DESIGN STEPS & ANALYSIS FOR MOEMS

Dr Umesh kumar*

Dr Ramesh Kumar**

Abstract :

MOEMS is the technology which is now taking shape in commercial way to fulfill present industrial requirement. It requires reliable method for design optical, mechanical & electronics in micro level for bulk manufacturing. Mechanical engineering design requires configuring optimum geometry and dimensions of the components that are to be assembled into Microsystems. Structural integrity and functional integrity with reliability are the primary goals of design. In general micro-system system involves major three tasks i.e. process flow design, electromechanical and structural design and design verification that include packaging and testing for successful design.

Keywords: Photonics, MOEMS, Simulation, Analysis, Reliability, Design.

* **Principal, Govt. Women's Polytechnic , Ranchi**

** **Professor, Computer Sc & Engg, B I T Durg, Bhilai**

Introduction:- MOEMS technology is a new approach to combine micro optics and MOEMS (Micro Electro Mechanical Systems). This technology started in late 1990's. it had given a new family of miniaturized devices with enormous potential to revoluturning Photonic systems. The growth of MOEMS market be about 1.6 per year; with the market size reaching $4 billion is 2007 .

It contains components of sizes in 1 micrometer (μm) to 1 millimeter (mm). It is constructed to achieve a certain engineering function.

The core elements in MOEMS generally consist of two principal components, a sensing or actuating elements and a signal transduction unit.

Typical MOEMS products are CD player, Hard Disk, Flat Panel display, inkjet printer, mobile phone, Air bag, optical telecommunication applications.

MOEMS Design: The designs generally work or both top down and bottom-up approach described in fig 1.

In top down approach evolves from a system model where the system architect makes design tradeoffs and determines the individual components specifications. In a high level simulators, users work with libraries of individual components with symbols that can be connected and configured to solve most MOEMS problem.

In bottom up designs flow begins with the available processes and involves detailed layout of the device, wither generated from a systems model or created with traditional layout tools.

In another way it includes these sub phases given in fig. 2. The first phase is optical or functional designs. It involves choosing the geometry and optical characteristics for the MOEMS, so that it will perform the desired functions.

The second process is the electro mechanical design of the MOEMS device. It involves iterature, detailed and self consistent calculations of the electronics and the mechanics of the devices. It includes varying degrees, material parameters and physical characteristics.

The third phase is process designs. Here, the patterning, material depositions and etching steps, which must be done sequentially to produce the desired devices with the needed performance. All can be defined in fig 3.

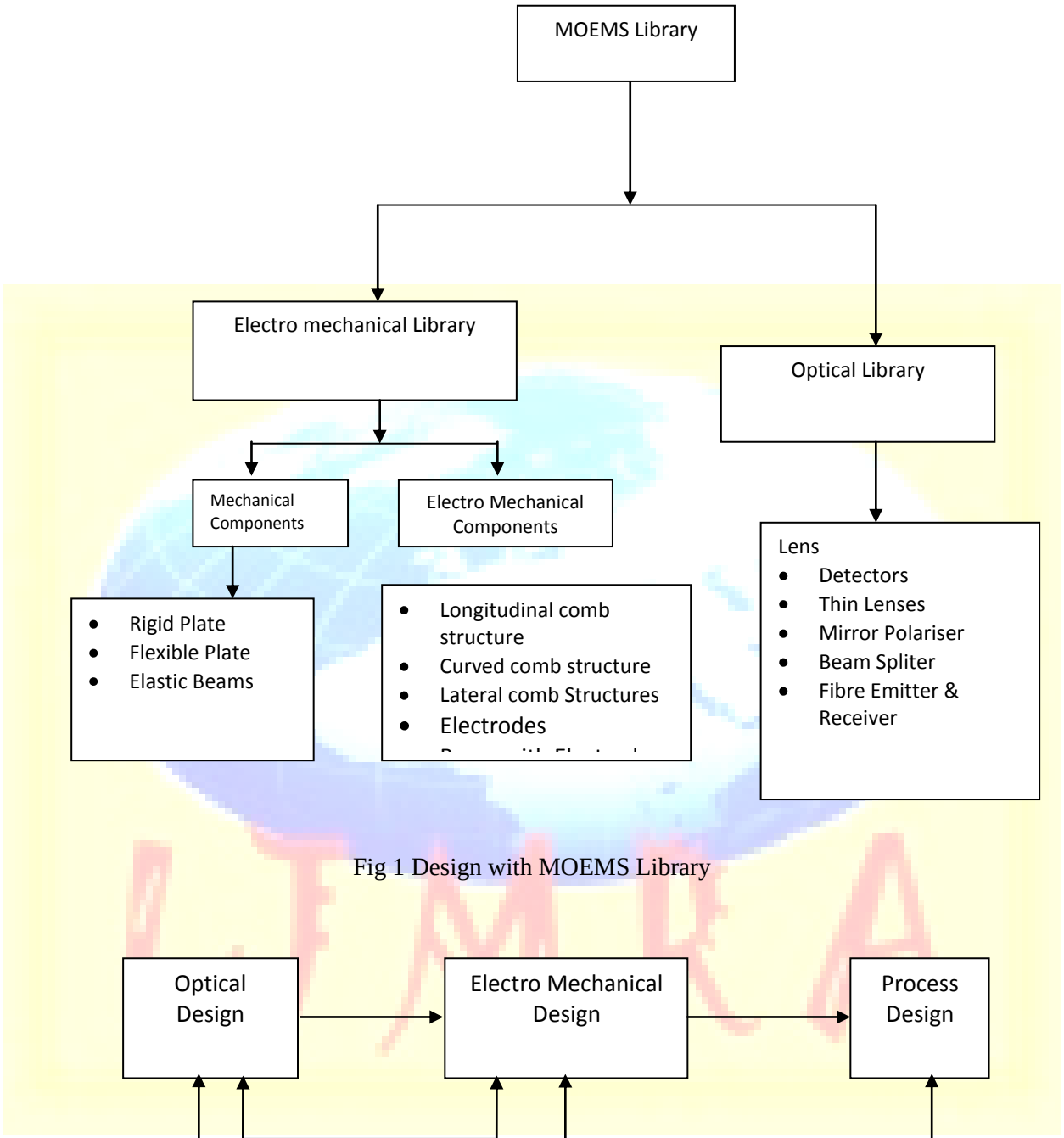

Fig 1 Design with MOEMS Library

Fig 2 Design phase

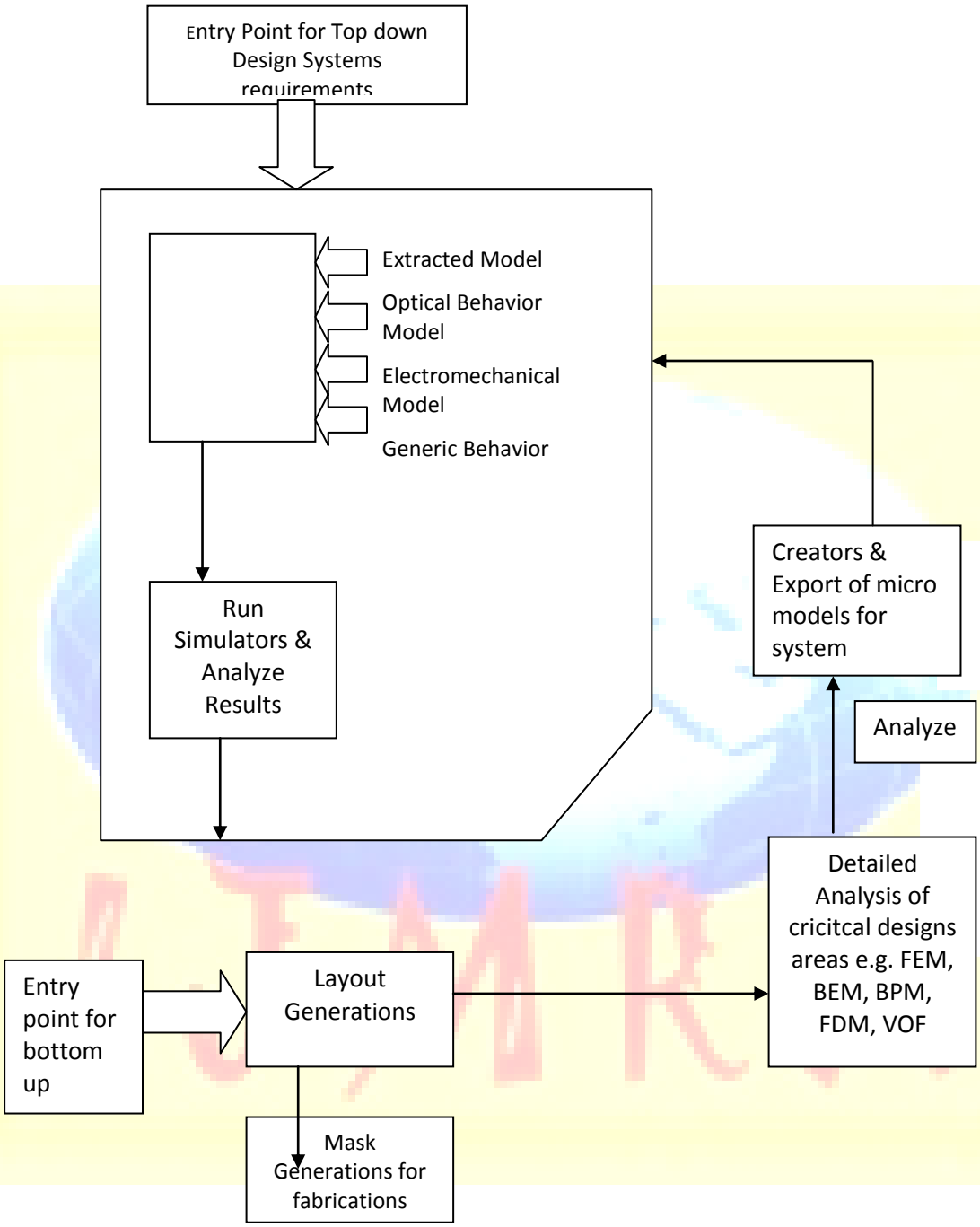

Fig 3 MOEMS Designs flow combining top down and bottom up.

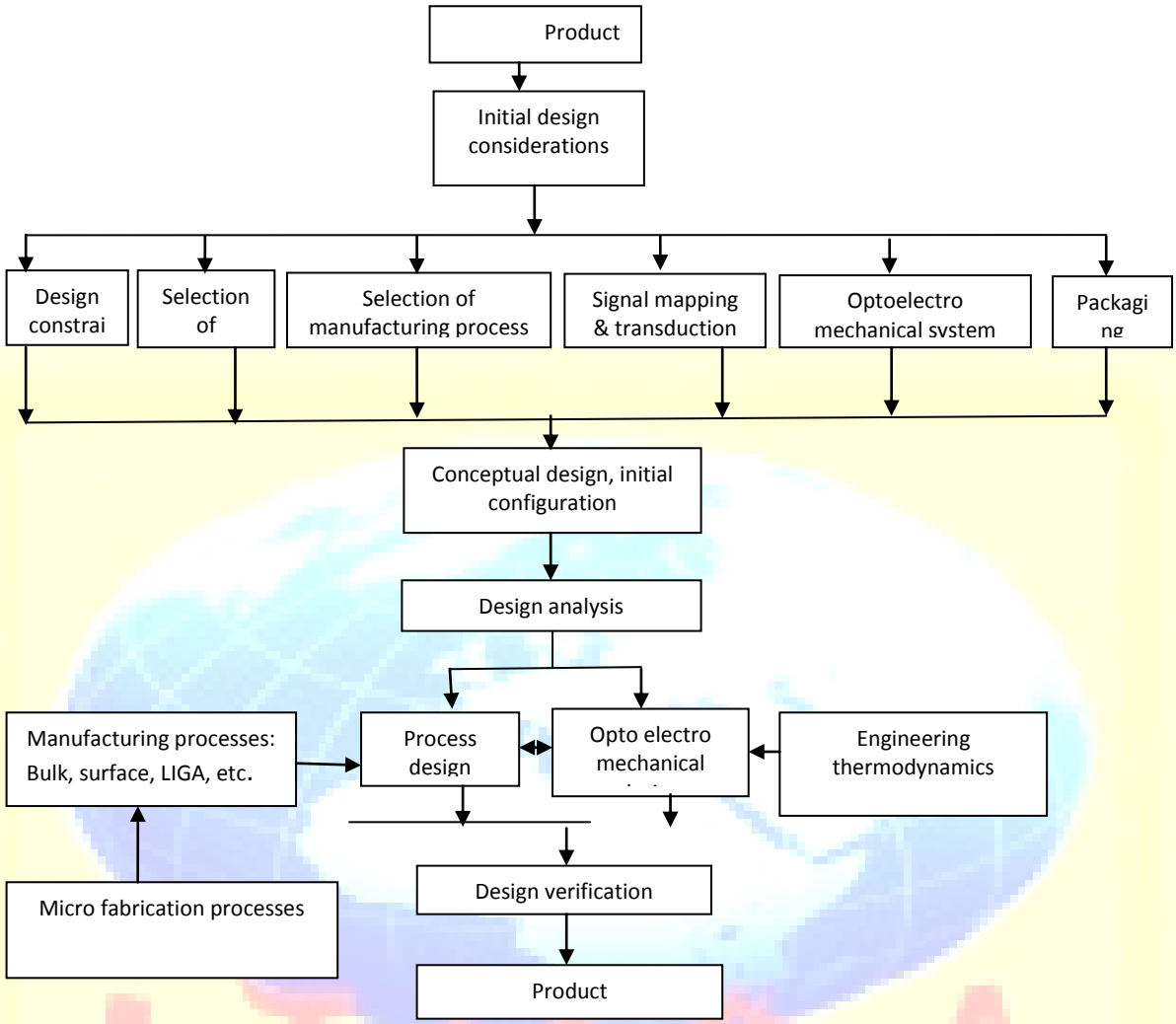

fig 4 Overview of micro system

The diagram in fig 4 indicates that once the product is properly defined by a specification, a number of particular items need to considered. These item includes

- Design constraint:
- Selection of materials
- Selection of manufacturing process
- Signal mapping & transduction
- Opto electro mechanical system
- Packaging of the product

After these considerations the development of the initial configuration of the product in terms of geometry, dimensions, materials and the fabrication & packaging methods

Design constraints can be many like customer demands, time of market, environmental conditions, physical size & weight limitations, types of applications, fabrication facility & costs.

Selection of materials considers substrate materials, with various properties, materials which is used for packaging

Selection of manufacturing processes defines the approach of bulk micro maching, surface micromachining other high aspect ratio processes.

Selection of signal transduction for both micro sensors & actuators. In either case there is a need to convert chemical, optical, thermal, or mechanical such as motion or other physical behavior of MOEMS components into an electrical signal or vice versa. Signal mapping is also considered.

Opto electro mechanical system is the system where without electrical power system it cannot be imagined. A preliminary assessment on the interface between the mechanical actions and the electrical system is needed in order to configure the product.

Packaging includes opto electro mechanical isolation, signal conditioning & processing, mechanical joints, processes for tunneling and then film lifting, system & procedures for system assembly, products reliability & performance testing

Modeling of MOEMS:-

1. System level model- it employs a top down design approach that hierarchically breaks down into manageable components.
2. Toolbox model – micro components as tool which commonly used in MOEMS integrated and then used for validation.
3. Components models – Each component described geometrically and parametrically electro mechanical and optical.

Conclusions:

The current literature is a comprehensive capability for the designs and analysis of MOEMS system. For initial design top down approach starts with systems requirements and uses parametric elements, optical, electronics and mechanical aspects are considered for simulators. For process design bottom up approach is beneficial. For optimal performance both type of approach is suitable

References

[1] P.Rai-Choudhary "MOEMS technology and application", Bellingham, Wash: SPIE, "MEMS and optical Engineering press, 2000[2]

[2] Hiroyaki Fujita and Hiroshi Toshiyoshi," Optical MEMS", IEICE TRANS. ELECTRON, Vol. E83-C, No. 9, (2000) 1427

[3] Yu Fan and Mojtaba Kahrizi "An Optical MEMS Sensor System",Monttreal May/Mai IEEE 2003

[4] Deier, E; Wilde J; "Thermo Mechanical Behavior of the die attachment adhesive of a MEMS pressure sensor", 14th European Microelectronics and Packaging conference & Exhibition Friedrichshafen, Germany, 23-25 June 2003

[5]]Ian Hunter ,"Theory and Design of microwave filters", Londan' Institution of electrical Engineers, 2001

[6] S.O.Kasap "Optoelectronics and Photonics principles and practices", Prentice Hall, 2004

[7] Wilde J, E Deier, Elena Zukowski " Influence of materials data on the performance Modeling in the design of MEMS Packages", IEEE 2004

[8] J Leuthold, F. Girardin, & et al " Polarization independent optical phase conjugation with pump signal filtering in a monolithically integrated Mach – Zehender Interferometer semiconductor optical amplifier configuration", IEEE 1998A

[9] Arthur Morris, Stephen Bart, Derek Kane, Gunar Lorenz and Vladimir Rabinovich.: A design flow for MOEMS, SPIE
Photonics East 2000

[10] Teegarden, D.; Lorenz, G. and Neul, R.: How to model and simulate microgyroscope systems. IEEE Spectrum, July 1998, pp. 66-75.

[11] Reinhard Neul, Gunar Lorenz and Stefan Dickmann: Modelling and Simulation of Micro Electromechanical Sensor Systems, Proceedings of the VDE World Microtechnologies Congress MICRO.tec 2000 September 25th - 27th, 2000, Hannover, Germany, Volume 2, pp. 67 - 72.

[12] Lorenz, G.: *Netzwerksimulation mikromechanischer Systeme*. Dissertation, Universität Bremen, Shaker Verlag, 1999.

[13] Przemieniecki, J. S.: Theory of Matrix Structural Analysis. Dover, 1985.

[14] Lorenz, G.; Neul, R.: Network-Type Modeling of Micromachined Sensor Systems. *Proc. Int. Conf. on Modeling and*Simulation of Microsystems, Semiconductors, Sensors and Actuators, MSM98, Santa Clara, April 1998, pp. 233-238.

[15] Coventor, http://www.coventor.com

[16] Kurzweg, et al., *Proceedings of Modeling and Simulation of Microsystems*, 768-773, June 2000.

[17] Walker and Nagel, "Optics & MEMS," Naval Research Lab, N

[18] Huang et al, Precision MESM….. IEE Prc Sci & Meas Teach Vol 151 2004

[19] Barwicz, F Tech Inte Mease Microsystem, IEEE Inst & Mag. 2004

[20] Yeatman et al, SD in Optical Position Encoder, IEEE Trans on Inst & Meas 2004

[21] Syms et al, MESM VOA, IEEE Photonics Tech Letters 2004

[22] Unamuno et al, F B G De mod based on Hy Op MEMS IEEE J on Quan Electronics May/June 2004

[23] Bromashhenko et al, New Kind of MOEMS, 0-7803-8715-5/04 2004

[24] Unamuno et al, Hy MOEMS T Filter, IEEE Pho Tech Let., Jan 2005

[25] Shea et al, Design for Reliability, 0-7803-7500-9/02 IEEE

[26] Noell et al, Optical MEMS base on SOI., 0-7803-7500-9/02 IEEE

[27] Mohammad A. Matin, Yun-Bo Yi and Vikram Gupta-Modelling and analysus of low actuation-voltage MEM mirror with spring structure for tunable optical filter J. Micro/Nanolith. MEMS MOEMS Vol. 6, 023011 (Apr. 18, 2007)

[28] Balint Meliorsiz and Andreas Eradmann- Simulation of mask proximity printing J. Micro/Nanolith. MEMS MOEMS Vol. 6, 023006 (Apr. 18, 2007)

[29] Microlithography and Aviation Burn J Lin J. Microlith., Microfab., Microsyst. Vol. 5, 040101 (Dec. 29, 2006)

[30] David L Dickensheets, Bishnu P Gogoi, Harald Schenk MOEMS and Miniaturized Systems VI VOLUME 6466 Jan- 2007