ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 3, Issue 4, pp: (66-72), Month: October - December 2015, Available at: www.researchpublish.com

Nano-Manufacturing and Product Design: Practical Solutions to Current Manufacturing Challenges

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Abstract: **The financial and natural maintainability of arrangements relative to nanotechnology are generally up until now obscure and some innovative arrangements carry with them prevalent challenges that act as threat to manufacturing and product design. Therefore, the requirement for improvement of moderate and safe methods for tending to worldwide difficulties, in territories, for example, vitality, environment and wellbeing, has never been appealing. These dangers need relief as a firm establishment for propelling nanotechnology solutions. For instance, while speculations to build up nanotechnology prevail, as found in the past, it is still troublesome for stakeholders to survey the depth at which research ventures are adequate and very much focused on and possible return and the influence of the technology exploration on societal and monetary goals. On the other hand, the high cost of Nano-manufacturing is a deterrent to improvements and the difficulties confronting integrated Nano-manufacturing systems represent an innately multi-disciplinary arrangement of issues tending to problems for working with structures in specific administrations.**

Keywords: **Nano-manufacturing, Product Design, Nanotechnology, Nano-manufacturing systems, Challenges, Threats, Society, Environment, Production, Markets, Costs, Safety.**

I. INTRODUCTION

In numerous nations, nanotechnology is the center of expanded co-appointment and fortifying coordinated effort between professions in different fields and offices particularly those in science, innovation and development, instruction, agribusiness, environment, vitality and industry and trade (*Zhao et. al, 2003*). Multiple compensations of nanotechnology count on its feasibility to modify the key configurations of things at the Nano-scale to undertake precise attributes along these lines incredibly broadening the all-around utilized toolboxes of the science of material. Utilizing nanotechnology, creation of materials can be more viable in respect to quality, weight, toughness, response, among other numerous and essentially vital characteristics (*Boysen, 2015*).

Regularly, nanotechnology serves to remarkably augment, even alter, copious modernization and production (*Madou, 2011*). Critical advances are common in the field because of past research and exhaustive tests, assisting it with more rapid stages to accomplishing its comprehensive potential (*Nano Gorvenment, 2015*). The financial and natural maintainability of arrangements relative to nanotechnology are generally up until now obscure and some innovative arrangements carry with them ecological, wellbeing and security (also known as *Environmental, Health and Safety*-EHS) dangers.

Therefore, the requirement for improvement of moderate and safe methods for tending to worldwide difficulties, in territories, for example, vitality, environment and wellbeing, has never been appealing. These dangers need relief as a firm establishment for propelling nanotechnology solutions. A percentage of the sub-segments of nanotechnology portray a

considerable measure of potential and expanding impact on a huge scope of monetary areas such sustenance bundling, car, tire-industry, hardware, among others for the field of nanotechnology (*Ivanova, 2013*). Nanotechnology turns out to be predominant in conjunction with different technologies and science innovations, for example, biotechnology and vitality advances, prompting items joining numerous mechanical developments.

Clearly, nanotechnology can have different roles and influence over the entire quality chain of an item and can be of an empowering nature, utilized as a device to bolster innovation or item improvement further (*Sargent, 2012*). Case in point, nanotechnology can assume a basic part and convey key usefulness to an item (e.g. batteries empowered by the technology). Then again, nanotechnology can enhance or empower more practical and improved assembling procedures without the last item containing any Nano-materials. Nevertheless, challenges in manufacturing and item design go about as preventions to accomplishing unlimited advancements and improvements in nanotechnology.

Keeping in mind the end goal to address these difficulties, included gatherings need to add to a scope of procedure developments and innovative solutions. Generally, there exists a requirement for troublesome procedures that alter Nano-producing, rather than transformative changes (*Szczęsna-Antczak et.al, 2012*). Assembling apparatuses likewise require incomprehensible educational info to meet the difficulties for future Nano frameworks coordination and creation. Additionally, preparing, instruction and effort to high schools, junior colleges and universities are fundamental essentials relative to the end goal of preparing the workforce without bounds for incorporated Nano frameworks production.

Resolutely, this research focuses on the challenges in Nano-manufacturing and product design, and practical solutions to these challenges. Past experiments and studies form the basis of this research focusing on nanotechnology as the general topic and some of its sub-sections such as green nanotechnology. The discussion section addresses the summary findings from the subject results, significance and implications of the research. Finally, the paper explicates the limitations of the overall study, methodology and materials used as confirmations of validity and reliability attributes of the study.

II. RESULTS

Challenges Resulting from the Gap between Nanotechnology Research and Market:

Background: Nanotechnology is creating critical interest amongst governments trying to recuperate from late financial emergencies and to address squeezing ecological needs (*Lavie &Drori, 2012*). While speculations to build up nanotechnology prevail, as found in the past, it is still troublesome for stakeholders to survey the depth at which research ventures are adequate and very much focused on and possible return and the influence of the technology exploration on societal and monetary goals (*Roco et.al, 2011*).

Indeed, even with immeasurable research and findings, there lacks routine characterizations or orders for the technology, nor meanings of its creations, practices or organization. Generally, it is vague to what degree associations, for example, companies, colleges and exploration foundations take part in exploiting research information and creating nanotechnology (*Falkner &Jaspers, 2012*). Characterizations are integral to comprehending the way of the commitment of nanotechnology and empowering information gathering.

Different workshops and research by National Science Foundation (NSF) and European Commission (EC) on developing worldwide interests in *Nano-scale Science and Engineering* in the US and European Union show a gap between nanotechnology research and its execution in the business sector. Ordinarily, determining the effect of the technology is more intricate relative its versatile nature (*Teizer et.al, 2011*). As aforementioned, experts in Nano-science concur that the nanotechnology can be crucial to an item and give it its key usefulness, or it may not even be available in the last item, just influencing the procedure prompting its creation; nonetheless, actualizing this in assembling or directing investigations to secure extra confirmation is not predominant (*Vandermoere et.al, 2011*). Nevertheless, it is clear that for complete effect appraisal, it is important to take a gander at the last item containing nanotechnology as well as the potential effect of nanotechnology up and down the quality chain (*LEIT Group, 2015*). The complete number of utilizations of nanotechnology over all innovation divisions, and the empowering attributes, makes a complex and eccentric scene for research hence assembling data from industry can be troublesome because of affectability encompassing nanotechnology items.

Practical Solutions: The best practical way to deal with upgrading usage of research in manufacturing is creating consistent combination of advances and handling for utilizing Nano-materials as a part of generation (*Teizer et.al, 2011*).

This will involve enhancing the control and checking of the conditions required for the utilization of Nano-materials in modern procedures and expanding the level of power and repeatability of such mechanical procedures.

Typically, so as to create and make utilization of the relevant knowledge and information; foundation limit and devices are imperative to complete the required advancements of procedure control, metrology and lifecycle research, which represent basic strides before resolving to pilot generation (*Roco et.al, 2011*). The cross-disciplinary, multi-scale nature of Nano-assembling requires incorporated/combinatorial/half and half hardware and "cutting edge" creation infrastructure to provide analysts with estimation abilities and materials. Relative to the conceivable expense and intricacy of this hardware, a system of topographically disseminated focuses, with tele-manufacture and tele-portrayal abilities, connecting with current focuses and systems, gives off an impression of a suitable model. This will give the pivotal and currently missing connection of Nano-assembling exploration base, crossing over current interests in Nano science (*Vandermoere et.al, 2011*).

In respect to comprehensive infrastructure, they ought not to be liable to test and logical improvement alone, as this will just give a more extensive scope of abilities at the Nano-scale. As an addition, these apparatuses should likewise work in situ, continuous, non-rudely or damagingly, and under the variable conditions found in manufacturing. As new instruments result from novelty, new routines for alignment, institutionalization and reasonable adjustment standards, will follow to guarantee the exact translation of results (*Falkner &Jaspers, 2012*). For adjustment, estimation, and manufacturing, reproducible situating and resituating with nanometer exactness is inclusive as part of the solution.

Finally, one of the key obstructions to quick advance in this cross-disciplinary field is the trouble of building groups with the proper blend of mastery. Every individual researcher, without another person's input, sees the issue with a limited degree and from a predetermined perspective (*Lavie &Drori, 2012*). Associations, for example, the NSF and the EC can serve to encourage the communication between different specialized and geographic gatherings through financing backing and through planning gatherings, for example, relative workshops.

Challenges Resulting from High Costs of Nano- Manufacturing and Product Design:

Background: The high cost of Nano-manufacturing is a deterrent to improvements, for example, taking advantage of the cross-area capability of Nanotechnologies and Advanced materials to drive aggressiveness and manageability (*Karn et.al, 2009*). The high expenses are the reason with reference to why Nano-innovation is yet to influence culture and innovativeness through novel materials. The accentuation is on developing to empower multi-sectorial potential, and progressing innovative status of arrangements with leap forward potential (*Qi &McAlpine, 2010*). On the other hand, the high expenses exude from the materials and the manufacturing procedures that have constrained technology and equipment (*Serano, 2009*).

For instance, presently, Graphene is without a doubt developing as the most promising nanomaterial in view of its one of a kind blend of sublime properties, which opens a path for its exploitation in a wide range of uses (*Boysen, 2015*). Nonetheless, it needs to conquer various deterrents before the understanding of its maximum capacity for down to earth applications (*Angeli et.al, 2006*). One of the best difficulties confronted today in commercializing graphene is the way to create excellent material, on an extensive scale requiring limited cost, and in a reproducible way (*Davis, 2015*). The nature of graphene assumes a vital part as the vicinity of imperfections, debasements, grain limits, various spaces, auxiliary issue; folds in the graphene sheet can have an unfavorable impact on its electronic and optical properties. Commonly, even the institutions concentrating exclusively on nanotechnology need adequate assets to cover all sections, settle on inventive decisions and facilitate development (*OECD, 2013*). The high cost of assembling is moderating nanotechnology advancement and acts as an addition to the difficulties in usage of research (*Balbus et.al, 2009*).

Practical Solutions: Given the challenge of manufacturing cost, global collaboration in this general zone is particularly apposite. The best arrangement, preceding more revelations and developments, is public – private coordinated efforts that will cultivate the move of nanotechnology from exploration to commercialization (*Karn et.al, 2009*). For organizations, interest in this technology for development is expensive and with no assurance of yields. Leadership regimes ought to try to moderate these dangers by encouraging different sorts of *public - private partnerships* (*OECD, 2013*).

Currently, there is pervasive reluctance from the private division to take part in nanotechnology. This is because of various variables, for example, the view of the EHS and moral dangers connected with the innovation (likewise prompting issues of customer acknowledgment), administrative vulnerability, the absence of development of the innovation,

potential financial expenses, market instability and solid rivalry with officeholder advancements (*Angeli et.al, 2006*). Nanotechnology frequently contends severely with existing innovations for two reasons – cost aggressiveness and nature (*Serano, 2009*). The greater part of the relative components leads to a situation of instability and an impression of high venture hazard. The potential outcomes that the technology can provide for advancement to counter a percentage of the major ecological and social difficulties triggers reactions from governments that ought to include attempting to diminish dangers and vulnerability for organizations, subsequently intending to encourage and quicken the exchange of nanotechnology development to the commercial center.

This business sector driven methodology incorporates direct speculation and making association between governments and public/private segments to unite the assets required. For instance, public/private organizations could receive extended support as a component of the arrangement created by the *Inter Ministries Nanotechnology Committee in Brazil* (*OECD, 2013*). In Korea, joint effort amongst manufacturing as well as the scholarly world fortifies the point of moving speculations from key R&D to exploration and commercialization that is more connected (*Qi &McAlpine, 2010*). In India, numerous nanotechnology foundations are prevalent as today and the administration ought to bolster access by industry to their facilities. Conglomerates of commercial enterprises that have been subject of discussion ought to be a piece of arrangement getting bolster or start from open bodies, for example, the development of the *Nano Business Alliance* USA and *the Nanotechnology Industries Association* in Europe (*OECD, 2013*).

Challenges facing Integrated Nano-manufacturing Systems:

Background: The difficulties confronting integrated Nano-manufacturing systems represent an innately multi-disciplinary arrangement of issues tending to problems for working with structures in specific administrations that must join the scope of top-down and bottom-up procedures accessible to give multi-scale frameworks mix (*Busnaina et.al, 2013 &Morse, 2008*). This raises the question on the impact of new ideas in accomplishing the important economy of scale for expansive scale generation. Current ideas do not give progressive methodologies, accordingly developing the abilities of existing manufacturing and infrastructure (*Li et.al, 2011 &Ho et.al, 2006*).

Relative difficulties for integrated Nano-manufacturing systems are the need to regulate assembly of three-dimensional diverse frameworks, to handle Nano-scale structures in high-rate/high-volume applications without trading off their inalienable properties and guaranteeing the long haul unwavering quality of nanostructures through testing and measurements (*Du et.al, 2006*). These shows absence of far reaching examination on the portrayal of Nano-materials and nanoparticles as the building-pieces of nanostructures and in the manufacture and combination of both top-down and bottom- up procedures (*Dimov et.al, 2012 &Busnaina, 2006*).

Practical Solutions: The prevalent practical solution involves understanding the instruments and examples of coordinated framework conduct as an element of parts, cooperation powers and systems at the Nano-scale. Besides, involved parties ought to consider the adaptability of frameworks having huge quantities of Nano-parts and non-straight communications (*Lai et.al, 2009*). They ought to build up solid, reproducible and monetarily practical methods for collecting varieties of Nano-scale segments, effecting their deterministic position and coordinating the nanostructures with gadget designs that compass various length scales (*Huang, 2011*). Accomplishment of this is through application proper assembling stages running from wafer-based group preparing to fast, minimal effort move producing stages. Generally, deciding the instruments required for measuring, reenacting and assembling of designed Nano-frameworks is essential (*Malshe et.al, 2010*).

Similar to other difficulties, reconciliation advancement needs a cross-segment of exploratory orders as a commitment to the more noteworthy comprehension and control of Nano-scale wonders (*Roco, 2005*). The aggregate information of these controls will reclassify the connections between materials, procedures and property wonders, taking into account the making of novel Nano-fabricating systems (*Ho et.al, 2009 &Du et.al, 2006*). Those methods will connect the manufacturing gap between the advancements of the examination research facility and the financial suitability of nanotechnology. Further, propelled instrumentation to portray and measure nanostructures is a superior way to deal with giving prescient reproduction of nanostructure conduct and adding to the outline and reconciliation of Nano-gadgets and frameworks (*Morse, 2008*). At last, knowledge sharing and combined effort are the general answers to empowering innovation exchange and affecting open attention to nanotechnologies.

III. MATERIALS AND METHODS

The study utilized expressive overview outline and variables that required appropriate recognizable proof to lay ground for the definition of a speculation examined utilizing the common strategies. The examination system depended intensely on prior learning and literature survey. There was literature review and a web search utilizing the generally known web indexes such as Google, with beginning inquiry concentrating on nanotechnology producers and associations. Work area study took after to get relative data that aided in supporting the theory.

Based on the nature of the methods, appraisal of legitimacy took into account the exactness and significance of deductions in light of examination results being the capacity of instruments used to quantify what they are expected to gauge (*Sullivan, 2011*). For the greater part of the utilized writing, pilot studies occurred preceding the original research and a percentage of the general populace was sufficient for guiding to empower specialist to figure out prevalence of any equivocalness in the material and guaranteed that the devices evoked the kind of information expected for the research (*Patten, 2004*). For the other literature, supervisors who are specialists in the territory of study looked into the instruments as well and those that neglected to gauge the variables expected were either changed or disposed of (*Dawson, 2002*). On reliability, it involved measuring the extent to which the exploration included predictable results or information after rehashed trials and instruments were dependable to the extent that they reliably measured the normal for enthusiasm over the long run (*Key, 1997*).

IV. CONCLUSION

The nature of the challenges demonstrates that in attempting to survey the estimation of nanotechnology, it is imperative to remember that advantages to manufacturers and buyers may not as a matter of course boost societal advantages. End clients, when they dissect the circumstance from their own particular financial viewpoints, will normally consider the value execution parameters of another innovation, for example, nanotechnology when contrasted with different choices. Contingent upon the client and application, the societal effects of the item or procedure could conceivably be quite compelling contrasted and particular components of execution and usefulness.

Moderately, diverse exploration points of reference have a reactant impact in investigating and mastering the whole region of Nano-scale handling and fabricating, and in reforming its use for the full range of potential longer-term applications (*Salamanca – Buentello et.al, 2005*). Besides, a bolster arrangement for the foundation required to accomplish the exploration/training goals is key in manufacturing and product design. This incorporates assets for backing of required improvements in instruction and workforce preparing, original thoughts, and exploration and training facilities for information creation and exchange (*Silva, 2006 &Priest, 2006*). Moreover, it ought to address systems for usage of the required moral, legitimate, financial and societal structures. Potential coordinated efforts between the American and European nanotechnology groups at all levels, and also extension of current worldwide system activities and the likelihood of growing new joint NSF (*U.S. government*) - EC automatic activities could be the answer for different difficulties. As essentialness in nanotechnology, involved parties ought to consider techniques to disperse data and report the exploration proposals, to cross-fertilize associations between different scientific fields, and to pull in more thoughtfulness regarding the examination opportunities in the Nano-assembling/preparing range.

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