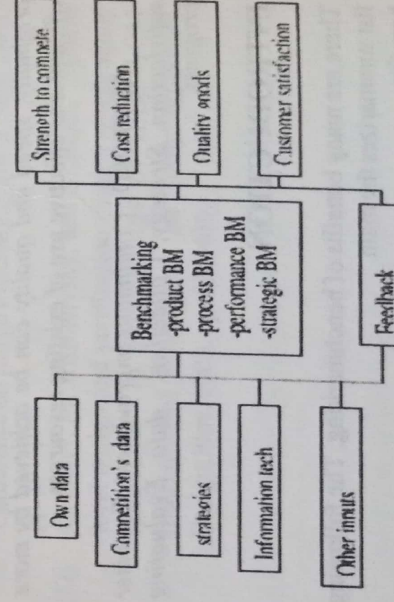


Fig.1. Follow up strategy for benchmarking

Benchmarking Application in India

S.No	Company Name	Area of Operation	Benchmarking Partner	Parameters of Benchmarking
1	R P G Group	35 Companies Spanning seven different business Rs. 5500 crore group	companies with in the group	Purchase Management, Energy saving, Demand forecasting, value Engineering, pricing Strategy.
2	City Bank	Banking services	Non competitors Indian companies	Business Development H R M, Customer Service, Environment management..
3	Modi Xerox	Manufacturing Xerox Machines	Rank Xerox Portugal	Satisfaction level Of Customers
4	Arvind mills	Denim & Textile Makers	P & G, HL Ltd	Shareholder Returns

CONCLUSION

Benchmarking as a core philosophy and is a primary tool for performance improvement, has taken firm root in the corporate world. This as been made amply clear by the following saying; " Know your enemy-and know your self" (Aristotle).

Companies rely on their core competencies to attain superior status or competitive advantage. For that Benchmarking is a precision and engineered algorithm, the gaps are have to be identified, measured bridge to become world class. Benchmarking has been found to be effective not only providing new improvement ideas for changing but also helps in assuring a serious commitment, self assessment, motivation and improvement we India are in dire need such exercise.

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LPG – AN ENVIRONMENT FRIENDLY FUEL

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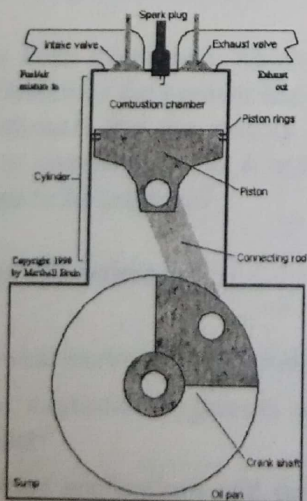
ABSTRACT

As per latest scenario the pollution is increasing everyday resulting in global warming. The larger part of this is contributed by our transport system, as they are emitting harmful gasses like CO, Nitrogen & Sulphur. So, this is the time to change our vehicles to be run on latest technologies of fuel combustion system like LPG, hydrogen gas. This paper deals with how we can convert our vehicle from petrol to LPG System. How much it is economical & at what percentage it reduces the amount of harmful gasses during emission.

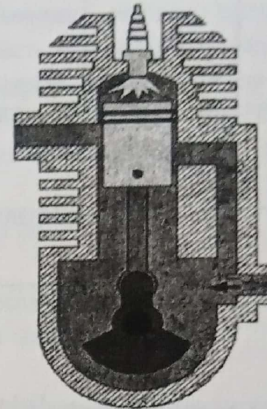
INTRODUCTION

How Engine Works On petrol

Petrol or diesel which we are getting from earth having hydrocarbons. So when we ignite these hydrocarbons in the presence of air it gives the chemical energy & that chemical energy is being converted into the mechanical energy by using piston & cylinder assembly. The type of engines used in vehicles are of I C Engine i.e internal combustion engines. It is basically of two types. one is 2-stroke & other is 4-stroke.



Four Stroke Engine



Two Stroke Engine

Conversion

The process of converting a car to run on propane is fairly demanding and requires a good knowledge of automotive systems in general to accomplish.* Several companies offer kits that include all the needed parts to perform the conversion. Those without the necessary know-how should try to find a local mechanic with experience in LP-gas conversions to get the job done. Although propane is very safe as an automotive fuel, if the system is not installed correctly, there can be safety problems.

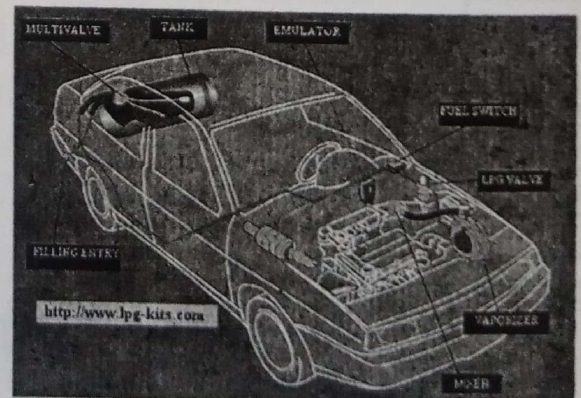


Photo courtesy WTV-UK
Example dual-fuel conversion system

The first step is choosing a tank. Most conversions are dual-fuel conversions, meaning you won't be replacing your old fuel system, you'll simply be adding a second. As a result, the propane tank will take up some of the storage space in your car, usually in the trunk.

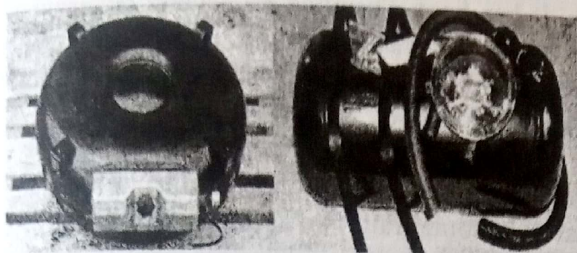


Photo courtesy WTV-UK

Donut tank (left) and torpedo tank

Tanks come in "torpedo" or "donut" form. Torpedo tanks generally have more capacity, but will take up more space in your car. Donut tanks are designed to fit in the spare tire well of your car. They are smaller tanks, and you'll have to sacrifice your spare tire. In larger vehicles, you could mount multiple tanks for increased capacity.

Once the tank is bolted in, a fill point must be drilled into the car's body, usually near the gasoline fill point or at the back of the trunk. The ideal location is one that requires minimal piping to connect to the tank. The fuel lines themselves are copper tubes, which offer a certain amount of flexibility when the lines are routed. The tank must be connected to the fill point, and lines also have to run along the underside of the car up to the engine.

A solenoid valve (LPG valve in the above diagram) must be installed on the fuel line in between the tank and the engine. This valve cuts the flow of LP gas when the car is running on gasoline and when the engine is shut off. It also has a filter built in that removes any dirt that may be in the fuel.

The next major component is called a regulator, also referred to as a vaporizer. This device performs one of the functions that a carburetor handles in a gasoline engine - it uses heat from the car's cooling fluids to vaporize the propane into gas form. Another safety check occurs at the regulator, as well. It includes an electronic circuit that cuts the flow of gas if the engine stops or stalls. The regulator is usually smaller than a regular carburetor, so finding space for it in the engine compartment shouldn't be a problem.

The other part of a carburetor's function is handled by a mixer mounted in the intake manifold. The mixer takes information from the car's sensors or ECU, and then it

controls the amount of gas that flows into the cylinders.

The system must then be wired into the car's electrical system, allowing for a functioning fuel gauge, as well as proper automatic switching between propane and gasoline (along with a dashboard-mounted manual switch). There must be connections to the car's ECU so that the engine controller can adjust for different fuel settings.

Cars with an electronic injection system will probably need an electronic emulator. When the car is operating on LP gas, the fuel injectors will not be sending any information to the other sensors in the car -- this will light up the "check engine" light and give incorrect diagnostic readings. The emulator fakes the proper signals so the ECU can operate properly.

What Are Diesel Emissions?

Diesel engines convert the chemical energy contained in the fuel into mechanical power. Diesel fuel is injected under pressure into the engine cylinder where it mixes with air and where the combustion occurs. The exhaust gases which are discharged from the engine contain several constituents that are harmful to human health and to the environment. Table 1 lists typical output ranges of the basic toxic material in diesel fumes. The lower values can be found in new, clean diesel engines, while the higher values are characteristic for older equipment.

CO	HC	DPM	NO _x	SO ₂
vppm	vppm	g/m ³	vppm	vppm
5-1,500	20-400	0.1-0.25	50-2,500	10-150

Carbon monoxide (CO), hydrocarbons (HC), and aldehydes are generated in the exhaust as the result of incomplete combustion of fuel. A significant portion of exhaust hydrocarbons is also derived from the engine lube oil. When engines operate in enclosed spaces, such as underground mines, buildings under construction, tunnels or warehouses, carbon monoxide can accumulate in the ambient atmosphere and cause headaches, dizziness and lethargy. Under the same conditions, hydrocarbons and aldehydes cause eye irritation and choking sensations. Hydrocarbons and aldehydes are major contributors to the characteristic diesel smell. Hydrocarbons also have a negative environmental effect, being an important component of smog.

Nitrogen oxides (NO_x) are generated from nitrogen and

oxygen under the high pressure and temperature conditions in the engine cylinder. NOx consist mostly of nitric oxide (NO) and a small fraction of nitrogen dioxide (NO2). Nitrogen dioxide is very toxic. NOx emissions are also a serious environmental concern because of their role in the smog formation.

Sulfur dioxide (SO2) is generated from the sulfur present in diesel fuel. The concentration of SO2 in the exhaust gas depends on the sulfur content of the fuel. Low sulfur fuels of less than 0.05% sulfur are being introduced for most diesel engine applications throughout the USA and Canada. Sulfur dioxide is a colorless toxic gas with a characteristic, irritating odor. Oxidation of sulfur dioxide produces sulfur trioxide which is the precursor of sulfuric acid which, in turn, is responsible for the sulfate particulate matter emissions. Sulfur oxides have a profound impact on environment being the major cause of acid rains.

Diesel particulate matter (DPM), as defined by the EPA regulations and sampling procedures, is a complex aggregate of solid and liquid material. Its origin is carbonaceous particles generated in the engine cylinder during combustion. The primary carbon particles form larger agglomerates and combine with several other, both organic and inorganic, components of diesel exhaust. Generally, DPM is divided into three basic fractions (Figure 1):

- ◆ Solids - dry carbon particles, commonly known as soot,
- ◆ SOF - heavy hydrocarbons adsorbed and condensed on the carbon particles, called Soluble Organic Fraction,
- ◆ SO4 - sulfate fraction, hydrated sulfuric acid.

The actual composition of DPM will depend on the particular engine and its load and speed conditions. "Wet" particulates can contain up to 60% of the hydrocarbon fraction (SOF), while "dry" particulates are comprised mostly of dry carbon. The amount of sulfates is directly related to the sulfur contents of the diesel fuel.

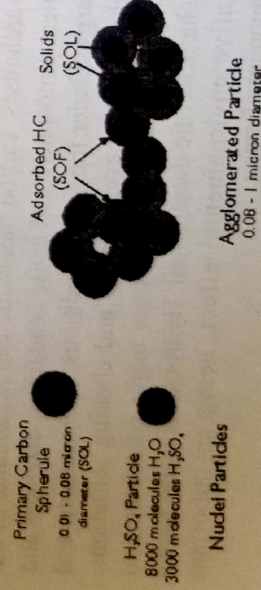


Figure 1. Schematic Composition of Diesel Particulate Matter

Diesel particulates are very fine. The primary (nuclei) carbon particles have a diameter of 0.01 - 0.08 micron, while the agglomerated particles diameter is in the 0.08 to 1 micron range. As such, diesel particulate matter is almost totally respirable and has a significant health impact on humans. It has been classified by several government agencies as either "human carcinogen" or "probable human carcinogen". It is also known to increase the risk of heart and respiratory diseases.

Polynuclear Aromatic Hydrocarbons (PAH) are hydrocarbons containing two or more benzene rings. Many compounds in this class are known human carcinogens. PAHs in the exhaust gas are split between gas and particulate phase. The most harmful compounds of four and five rings are present in the organic fraction of DPM (SOF).

What Are LPG Emissions?

The major harmful emissions from LPG engines are similar to those from other internal combustion engines:

- Carbon monoxide (CO)
- Hydrocarbons (HC)
- Nitrogen oxides (NOx)

Unlike diesel engines, there are practically no particulate emissions from LPG engines. Concentration ranges of particular emissions are listed in Table 4.

CO	HC	NOx
vol. %	ppm C1	vppm
0.2 - 2	50-750	250 - 2,000

Table 4. Emissions from LPG Engine

Carbon monoxide is generated in the exhaust as the result of incomplete combustion of fuel. CO is a very toxic, colorless and odorless gas. LPG emissions may contain considerable amounts of CO. When engines operate in enclosed spaces, such as warehouses, buildings under construction, or tunnels, carbon monoxide can accumulate quickly and reach concentrations which are dangerous for humans. It causes headaches, dizziness, lethargy, and death. CO is usually the major concern whenever LPG engines are used indoors.

Hydrocarbons are also a product of incomplete combustion of fuel. LPG emissions, because of the composition of fuel, contain only short chain hydrocarbons. They are not likely to contain toxic components which are found in gasoline HC emissions.

Also the environmental impact of LPG hydrocarbon emissions (ozone reactivity contributing to smog) is much smaller than that of gasoline. However, hydrocarbon derivatives are responsible for the characteristic smell which is often a nuisance when LPG engines operate indoors.

Nitrogen oxides are generated from nitrogen and oxygen under the high temperature and pressure conditions in the engine cylinder. NOx consists mostly of nitric oxide (NO) and some nitrogen dioxide (NO2). Nitrogen dioxide is a reactive gas, very toxic for humans. Accumulation of NOx in a warehouse atmosphere may be also detrimental for the stored goods. For example, only a few ppm of NOx in the ambient air can change the color of paper stock from white to yellowish. NOx emissions are also a serious environmental concern because of their ozone reactivity and important role in smog formation.

How Clean Are LPG Engines?

LPG was introduced to the market as a "clean-burning" fuel. Is it still clean today, many years down the road? LPG definitely had the potential to become a clean fuel. The reasons for the superior emissions performance were the following:

- * Reduced emissions of carbon monoxide compared to gasoline engines (but not as low as in diesel engines).
- * No heavy hydrocarbon emissions. HC which are emitted, are of short carbon chain and low ozone-forming reactivity.
- * Low emission of toxic air contaminants such as benzene and 1,3-butadiene.
- * Low cold-start emissions.
- * Likely better emissions durability than that of gasoline engines. LPG emissions should not increase as dramatically with the engine wear and deposit build-up.
- * Zero evaporative and running losses due to the sealed fuel system.

For a variety of reasons LPG is not considered the alternative fuel of the future any more. Its place has been taken by natural gas competing with diesel and biodiesel. Consequently, there has been little development in dedicated LPG engine technology. On the other hand, gasoline engines and their emissions improved tremendously over the last decade. As a result of that development, some of the used-to-be advantages of LPG fuel, especially the low CO emissions, are now less pronounced.

Essentially all LPG engines are gasoline engine conversions. As such, they are not engineered to take advantage of the low emission potential of LPG. Their engine/fuel control system is not optimally calibrated for the new fuel, often sacrificing performance, fuel economy, and emissions. The performance and emissions vary between different engines and conversion kits. Electronic LPG conversion kits are available now which should provide the lowest emissions and best fuel economy, but little data exists so far to verify that statement. Many of the mechanical conversions produce engines not even remotely resembling the ideal, low-emission LPG picture. It is wise to request emission data from the vendor when buying an LPG vehicle for indoor application. Unfortunately, brand new LPG conversions emitting CO levels of 2 to 4% are not uncommon. As a generous guideline, an acceptable LPG engine should have exhaust CO concentration of less than 1% under any steady-state condition.

Emissions from LPG engines depend also heavily on engine tune-up. An example plot illustrating the CO levels for different air to fuel ratios is shown in Figure 4. Carbon monoxide emissions skyrocket when the mixture becomes rich. The importance of proper engine tune-up and maintenance for low emissions can not be overestimated.

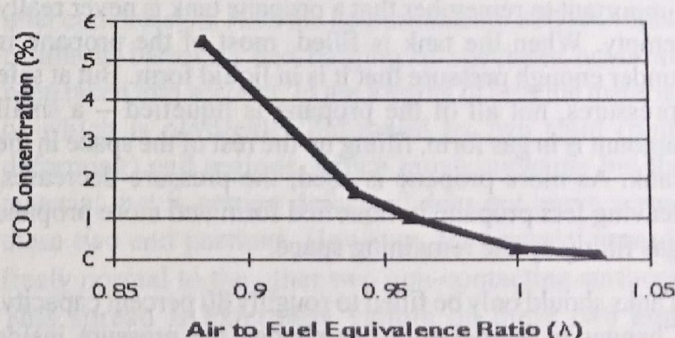
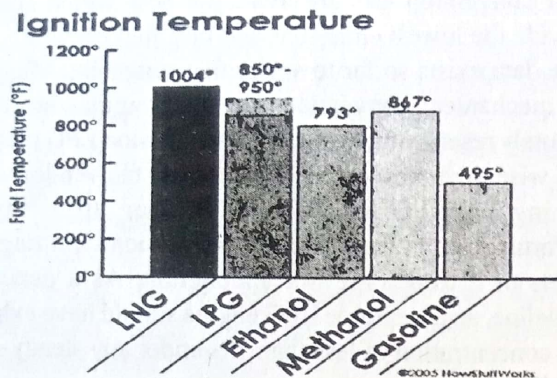


Figure 4. Sensitivity of LPG Emissions to A/F Ratio Comparison Chart

Sr. No.	CNG	LPG	Petrol
1 Rate	19.20/KG	27.00/Litre	44.00/Litre
2 Average	16.80 km/kg	10 km/litre	12 km/litre
3 Running cost/km	Rs. 1.14	Rs. 2.70	Rs. 3.66
4 Save/100KM	Rs. 252	Rs. 96	Nil

Safety and Storage :-

LP gases are actually quite safe in comparison with other fuels. Propane has a high ignition temperature, about 850-950 F (450-510 C), compared to about 495 F (257 C) for gasoline. This makes it less likely to ignite spontaneously.



Also, the tanks used to store propane are stronger than gasoline tanks because of the pressure needed to keep the propane in liquid form. This makes on-board propane storage safer than a typical gas tank -- it is more resistant to rupturing in the event of a collision. Special safety valves and cut-offs increase the safety factor.

To store LP gas safely, there are some guidelines. It's important to remember that a propane tank is never really empty. When the tank is filled, most of the propane is under enough pressure that it is in liquid form. But at safe pressures, not all of the propane is liquefied -- a small amount is in gas form, filling up the rest of the space in the tank. As more propane is used, the pressure decreases, leaving less propane in liquefied form and more propane gas filling up the remaining space.

Tanks should only be filled to roughly 80 percent capacity. Changes in temperature can change the pressure inside the tank. If you were to fill your tank to 100 percent on a cool, cloudy day, and then leave your car out in the sun the next day, the increase in temperature would cause an increase in pressure within the tank that could cause it to fail without that 20 percent headroom.

Safety Issues:-

Vehicles that run on clean burning gas are actually safer than vehicles operating on traditional fuels such as Petrol. In fact, many school transportation managers choose gas to power their school buses because compressed natural gas, unlike petrol, dissipates into the atmosphere in the event of an accident. Petrol pools on the ground creating a fire hazard.

Thick-walled reinforced cylinders, steel cylinders or 100% composite materials are used to store compressed gas as a vehicle fuel. These cylinders are manufactured and tested

in compliance with strict regulations, and have withstood severe abuse testing under conditions far more stringent than tanks designed for storing petrol. Bonfire and dynamite tests push cylinders to temperature and pressures exceeding specified limits showing that compressed gas cylinders are durable and safe. Of course, as with all fuel systems, these cylinders are not indestructible and should be inspected periodically to ensure that no surface damage has occurred.

There needs to be three requirements before there is the potential for a fire or an explosion. First the leakage of the fuel, second a situation where a mixing of the fuel with air gives a mixture in the flammable range and third a source of ignition. Most gases have an odorant added so that leakage can be detected by people in the vicinity.

Once a leakage occurs and a source of ignition is present - say a spark or a naked flame of sufficient energy - there must still be a mixture of the gas in the flammable range. The safety measures include a strict adherence to the regulations for installation and operation of the equipment and the use of care and common sense.

L.P.G. Kit :

- ❖ Pressure Valve: In the unlikely event of excessive pressure, the pressure relief valve releases the pressure there by maintaining safe pressures at all times.
- ❖ Fusible plug: In the event of any excess heat in and around the tank, the fusible plug melts and cuts off the gas supply.
- ❖ 80% fill limiter: It permits the tank to be filled only up to 80% of its capacity. This ensures that internal pressure is always within safe limits.
- ❖ Remote Controlled Valve: The electro-valve ensures that whenever the engine is switched off, the gas supply is automatically cut off.
- ❖ Excess Flow: In the unlikely event of any breakage of the copper pipe that supplies gas to the engine, the flow is automatically stopped.

CONCLUSION

Eventually I would like to say that it is the time to change our transport system from traditional methods to new kind of fuel technologies to reduce the pollution.

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THEORETICAL ANALYSIS OF BAR FORGING OF SINTERED PREFORM

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Abstract.

The paper reports on an investigation into the various aspects of bar forging between two open flat dies solid powder preforms, which have been compacted and sintered from atomized powder. The deformation pattern during the operation is influenced by many factors, which interact with each other in a complex manner. The relative velocity between the work piece material and the die surface together with high interfacial pressure and/or deformation modes will create the conditions essential for adhesion in addition to sliding. The decisive factors are the interfacial conditions, initial relative density of the preform and the geometry of the preform. An attempt has been made for the determination of the die pressures developed during the bar forging of sintered powder preform by using an upper bound approach. The results so obtained are discussed critically to illustrate the interaction of various process parameters involved and are presented graphically.

Keywords. Preform, Sintering, Bar Forging, Interfacial Friction Law.

1. Introduction

During the last few years' metal-powder components have assumed an important position in industry, as they are being used successfully in a wide range of applications. Both the mechanical and the metallurgical properties of the metal powder components compare favorably with those of wrought materials[1]. Bulk processing of metal powder preforms is a convenient method of reducing or eliminating the porosity from the conventional powder metallurgy products. Process is attractive because it avoids large number of operations, high scrap losses and high-energy consumption associated with the conventional manufacturing processes such as casting, machining etc. In this new technology sintered porous powder preforms are used as starting materials in metal forming processes. Metal powder products manufactured by this new

technology are comparable and in some cases even superior to those of cast and wrought products.

Although a considerable amount of work has been reported recently as the various technological aspects of the industrial processing of metal-powder preforms[2-4], no systematic attempt has been made so far to study the processing load and deformation characteristics of bar forging of solid powder preforms between two flat open dies.

Baraya and Johnson[5] have made an analysis of bar forging with the help of triangular velocity field. In their solution it is assumed, besides the discontinuity in velocity field, that straight boundaries remain straight after compression. Also the non-uniformity of flow, which results in barreling and bulging of specimen have not been taken into account. In the forging of bars the material of which is plastically deformed by two rigid (non-deforming) end regions, which move outwards but the material that is getting deformed does not move across these two end portions. However, the material spreads freely normal to the other two non-contacting surfaces. This spread is externally visible on these two non-contacting surfaces. When the reductions are large cracks appear on the boundary of the specimen. This mechanism of failure due to high reductions has been studied by Razestiev[6]. He found that formation of cracks could be prevented if the bars were forged under conditions of plane strain, thus preventing the spread that causes the cracks.

It is expected that the present work will be of great importance for the assessment of die load during the forging of metal powder preforms.

2. Interfacial Friction Law and Plastic Deformation of Sintered Preform

In an investigation of the plastic deformation of metal-powder preforms, it is evident that with the

In an investigation of the plastic deformation of metal-powder preforms, it is evident that with the application of compressive hydrostatic stress the pores will close and the relative density will increase, whereas the application of tensile hydrostatic stress the pores will grow and the relative density will decrease. The density distribution also does not seem to be uniform throughout, being high in the central region and low at the edges. The density distribution will be more uniform for smaller coefficient of friction and for a greater initial density[7].

Friction condition between deforming tool and work piece in metal forming are of the greatest importance concerning a number of factors such as force and mode of deformation, properties of the finished specimen and resulting surface roughness. During the sinter forging process it is very important to keep special consideration on the interfacial friction, as this will determine the success or failure of the operation. The relative velocity between the work piece material and the die surface, together with high interfacial pressure and or deformation modes, create a condition of composite friction, which is due to adhesion and sliding[8]. The shear equation becomes:

$$\tau = \mu[\rho_m + \rho_0 \phi_0] \quad (1)$$

The first term ρ_m being due to sliding and second term $\rho_0 \phi_0$ being due to adhesion, which later arises from change of the relative density of the preform during the process.

In an investigation of the plastic deformation of sintered metal powder preforms it is clear that change in volume occurs due to porosity. A preform with a high relative density yields at a relative high stress whereas a low relative density preform yields at a relatively low stress. Even hydrostatic stress can cause the sintered metal powder preforms to yield, as the yield surface is closed on the hydrostatic stress axis. The density distribution also does not seem to be uniform throughout, being high in the central region and low at the edges. The density distribution will be more uniform for a smaller coefficient of friction and for a higher initial-density preform.

Tabata and Masaki[9] proposed the following yield criterion for porous metal powder preforms:

$$\rho^k = \sqrt{3J_2'} \pm 3\eta\sigma_m \quad (2)$$

The negative sign is taken for and the positive sign is taken for.

The values of and k were determined experimentally from simple compression and tension test of sintered copper-powder preforms[9] as

$$\eta = 0.54(1 - \rho)^{1.2} \quad \text{for } \sigma_m \leq 0$$

$$\eta = 0.55(1 - \rho)^{0.83} \quad \text{for } k=2$$

The compctibility equation for plane strain condition is given by

$$\epsilon_x = \left[\frac{2\eta\sqrt{3(1-\eta^2)} - (1+2\eta^2)}{(1-4\eta^2)} \right] \log_e \frac{t_2}{t_1}$$

(Appendix A)

3. Velocity Field Strain Rate

The velocity field in the triangular region BOF (Fig. 1) expressed in the cylindrical co-ordinate system with origin at O can be written as

$$U_r = \frac{(1-2\eta)}{2(1+\eta)} \left[\frac{U}{2t} r - Br \cos 2\theta \right] \quad (3)$$

$$U_\theta = \frac{(1-2\eta)}{2(1+\eta)} Br \sin 2\theta \quad (4)$$

$$U_z = -\frac{Uz}{t} \quad (5)$$

Where r is the radial distance of a generic point P and the angular position of point P inside the rectangular portion ABCD. The angle θ is positive when the rotation about the vertical axis is counter-clockwise.

Velocity in XX direction

$$U_x = U_r \cos \theta - U_\theta \sin \theta$$

$$\text{OR } U_x = \frac{(1-2\eta)}{2(1+\eta)} \left(\frac{U}{t} - B \right) r \cos \theta$$

At $\theta = 0, r = x = L$

$$U_x = \frac{(1-2\eta)}{2(1+\eta)} \left(\frac{U}{t} - B \right) L \quad (6)$$

Hence, velocity in XX direction is uniform. Similarly, it can be shown that velocity in YY direction is also uniform.

The velocity discontinuities on the die metal can be written as,

$$|\Delta v| = \left| U_r^2 + U_\theta^2 \right|^{\frac{1}{2}} = (U_r + U_\theta) \left| 1 - \frac{2U_r U_\theta}{(U_r + U_\theta)^2} \right|^{\frac{1}{2}}$$

$$\text{Since, } \left| 1 - \frac{2U_r U_\theta}{(U_r + U_\theta)^2} \right|^{\frac{1}{2}} \approx 1$$

$$U_{\theta} < U_r$$

$$\text{So, } |\Delta v| = (U_r + U_{\theta}) \quad (7)$$

Velocity discontinuities on surface 1, 2 are given by U_y and U_z .

4. Strain Rate

Let ϵ_r , ϵ_{θ} and ϵ_z denote the strain rates in radial, angular and vertical directions respectively.

$$\epsilon_r = \frac{\partial U_r}{\partial r} = \frac{(1-2\eta)}{2(1+\eta)} \left[\frac{U}{t} - B \cos \theta \right] \quad (8)$$

$$\epsilon_{\theta} = \frac{U_r}{r} + \frac{1}{r} \frac{\partial U_{\theta}}{\partial \theta} = \frac{(1-2\eta)}{2(1+\eta)} \left[\frac{U}{t} + B \cos \theta \right] \quad (9)$$

$$\epsilon_z = \frac{\partial U_z}{\partial z} = -\frac{U}{t} \quad (10)$$

The normal-strain components must satisfy the following compressibility equation for porous materials [10]:

$$\epsilon_r + \epsilon_{\theta} + \frac{(1-2\eta)}{2(1+\eta)} \epsilon_z = 0 \quad (11)$$

The shear component of strain rate is given by

$$\epsilon_{r\theta} = \frac{1}{2} \left[\frac{1}{r} \frac{\partial U_r}{\partial \theta} + \frac{\partial U_{\theta}}{\partial r} - \frac{U_{\theta}}{r} \right] = \frac{(1-2\eta)}{2(1+\eta)} [B \sin 2\theta] \quad (12)$$

5. Die Load

For plastic deformation of a metal powder the external power J^* supplied by the platens is given as-

$$J^* = W_i + W_f + W_a + W_t \quad (13)$$

The first term on the right hand side denotes the rate of internal energy dissipation W_i , the second term denotes the frictional shear energy losses W_f , the third term denotes the energy dissipation due to inertia forces W_a , and the last term covers power supplied by predetermined body tractions W_t . In this case forces due to inertia is negligibly small and no external surface traction is stipulated. Therefore, $W_a = W_t = 0$.

Now the external power J^* supplied by the top and bottom dies is given by -

$$J^* = 2p_m (2L \times 2w) U = W_i + W_f + W_1 + W_2; \quad (14)$$

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Where W_1 and W_2 are the rate of energy dissipation due to velocity discontinuity.

6. Rate of Dissipation of Deformation Energy (W_i)

$$W_i = \frac{2}{\sqrt{3}} \sigma_0^* \int \left[\frac{1}{2} (\epsilon_r^2 + \epsilon_{\theta}^2 + \epsilon_z^2 + 2\epsilon_{r\theta}^2) \right]^{1/2} dv \quad (15)$$

$$\text{and } dv = 8wLt$$

Simplification of yield criterion for axisymmetric condition gives:

$$\sigma_0^* = \frac{\rho^k \sigma_0}{(1-2\eta)}$$

After putting the value of strain rates from equations (8), (9), (10) and (12), we can get,

$$W_i = \frac{8\sqrt{2}wLU}{\sqrt{3}} \frac{\rho^k \sigma_0}{(1-2\eta)} \left[1 + \frac{(1-2\eta)^2}{2(1+\eta)^2} (1+K^2) \right]^{1/2} \quad (16)$$

7. Frictional Energy Dissipation (W_f)

$$W_f = \int_S \tau |\Delta v| ds \quad (17)$$

$$\text{Where ; } \tau = \mu [p_m + \rho_0 \phi_0]$$

$$|\Delta v| = (U_r + U_{\theta})$$

$$W_f = 8\mu [p_m + \rho_0 \phi_0] \left[\int_0^{\alpha r} \int_0^{\alpha r} (U_r + U_{\theta}) r dr d\theta + \int_0^{\alpha \pi/2} \int_0^r (U_r + U_{\theta}) r dr d\theta \right]$$

On integration,

$$W_f = 4 \frac{(1-2\eta)U}{3(1+\eta)t} \mu [p_m + \rho_0 \phi_0] L^3 \left[\frac{FA(\alpha) + FC(\alpha) + K\{FB(\alpha) + FD(\alpha)\}}{K} \right] \quad (18)$$

Where

$$FA(\alpha) = \frac{1}{4} [\tan \alpha \sec \alpha + \log(\tan \alpha + \sec \alpha)]$$

$$FB(\alpha) = \left[2 \sec \alpha - 2 + \frac{\tan \alpha \sec \alpha}{2} - \frac{3}{2} \log(\tan \alpha + \sec \alpha) \right]$$

$$FC(\alpha) = \frac{1}{4} \left[\tan^3 \alpha \left\{ 2 \left(\cot \alpha \operatorname{cosec} \alpha - \log |\operatorname{cosec} \alpha - \cot \alpha| \right) \right\} \right]$$

$$FD(\alpha) = \tan^3 \alpha \left[\frac{2 \operatorname{cosec} \alpha - 2 - \cot \alpha \frac{\operatorname{cosec} \alpha}{2}}{\frac{3}{2} \log (\operatorname{cosec} \alpha - \cot \alpha)} \right]$$

(19)

8. Energy Dissipation due to Velocity Discontinuity (W 1 and W 2)

Consider the rectangle FOSB on face 1. The rate of energy dissipation due to velocity discontinuity is given by

$$W_{\Gamma 1} = \frac{\sigma_0}{\sqrt{3}} \left[\int_0^w (U_y) t dy + \int_0^t \frac{U}{t} w dz \right]$$

(20)

Where $U_y = U_r \sin \theta + U_\theta \cos \theta$

$$= \frac{(1-2\eta)}{2(1+\eta)} \left(\frac{U}{t} + B \right) r \sin \theta$$

$$\text{At } \theta = \frac{\pi}{2}, \quad r = w; \quad \text{So, } U_y = \frac{(1-2\eta)}{2(1+\eta)} \left(\frac{U}{t} + B \right) w$$

$$W_{\Gamma 1} = \frac{\sigma_0 U w}{2\sqrt{3}} \left[\frac{(1-2\eta)}{2(1+\eta)} (1+K)w + t \right]$$

(21)

The angular portion FO'SB is one of the four rectangular portion of the total area of the surface 1. Similarly, for the surface 2, the rate of energy dissipation due to velocity discontinuity can be found and the values on 1 and 2 are the same.

So,

$$W_{\Gamma 1} + W_{\Gamma 2} = \frac{4\sigma_0 U w}{\sqrt{3}} \left[\frac{(1-2\eta)}{2(1+\eta)} (1+K)w + t \right]$$

(22)

The total rate of energy dissipation is given by from equation (14), (16), (18) and (22)-

$$J = \frac{8\sqrt{2}wLU}{\sqrt{3}} \frac{\rho^k \sigma_0}{(1-2\eta)} \left[1 + \frac{(1-2\eta)^2}{2(1+\eta)^2} (1+K^2) \right]^{\frac{1}{2}} + \frac{4(1-2\eta)U}{3(1+\eta)t} \mu [p_m + \rho_0 \phi_0] L^3 [FA(\alpha) + FC(\alpha) + K\{FB(\alpha) + FD(\alpha)\}] + \frac{4Uw}{\sqrt{3}} \frac{\rho^k \sigma_0}{(1-2\eta)} \left[\frac{(1-2\eta)}{2(1+\eta)} (1+K)w + t \right]$$

(22)

The arbitrary parameter K is chosen so that the above expression for J^* is minimum.

$$\frac{\partial J}{\partial K} = 0 \quad \text{where } K = \frac{Bt}{U}$$

$$\text{So, } K = \pm \frac{\sqrt{2 + \left(\frac{1-2\eta}{1+\eta} \right)^2}}{\left(\frac{1-2\eta}{1+\eta} \right) \sqrt{\frac{4}{s^2} - 1}}$$

(23)

Where

$$s = \left[\frac{2}{3} \frac{L}{w} \frac{L}{t} \mu (p_m + \rho_0 \phi_0) \{FB(\alpha) + FD(\alpha)\} + \frac{w}{4L} \right]$$

One of the two values of K satisfies the condition that all three terms on the right hand side of equation (22) are separately positive.

Now putting the value of $J^* = 8wLU$ from equations (14) into equation (22), we get

$$\frac{p_m}{\sigma_0} = \left[1 - (1+x) \frac{(1-2\eta)}{6(1+\eta)} \frac{L}{w} \frac{L}{t} \left\{ FA(\alpha) + FC(\alpha) + K(FB(\alpha) + FD(\alpha)) \right\} \right]^{-1}$$

$$X = \frac{\sqrt{2}}{\sqrt{3}} \frac{\rho^k \sigma_0}{(1-2\eta)} \left[1 + \frac{(1-2\eta)^2}{2(1+\eta)^2} (1+K^2) \right]^{\frac{1}{2}} +$$

$$\frac{1}{2\sqrt{3}} \frac{\rho^k \sigma_0}{(1-2\eta)} \left[\frac{(1-2\eta)}{2(1+\eta)} (1+K) \frac{w}{L} + \frac{t}{L} \right]$$

(24)

9. Results and Discussion

During compression of bars having t/L more than one,

there is curving along height called barreling. In the bar having t/L equal to one, there is uniform deformation and the die loads were calculated theoretically for this type of deformation. In the bars having t/L less than one, the curving of lateral sides is more prominent and this is called building.

The right side of equation (24) contains terms, which depend for their values on the geometrical parameters that is, length of the die, width of the bar and thickness of the bar and on the conditions of lubrication between the contacting surfaces. The result is presented in the dimensionless parameters, namely, L/t , w/L , L/w , t/L etc.

Fig. 2 and Fig. 3 show the variation of relative average pressure at different value of percentage reduction in the height of the preform. Initially, the average forging pressure varies slowly. It is due to the fact that at early stage compaction dominates. After getting sufficient densification deformation of preform dominates and the relative average forging pressure increases more and more. Fig. 4 shows the effect of coefficient of friction on relative average forging pressure at different value of percentage reduction in the height of the preform. Relative average forging pressure increases with increasing value of coefficient of friction. The relative average pressure increases with increase in the value of L/t ratio, Fig. 5. Fig. 6 shows the effect of adhesion constant (x) on relative average forging pressure. The relative average forging pressure increases with increasing the value of x .

10. Conclusion

During forging of powder preforms, the mode of deformation is quite different from wrought materials and it is function of both density and hydrostatic stress. In powder forging, mass constancy is to be assumed. During forging of metal powder preforms through closed dies, it is seen that compaction and compression both take place simultaneously. Initially the closing of pores dominates the compression process. The larger amount of applied load is utilized in densification and lesser amount is consumed for compression.

A composite interfacial friction law has been taken for studying the deformation characteristics of the sintered porous materials. The relative average forging pressure increases with increasing percentage reduction of height of the preform, coefficient of friction and L/t ratio.

The work will found to be effective for the determination of die loads during the forging of porous metal bars by using Upper Bound approach.

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Appendix A

According to Tabata and Masaki [9], the principal strain increments are given as

$$d\epsilon_i = d\lambda \left[\frac{3(\sigma_i - \sigma_m)}{2\sqrt{3}J_2'} \mp \eta \right] \quad (i=1, 2, 3) \quad (1A)$$

Where

$$d\lambda = \frac{\sqrt{2}}{3} \left[(d\epsilon_1 - d\epsilon_2)^2 + (d\epsilon_2 - d\epsilon_3)^2 + (d\epsilon_3 - d\epsilon_1)^2 \right]^{\frac{1}{2}} \quad (2A)$$

= a positive constant

The volumetric strain increment $d\epsilon_v$ is given as

$$d\epsilon_v = d\epsilon_1 + d\epsilon_2 + d\epsilon_3 = \pm 3\eta d\lambda$$

$$= \mp \sqrt{2}\eta \left[(d\epsilon_1 - d\epsilon_2)^2 + (d\epsilon_2 - d\epsilon_3)^2 + (d\epsilon_3 - d\epsilon_1)^2 \right]^{\frac{1}{2}} \quad (3A)$$

Considering $d\epsilon_1 = d\epsilon_x$, $d\epsilon_2 = d\epsilon_y$ and $d\epsilon_3 = d\epsilon_z$ in equation (3A).

For plane strain condition $d\epsilon_z = 0$. Thus equation (3A) becomes

$$d\epsilon_x + d\epsilon_y = -\sqrt{2}\eta \left[(d\epsilon_x - d\epsilon_y)^2 + d\epsilon_y^2 + d\epsilon_x^2 \right]^{1/2} \quad (4A)$$

Solving

$$d\epsilon_x = - \left[\frac{(1 + 2\eta^2) - 2\eta\sqrt{3(1 - \eta^2)}}{(1 - 4\eta^2)} \right] d\epsilon_y \quad (5A)$$

(For negative sign)

Considering $d\epsilon_y = \frac{dt}{t}$ and putting in equation (5A)

$$d\epsilon_x = - \left[\frac{(1 + 2\eta^2) - 2\eta\sqrt{3(1 - \eta^2)}}{(1 - 4\eta^2)} \right] \frac{dt}{t} \quad (6A)$$

Integrating one gets

$$\epsilon_x = - \left[\frac{2\eta\sqrt{3(1 - \eta^2)} - (1 + 2\eta^2)}{(1 - 4\eta^2)} \right] \log_e \frac{t_2}{t_1} \quad (7A)$$

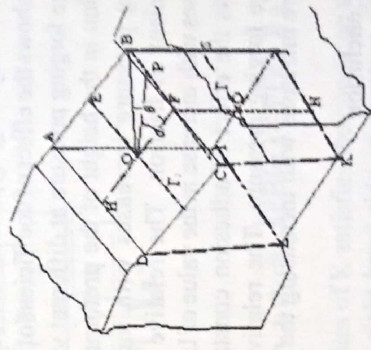
NOMENCLATURE:-

- B = constant
- = Second invariant of deviatoric stress
- k = Constant equal to 2 in yield criterion
- 2L, 2t, 2w = length of die, thickness and width of bar respectively
- pm = average die pressure
- r = Radius of the sticking zone
- U = velocity of the die
- V = volume of zone of plastic deformation
- r, θ, z = Cylindrical co-ordinates
- = Principal strain increment
- = Coefficient of friction
- = Constant and a function of μ only

- = Relative density of the preform
- = Shear stress
- = Yield stress of the non-work hardening matrix metal

Captions of Figures

- Fig.1 - Velocity Field
- Fig.2 - Variation of Relative average Pressure with respect to Percentage Reduction in Height of the Preform ($\mu = 300$).
- Fig.3 - Variation of Relative average Pressure with respect to Percentage Reduction in Height of the Preform ($\mu = 400$).
- Fig.4 - Variation of Relative Average Forging Pressure at Different Value of Coefficient Friction.
- Fig.5 - Effect of L/t Ratio on Relative Average Forging Pressure.
- Fig.6 - Effect of μ (a constant) on Relative Average Forging Pressure.



AD=2t
DC=2L
DL=L
SURFACE $\Gamma = CBJK$
SURFACE $\delta = DAL$

Fig. 1

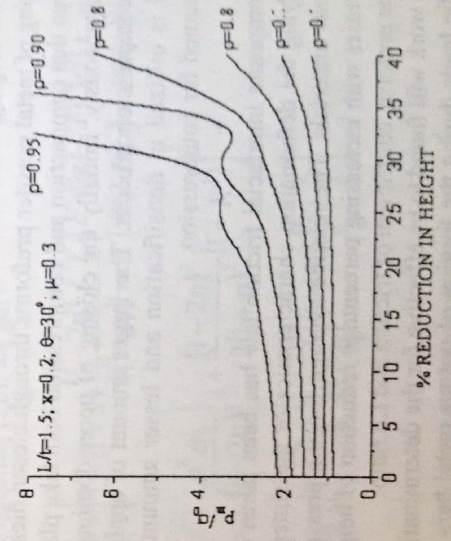


Fig. 2

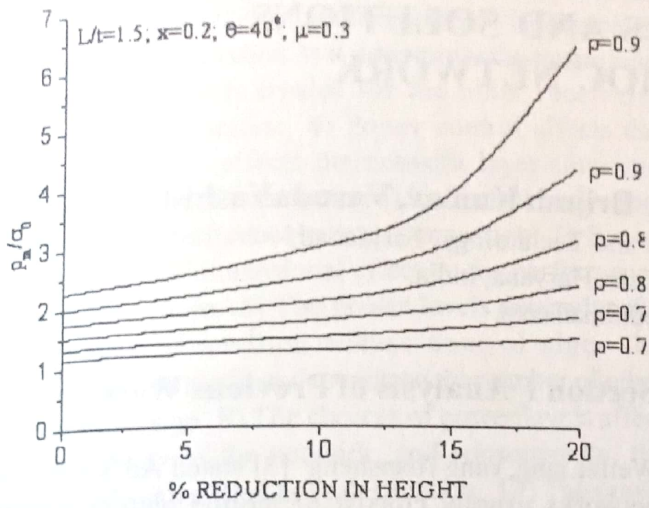


Fig. 3

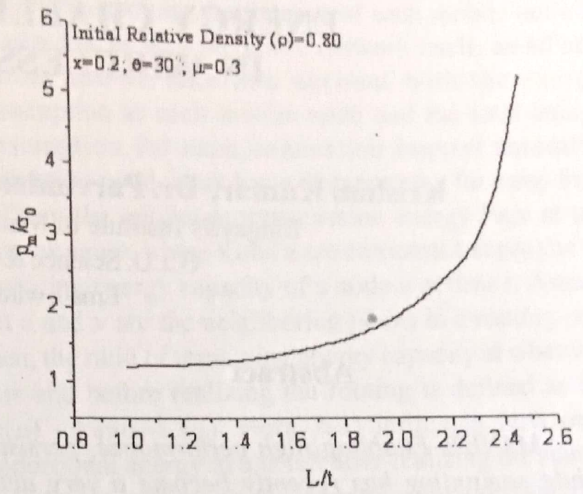


Fig. 5

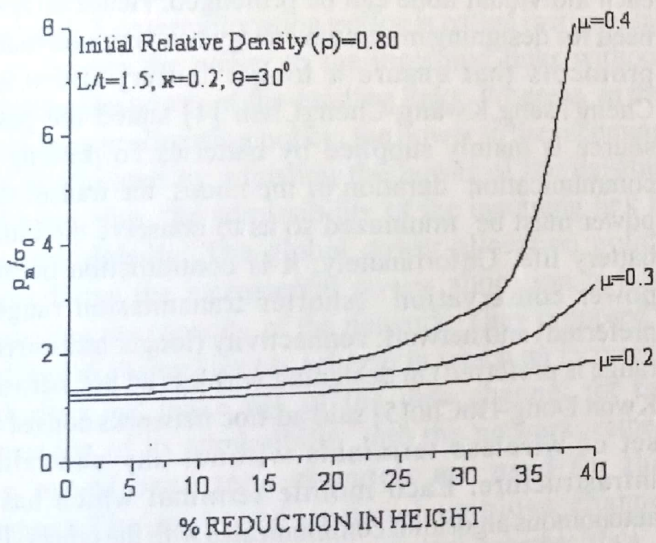


Fig. 4

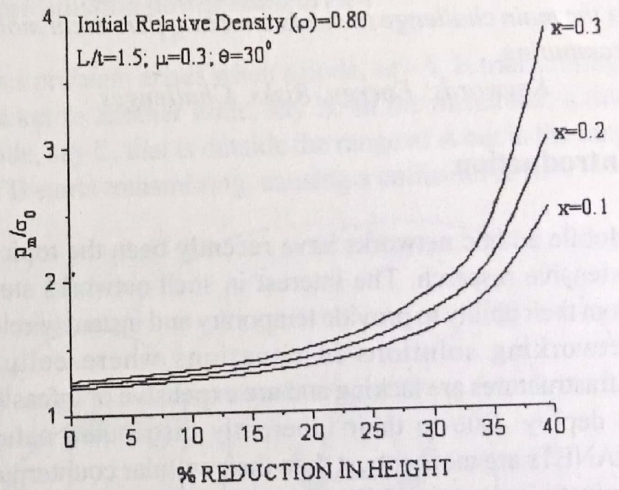


Fig -

ENERGY CHALLENGES AND SOLUTIONS IN WIRELESS ADHOC NETWORK

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Abstract

MANETs Enabling high performance, persistent mobile computing has recently become a very active research area. The widespread popularity of mobile computing devices, such as laptops, handheld devices and cell phones, as well as the recent advances in wireless communication technologies are the principal motivators of this research area. However, battery energy limitation is the main challenge towards enabling persistent mobile computing.

Keywords: Energy, Risks, Challenges.

Introduction

Mobile ad hoc networks have recently been the topic of extensive research. The interest in such networks stems from their ability to provide temporary and instant wireless networking solutions in situations where cellular infrastructures are lacking and are expensive or infeasible to deploy. Due to their inherently distributed nature, MANETs are more robust than their cellular counterparts against single-point failures, and have the flexibility to reroute around congested nodes [1]. A MANET is a wireless, self-organized network, which involves a set of heterogeneous mobile computing devices equipped with wireless communication and networking facilities [2]. Most wireless ad hoc networks consist of mobile devices which operate on batteries. Power consumption in this type of network therefore is paramount important. To maximize the lifetime of an adhoc network, it is essential to prolong each individual node (mobile) life through minimizing the total transmission energy consumption for each communication request. The power-aware routing algorithms which find routing paths that maximize the lifetime of individual nodes and minimize the total transmission energy consumption, thereby prolong the life of the entire network. This paper is organized as follows. In section I, we analysis previous work. Section II, we introduce the energy challenges. Section III describing solution. Section IV describes Finally, the brief conclusion of our research work

Section I Analysis of Previous Work

WeifaLiang, YangYuansheng [3] stated Ad hoc wireless networks usually consist of mobile battery operated computing devices that communicate over the wireless medium. These devices are battery operated and therefore need to be energy conserving so that the battery life of each individual node can be prolonged. Hence there is a need for designing minimum energy consumption routing protocols that ensure a longer battery life. Chih-ChengTseng, Kwang-ChengChen [4] stated the power source is mainly supplied by batteries. To prolong the communication duration of the nodes, the transmission power must be minimized so as to conserve the limited battery life. Unfortunately, it is contradiction between power conservation (shorter transmission range is preferred) and network connectivity (longer transmission range is preferred) in designing wireless ad hoc network. Kwon Dong-HoCho[5] said ad-hoc networks consist of a set of wireless terminals without any centralized infrastructure. Each mobile terminal which has an autonomous algorithm communicates with the others. They can communicate with another node through single hop or multi-hop connections if a mobile is within the radio coverage of sender or intermediate mobiles. Intermediate nodes are used to relay or forward the packet from the sender toward the receiver. The necessity of the ad-hoc networks is shown in many commercial, military, and urgent environments. There are several methods to reduce the power consumption in the wireless networks. One of methods to reduce power consumption in wireless networks is to use the LOW-Power Mode (LPM). In other words, if the terminal neither transmits nor receives the packet during the certain period, the terminal is allowed to change to LPM which can't transmit and receive. LPM uses three modes: sleep, listen, active. to use the LPM in wireless ad-hoc networks. o no clock synchronization o no state information of neighbor terminal Kawadia, V. Kumar, P.R. [6] said POWER control problem in wireless ad hoc networks is that of choosing the transmit power for each packet in a distributed fashion at each node. The problem is complex since the choice of the power

level fundamentally affects many aspects of the operation of the network. 1) The transmit power level determines the quality of the signal received at the receiver. 2) It determines the range of a transmission. 3) It determines the magnitude of the interference it creates for the other receivers. Because of these factors: 4) Power control affects the physical layer. 5) It affects the network layer since the transmission range affects routing. 6) It affects the transport layer because interference causes congestion. 7) Power control has a multidimensional effect on the performance of the whole system: 8) The power levels determine the performance of medium access control since the contention for the medium depends on the number of other nodes within range. 9) The choices of power levels affect the connectivity of the network, and consequently, the ability to deliver a packet to its destination. 10) The power level affects the throughput capacity of the network. RazaNaqvi, S.H. Patnaik, L.M. [7] Considered power as one of the critical resources in the network, the policies for distributed allocation of power are classified as incremental or global. A power allocation policy is called incremental if it allocates the power to the incoming links without adjusting the power of the existing links. Whereas, in the global power allocation policy, the power to the incoming link is allocated by adjusting the power of the existing links and, thus, the admissibility of the incoming link is decided globally. The global power allocation policy outperforms the incremental power allocation policy, increasing the capacity of the network. They proposed a distributed channel access scheme in which an incoming link does not make use of the data channel for the estimation of its admissibility into the network; rather, two out-of-band tone channels are used for this purpose. The proposed protocol employs channel reservation as well as a power control scheme; thus, it serves the dual purpose of eliminating the problems of self and direct-interference and hidden-terminals, as well as exercising the power control scheme for balancing the links' SIR. Since the designed channel access protocol easily fits into the dual busy tone multiple access (DBTMA) framework for ad hoc networks. Most of the existing protocols for ad hoc networks employ incremental power control. This paper introduces a global power-controlled protocol called FPC-DBTMA in ad hoc networks for increasing the capacity of the networks.

Section II Energy Challenges

Longer routing path may take more risks

The mobile nodes in an ad hoc network need to relay their packets through the other mobile nodes toward the intended destinations, a decrease in the number of

participating mobile nodes may lead to the network disconnected, thereby affecting the performance of the network. To prolong the lifetime of each mobile node in the network as well the entire network itself, an ad hoc routing should take into account both the energy consumption at each mobile node and the total energy consumption for each connection request carefully, destination node v that has a distance $e_{u,v}$ far away from u . Then, the minimum transmission energy $P_{u,v}$ at u is $P_{u,v} = k e_{u,v}^a$, where k and a are constants. Let $p(u)$ be the remaining energy capacity of a node u at time t . Assume that u and v are the neighboring nodes in a routing path. Then, the ratio of remaining energy capacity at u between after and before realizing the routing is defined as $\eta(u) = p(u) - k e_{u,v}^a C(u)$. Here $\eta(u)$ indicates how much proportional energy in u is left after realizing the routing. In order to minimize the energy consumption for a connection request, a routing path with more hops than another path is favored. This means that a longer routing path may take more risks [8].

Transmission power control risk

This problem arises when a node, say A , is transmitting a packet to another node, say B . In the meantime, a third node, say C , that is outside the range of A but in the range of B starts transmitting, causing a collision at B .

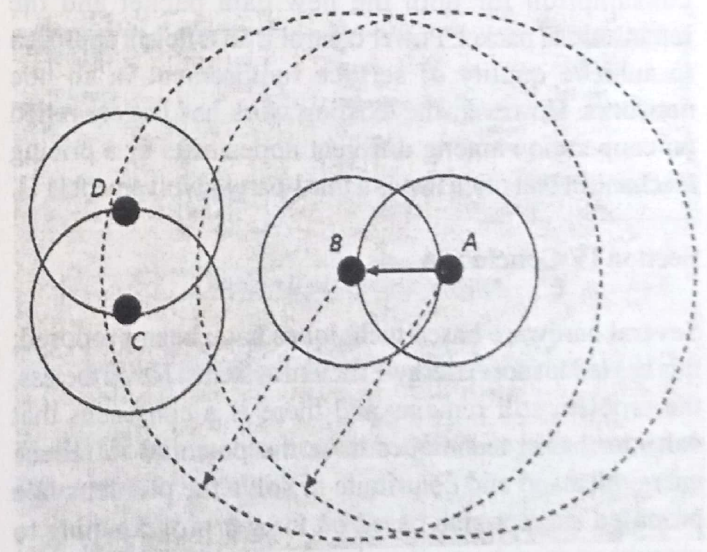


Fig. 1: Nodes A and B are allowed to communicate, but nodes C and D are not allowed to communicate

This situation is shown in Fig. 1, where node A uses its maximum transmission power to send its packets to node B . The second drawback of the fixed-power approach is that the received power may be far more than necessary to achieve the required signal-to-interference- and-noise ratio (SINR), thus wasting the node's energy and shortening its lifetime. [9].

Section III Transmission power solution

(1) Power-Aware Routing Protocols Several recent routing protocols propose energy-efficient schemes. Power awareness issue in ad hoc routing, which include the energy consumed per packet, network connectivity duration, node power variance, cost per packet, and maximum node cost. 2) Interference-Aware MAC Protocols MAC protocols, in which information about an ongoing transmission is made known to all possible interferers. 3) The energy consumption models [10] can be generally classified into the following three categories: First, Total Transmission Power Model: This model simply sums up the transmission power of the data packet at each link. With this model, a minimum energy routing protocol can use the transmission power as the link cost and select the route that minimizes the total transmission power along the path. Second, Total Transmitting Power Model: As the intermediate nodes consume energy not only when forwarding packets but also when receiving packets, this model sums up both the transmission power and the receiving power for transmitting the data packet at each link. Third, Total Reliable Transmission Power Model: If a data packet is lost during transmission over one link, such packet has to be retransmitted, which will consume some extra energy. Therefore, this model includes the energy consumption for both the new data packet and the retransmitted packet. Power control is an efficient approach to achieve quality of service requirement in ad hoc networks. However, the existing work has largely relied on cooperation among different nodes/links or a pricing mechanism that often needs a third-party involvement [11].

Section IV Conclusion

Several hardware based techniques have been proposed; this has led to more energy-efficient systems. Nevertheless, the problem still remains and there is a consensus that software based techniques have the potential to reduce energy demand and contribute to solve the problem. We proposed an approach based on integer programming to obtain the optimal energy solutions. Routing Protocol and energy model may minimize the energy consumption in wireless ad hoc network.

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INTERNET PROTOCOL TELEVISION (IPTV)

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Abstract

IPTV is basically a fusion of voice, video, and data service. It is not a new idea or, rather, development, but it is a result of high bandwidth and high speed Internet access. In earlier days, the speed of the Internet did not suit the concept and, as a result, it affected the voice and video services. In recent times, the speed of Internet and bandwidth has increased considerably, making IPTV prevail and become reasonably successful. Also, first generation Set Top Boxes were prohibitively expensive. Technology costs now permit a viable business model.

Introduction

IPTV is a system used to deliver digital television services to the consumers who are registered subscribers for this system. This delivery of digital television is made possible by using Internet Protocol over a broadband connection, usually in a managed network rather than the public Internet to preserve quality of service guarantees. Often, this service is provided together with Video facility on demand. In addition to this, there is provision to include Internet services such as web access and Voice over Internet Protocol (VoIP). In cases when internet service is also provided, it may be called Triple Play.

Today, IPTV is creating headlines all over the world. This mass publicity is the result of numerous instances and stories depicting its humble deployments and its future. IPTV is a very useful system, through which you can receive both TV and video signals along with other multimedia services by means of your Internet connection. In a nutshell, it is nothing but a broadband connection and a system to deliver various programs of television using the Internet protocol (i.e., language) over computer networks.

IPTV Architecture

Telephone companies will most likely be the first ones to offer IPTV service. Later on, this facility will be extended to other current television carriers. IPTV is not a costly

affair, and it is even both operator and consumer friendly. Because it uses the Internet and sends less information compared to standard analog or digital television, IPTV promises both lower costs for operators and lower prices for consumers. The use of set-top boxes through road band or DSL Internet is very helpful to transfer video signals. Therefore, video can be streamed to households more efficiently compared to signaling by coaxial cable. In addition to its higher speed, it can record multiple programs at once by use of digital video recorders (DVR). In ROI terms, the copper was already paid for by the phone service and the fiber/DSL by the broadband service. Therefore, IPTV only has incremental costs. Let us have a look at the architecture of IPTV through Figure 1:

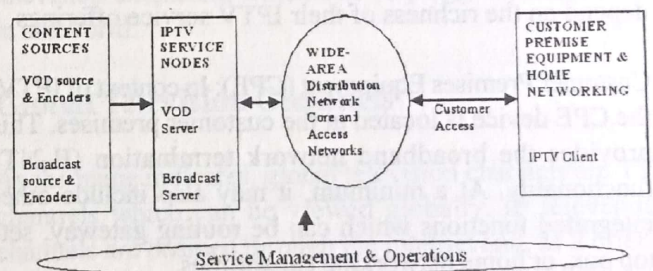


Figure 1: Generic IPTV System Architecture

The IPTV architecture consists of the following functional components:

Content Sources: The 'Content Source' is defined as a functionality which receives video content from producers and other sources. Afterwards, these contents are encoded and store in an acquisition database for video-on-demand (VoD)

Service Nodes: The 'Service Node' is defined as a functionality which receives video streams in different formats. These video streams in different formats then reformat and encapsulate it for transmission with appropriate quality of service (QoS) indications to the

wide-area network. This makes it ready for delivery to customers. In regards to service management, the Service Nodes communicate with the customer premises equipment (CPE); for the subscriber, session and digital rights management, service nodes communicate with the IPTV service.

Wide Area Distribution Networks: The Wide Area Distribution Network is made up of distribution capability, capacity, and quality of service. It also consists of other capabilities, such as multicast, which is necessary for the reliable and timely distribution of IPTV data streams from the service nodes to the customer premises. Moreover, the core and access network cover the optical distribution backbone network and the various digital subscriber line access multiplexers (DSLAMs). This is located at the central office or remote distribution points.

Customer Access Links: In the customer access links, high-speed DSL technologies such as ADSL2+ and VDSL are required; with the help of such technology, customer delivery can be provided over the existing loop plant and through phone lines to homes. There are some other options available. Service providers may use a combination of fiber-to-the curb (FTTC) and DSL technologies for delivery to customers. They can also implement direct fiber-to-the-home (FTTH) access. However, good results depend on the richness of their IPTV service offerings.

Customer Premises Equipment (CPE): In context of IPTV, the CPE device is located at the customer premises. This provides the broadband network termination (B-NT) functionality. At a minimum, it may also include other integrated functions which can be routing gateway, set-top box, or home networking capabilities.

IPTV Client: The IPTV client is a functional unit which terminates the IPTV traffic at the customer premises. This is only a device, such as a set-top box, which performs the functional processing. The functional processing includes setting up the connection and QoS with the service node, decoding the video streams, channel change functionality, user display control and connections to user appliances such as a standard definition television (SDTV) or a high definition television (HDTV) monitor.

IPTV vs. Internet Television

Now, let us take a look at what makes IPTV and Internet Television different. To differentiate these two models is in general quite challenging. But studying and analyzing the said concepts in depth explains the differences.

IPTV is the representation of a profile of a closed, proprietary TV system. This is somewhat similar to the present day cable service providers. But, unlike IPTV, it is delivered via IP-based secure channels. As a result, it sharply increases the control of content distribution.

Internet Television is an open evolving framework where a huge number of small and medium-sized video producers contribute. Such a service provides highly innovative content, where the contributors are very much comfortable. This is due to the opening of different traditional channels which are either retail and for wide distribution.

Applications and Services

The applications for IPTV deployment are to provide the delivery of digital broadcast television and also the selected VoD. Such application enables service providers to offer the so-called "triple play," which is video, voice and data. The IPTV infrastructure also provides additional video applications mostly after the installation of IPTV infrastructure is in place.

Now, let us take a look at the major applications and services enabled by IPTV.

Digital Broadcast TV

Customers get a conventional digital television through IPTV. This digital broadcast TV is delivered to subscribers via an upgraded cable TV plant or through satellite systems. The initiation of higher-speed DSL technology such as ADSL2, ADSL2+ and VDSL has brought a revolution to this field. This higher-speed technology enables IPTV to be a convincing and highly competitive substitute for customers. Today, a number of telecom service providers are testing, planning, and building collaborations around IPTV throughout North America, Europe, and Asia.

IPTV has the full potential to offer various high-quality services and much more than what traditional broadcast, cable, and satellite TV providers have offered subscribers in the past. Another utility with IPTV is that it has more content variety with a larger number of channels to choose depending on the customers' preferences. This makes a promising start especially as customers can choose from its diversified content. It will reach its target group no matter whether the subscribers are in the mass markets, in specialized groups, or spread out in demographic communities.

The function of conventional broadcast, cable, and satellite TV is to provide all channels simultaneously (i.e., broadcast) to the subscriber home. However, IPTV is unique and different from all conventional groups. IPTV only delivers those channels which are being viewed by the subscriber and has the potential to offer practically an 'unlimited' number of channels. The IPTV consumers will get the freedom to control what they want to watch and also when they want to watch. This is possible because it has a combination of two-way interactive capability. This is inherent in IPTV because of its association with IP. This association is built-in and tied to a robust internal network. Therefore, subscribers are enjoying the facility to broaden the unique experience at home or in their business.

Video on Demand (VoD)

VoD is a service which provides television programs per the demands of the subscribers. The users interactively request and can receive television channels. These television services are beamed from previously stored media consisting of entertainment movies or education videos. It has a live access through live connection, such as news events in real time. The VoD application provides freedom to the individual subscribers to select a video content and view it at their convenience.

When the initial IPTV infrastructure is in its place, IPTV applications and potential revenue-generating services, such as video telephony and video conferencing, remote education, and home security/monitoring cameras, will be available.

There are also some additional features and services available, which are much more advanced in comparison to traditional broadcast television systems. In addition to providing the basic television services and features, IP Television can provide the following advanced features and services:

- Anywhere Television Service
- Global Television Channels
- Personal Media Channels
- Addressable Advertising

We think of these as VOD, time shift TV and Network PVR...all based on the Media Server approach.

Anywhere Television Service

Anywhere Television Service uses television extensions, which are the viewing devices that can be connected to

the system of a television distribution. There are two options in this regard: (1) these connections may be shared, for example, by several televisions on the same line or (2) they may be controlled independently, such as the case of a private television system.

Conventionally, television extensions have a fixed wire or a connection line. This is because: (1) it allows a television viewing device to either share (i.e., directly connect to) another communication line or (2) it allows an independent connection to a switching point (such as a private company television system).

In IPTV, when an IP television viewer is connected to a data connection for the first time, it sends the request to an assignment of a temporary Internet address from the data network. After its connection to the Internet, it uses the said Internet address to get registered with the Internet Television Service Provider (ITVSP). The reason is that the ITVSP is always aware of the current Internet address, which is assigned to the IP television each time it has been connected to the Internet. This also allows IP televisions to operate at any connection point that is willing to provide it broadband access to the Internet. In real meaning, this allows an IP television to operate like a television extension, which can be plugged in anywhere in the world.

Global Television Channels

As the name indicates, global television channels are TV channels which can be viewed globally. IP television channels are beamed through the Internet and, as it offers broadband data access, it can thus be typically viewed in any part of the globe.

The IP television system is capable of providing video service outside the purview of their local, often regulated, areas. This ability makes IP television a very competitive tool around the world. The typical cost for viewing global television channels is the content media access costs, for example, the cost or fee for watching a movie. Moreover, the cost includes the broadband data access cost, which is a monthly charge for broadband access. Personal Media Channels (PMC)

PMC is a communication service which is user friendly to subscribers. It allows a media user, for example, to select and view media from different media sources such as video or music.

Here is an example how a PMC may be used for IP television.

The control and distribution of mixed media, such as digital pictures and digital videos, can be done through a personal television channel for the service of friends and family members. In this regard, an IP television customer can be assigned a personal television channel. Then, the user can upload media to their personal media channels and can thus allow friends and family to access their pictures and videos. This is done via their IP televisions.

Addressable Advertising

The well-knit communication of a particular message or media content between a specific device and the customer based on their address is called addressable advertising. Here, the said address of the customer may be obtained by scrutinizing the profile of the viewer. This is done in order to determine whether the advertising message is appropriate for the recipient or not. Therefore, addressable advertising allows for speedy and straight measurement of the efficiency of advertising campaigns.

The cooperation of the viewer is the key aspect of addressable advertising. As soon the IP television is turned on, the IP television systems may ask or prompt the viewer to pick their name from a list of registered users. As a reply, viewers will typically want to select their programming name. Here, the programming name has a profile (or, preferences) and the advertising messages can be selected, which are the best match to the concerned viewer profile. Because of the advanced features offered by IP television, such as incoming calls and e-mails and programming guides that remember favorite channels, the viewers can actually do so here.

The generated revenue for addressable advertising messages sent to viewers with specific profiles can be 10 to 100 times higher than the revenue for broadcasting an advertisement to a general audience. The ability to send commercial advertisements to a specific number of viewers allows the advertisers to fix a precise budget for addressable advertising. It also allows the advertiser to experiment a number of different commercial advertisements in the same geographic area at the same time.

Multicast

By using the IP multicast feature in providing an IPTV service, a service provider can conserve bandwidth in their core and access networks. When more than one user is viewing the same channel in a home network, the service provider may only deliver a single video stream. But, at

the same time, the home network technology must be competent to distribute this towards multiple users on the home network.

Imagine the core requirements for bandwidth if all customers are watching a different time-shifted channel to when they wanted to watch. Both Multicast and Unicast are needed in the IPTV world, but the former is quicker and easier to deploy in terms of core network capacity than the latter which mostly requires a dedicated one-to-one relationship from customer to server.

Privacy and Security

Let us look at the important aspect of privacy and security of the subscribers. In this regard, the home network must be a closed one. Where is the user's security in this regard? It should be a secure network where access is limited only to users and concerned devices within the home. This is an important factor for the home networks as it uses wireless technologies or shared media technologies such as power line networking. Further, the user data on the home network is protected and no outsiders or intruders have the power to intercept. Unauthorized users do not have the capacity to view it.

Protocols

As already discussed, IPTV covers both Live TV, i.e., multicasting, as well as stored video or VoD. The requirements for playback of IPTV are either a personal computer or a "set-top box" connected to a TV. Typically, the video content is a moving pictures expert group (MPEG) 2-transport stream (TS) delivered via IP multicast. This is a method in which information can be sent to multiple computers at the same time, with the newly released H.264 format predesigned to replace the older MPEG-2. In standard-based IPTV systems, the primary underlying protocols used for IPTV are Internet group management protocol (IGMP) and real time streaming protocol (RTSP). Here, IGMP is the version 2 for channel change signaling for Live TV and RTSP for VoD. Currently, only one alternative exists to IPTV which is the traditional TV distribution technology covering terrestrial, satellite and cable TV. However, when there is a possibility for the cable TV, it can be upgraded to two-way capability system and thus also carry IPTV. Another alternative available is VoD which is usually delivered in the US over cable TV through the digital video broadcasting (DVB) protocol, but it is not labeled as IPTV services.

Advantages of IPTV

Now, let us have a look at the various advantages of IPTV. It has already been established that IPTV system conserves bandwidth. But there are many more advantages beyond this.

In IPTV, a new level of interactivity among Internet, voice, and video can be established. This enables new types of services which were previously unavailable over stacked networks. For example, in traditional cable TV networks, video transmission is beamed over MPEG streams on an explicit portion of the bandwidth. On the other hand, high speed data products, such as cable- and modem-based Internet service, are delivered over an IP based network. It is separate from the broadcast TV network that uses MPEG transmission. In this case, both services were delivered via an IP network then, in such a situation, overlapping products are possible. Interactive TV is a good example which often relies on data-centric applications. Today, the delivery of such applications is quite complex due to the separation of IP packets from MPEG streams. These would be missing if such IP packets delivered all video and data.

IPTV can be very helpful in providing web-based training to courses. If we take a case of large size courses, they contain many sections and instructors that can easily share video materials. Therefore, if you own an instructional video which needs to cover ten sections of a course, IPTV can greatly extend its service. The video can be put on IPTV and then all the ten sections could be viewed at one time, or each instructor will have the freedom to schedule a broadcast time for their concerned section. As a result, this removes the scheduling conflicts, if any. Moreover, appearances of any valuable guest lecturers can be recorded and kept for future use. The recording can be used for multiple courses and can be viewed semester after semester. In addition, different orientations, which are given to a large group of people on a regular basis, can be recorded and stored. The recording can be viewed through IPTV, which is possible as long as you have rights from the publishing company to do so.

IPTV can report detailed levels of usage and viewer ship which can allow the operator to report statistics of programs/channels/adverts watched as well as be able to bill using various methods of bundled or a-la-carte content....billed by the second, minute, month or par per view.

Conclusion

Among the diverse areas within an IPTV solution, which

are to be addressed, it is obvious that the standardization process related to it is in its early stages. In the different parts of the whole system, many entities are working. However, so far, the observation is that there is little coordination among them. After issuing a standard offer, it can be observed that one component of a system is a good step forward, but too little. Now for IPTV the need of the hour is to gain mass acceptance and to reach to the optimum technical and commercial success as per everyone's expectation. In order to achieve this, the IPTV market must make itself free from closed solutions, which may hamper the following three goals: innovation, development, and competition.

In regards to the future of IPTV, it can only follow one path, which is close to what the market has witnessed in the traditional broadcast world. Moreover, it is important to note that this market has built an open system, which is well defined and relies on open standards. To make IPTV successful and perfect as per expectations, it has to guarantee the interoperability between all the building blocks. But, the conformance program related to it is critical.

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A GEOMETRIC MODELING SCHEMA FOR NON-MANIFOLD GOLD METAL ORNAMENTS

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Abstract

In this paper, we analyze the topological properties of gold sheet metal for the designing of ornaments schematically (Zero thickness, Zero bend radii). Although, such parts are usually non-manifold objects, this paper establishes a general topological invariant, which may be used as basic building block for a model representation of gold metal ornaments in a non-manifold modeling system in terms of number of facets, components, bends, free edges, welds, vertices, Non-manifold genus and volumes respectively. Corresponding Euler operators are derived, providing a basis for a gold modeling system. With this, it is possible to reason about manufacturing process such as number of components and arrangement of bend and weld lines, using only a single qualitative model of the product.

Key words: Non-manifold geometry, gold modeling, topology, Euler law, Euler operators.

1. INTRODUCTION

Although, traditional methods of design of gold ornaments are still widely practiced, the advances in the area of Computer Aided Geometric Design (CAGD) have opened up an arena that could lead to development of some modeling system that may be used for design and manufacturing of gold ornaments. Such a modeling system can help in realistically rendering the designed ornaments from various view points, giving the designer a clear optical understanding of the final result. Gold sheet metal ornaments are often represented schematically by a structure of zero thickness facets connected with zero radius bend lines. Some time such representations constitute a non manifold model. Examination of topological properties of such products does reveal some interesting relationships. To establish the relationship between fundamental elements of gold sheet metal parts, product formulation is required along with manufacturing constraints. Formulation of these elements makes it

possible, such as minimum number of required components, arrangement of bend lines and connecting (weld) lines, flat patterns, etc. In addition this formulation can provide a basis for modeling gold parts, classifying parts, and detecting error both in representation and in design. Moreover, since only the topology of the gold part is required to extract this information only a qualitative model is necessary without accurate dimensions of any kind.

Several CAD/CAM systems have been developed for modeling, process planning and manufacturing sheet metal products. The systems proposed in (Shpitalni, 1993) and (Lee & Lim, 1995) describe the use of sheets for efficient modeling of general thin objects. Some systems model the sheet metal product, including its thickness and bend fillets, etc. in a manner similar to conventional three-dimensional models. A more recent approach has been to model the sheet metal product in a form with zero thickness and zero bend radii, along with manufacturing constraints.

Interest in modeling non-manifold topology has grown. Generalizing solid modeling schemes to include wire frames and surfaces was explored in. (Wang et al., 2003). Masuda et al. (Masuda et al., 1990) suggested non-manifold extensions to solid modeling and implemented them by using a more general formulation that includes non-manifold elements, such as the disks, cusps, zones, regions and walls or shells, complexes, cavities and holes, of various types. Applications of Euler characteristics and topology in design are also discussed and more detailed topological models are proposed in the references (Lee & Lim, 1995; Shah & Mantyla, 1995; Lipson & Shpitalni, 1998), they are still confined to a relatively narrow topological domain and may therefore use simpler relationships.

The basic relationship between the fundamental elements of a gold sheet metal part is described and a topological invariant is derived that is applicable to a gold part both in its final form and in intermediate bending stages. This invariant is then used to analyze various manufacturing

alternative options. This principle of Euler operators for manifold objects is then applied to create similar topological operators for gold sheet metal parts.

Section 2 of the manuscript discussed about modeling schema of a gold sheet metal object and establishes relationship between its fundamental elements. Section 3 presents the equivalent Euler operators for gold sheet metal parts, while concluding remarks are presented in Section 4.

2. MODELING GOLD SHEET METAL OBJECTS

A Gold sheet metal part consists of one or more pieces of gold sheet that are bent and welded. Hence, the product is composed of facets joint along bend lines or weld lines. The term weld is used in a general context to denote any kind of physical bonding. The part also contains free edges. All line types meet at vertices of the product. These terms are illustrated in Fig. 1.

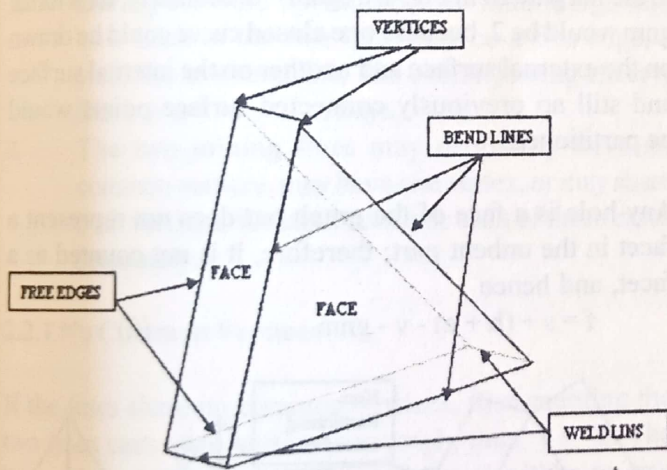


Fig. 1. Basic elements of a gold sheet metal ornaments.

The following subsections establish the existence of a constant relationship among these elements of the gold sheet metal parts composed of one or more components. The relationship between these parts is developed on the basis of the following steps:

- A relationship based on Euler-Poincare formula is derived for an unbent part.
- The concepts of non-manifold genus, weld lines and volumes are defined. Corresponding terms are added to the relationship, which retains its validity for the flat pattern.

This relationship is shown to remain valid during any bending and welding steps through systematic considerations of the possible topological changes.

2.1 The Flat Pattern

We start by examining a gold sheet metal ornament in its initial unbent form, i.e., its flat pattern, as illustrated in Fig. 2. The flat pattern is a special case of a Gold sheet metal product in which all the bends are at zero degrees. We proceed to analyze the schematic drawing of a flat pattern as a topological graph consisting of edges (corresponding to bend lines and free edges), vertices, and faces (corresponding to the unbent facets).

Since, by definition, bend lines and free edges intersect only at vertices and facet borders consist of free edges or bend lines, it can be concluded that the graph is planar and that each face of the graph corresponds to a facet of the product.

Euler-Poincare's formula for a single component planar graph asserts that

$$f + v - e = 2 \quad (1)$$

where f represents the number of faces of the graph (including the exterior faces), v the number of vertices, and e the number of edges.

In a flat pattern of a sheet metal product, the exterior face does not represent a facet. The corresponding formula for a graph representing a flat pattern of a gold part would therefore take the form

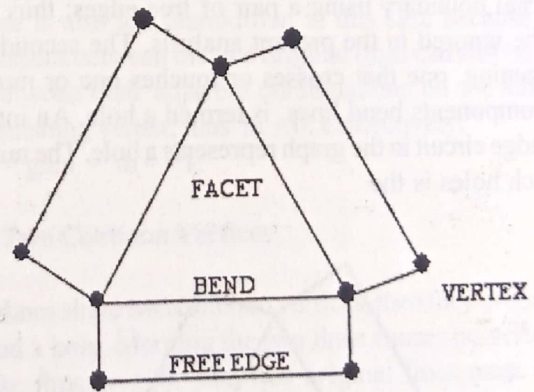


Fig. 2. Flat pattern (planer graph) of a gold sheet metal ornament.

$$f + v - e = 1 \quad (2)$$

A more general version of Euler-Poincare's formula for a multiple component planar graph state that

$$f + v - e = 2s \quad (3)$$

where s is the number of graph components (or shells, as often termed in the solid modeling context). A graph is

said to have several components if it consists of disconnected sub-graphs. Since each component contains an exterior face which is to be ignored for sheet metal products, we arrive at the corresponding relationship for sheet metal parts:

$$f + v - e = s \quad (4)$$

where s represents the number of disconnected flat patterns, f represents the number of facets in the flat patterns, v the number of vertices, and e the number of edges (including bend lines and free edges). For example for the object shown in Fig. 2, $f=4$, $v=9$, $e=12$ and $s=1$. This validates the relation shown by Eq. (4).

So far, the term e has denoted the number of all the lines in the flat pattern, both free edges and bend lines. To proceed, we must distinguish between the two types. The symbol b will denote the number of bend lines, and e will therefore now represent only the number of remaining free edges. The term free edge relates to any edge that is not a bend line (and, later on, not a weld line). Accordingly, modifying and reordering Eq. (4) results in:

$$f = s + (b + e) - v \quad (5)$$

A flat pattern can also contain two types of interior loops, as illustrated in Fig. 3.

The first type is a ring: an edge loop interior to a facet disconnected from the external boundary of the facet. Traditionally, rings are considered as special topological elements and are counted explicitly in a modified Euler-Poincare's formula for manifold objects. However, since a ring is local to its facet and is disconnected from the main component topology, it can either be ignored and modeled as a separate component or "artificially" connected to the external boundary using a pair of free edges; thus rings can be ignored in the present analysis. The second type of opening, one that crosses or touches one or more of the components bend lines, is termed a hole. An interior free edge circuit in the graph represents a hole. The number of such holes is the

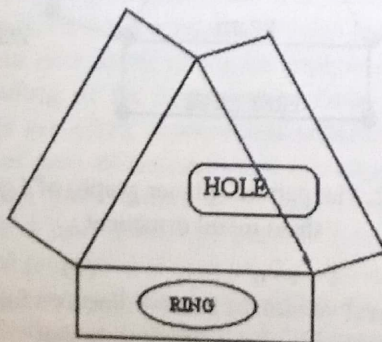


Fig. 3. A Flat Pattern with a Ring and a Hole.

genus of the flat pattern. The original Euler-Poincare formula uses a definition for genus suitable for manifold objects and is often denoted by symbol g . To make the following discussion more clear, we label the non-manifold genus with g_{nm} . Later on, we will encounter other holes formed as the product is bent and the free edges join; they will also be counted in g_{nm} .

For a multi-component part, the genus is the sum of the genres of the individual components. Note for the purpose of this definition, a surface is considered two-sided, and the sides meet at free edges. For example, a flat plate has one surface that spans both sides of the plate, since the two sides are connected along the free edges. If it has no holes, then no closed curve may be drawn on it without partitioning the surface into two surfaces, internal and external, which are separate because they have no common edge. By the above definition the genus of an object corresponds to the connectivity of its surface, where connectivity is a topological quality which measures the number of topologically different paths connecting any two regions on a surface. It is easy to verify, using this criterion, that $g_{nm} = 1$ in the flat pattern shown in Fig. 4(a), (ignoring the local rings). In Fig. 4(b), $g_{nm}=1$ as well, but in the flat pattern in Fig. 4(c), $g_{nm} = 0$. Similarly, for a torus, g_{nm} would be 2, because one closed curve could be drawn on the external surface and another on the internal surface and still no previously connected surface points would be partitioned.

Any hole is a face of the graph but does not represent a facet in the unbent part; therefore, it is not counted as a facet, and hence

$$f = s + (b + e) - v - g_{nm} \quad (6)$$

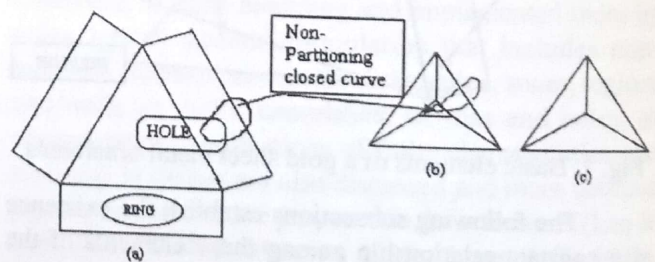


Fig. 4. Determination of the Genus of a sheet metal part.

2.2 Bending and Welding

The analysis so far has applied to a flat layout. We now proceed to bend the flat pattern into a full product, showing that Eq. (6) can be modified to include terms for weld lines and volumes and still hold true. As the bend lines are folded, some free edges and vertices may join together to form so-called weld lines. The number of weld lines is

denoted by w . According to this definition, a bend line is interchangeable with a weld line. This is true both from a manufacturing point of view and from a mathematical standpoint, as will become apparent below. Additional loops (holes) may be created and some volumes may be sealed off when bend lines are bent.

Volumes are counted using the term m . Initially, in the flat pattern, there are no weld lines, i.e. $w = 0$, and no volumes i.e. $m = 0$. Hence Eq.(6) can be modified to include weld lines and volumes. Since $m = 0$ and $w = 0$ for the flat pattern, Eq.(7) holds true for a flat pattern

$$f = s + b + e + w - v - gnm + m \quad (7)$$

We will now show that this relationship also holds true for bent and welded parts. During the bending and welding of a flat pattern into a final product, free edges join together in various ways. The bending operation itself does not change the topology or the count of the fundamental elements. The welding operations, however, join the free edges, vertices and bend lines, causing the topology to change. We denote the changes in f, s, b, e, w, v, gnm and m by $\Delta f, \Delta s, \Delta b, \Delta e, \Delta w, \Delta v, \Delta gnm$ and Δm , respectively.

1. During the weld operations, two lines merge into one. Each of the two lines may be a free edge, a weld line or a bend line. The overall joining effect is that $\Delta b + \Delta e + \Delta w = -1$ always.
2. The two joining lines may originally have no common vertices, may have one vertex, or may share both vertices. We shall consider each of these cases separately.

2.2.1 No Common Vertices

If the lines share no common vertices, then merging the two lines cause two vertices to vanish, thus $\Delta v = -2$. The two original lines may have belonged either to one component or to two separate components.

- (i) If the two lines belong to two separate component (Fig. 5(a)), then the merge united them so that $\Delta s = -1$. Any partitioning curve across the joint will partition the component back into two parts, and therefore cannot contribute to the genus. Thus $\Delta gnm = 0$.
- (ii) If the two belong to the same component (Fig. 5(b)), then $\Delta s = 0$ but the genus is increased because, according to the definition of gnm , a single closed partitioning curve can now be traced round the two sided merged line without partitioning the

component; thus $\Delta gnm = +1$. The number of volumes is left unmodified in this case, because any ray cast out between the two original lines can still be cast out

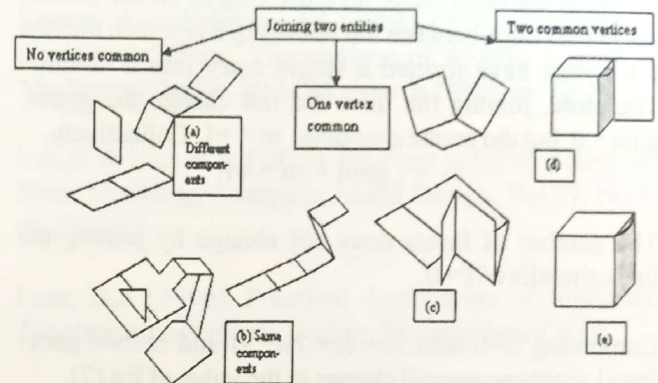


Fig. 5. Alternatives in joining two lines.

between their adjacent continuations; thus $\Delta m = 0$. Collectively,
 $\Delta s - \Delta v - \Delta gnm + \Delta m = +1$.

2.2.2 One Common Vertex

If the lines share one common vertex (Fig.5(c)), then merging the two lines causes one vertex to vanish; thus $\Delta v = -1$. The two original lines must have originated from the same component because they shared a vertex; therefore $\Delta s = 0$. Also the genus does not change because connectivity is not modified, i.e. no existing paths removed or new paths formed; therefore $\Delta gnm = 0$. The number of volume is also left unmodified in this case because any ray cast out between the two original lines can still be cast out between their adjacent continuations on the side of the vanishing vertex; thus $\Delta m = 0$. Collectively:
 $\Delta s - \Delta v - \Delta gnm + \Delta m = +1$.

2.2.3 Two Common Vertices

If the lines share two common vertices, then they originally formed a hole. Merging the two lines causes no vertex to vanish; thus $\Delta v = 0$. The two original lines must have originated from the same component because they shared vertices; therefore $\Delta s = 0$. Any partitioning curves on the surface can be arranged so that not more that one passes through the hole created by the two lines. Two cases must be distinguished.

- (i) If a closed curve on the surface passed between the lines once (Fig.5 (d)), then joining the lines would eliminate the curve; therefore by the definition of non-manifold

genus, $g_{nm} = -1$. In this case, the number of volumes does not change because if a ray is cast through, it can still be cast by following the curve continuation and hence $m = 0$.

(ii) If, on the other hand, no closed curve on the surface could pass once between the lines (Fig.5 (e)) then the two lines must have formed a single entry into a volume. Therefore, joining the lines did not change the genus, $g_{nm} = 0$, but did create a volume, $m = +1$. Collectively,
 $s - v - g_{nm} + m = +1$.

The number of facets does not change by joining the lines, therefore $\Delta f = 0$.

Combining $\Delta f = 0$ with $\Delta b + \Delta e + \Delta w = -1$ and $\Delta s - \Delta v - \Delta g_{nm} + \Delta m = 1$ yields no overall change in the value of Eq.(7).

It can therefore, be concluded that Eq.(7) holds true both for final products and products at intermediate bending stages. Moreover, from the preceding analysis it is evident that a collection of objects composed of facets, bends, welds, free edges, vertices and volumes can form a valid schematic model of a gold part if and only if the number of these elements satisfying Eq.(7) can be considered as a necessary integrity criterion for such schematic models. An additional constraint requires that the minimum number of bends or weld required to keep the 'f' facets of a component together is (f-1). Consequently, the number of bends/welds require to construct 's' components is at least (f-3). Hence,

$$b + w = f - s \quad (8)$$

Combining Eq.(7) & Eq.(8) yields difference d between the actual number of bend/weld lines in a product Eq. (7) and the required number of bend/weld lines for construction (holding the component together).

$$d = v - e + g_{nm} - m \quad (9)$$

The topology of gold products can be manipulated in a gold modeler by adding and removing facets, bends, welds, edges, vertices, etc. to design any meaningful ornament. In the original Euler-Poincare equation for manifold solids, the basic topological manipulations complying with the equation are termed Euler operators. They were originally introduced by (Masuda et al., 1990 and Shah & Mantyla, 1995). The same notion can be carried over to analyze gold ornaments using Eq. (7).

By historical convention, the operators are denoted by mnemonic names, as follows:

M=Make	V=Vertex
G=Genus (Non-Manifold)	K=Kill
E=free Edge	W=Weld

F=Facet
C=Component

B=Bend
U=Volume

For example, the operator MEV is translated as "Make Edge and Vertex". These operators can be implemented on top of a data structure describing a schematic gold part. Numerous valid operators can be established. However, only a few of them are essential in that they are sufficient to enable any manipulation or creation leading to construction of a gold part. A fundamental set of operators provides the basic tools in an implementation of a gold modeling system in the same way that the original manifold operators provides the basis for solid modeling.

There are many possible sets of operators: the following is a description of one such set. The most basic operation is skeletal primitive creation. The operation MCV creates a new component comprised of one vertex. The next two operators are MEV and MEF.

These operators correspond exactly to polygon and vertex splitting operations for plane models. In essence, MEV "splits" a vertex into two vertices joined with an edge. The MEF operator joins two vertices while creating an additional facet.

The next operator, MGB (KGB), provides a means for manipulating the non-manifold genus of a product and for joining and merging circuits. A single component composed of a face with a local ring is transformed to a single component with a genus. This operator provides the mechanism for handling local rings and incorporating them into the main topology.

The MUKE (KUME) operator allows sealing off volumes by merging edges. The remaining edge can be changed to a weld or bend using the next operators.

Finally, two operators allow interchanging between bend lines, weld lines and free edges. Note that free edges, bend lines and weld lines are interchangeable both mathematically and during manufacture, as a bend can be replaced by a welding or a unification of two free edges. These operators are the consequence of this interchangeability.

4. CONCLUSIONS

This paper proposes topological invariant as adapted to a general non-manifold gold sheet metal ornaments. This paper has proposed a topological invariant for all schematic gold parts. The proposed invariant was then

generalized to support general manifold and non-manifold gold models. The validity of the proposed invariant constitutes a necessary condition for the validity of a schematic representation of a gold product from a topological point of view. Based on this invariant, a basis of Euler operators for gold products has been defined which can serve as the fundamental tool set required in managing the topological representation of a product in a gold modeling system. In particular, these operations can be used as the basis for developing improved CAD/CAM systems for the gold ornaments based on schematic representation. The derived relationship has been simplified to support general non-manifold surface models, without rings. This relationship can be employed to analyze various manufacturing aspects of a gold product based on its topology alone, without the need for accurate information. This, in turn, implies that the proposed tools can be used for preliminary planning in the conceptual design stage when accurate dimensions are not yet available. We intend to pursue this concept in analyzing freehand sketches of gold products. Since these sketches convey the topology of a product, such an interpretation system can furnish useful insight into the manufacturing process of a product based on a sketch alone and thus provide assistance at the very early stages of conceptual design and process planning.

Overall, the work introduces two concepts that may lead to overall development of a gold modeling system. These concepts include:

(i). A topological invariant for all gold sheet metal ornaments and thin walled objects that may be used as a necessary condition for proving topological validity and reasoning as well as topological configurations.

(ii). A set of topological operators that can be used as basic building blocks for a model representation of gold sheet metal ornaments in a sheet modeling paradigm.

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HOLOGRAPHIC MEMORIES PUT SHAME TO SURFACE STORAGE MEMORIES

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Abstract

As the computer undergo transformations there always arises, greatly increasing the need for high capacity data storage and data access. A new high capacity form of data storage must be developed to handle these large files quickly and efficiently.

Introduction

Although when we need to increase the speed of the computer we thought of increasing the speed of processors and buses but it increases the data requirement by the processor for further processing Which roughly double their data capacity every three years (Moore's Law) and data storage has struggled to close the gap. CPU's can perform an instruction execution every nanosecond, which is six orders of magnitude faster than a single magnetic disk access. Much research had tried to fill the gap between CPUs and data storage. Some of these advances include cache, pipelining, optimising compilers, and RAM.

As the computer undergo transformations there always arises, greatly increasing the need for high capacity data storage and data access. A new high capacity form of data storage must be developed to handle these large files quickly and efficiently.

From last two decades Optics the backbones of data store and read data. Compact disc with a diameter of a mere 12 centimeters and a thickness of about 1.2 millimeters can hold 783 megabytes of data. In 1997, an improved version of the CD, called a Digital Versatile Disc (DVD), was released, which enabled the storage of full-length movies on a single disc. A double-sided, double-layer DVD can hold 15.9 GB of data, which is about eight hours of movies. These conventional storage mediums meet today's storage needs, but storage technologies have to evolve to keep pace with increasing consumer demand. Scientists are now working on a new optical storage method

called holographic memory that will go beneath the surface and use the volume of the recording medium for storage, instead of only the surface area. Three-dimensional data storage will be able to store more information in a smaller space and offer faster data transfer times. It can store data upto 1 Tb in a sugar cube sized crystal. Data from more than 1000 CDs can fit into a holographic memory System. Most of the computer hard drives available today can hold only 10 to 80 GB of data, a small fraction of what holographic memory system can hold. It is based on the principle of holography.

Holographic image (hologram) is coded in one big data block which is recorded at one access. And while reading this block is entirely extracted out of the memory. For reading and recording of the blocks kept holographically on the light-sensitive material (LiNbO₃ is taken as the basic material) they use lasers.

The idea of holographic (three-dimensional) storage was first given by Scientist Pieter J. van Heerden in the early 1960s. After a decade, few scientists at RCA Laboratories demonstrated the technology by recording 500 holograms in an iron-doped lithium-niobate crystal and 550 holograms of high-resolution images in a light-sensitive polymer material. The lack of cheap parts and the advancement of magnetic and semiconductor memories placed the development of holographic data storage on hold.

Properties of Holograms

A hologram is a block or sheet of photosensitive material which records the diffraction of two light sources. To create a hologram, laser light is first split into two beams, a source beam and a reference beam. The source beam is then manipulated and sent into the photosensitive material. Once inside this material, it intersects the reference beam and the resulting diffraction of laser light is recorded on the photosensitive material, resulting in a hologram. Once a hologram is recorded, it can be viewed with only

the reference beam. The reference beam is projected into the hologram at the exact angle it was projected during recording. When this light hits the recorded diffraction pattern, the source beam is regenerated out of the refracted light. An exact copy of the source beam is sent out of the hologram and can be read by optical sensors. For example, a hologram that can be obtained from a toy store illustrates this idea. Precise laser equipment is used at the factory to create the hologram. A recording material which can recreate recorded images out of natural light is used so the consumer does not need high-tech equipment to view the information stored in the hologram. Natural light becomes the reference beam and human eyes become the optical sensors.

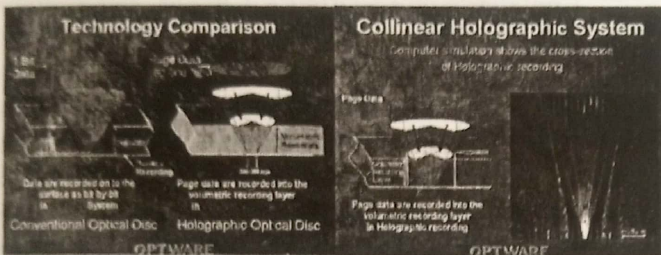


Table: Comparison of features of different types of memories

Feature	Magnetic	Flash	Holographic
Non-volatile	Yes	Yes	Yes
Data Retention	> 10 yrs	> 10 yrs	> 10 yrs
Endurance (Erase/write Cycles)	10 ⁵	10 ⁶ (commercial)	Unlimited
Data Transfer rate	10 Mb/sec	160 Mb/sec	> 1 Gb/sec
Power Consumption	1Gb/Watt	10 Gb/watt	100 Gb/watt
Current Package	6 x 3.5-in disk < 100 GB	256 Mb & 512 Mb (per die) 100's Gb (MCM)	100 Gb/cm ³ cube. 1 Tb/card

Benefits :

1. The main advantage is that mechanical components are practically absent (those that typical for current storage devices).
2. A fast data access.
3. Such system(Holography) doesn't have any moving parts
4. Pages are accessed parallel.
5. Less probability of failures.
6. Lower power consumption, since today a hard disc is one of the greatest power-consuming elements of a computer.

7. Conventional memories (CDs, DVDs and magnetic storage) all store bits of information on the surface of a recording medium while the holographic memories store data in the volumetric form.
8. Three-dimensional data storage will be able to store more information in a smaller space and offer faster data transfer times.
9. Data transfer rate is 1Gb/Sec that is about 40 times faster then the DVD.
10. Data density to be 1 TBytes per cubic cm (TBytes/cm³) which is rather impressive when comparing with the current magnetic method which allows around several MBytes/cm².

Drawbacks :

1. Main drawback has to do with incompatibility with current storage media: Traditionally, holographic storage systems contained no servo data, because the beam carrying it could interfere with the holography process. Also, previous holographic memory discs have been notably thicker than CDs and DVDs.
2. Once the hologram is recorded it cannot be erased, which is why the medium is intended for write-once, read-many-times applications.

Discussion :

1. First proposed the idea of holographic storage was in the early 1960s but to date not much work has been done in this regard.
2. Utilisation of the existing production infrastructure has not been considered. This means that the production of holographic memories requires investments in new equipment.
3. This system utilizes the technique similar to the natural process in the human mind as the god had gifted the way of collecting the information and then storing the information in the human brain in the intelligent way.
4. Data transfer rates must be improved, hologram decay must become negligible, and hologram recording time must be reduced. This will make holographic memories economical to be produced for mass

Conclusion :

Holographic memory will most likely be used in next generation as most prevalent storage medium for the simple desktop to super computers like the magnetic memories in

the current era. But as per the cost issue as described in the drawbacks, cost is not as much of an issue as it provides the lot of benefits like data reliability and the storage capability. Current magnetic storage devices remain far more cost effective than any other medium on the market. As computer systems evolve, it is not unreasonable to believe that magnetic storage will continue to do so forever in the computer world. The parallel nature of holographic memory has many potential gains on serial storage methods. However, many advances in optical technology and photosensitive materials need to be made before we find holograms in computer systems.

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INTERLEAVERS FOR TURBO CODES

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Abstract

Since their introduction in 1993, in a seminal paper by Berrou, Glavieux, and Thitimajshima, Turbo codes have changed the way we look at high-performance error-control coding. After some initial skepticism from the coding community, Turbo coding gained rapid acceptance as the original results (Berrou et al. claimed a Bit Error Rate of 10^{-5} within 0.7 dB of the Shannon limit) were replicated by a number of independent researchers. A flexible software Turbo codec and simulation environment is designed and tested.

Using this tool, the Turbo code interleaver design problem is considered for large block sizes, where the effect of trellis termination is less marked. The performances of various interleavers with a similar block size are compared, including and implementation of the uniform interleaver. An optimized interleaver design technique based on simulated annealing is proposed - the results obtained show that the error performance may be significantly improved without increasing the delay. Finally, interleaver design for small Turbo codes is considered. In this case it is shown that while correct termination improves the performance for an average interleaver, its effect on Turbo codes with optimized interleavers is negligible.

Using our simulated annealing design technique it is easier to include restrictions which make the interleaver correctly-terminating or odd-even. While the S-random algorithm serves well for specifying interleaver spread, we believe that our algorithm is better suited for more sophisticated design criteria.

Key words: - Turbo, Interleaver, Uniform, Random, BER, FER

1 Introduction

Interleaver Design for Large Frames

1.1 Introduction

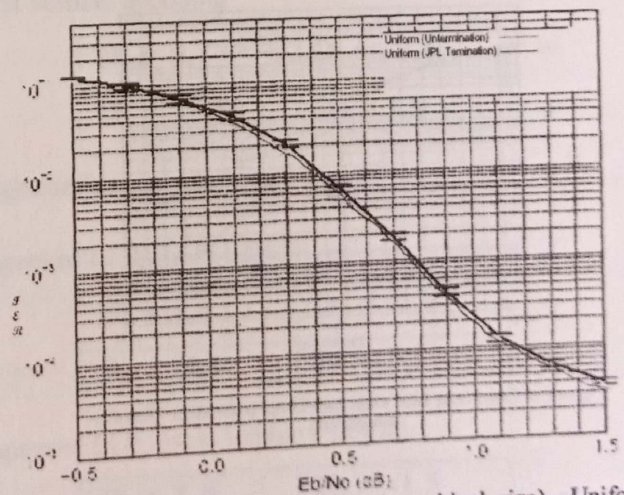
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In this chapter we consider the interleaver design problem for large block sizes, where the effect of trellis termination is less marked. This is done by comparing the performance of various interleavers with a similar block size; novel interleaver schemes are also used, from which we gather some further insight into the problem. Finally, the performance of an optimized interleaver design technique based on simulated annealing is considered.

1.2 Performance Reference

We restrict ourselves to unpunctured rate-1/3 symmetric Turbo codes with encoder memory $v=2$ and generator (1; 5/7). In order to avoid the effects of trellis termination, we also choose a relatively large block size $t = 1024$.

The effect of interleaver choice for Turbo codes with this component code and block size are indicative of what can be expected with other good component codes and larger block sizes. The design problem of choosing the best component codes has been tackled by the JPL team [Divsalar & Pollara, 1995b].



1.1: Turbo code BER simulation (large block size) - Uniform interleaver

As a reference for performance, we implement a uniform interleaver by using a different random interleaver for every block simulated. To confirm the validity of the statement that trellis termination does not have a significant effect at

the chosen block size, we simulate the uniform interleaver with and without termination. To terminate the uniform interleaver we use the scheme proposed by the JPL team. The Bit Error Rate (BER) and Frame Error Rate (FER) results for these two Turbo codes. All simulations were performed using 10 iterations, with a target tolerance of $\pm 10\%$ at a confidence of 95% - these tolerance limits are also shown in the graphs. As expected, trellis termination does not significantly affect the performance of Turbo codes with encoder memory $v = 2$ at this block size. 1.3 Regular Interleavers

It has mostly been argued that interleavers with a high regularity perform poorly in Turbo codes. This is confirmed in figure where we simulate Turbo codes with Square, Rectangular, and Helical interleavers. For comparison, the performance of a uniform interleaver is also shown in the graphs. Note that the Rectangular and Helical interleavers satisfy all the restrictions detailed in [Ramsey, 1970] and [Barbulescu & Pietrobon, 1995] respectively:

- Rectangular: for the interleaver with $R=21$ rows and $C=49$ columns,
- " $R+1$ and C are relatively prime and $R+1 < C$.
 - " The interleaver spread is greater than $5v$.

Additionally, R and C are both odd, so that the interleaver is odd- even.

This allows the same interleaver to be fairly compared with other such interleavers in a study of punctured Turbo codes

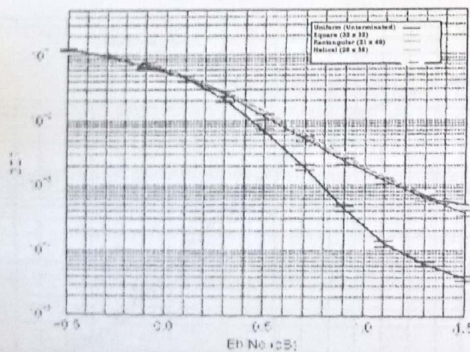


Figure 1.3: Turbo code BER simulation (large block size) - Regular interleavers

Helical: for the interleaver with $R = 29$ rows and $C = 36$ columns,

- R and C are relatively prime.
- C is a multiple of $v + 1$ and the RSC code's feedback polynomial is full, making the interleaver simple. This

allows the same tail to be used with both the interleaved and non-interleaved sequences. In our implementation, we use the Tail Not Interleaved scheme proposed in [Barbulescu, 1996], which was shown to give better results.

- Additionally, C is even, so that the interleaver is odd-even. This allows the same interleaver to be fairly compared with other such interleavers in study of punctured Turbo codes.
- It is interesting to note that the BER performance improvement of the Helical interleaver over the Square and Rectangular interleavers is minimal, and can probably be attributed mostly to the termination. Its FER performance, however, is significantly better, though still far from the uniform interleaver.

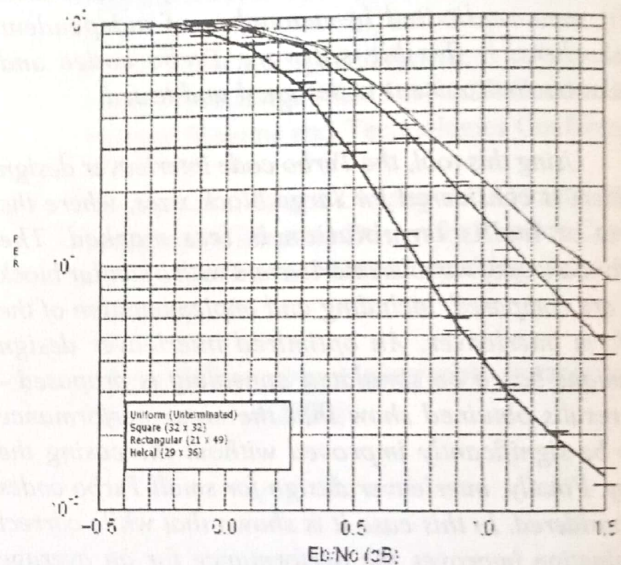


Figure 1.4: Turbo code FER simulation (large block size) - Regular interleavers

1.4 Randomised Interleavers

The interleaver originally used by Berrou, described in [Berrou & Glavieux, 1996], is essentially a Square interleaver with some pseudo-random perturbations. However, its performance is significantly better than a regular Square interleaver with the same dimensions. A comparison between the Berrou-Glavieux interleaver and the Square interleaver is shown in Fig. For comparison, the performance of a uniform interleaver is also shown in the graphs.

2 Interleaver Design for Small Frames

2.1 Introduction

In this chapter we consider the interleaver design problem

for small block sizes. The effect of various trellis termination schemes is analysed by comparing the performance of the uniform interleaver with and without termination. We also analyse the performance of different termination schemes when used with an optimized interleaver.

2.2 Performance Reference

We restrict ourselves to unpunctured rate - 1/3 symmetric Turbo codes with encoder memory $v = 2$ and generator (1; 5/7). In contrast, though, we choose a very small block size $t = 64$ to analyse the effect of termination where it should be most pronounced. The effect of interleaver choice for Turbo codes with this component code and block size are indicative of what can be expected with other good component codes and similarly small block sizes. We simulate the uniform interleaver with and without termination. To terminate the uniform interleaver we use the scheme proposed by the JPL team. The Bit Error Rate (BER) and Frame Error Rate (FER) results for these two Turbo codes are shown respectively in Figs. all simulations were performed using 10 iterations, with a target tolerance of $\pm 10\%$ at a confidence of 95%. While at low SNR the performance of the two codes is almost identical, at high SNR trellis termination improves the performance of Turbo codes with encoder memory $v = 2$ at this block size. In particular, the FER performance is markedly better and the BER performance is marginally improved.

2.3 Two Dimensional single parity code

Message Bit 1001

D1=1	D2=0	P12=1
D3=0	D4=1	P34=1
P13=1	P24=1	

Transmitted bit sequence

D1	D2	D3	D4	P12	P34	P13	P24
1	0	0	1	1	1	1	1
+1	-1	-1	+1	+1	+1	+1	+1

Assume Received sequence:

0.75, 0.05, 0.10, 0.15, 1.25, 1.0, 3.0, 0.5, =

X1, X2, X3, X4, X12, X34, X13, X24

$L_c(X), L_c(X_{ij}) =$

(1.5, 0.1, 1.2, 0.3, 2.5, 2, 6, 1)

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$L_c(X_1) =$ 1.5	$L_c(X_2) =$ 0.1	$L_c(X_{12}) =$ 1.25
$L_c(X_3) =$ 0.2	$L_c(X_4) =$ 0.3	$L_c(X_{34}) =$ 1.0
$L_c(13) =$ 3.0	$L_c(24) =$ 0.5	

Leh(d1) = -0.1 (new)

Leh(d2) = -0.5 (new)

Leh(d3) = -0.3 (new)

Leh(d4) = -0.2 (new)

Lev(d1) = 0.1 (new)

Lev(d2) = -0.1 (new)

Lev(d3) = -1.4 (new)

Lev(d4) = 1.0 (new)

Original $L_c(x_k)$

1.5	0.1
0.2	0.3

First Iteration (first horizontal decoding)

D1 = -0.1	D2 = -1.5
D3 = -0.3	D4 = -0.2

Low confidence in D3 & D4

First vertical decoding

D1 = 0.1	D2 = -0.1
D3 = -1.4	D4 = 1.0

High confidence in D3 & D4

Improved LLR due to $L_c(d)$

D1 = 1.4	D2 = -1.4
D3 = -0.1	D4 = 0.1

Improved LLR due to $L_c(d) + L_e(d)$

D1 = 1.5	D2 = -1.5
D3 = -1.5	D4 = 1.1

Leh(d1) = 0 (new)

Leh(d2) = -1.6 (new)

Leh(d3) = -1.3 (new)

Leh(d4) = 1.2 (new)

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