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highlights

Reconstruction of the Zaghen-Tulcea

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From the Chief Author's Desk

We see a drastic momentum everywhere in all fields now a day. Which in turns, say a lot to everyone to excel with all possible way. The need of the hour is to pick the right key at the right time with all extras. Citing the computer versions, any automobile models, infrastructures, etc. It is not the result of any preplanning but the implementations of planning.

With these, we are constantly seeking to establish more formal links with researchers, scientists, engineers, specialists, technical experts, etc., associations, or other entities, particularly those who are active in the field of research, articles, research paper, etc. by inviting them to become affiliated with the Global Journals.

This Global Journal is like a banyan tree whose branches are many and each branch acts like a strong root itself.

Intentions are very clear to do best in all possible way with all care.

Dr. R. K. Dixit
Chief Author
chiefauthor@globaljournals.org

CFD Analysis of Catalytic Converter to Reduce Particulate Matter and Achieve Limited Back Pressure in Diesel Engine

GJRE-A:Classification(FOR) 091304, 091399

PL.S. Muthaiah[1], Dr.M. Senthil kumar[2], Dr. S. Sendilvelan[3]

***Abstract*-The superior performance, higher output power and comparatively less-cost fuel make the diesel engines more popular in both heavy and light duty automobile applications. The main disadvantage in diesel engines is the emission of dangerous pollutants like oxides of nitrogen (NO_X) and particulate matter (PM) heavily, which affect seriously the environment and human health. The rare earth metals now used as catalyst to reduce NO_X are costly and rarely available. The scarcity and high demand of present catalyst materials necessitate the need for finding out the alternatives. Among all other particulate filter materials, knitted steel wire mesh material is selected as filter materials. Models with filter materials of very fine grid size wire meshes packed inside the manifold develop more back pressure which causes more fuel consumption due to lower volumetric efficiency. Use of larger grid size wire meshes results in less back pressure, but the filtration efficiency is also reduced which may not be sufficient to meet the most stringent emission norms prescribed. Through CFD analysis, a compromise between these two parameters namely, more filtration efficiency with limited back pressure is aimed at. In CFD analysis, various models with different wire mesh grid size combinations were simulated using the appropriate boundary conditions and fluid properties specified to the system with suitable assumptions. The back pressure variations in various models are discussed in this paper.**

I. Introduction

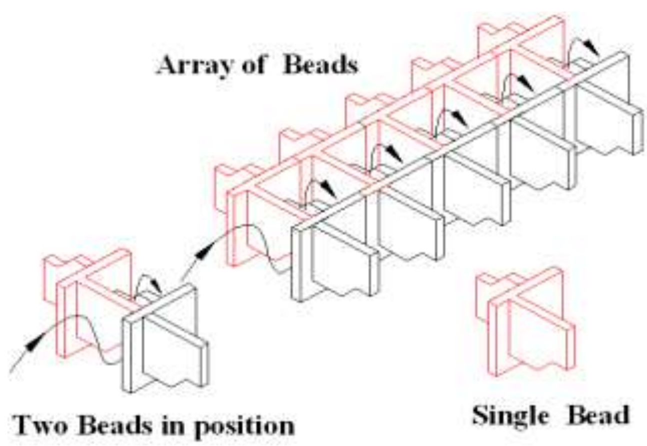
With the introduction of the turbo charged high-speed diesel engines, the use of diesel engine vehicles in transport sector is increasing enormously. The main drawback in diesel engine is that it produces large amount of pollutants which include NO_X, CO, unburned HC, smoke etc. Apart from these unwanted gases, air borne Particulate Matter (PM) such as lead, soot, and other forms of black carbon are also produced in the diesel engine exhaust. All these pollutants are harmful to environment and human health. They are the main causes for greenhouse effect, acid rain, global warming etc. The simplest and the most effective way to reduce NO_X and PM, is to go for the after treatment of exhaust. The catalyst and filter materials placed inside the exhaust manifold increase back pressure

About[1]. Research Scholar, Sathyabama University, Chennai
About[2]. Principal, SKR Engineering College, Chennai
About[3] Principal, Aksheyaa College of Engineering, Chennai

This increase in back pressure causes more fuel consumption, and in most cases, engine stalling might happen. The filtration efficiency and back pressure are interrelated. If maximum filtration efficiency using very fine grid size wire meshes, is achieved, the back pressure will also be increased, which causes more fuel consumption. On the other hand, if larger grid size wire meshes are used, back pressure will be less, but the filtration efficiency will also be reduced, which does not help in meeting the present emission norms. With the help of CFD analysis, it is attempted to find out the optimum solution to get maximum filtration efficiency with limited back pressure developed inside the exhaust manifold.

II. Catalyst

As this study deals only with the filtration efficiency of the trap system and the back pressure developed inside the exhaust manifold, the details pertaining to the type of catalyst, preparation of catalyst, reaction chemistry and NO_X conversion efficiency that can be achieved are not discussed in this paper. However, the shape of the catalyst bead which is relevant for the back pressure development inside the manifold is shown in Figure 1.



The flowing exhaust gas is free to move in all directions inside the manifold. As the movement of exhaust gas is not abruptly obstructed anywhere in its path, the back pressure is limited to minimum level. The porous nature of catalyst beads also help the gas to flow over the larger surface area of the catalyst enabling better reaction to take place for reducing NO_X as in the case of SCR system.

1) SCR Catalyst System

Presently, ammonia derived from urea is used to reduce NO_X from diesel engines. This is achieved by allowing the ammonia plus exhaust gas to flow over the platinum coated ceramic substrates, and it has been proved as highly effective in reducing NO_X in heavy duty applications [2]. Ammonia is produced on-board by rapid hydrolysis of nonhazardous form of urea solution. The problem with this is, cost of on-board production of ammonia, cost of additional on-board air supply equipments, and high cost of rare metals like platinum etc. In this paper, rare earth metal catalyst is replaced by a specially prepared catalyst. This catalyst selectively reacts with NO and NO_2 species and effectively reduces them to form nitrogen and oxygen using SCR technology.

2) Diesel Oxidation Catalyst

DOC is made as a flow through device that consists of specially made catalytic beads and steel wire mesh material which are coated with metal catalyst. As the hot gases contact the catalyst and the coated wire mesh, most of the exhaust pollutants such as CO, gaseous hydrocarbons, unburnt fuel and lube oil, toxic aldehydes etc. are oxidized to CO_2 and water, thus reducing harmful emissions. DOC does not collect or burn the soot particles in diesel exhaust. But it is accomplished by oxidizing the soluble organic fraction of diesel PM.DOC can also produce sulphate particles by oxidizing the SO_2 present in the exhaust gas and thus increases the PM emission. This may not be a problem, if the fuel contains <50ppm of sulphur [3].

3) Volume Of Catalyst

The size of exhaust manifold is based on the engine exhaust flow rates. For maximizing catalyst applied surface area, the volume of catalyst must be 1.5 to 2 times the engine displacement [3]. The engine selected for this study is a four stroke twin cylinder (80mm bore and 110mm stroke length) water cooled diesel engine. The engine displacement is calculated as 603 cm^3/sec for the assumed velocity of 60 m/s. The total volume of catalyst used in the model is 1383 cm^3. The total trap material (catalytic beads plus coated wire meshes) kept inside the manifold occupies one third of its total volume. This means, the remaining volume is used for the exhaust gas to flow out freely. This helps for limiting the back pressure and ensuring effective DOC and SCR systems.

III. Selection of Filter Material

Ceramic monolith, ceramic foam, steel wire meshes, ceramic silicon fiber, porous ceramic honey comb are the few types of filter materials reported in the literature. Out of these filter materials, steel wire mesh is selected as trap material because knitted steel wire mesh material is ranked first [4] for its collection efficiency of PM. The other reasons for its selection are,

Thermal stability during regeneration.
Good mechanical properties.
Long durability.
Easy availability and less cost.

Wiremesh Specifications

In this analysis, the selected steel wire mesh grid sizes are 1.96, 1.61, 1.01 and 0.65mm. The specifications of these wire meshes are shown in Table 1. Three models are made, each using two different grid size wire meshes placed in two separate compartments. The details of wire mesh grid sizes used in different models are shown in Table 2.

Table 1: Wire Mesh Specifications

Wire Mesh size (gap) in mm	**Wire Dia (d) in mm**	**Open Area %**	**Wt in Kg/m²**	**Mesh per inch**	**CPSI**
1.96	0.58	59.3	1.71	10	100
1.61	0.51	57.7	1.56	12	144
1.01	0.41	50.8	1.51	18	324
0.65	0.25	51.8	0.92	28	576

Table 2: Models and Wire Mesh Grid Sizes

Model No.	**Wire Mesh Grid Size (in mm) in Compartment I**	**Wire Mesh Grid Size (in mm) in Compartment II**
Model 4	1.96	1.61
Model 5	1.61	1.01
Model 6	1.01	0.65

Since number of steel wire mesh pieces are stacked one over the other as a bunch, the gas flow cannot be straight, rather it is a zig-zag flow. This type of flow provides increased travel length and contact time so that more amount of DOC action can take place and hence more PM reduction is achievable.

IV. Physical Model

To meet the less ground clearance available in the present vehicles, the height of the manifold is restricted to 110 mm. The cross section is made as rectangular of size 176 x 110 mm. In CFD, the system consumes less memory space and less response time, if the rectangular cross section is assumed. However, in actual practice, the rectangular corners are suitably rounded off which ensures the smooth flow of exhaust gas with less turbulence near the wall sides.

a. Construction

The exhaust manifold designed for this study comprises two compartments. The first one is meant for filtration and DOC catalyst. The second compartment is meant for filtration and SCR system.

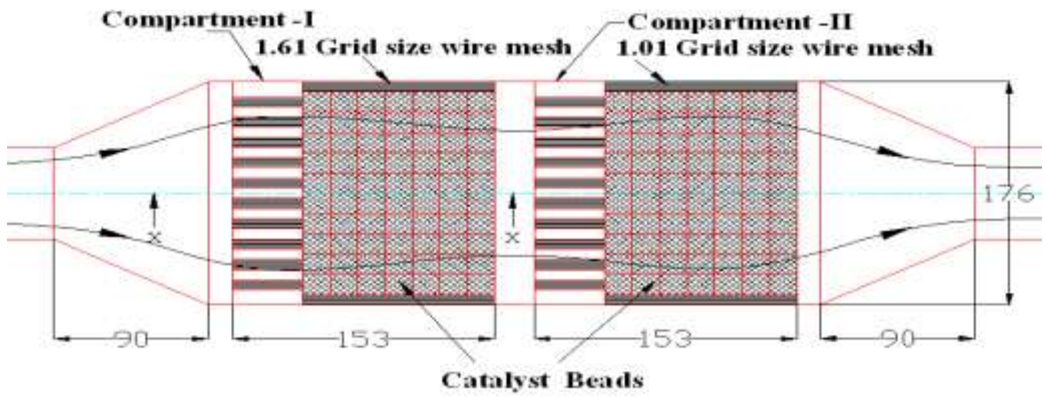


Figure 2: Sectional Plan Showing Two Compartments

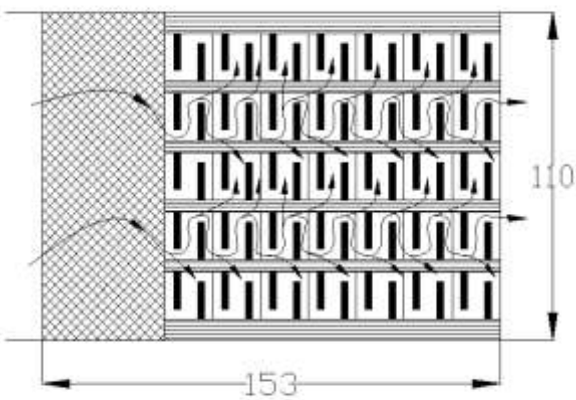


Figure 3: Sectional Elevation at x-x

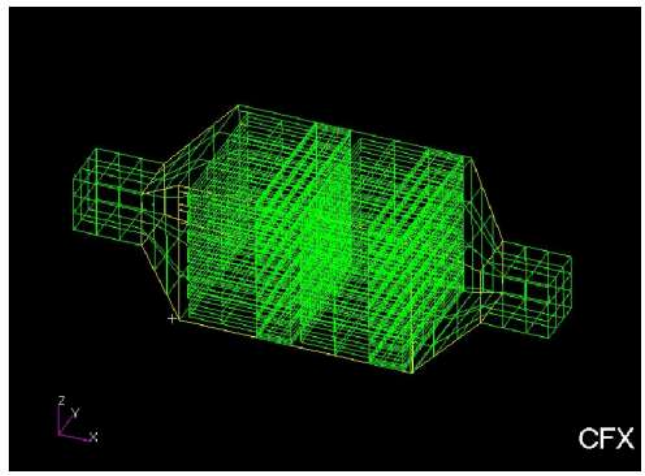


Figure 4: Meshing of Elements

The upstream of the first compartment is filled with steel wire meshes for about one-fourth of its length. These wire meshes are placed vertically with their surface being parallel to the flow of gas. Sufficient gaps are provided amongst the bunch of wire meshes which make the gas to flow crosswise also for better filtration and reduce back pressure as shown in Figure 2. The enlarged view showing the flow directions of exhaust gas is shown as sectional elevation in Figure 3.The downstream of first compartment is filled with catalyst beads and steel wire meshes arranged in alternate layers. The beads are arranged horizontally in a single layer so that the gas can enter at one end of the bead and come out in the opposite end. During its travel, the gas follows the up and down movement and meets the entire inner surface area of the catalyst as shown in Figure 3. There are 322 catalytic beads of size 16x16x16 mm placed in each compartment. More contact surface area of the catalytic beads enables the better catalytic reaction to take place between the catalyst and the flowing exhaust gas. The beads are designed so that the top and bottom portions are open and the gas can go up and down to the next layer of beads through the steel wire mesh layers which are also horizontally placed as shown in Figure 3.

b. Operating Principle

A part of the exhaust gas passes through the wire mesh layers which trap a portion of the soot. The remaining exhaust gas flows out to the neighboring bead placed in the same line – similar to a flow-through substrate. The soot trapped in the wire mesh material is combusted by the NO_2 that is generated by the upstream catalyst and thus the filter is regenerated continuously. If a situation occurs where filter regeneration is stopped and a saturation point occurred with the collected soot, the wire meshes placed over the catalytic beads will not plug as happened in wall flow filter. In this condition, the exhaust gas can flow out through the catalytic beads which are similar to a flow-through substrate. However, much larger part of exhaust gas flows through the catalytic beads in the direction as shown in Figure 3.As the path of the gas is not totally blocked, the back pressure developed inside the exhaust manifold is very much limited and no further increase in back pressure can happen beyond certain limit, irrespective of the soot loading over a period of time.A compressed air cleaning process is suggested to clean the PM deposition on steel wire meshes and catalytic beads. In this process, two numbers of compressed air inlet points are placed in between two compartments at diametrically in opposite position. By using compressed air available air at the fuel filling stations, the cleaning operation can be carried out. A hinged door of very thin size provided at the inlet end of the exhaust manifold will act as a non-return valve. This will prevent the cleaned PM dust going back into the engine while cleaning.It can be estimated and proved that, with the existing volume of catalyst and steel wire meshes, the cleaning may be required for every 10,000 Kilometers of engine run, for efficient fuel consumption.

V. Mathematical modelling

Air is used as fluid media, which is assumed to be steady and compressible. High Reynolds number k-ε turbulence model is used in the CFD model. This turbulence model is widely used in industrial applications. The equations of mass and momentum are solved using SIMPLE algorithm to get velocity and pressure in the fluid domain. The assumption of an isotropic turbulence field used in this turbulence model is valid for the current application. The near-wall cell thickness is calculated to satisfy the logarithmic law of the wall boundary. Other fluid properties are taken as constants. Filter media of catalytic converter is modelled as porous media using coefficients. For porous media, it is assumed that, within the volume containing the distributed resistance there exists a local balance everywhere between pressure and resistance forces such that

$$-K_i u_i = \frac{\partial p}{\partial \xi_i}$$

Where ξ_I (i = 1, 2, 3) represents the (mutually orthogonal) orthotropic directions.

K_i is the permeability

u_i is the superficial velocity in direction ξ_iThe permeability K_i is assumed to be a quasi linear function of the superficial velocity. Superficial velocity at any cross section through the porous medium is defined as the volume flow rate divided by the total cross sectional area (i.e. area occupied by both fluid and solid).

VI. Three dimensional CFD study

A three-dimensional model of a catalytic converter is generated in CFD tool CFX for the analysis.

1) Modeling And Meshing

The geometry of the element is made as tetrahedral mesh, with a refined mesh near the wall. The RNG K-E turbulence model is used, with standard wall functions for near-wall treatment. The model has approximately 0.8 million tetrahedron fluid elements, and the same is shown in Figure 4.

2) Governing Equations

Commercial CFD solver CFX is used for this study. It is a finite volume approach based solver which is widely used in the industries. Governing equations solved by the software for this study in tensor Cartesian form are

Continuity:

$$\rho\left[\frac{\partial u_j}{\partial x_j}\right] = 0$$

Momentum:

$$\rho\frac{\partial}{\partial x_j}\left(u_j u_i\right) = -\frac{\partial p}{\partial x_i} + \frac{\partial \tau_{ij}}{\partial x_j} + S_{cor} + S_{cfg}$$

Where ρ is density, u_i and u_j Cartesian velocity, p is static pressure, τ is viscous stress tensor.

3) Boundary Conditions And Solver Modeling

The inlet boundary condition is defined with the static pressure and temperature, and the outlet boundary condition is defined with the outlet static pressure. Exhaust gas is used as working fluid with initial pressure of 1.35 bar and 350^o C.Isothermal heat transfer model is for the entire domain. For outlet, the static pressure is specified as 1.15 bar. No slip boundary condition is applied on all wall surfaces. The discretisation scheme used is second order in space. The convergence criterion is set to a maximum residual equal to $1x10^{-4}$ for all the equations.

VII. Methodology

In the present study, the CFD analysis is carried out in two different stages as Stage I and II.

STAGE I

In Stage I, the length of conical portions of inlet and outlet of the exhaust manifold is varied as 70, 80, and 90 mm and are named as model 1, 2, and 3 respectively and the flow pattern is studied in CFD. The model which offers less back pressure is selected for further analysis.

STAGE II

In Stage II, 1.96 and 1.01 mm grid size wire meshes are filled in first and second compartments respectively. This particular combination is named as model 4. Similarly, the model with 1.61 and 1.01 mm grid size wire mesh is named as model 5. The model 6 contains 1.01 and 0.65 mm grids size wire meshes. After the CFD analysis, the best one from these three models is selected for further analysis.

VIII. Results and discussions

The primary aim of this CFD analysis is to find out the right grid size of the filter material for the exhaust manifold which can offer minimum back pressure with maximum filtration efficiency of PM, using new catalyst for NO_X reduction. At present, the wall flow ceramic substrate are used as filters which are costly and also offer more back pressure resulting more fuel consumption. In the present study, steel wire meshes with coarse, fine and very fine grid sizes are used as filter materials.

a) Back Pressures In Models 1, 2 & 3

It is observed that the back pressure in model 1, 2 and 3 are found to be 0.907, 0.812 and 0.784 bar respectively as shown in Figure 5. The back pressure is found to be reduced with the increase in length of taper for the same inlet and outlet bound conditions. The back pressure variations are shown in graphical form in Figure 6.

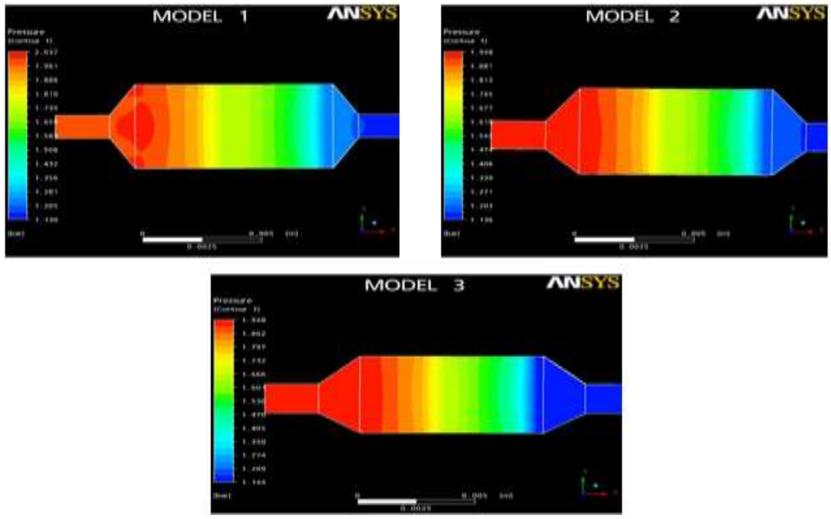


Figure 5 – Pressure Variations

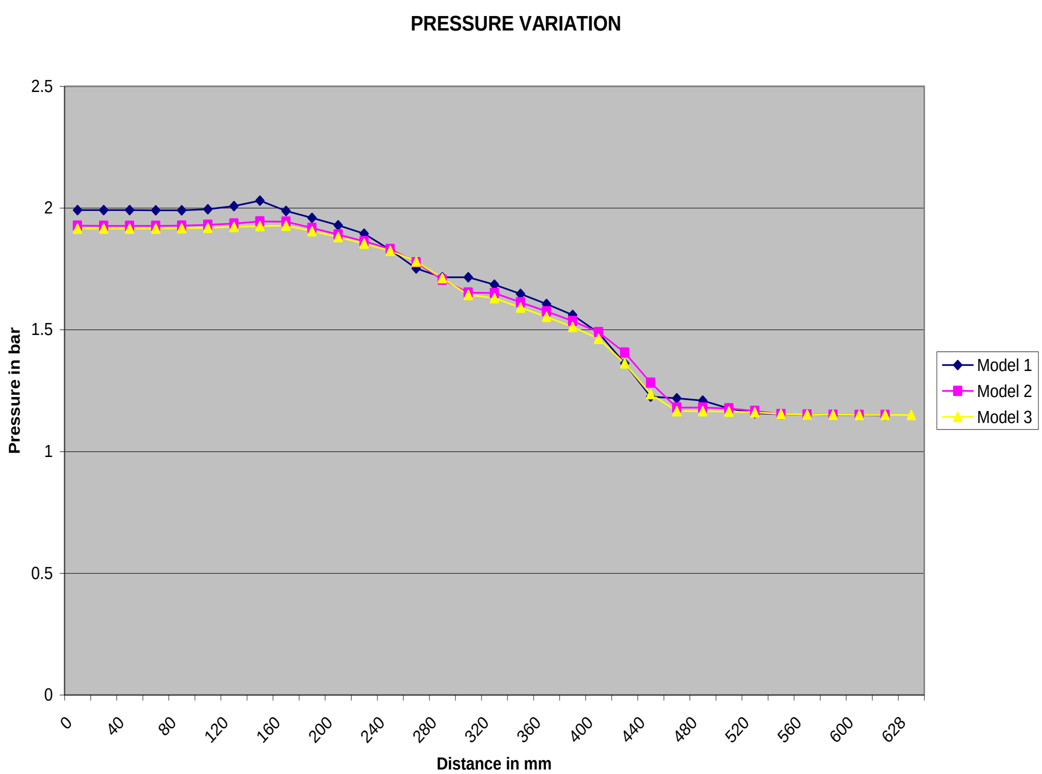


Figure 6 – Pressure Variations (Graphical)

b) Back Pressures In Models 4, 5 & 6

For the same input pressure of 1.142 bar, the outlet pressure is found to be varied as 2.399, 1.975, and 2.148 bars in model 4, 5, and 6 respectively as shown in Figure 7. The model 5 with medium grid size of 1.61 and 1.01 mm combinations offer minimum pressure drop of 0.833 bar.

The Figure 8 clearly indicates that in Model 4 the back pressure is very high in first compartment, and it is low in second compartment, whereas, in Model 6, it is reversed. But in Model 5, the back pressure is found to be less in first compartment. In second compartment, the back pressure is slightly higher but less than that of Model 6, which is due to the wire mesh grid size of 144 cpsi placed in the first and 324 cpsi placed in second compartment. Figure 8

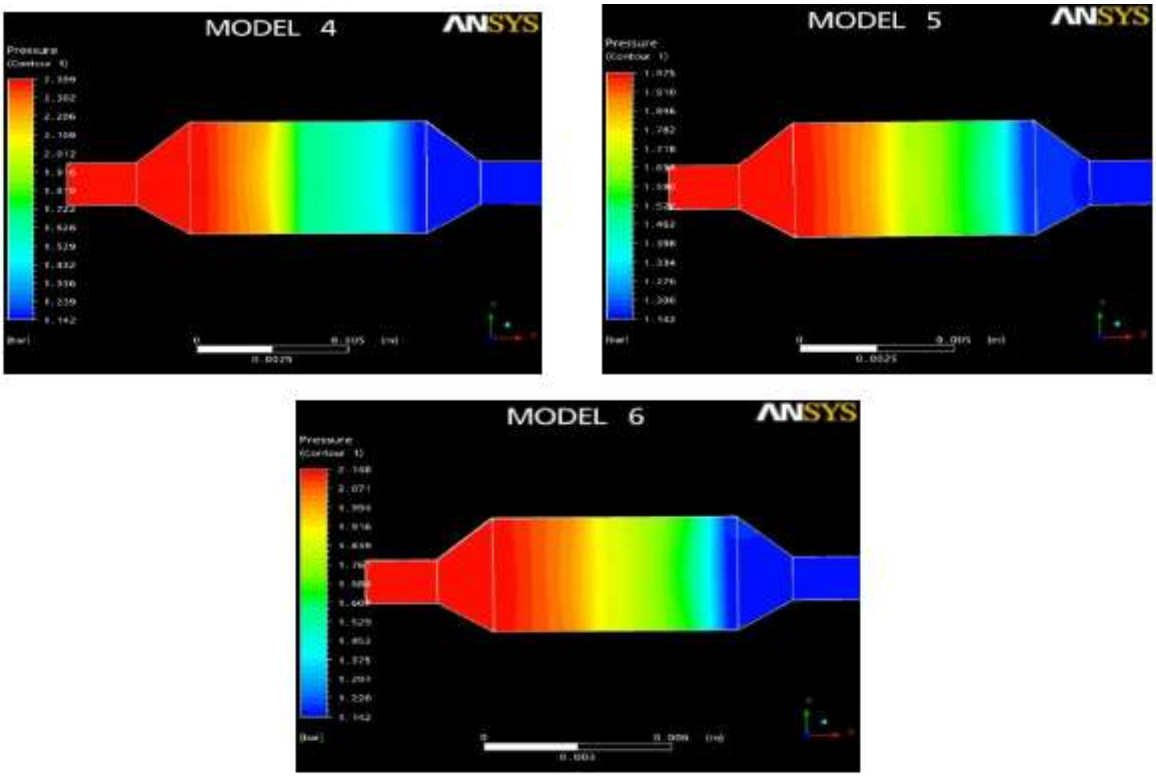


Figure 7 – Pressure Variations

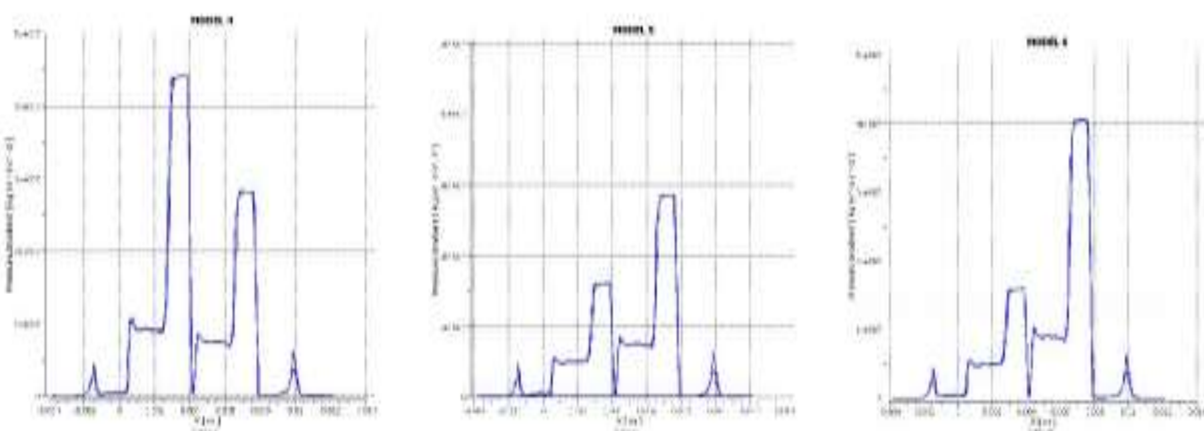


Figure 8 – Pressure Variations (Graphical)

IX. Conclusion

Based upon the work presented in the paper, the following conclusions can be drawn. The special shaped catalytic beads allow the exhaust gas to flow freely without making any obstruction or blocking. Since the partial flow technology is used, it helps to limit the back pressure to the minimum level resulting in better engine performance and fuel saving. The process of regeneration of PM through DOC is continuous. Even if the automatic regeneration is saturated with the collected soot over a period of time, the system will not fail as it happens in wall flow filter, rather all the exhaust gases can flow straight to the other end of the neighboring catalytic bead, similar to flow through substrate. It is estimated that, with the existing volume of catalyst and steel wire meshes, the cleaning may be required for every 10,000 Kilometers of engine run, for efficient fuel consumption. As the catalytic beads are very hard, no wear and tear of catalyst can take place, and hence long life of catalyst is assured. This also ensures no chance of washout catalytic materials coming out along with the exhaust gas adding further pollution to the environment. This after treatment technology for PM reduction is cost effective and robust which needs no interaction with the engine management system and is totally independent.

Abbreviations

CFD – Computerized Fluid Dynamics
NO_X – Oxides of Nitrogen
PM – Particulate Matter
DOC – Diesel Oxidation Catalyst
SCR – Selective Catalytic Reduction
CPSI – Cells Per Square Inch

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The Ecological Reconstruction of the Zaghen Tulcea Wetland and Its Evaluation

Dr. Maria Dimitriu[1], Marian-Albert Scrieciu[2], Ioana-Aurelia Oprea[3]

GJRE-J: Classification(FOR) 090701

***Abstract*-The wetland undergoing the ecological reconstruction is located in the east of Tulcea municipality and is marked on the map with the toponym "Lake Zaghen".The enclosure Tulcea-Malcoci-Nufărul was embanked in the 60s, in order to use the land for agricultural purposes. Due to the high level of groundwater and the intense evaporation (favored by the use of mechanised agriculture), the soil salinity tends to increase and agriculture can be practiced only with persistent irrigation. Additionally in the years 1970-72 works for dewatering of Lake Zaghen have been attempted, which were not completed with a canal which links the South of the lake and the Danube and has at each end two pumping stations, a reversible one at the Danube (for irrigation and dewatering) and a unidirectional one at the lake (for the desiccation of the lake).Farming activities in the area have been abandoned after 1990 due to soil salinity and lack of productivity.Lake Zaghen has been strongly affected by human intervention. Habitat deterioration is confirmed by studies and field observations and caused the population decline and the reduction of species diversity. The most endangered are the fish and bird species.The ecological reconstruction aims at restoring the natural balance through adequate technical and technological means, offering a long-term solution that will comply with the interests of the local population.**

For this project have been contracted bank loans,* European funds have been allocated, *funds to state / local budget, foreign loans contracted guaranteed by State and other external sources

. *Keyword*-wetland ,ecological reconstruction, habitat, renaturation, protected area

I. Introduction

The term "wetland" defines a habitat where the soil is permanently saturated with moisture and extremely fertile, encompassing swamps, bogs, watermeadows and low-lying coastal areas. It provides sheltered warm waters, favoring fish hatcheries, and rich vegetation necessary for grazing and a large variety of wild animals.In many countries, wetlands constitute conservation areas, because besides that they present a rich biodiversity, they also contribute to the purification of wastewater.The Zaghen polder is located in Northern Dobrogea, east from Tulcea municipality, bounded by the eastern limit of the locality of Tulcea, the Tulcea arm of the Danube River on the northern side, and the regional road DJ 222C Tulcea – Malcoci. The region consists of the Tulcea – Malcoci – Nufăru area confined by dams, and is under the administration of the mayor of Tulcea, and the town of Nufaru. In the south there are the hills of Tulcea and Mahmudia.From a hydrological standpoint, the area belongs to the hydrographic basin of the Danube, on the inferior course, down river from where the Danube branches into the two distributaries Chilia and Sfântu Gheorghe, and upriver from where it branches into the Sfântu Gheorghe distributary and the Sulina navigation channel.LakeZaghen is located in Zaghen polder, east from Tulcea municipality, has a surface of 180ha and a volume of 937.000 mc. It is an area of embanked bottomland. Lake Zaghen is undergoing ecological reconstruction on 200 ha of its surface. The Zaghen polder is the outlet point of the streams Lipca and Băbăianu, that flow from the Tulcea hills.The embanked area where Lake Zaghen is located used to be the bottomlands of the Danube River, which was characterized also by floods, brooks, channels and depression areas. It is separated from the Danube by a flood embankment with a 1% insurance with the crest elevation at + 6,30 RMNS. The embankment is earth-filled and has been created in 1962. The crest width of the dam is 4 m, and has grass slopes with a 1 : 2 inclination, protecting an area of 2811 ha from flooding.The land is in the patrimony of the Tulcea Local Council, outside the city limits. Some grass lands have been rented in the past, but the contracts have not been renewed. Some of them are occupied illegally, and enclosed with light wooden fences, for animal husbandry, or through the extension to the lake of the houses in Orizont street, beyond the property limits. The proclaimed purposes of use (farming or grazing land) have been abandoned.The lands that "cannot be used for the purpose they have been set up for, are due to be integrated in the natural system of use by being subjected to the ecological reconstruction procedures determined by A.R.B.D.D." in agreement with the stipulations of the nr 18/1999 Act of the territorial fund and 82/1993 Act regarding the creation of the Danube Biosphere Reservation.The geology of the area was established after performing two drilling operations and analyzing the water and soil samples obtained.From a geological standpoint, the Tulcea municipality is located on the Triassic carbonate platform of the North-Dobrogea orogen. The Triassic carbonate platform lies on top of a pre-Alpine basement composed of crystalline formations (crystalline epimetamorphic schists). Daily on the hill Hora Tepe (the Monumentului hill) protrudes a pre-Alpine basement outcrop. The hills of the Tulcea municipality are composed of limestone, marno-limestone, lower/early Triassic sandstone folded on large areas in the chimeric tectogenesis. These rocks are exploited in the Bididia I and II and Trei Fântâni quarries and are used in civil and

About-[1] Academy of Economic Studies, Bucharest
About[2] Bucharest University
About[3] Academy of Economic Studies, Bucharest

hydrotechnic constructions and in concrete fabrication.In the Tulcea area we find dark grey types of soil and leaching black earth soil and to a lesser extent litosoil and carbonate black earth. These soils have a clay or clay-loam texture and have formed on Quaternary loess units, very sensitive to moisture. They consist of mineral material formed through rock decomposition and alteration, but also of organic matter derived from vegetation decay. Their thickness varies between 2 and 3.5 m. The soils are neutral to slightly alkaline (pH 6,5 – 7).Lake Zaghen is located in the Danube bottomlands, at the south-west end of the Danube Delta, on Quaternary deposits dating from late Holocene (qh_2) probably added on top of early Holocene (qh1) or even Pleistocene deposits.The thickness of the Quaternary deposits from Lake Zaghen area is approximately 30-40 m, of which "the aleuritic complex" from late Holocene (qh_2) ranges between 5-8 m.The alluvia from late Holocene (qh_2) found around Lake Zaghen region are largely aleuritic (lutitic) belonging to an area of "river divagation" and were deposited at different stages of the changes in the river course.If 30-40 years ago Lake Zaghen had a 2 m depth (according to some old fishermen), at present its depth has greatly been reduced due to drainage works and the colmation with terrigenous material drifted from the neighboring higher land.From a seismic standpoint, the city of Tulcea region is situated in the macro-area with 7_1 intensity and a recurrence of 50 years. In the city of Tulcea area the peak ground acceleration for design/engineering is a_g=0,16g, for earthquakes having the mean recurrence interval IMR=100 years and the control period of response spectra Tc=0,7 sec. The area limitrophe to the Zaghen polder consists of current loose deposits intercalated with turf and slurry. On the land's surface, underneath the vegetal soil, its thickness ranging from 0.80m in F2 to 3.80m in F1, there is a crust of clay dust and dusty clay, soft /stiff plastic to hard plastic. Directly underneath this crust formed through atmospheric contact drying are the highly compressible layers of turf - with a thickness of 1.70m in F1 and 2.70 m in F2, followed by clay sand and silty sand.Through drilling the underground water has been intercepted in the form of infiltrations at 1.30-1.50 m depth and in the form of aquifer level (ascensional) at 6.30m, 6.10m depth respectively below the natural ground level. The infiltrations in the excavations will depend on the pluviometric regime of the season when the work will be performed. In a rainy season, water might be found at depths under 1 m below the natural ground level.The chemical analysis of the groundwater samples collected from drilling operations have shown that the waters in the area present a slightly carbonic aggression toconcrete, according to the stipulations/regulations STAS 3349-83. To metals, the samples have proved to be highly aggressive, as outlined in I 14-76. *Special data*The maximum frost line is 80-90cm, according to STAS 6054/77.According to the NP 074/2002 regulations, the area is characterized by the following:Terrain conditions difficult terrains 6 pointsgroundwater normal levels 2 pointsimportance of constructio reduced 2 poin works neighboring regions medium risk - 3points seismic(P100-92) zone C 1 pointTotal: 14 points.In conclusion, it can be said that the geotechnical risk of the location is MODERATE. The geotechnical category is 2.The optimal foundation depth, if not technologically determined, is conditioned by the frost line and will be with 0.10-0.20m above 0.80-0.90m, namely 1m below the natural land level. The foundation ground consists of clay dust or dusty clay, soft /stiff plastic to hard plastic. Below 1m, at very small vertical distances – 0.10cm in F2, there is a thick layer of turf. To avoid differential settlements, light construction works are recommended.

II. Criteria for Identifying a Wetland Hydrological Criterion

The area known under the toponym Lake Zaghen is a wetland ecosystem. In the last 100 years it has lost its lake characteristics, in the 60s-70s being described as a bog, and as a result of the dewatering operations performed in the 70s it has been downgraded to the swamp category due to the high water deficit and the colmation process. The reed has invaded practically the entire central part of the lake and large areas are completely dry during dry seasons, when water remains only in the channels. The normal hydrologic regime that depended on the Danube is no longer functional, due to the embankment of the Tulcea-Nufăru area. At present the water body is maintained through rainwater and riffles from Tulcea Hills. The temporary excess water is systematically moved to the Danube through the Bididia pumping station. In November 2008 measurements have shown that the water level at Zaghen is at 0.00m dMN, with 60cm below the Danube level. The supply of water is also sustained by the low ground level (under 1m dMN per perimeter and – 0.50m dMN at the center), the lakebed being supplied with groundwater as well. The springs that were observed in the 70s in the southern part of the lake, are no longer active at the surface. The current hydrologic regime enables soil moisture in periods of plant growth (spring).

III. The Criterion of Substrate Saturation

In order to develop wetland characteristics the soil must be saturated with water as deep as 30cm, for at least 2 weeks, during plant growth. At Zaghen the soil that was maintained for a long period of time in a state of saturation developed specific physicochemical properties: a specific sign is the lack of oxygen in the moisture saturated soil (anoxia), the oxygen being absorbed by roots, microbes and microorganisms, and its diffusion in soil becoming greatly reduced. The redox potential is high. the chronic lack of oxygen causes the accumulation of decomposed biological material (turfary areas have been observed in the south) and the selective growth of vegetation that support such conditions.

IV. The Biological Criterion

This refers mainly to vegetation, the general rule being that of having over 50% of the dominant taxa of the hydrophytes category. The Zaghen area meets this criterion, including reed, cattail, scouring rush and the rich channel vegetation.

V. THE NATURAL BOUNDARIES OF THE WETLAND

Setting the boundaries of the wetland is based on the aforementioned criteria, which lend it the attributes that clearly distinguish it from the neighboring regions. The polder created through the embankment of the Tulcea-Nufăru area is no longer a wetland, but Lake Zaghen has withstood the pressure of the human impact and can still be identified and recognized as a wetland. In the polder area a similar region can be found near Murighiol. From comparing the maps from the last 150 years it has been observed that the surface of Lake Zaghen has been reduced by about 1/3 on the north-eastern side. Satellite snapshots can still capture the natural historical boundaries of the lake, because the lost surface is still saturated enough with moisture to be identified through color contrast.On the current cadastral map, “lake” Zaghen consists of the parcels 79 and 80, that can be easily recognized due to the channels of the perimeter. The wetland still “lives on” in parcel 81, 89, 90. The riparian area includes the parcels east of the lake, the ones from the subsiding tank and the ones in the south (parcel 77).

VI. THE STATE OF THE HABITATS

Lake Zaghen has not been a lake ever since in the 70s, the dewatering project was launched, with the intention of using the land for farming. The project was never finished, but the impact of the executed works has been disastrous for the wetland habitats. Even after the embankment of the Tulcea-Nufăru area (1962), the water was deep enough, so that the reed was present only along the borders. In the 50s the maximum depth was 2-3m, and in the 70s it became 0.6m. The systematic exploitation of the dewatering pumps from the Bididia station has made the normal retention capacity of the lake to drop at 0m dMN. Since in Tulcea the evaporation rate fairly matches the precipitation rate, in the years following the beginning of the dewatering project, a major water deficit has been recorded with a negative impact on the wetland habitats. The drainage channel of the waters from the hills located in the south of the city has led to an increased transport of solid material into the lake. Theoretical calculations estimate an annual rate of over 300 mc solid material that has reached the lake in this manner. Three siltations/ deposit cones/ debris cones/alluvial cones are clearly visible at the mouth of the channel, corresponding to the discharge locations this channel has had over the years.As a result of the colmation process and the systematic pumping of the temporary excess water, during dry season the reed covered surfaces have become dry, and the water level in the channels, where water is still present, has dropped to 0.5m. The reed growth has extended to the center of the lake, the birds being the most affected by the waterbody loss and shoal reduction (feeding area for waders/shorebirds).

In the 70s the water supply of the lake came also from 12 springs (south of the lake), which held a constant temperature of 15-16 °C almost year-round, which had a positive effect on the population of some bird species, among which the wild duck, the northern lapwing, the wagtail, the grasshopper warbler, the coot, the bearded reedling, species that find shelter in the reed and cattail layers. The cattail clusters at the edge of the waterbody offered good conditions for early nesting birds.

The habitats encountered at Zaghen are:-*natural, partially altered by people:* reed beds, parks of water willows, water meadows.-*anthropic, naturalized:* drainage channels.-*anthropic:* farming lands, groups of individual agricultural settlements and houses (without legal status), infields. The natural regeneration capacity has been outbalanced by the human impact even in those areas where wildlife seems preserved. The major consequence of this was the decrease of the biodiversity and the reduction of the species populations, except for the marsh vegetation that invaded the lake. Systematic studies have been done only for bird species that used the region as nesting, feeding and rest area. They have been strongly affected by human interference in the area, but have not left the region entirely, although the habitat destruction has accelerated in the last 40 years. On the other hand, the lack of maintenance works for the central area of the lake has led to the reed invasion in that part. Specialists suggest the reed to be reaped or burnt regularly to avoid its degradation, to keep the nutrient balance and avoid the colmation process. The region is located on the migration route of birds and belongs to the avifauna special conservation area of national interest. Signs of pollution are visible (alluvia transported by streams, animal and household waste), but the regeneration capacity limit has not yet been reached, and this aspect will be kept under control after the ecological reconstruction procedures. As part of the main objective for the habitat restoration is the necessity of reconstructing the connection to the Danube, which will ensure water transport and biological material directly from the river. The secondary objectives are the following:the decolmation of the channels and other major areas to alter the waterbody: heed ratio, in favor of the former.Reducing human presence and interference in the area (including through the evacuation from illegally occupied spaces) by creating protection corridors (the width of which will inevitably be less than that stipulated in the regulations due to the close vicinity to the urban area).Reconsidering the human presence in the area and redirecting it towards leisure, educational, research, maintenance and wildlife conservation activities.

VII. FAUNA

Local invertebrate species are the protozoa, ringed worms, leeches (*Hirudo medicinalis*), snails (gastropods), shells, spiders, myriapods, diurnal and nocturnal butterflies and numerous insects: gadflies, mosquitoes, wasps, bumblebees, ants, woodboring beetles, great silver beetles, May beetles, dragonflies, bush-crickets, crickets, mole crickets, grasshoppers.The vertebrates here are represented by numerous species of fish, batrachians, reptiles, birds, and mammals. Up until two years ago fishing could be practiced Lake Zaghen’s channels, the fish species including the European perch (*Perca fluviatilis*), the common bleak

(*Alburnus alburnus*), the carp bream (*Abramis brama*), the sunfish, the northern pike (*Esox lucius*), the common carp (*Cyprinus carpio*), the European weather loach (*Misgurnus fossilis*), the crucian carp (*Carassius carassius*).Batrachians include the marsh frog (*Rana ridibunda*), the edible frog (*Rana esculenta*), the European tree frog (*Hyla arborea*).The local reptiles are the dice snake (*Natrix tessellata*), the European green lizard (*Lacerta viridis*), the sand lizard, the European pond turtle. The mammals in the area are the European mole (*Talpa europaea*), the European hedgehog (*Erinaceus europaeus), the European brown hare (*Lepus europaeus*), the black rat (*Tattus rattus*), the house mouse (*Mus musculus),* the common vole (*Microtus arvalis*), European souslik (*Citllus citellus*), the lesser mole rat (*Spalax leucodon*). In the area, numerous previously domesticated animals also live in the wild.

VIII. The Avifauna

After reviewing the research studies performed in the area before 1980, we have reached to an impressive number: 89 species had been identified, representing more than a quarter of the total number of species observed in the Danube Delta. The avifauna potential of Lake Zaghen is truly impressive, but so is its decline. Today birds are still present in the region, especially nesting bird species. Shorebirds, however, have lost their feeding grounds while the birds of passage have lost the resting grounds.The conservation regime of the Danube Delta avifauna ROSPA0031 that includes Lake Zaghen represents another strong argument in favor of the ecological reconstruction.

IX. Flora

Among the woody plants present are the white willow (*Salix alba*) and the black poplar (*Populus nigra*).On the surface of the former settling tank a population of saltcedar (*Tamarix ramosissima*), a plant well-known for its healing properties, has grown rapidly.Reed species like the common reed (*Phragmites communis*) occupy the central basin and stretch even north and east, beyond the channels from the lake perimeter.Besides reed we find common bulrush (*Typha latifolia*), true bulrush (*Scirpus lacustris*), arrowhead (*Sagittaria sagittifolia*), flowering rush or grass rush (*Butomus umbellatus*), cowbane (*Cicuta virosa*), fineleaf waterdropwort (*Oenanthe aquatica*), purple loosestrife (*Lythrum salicaria*), water mint (*Mentha aquatica*), marsh euphorbia (*Euphorbia palustris*) stinging nettle (*Urtica dioica*), three-parted beggar-ticks (*Bidens tripartitus*), marsh sow-thistle (*Sonchus paluster*), the marsh thistle (*Cirsium paluster*), the common water-plantain (*Alisma plantago-aquatica*), soft rush (*Juncus effusus*), the water soldier (*Stratiotes aloides*).Inside the channels, where the water is deeper and contains more oxygen, the flora is richer and specific to this type of habitat: tape grass (*Vallisneria spiralis*), the curly-leef pondweed (*Potamogeton crispus*), frogbit (*Hydrocharis morsus-ranae*), spiked water-milfoil (*Myriophyllum spicatum*), soft hornwort (*Cerathophyllum submersum*), common duckweed (*Lemna minor*), and the Spirogyra algae.The sandy land areas are covered with grass and other plant species characteristic of the steppe.

X. The Functions of the Wetland

a) *Hydrological functions*:

the Zaghen region collects the high floods/waters and alluvia from Tulcea valley, stores water that replenishes the groundwater levels, maintains a beneficial wet environment during dry seasons, regulates temperature in seasons of extreme temperatures, serves as protection for farming lands against floods.

b) *Biogeochemical function*:

retains and recycles nutrients (nitrogen, phosphorus), mineralizes organic pollutants (denitrification), enables a natural and efficient carbon cycle, maintains the surface layer of the soil in an anoxia state.

c) *Ecological functions*:

habitat for plants and animals (reproduction area for fish, nesting, feeding and resting grounds for birds); an essential habitat for migratory birds, reservoir of genetic resources and biodiversity, the aquatic macrophytes and microbes are necessary for the decay of organic waste (including vegetation) and nutrient recycling, the underwater macrophytes regulate the microbial metabolism and biogeochemical cycles.

d) Socio-economical functions**:**

ecotourism, education, leisure activities (unexplored until now), the creation of new work opportunities by making use of traditional occupations (fishing, reaping the reed for construction work, collecting plants), habitat for a population that finds itself at a disadvantage because of the technological progress, but which is also very well adapted to the delta environment, the natural purification area for household waste.
These functions of the wetland are only partially and in an uncontrolled manner explored today, but this process can become more efficient through the ecological reconstruction that will add value to the area.

XI. The Value of the Wetland

Although many years ago, wetlands were regarded as areas of discomfort (mosquitoes, moisture, unexploitable land) and have systematically went through land reclamation, nowadays the role of wetland ecosystems in preserving the water quality and biodiversity is better understood. Gaining the awareness that the right to a clean environment belongs to the public rights domain has been a step forwards, favoring the conservation of these areas. After being under anthropic pressure so severe that it could have led to its extinction, presumably followed by a period of falling into complete oblivion, the time has come for the Zaghen area to be discovered and explored for the benefit of the community. For the Tulcea municipality the area can be developed for its sanitary, leisure and esthetic values. The close location to the Danube also makes it suitable for tourism and scientific research.

XII. Project's Outline

Within the Tulcea-Malcoci-Nufărul embanked region, an area of about 200ha from the Lake Zaghen perimeter undergoes the ecological reconstruction. This aims at restoring the natural balance of the environment through adequate technical and technological means, offering a long-term solution that would also answer the local community's needs. This implies the following:enabling the water input from the Danube into lake Zaghenthe restoration of a variety of natural habitats specific to wetlands facilitating the development of aquatic and terrestrial fauna and flora, the development of natural resources: fish, reed, cattail, wood, and establishing the adequate hydrologic regime. The creation of special recreation areas for the local people of the Tulcea municipality as well as for its visitors.

Setting up an inside tourist route consisting of a navigable channel for small boats; setting up along the banks characteristic tourist stops, fishery, wind mill, traditional fisherman houses, birdwatching facilities, workshops for exploring the natural resources (carpentry, spaces for the creation of trellis and other wood or cattail interwining work and artisanship), tourist center, etc.Providing facilities for visitors to take part in local events and activities: sport fishing, non-motorized boating, exploration and understanding of the fauna and flora specific to the delta, landscape exploration with recording devices (cameras), cultural events, culinary events with local food, etc.Ensuring the necessary utilities and ways of access. Maintaining the current function as a buffer zone against the high floods of Tulcea valley, by preserving the existing polder, which must not affect the facilities area. The drainage system of Lake Zaghen and SP Bididia will be restored and activated, as well as the purification basin for torrential pluvial waters that come through the Valea Tulcei channel and the two reversible pumping stations. Additionally the adjacent areas of Lake Zaghen will undergo ecological measures like the removal of all inadequate dwellings and extensions.Based on the studies and observations made, the wetland area that had no economic relevance will be transformed into a leisure, education and research area, that will be added to the list of tourist attractions. The area will serve as a means of ecological education and raising awareness for children and students, and as a practical example of the development of a conservation area. The ecological objectives are the renaturation of the wetland and the restoration of biodiversity. From a technical standpoint the solution lies in the restauration of the hydrologic regime specific to floodplains. Coming back to the normal hydroperiods will result in the recovery of the wetland's functions:habitat for plants and animals specific to wetlandshabitat and reproduction area for fishhabitat and reproduction area for water and shore birdssource of biodiversity and genetic resourcesbio-corridor and genetic exchange biological productionresuming the normal biogeochemical cycle of the elementssettlement of sediments and toxic substances (purification function)The habitat restoration is permitted in order to resume the long-term development process for the local economic, touristic and recreation resources of the wetland.

Scenario zero, of non-intervention would condemn the lake to advanced colmation in the next 30-40 years. The area presenting no interest anymore would be degraded by uncontrolled human interference. Because its natural purification capacity would be irreversibly damaged, the area would become another "rubbish dump" of the city. This process has actually already begun:Without intervention the colmation process will continue until the area's function to attenuate the floods collected through Valea Tulcei will be entirely compromised. Because the colmation area does not match the location of the floodplains (adjacent to inhabited areas), the output channels of the water will close, the water will longer longer in the same location, and the precession of pollutants will be reduced, the floodplains becoming "hotbedsfor infections", in close vicinity to the inhabited area.

Minimal intervention scenario would imply only:taking sanitary measures to clean the area along with the removal of farms dealing with animal husbandryCorrecting the channel in the Tulcea valley and creating a new output way towards the pumping station.This scenario ignores lake Zaghen's potential and the possibility for it to become a restored wetland and be explored as a natural environment.If there is no clearly outlined function of the area, the sanitation costs will not bring in return direct and explicit benefits.

Maximal intervention scenario, the renaturation of the entire Tulcea – Nufăru area as a floodplain, is not feasible, because the embankment plays also a role in protecting the Tulcea municipality from flooding.

Feasible scenarios are compromises that must reach a balance between the need to restore the natural habitats and the interests of the urban community to develop this area. Therefore, the project has a different approach than the other renaturation projects from the Danube Delta.The close proximity to the city is a major advantage when it comes to develop the region as a tourist, recreational, educational and research attraction. Secondary scenarios and objectives can be described as follows: the rehabilitation of the pumping stations and dredging the channel between Lake Zaghen and the Danube, "ensuring the operation of reversible pumps at both stations" the downside of this is that pumping destroys the biological material, which comes from the Danube and is essential.Protecting the wetland with an embankment, in order to trace clear boundaries for the perimeter, to protect the banks and stabilize the specific hydrologic regime.Dredging a large area of Lake Zaghen to restore different habitat types: lake, bog, island, shoal.

The separation of the waters flowing from Valea Tulcei into Lake Zaghen and the creation of a separate discharge way into the DanubeModeling the wetland with islands and channels, diversifying the recovered dry land through plantingConnecting Lake Zaghen to the other wet areas from the embanked region, in an integrated

systemConducting specialized studies for the identification of species and habitats that are in need of protection and relevant to the community
Setting up recreation facilitiesSetting up research and conservation facilities

XIII. The Current Economic Situation

the Zaghen area has a direct cost that can be estimated from the exploitation costs of the dewatering system (water pumping, building, equipment, hydrotechnic works amortization) the Zaghen area has also a hidden cost consisting of sanitation costs, irretrievable but necessary for the community's well-beingthe Zaghen area has indirect costs which represent losses arisen from the fact that the land and the natural resources have not been exploitedthe Zaghen area does not produce revenue (terrains have not been leased anymore because this leads to indirect losses through pollution, the beneficiaries of the hydrotechnic works do not pay taxes, those responsible for pollution do not pay taxes for the water that has been naturally purified by the wetland)the indirect benefits of the wetland location (influences on the urban microclimate, depolluting the pluvial waters containing urban pollutants in a natural manner, minor resource for work opportunities for the low-income population in the area) are hard to evaluate; they create a socio-economic value, without any influence on the financial prospects.The costs are greater than the financial benefits. It is advisable that for economic calculations to take into account the average economic value of the land is null (calculation value = 0), because the value of current ecological services is compensated by the operating costs. Options for investment may be limited to strict the renaturation (variant A) or an investment which can be expanded to develop the area of social functions (variant B).Variant A can be achieved by limited hydraulic works, with an investment of 7 200 000 euro , and by renaturation the value of ecological services increases (estimate 200 ha.x 3000 Euro / ha / year = 600 000 euros/ ha / year. Under the financial terms this the economic value is doomed to failure because society is not yet prepared to recognize and pay the price of services. The solution is the combination of ecological services with other services that the company is willing to pay.This intervention has effect on the economic value of the area. Its value will be 8.35 million euro (NPV), but enhances the financial effects only in particular conditions.Because of investment, financial NPV is negative, -2.35 million euro. The investment is economically justified, but only in conditions of unsustainable financial i.e.only in conditions of subsidies.In variant B, developed in this study, the development of area is complex, with a lot of direct and indirect effects.The beneficiary has the opportunity to obtain financial income from operating (sale or exploitation of land, area concession , access fees, taxes).If the area enters into a development process to exploit its natural potential and specificity we can set achievable objectives:Minimum value of leaseable land without infrastructure 10 euro / sqm;Average leaseable land with infrastructure minimum 30 euro/ sqm;Value of leaseable land with complete infrastructure 100 euro / sqm.This potential developes and produces financial revenue.The 296 ha area, studied by the project can update its value as follows:- 60% as area protected by anthropogenic effects, 2 euro/ sqm.- 10% as area with permission for operating with minimal anthropogenic effects (Scientific Tourism, Education, Research), 10 euro / sqm- The proportion of 12% as utility area (research, education, urban park), 20 euro / sqm- 15% as dwelling area,30 euro/ sqm- The rate of 3% for commercial development, 100 euro/ sqm.Exploitable value estimated in this scenario is calculated as folows:296 hectares x Σ (proportion* value of unit) = 15 764 000 euroOption B has three versions, described in the text as variants I, II and III. The values of investments proposed by the project are:
Option I or II: 13 000 000 euro
Option III: 18 808 000 euro
Calculation assumptions for these variables are:- The projected period of 15 years;- Residual value of buildings and utility at the end of period is 60% from investment, in conditions to recovery the specific investment cost and obtain a 10% profit;
- Residual value of hydraulic works , in the end, is 50% of investment;- The value of ecological services of wetland (180 hectares) is reconsidering to the internationally recommended value (10 000 euro/ year / ha for lakes and 20 000 euro / year / ha of ponds, swamps, delta);- Financial revenues are calculated from the amount of concessions (5% / year in land value and 10% / year in the amount of interest decorations);- Economic revenues are calculated as the sum between the value of ecological services, direct financial income and indirect effect on social economic development (calculated as 25% flat rate of direct financial revenue);- Operating costs are mainly related to the exploitation of hydro, other activities are covered by lease scenario.

Table 1 Comparison of variants (in constant prices):

	Variant I	Variant II	Variant III
Economic revenues	56156	83156	59941
Financial revenues	23325	23325	26353
Operating costs	9000	3000	6000
Loan cost	6500	6500	9404
Residual value of investment	7261	7261	10371
Land value	15764	15764	15764
Economic NPV 1-3-4+5+6-9	**50681**	**83681**	**51864**
Financial NPV 2-3-4+5+6-9	**17850**	**23850**	**18276**
Investment value	13000	13000	18808
- of which tourist amenities	7668	7668	9687

Source: own calculations

XIV. Conclusions

a) *Economic analysis***:**

The benchmarks for this type of project, qualified as investment environment are:- Discount rate 5% (in real terms since the projections in this draft have been in constant prices)
- Financial IRR -0.1% (may increase up to max. 5%)- Economic IRR 15.8%- reference period 15 yearsThe economic significance of the results of cost-benefit analysis is that the investment is justified as economic, but in financial terms it requires financing, including non-refundable grant form. This situation is relatively normal, because the largest share in investment is environmental intervention works (ecological reconstruction) that produce value in the first and only appearance in the socio-economic background financial value (net revenue, profit).

b) Sensitivity analysis

In terms of financial efficiency, the project is sensitive to market behavior. Market failure is taken into account, at least in the short term, considering the possible lasting effects of the current financial crisis.
The project remains desirable even in those circumstances, considering this is a restoration project of an area affected by anthropogenic intervention. Restoration of this area is a legal obligation.

c) Risk analysis.

Similar projects have been a success in Delta, nature showing a remarkable capacity for regeneration, if the human been removes the obstacles. In terms of risk, variant A and B are similar. A difference in this case are between versions 1 and , version for hydro works. Both are technically feasible, but variant 1 modify the type of ecosystem, while version 2 restoring the existing support.

d) Sources of investment financing

Funding source of investment will be in accordance with the law and consist in equity, bank loans, funds to state / local budget, foreign loans contracted or guaranteed by State grants and other sources of external funds legally constituted.

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A Literature Review on Inventory Lot Sizing Problems

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Hafiz Ullah[1], Sultana Parveen[2]

***Abstract*- The present paper, discuss one of the most challenging subjects for the management namely production planning. It appears to be a hierarchical process ranging from long to medium to short term decisions. Production planning models are divided into two categories which are capacitated and uncapacitated. This paper reviews the literature on single-level single-resource lotsizing models and provides a survey of the literature dealing with inventory lot sizing problems and other concepts considered in this area. The purpose of this dissertation is to review the developments and to identify the status of existing literature in this area.**

Keywords- inventory, capacitated lotsizing, production planning, uncapacitated lotsizing.

I. Introduction

There are several ways of classifying the inventory models. Some of the attributes useful in distinguishing between various inventory models are given in this section. (Giil 1992, see Figure-1). Obtaining cost-efficient production plans balancing the trade-off between setup and inventory holding costs - lot-sizing - has been a fundamental goal of practitioners since the beginning of industrialization. The first published work in this area by Harris titled "How many parts to make at once?" dates back as far as to 1913(Harris, 1913) which is known as EOQ model. Several extensions to the basic EOQ model are discussed in Hax and Candea (1984). They cover models which allow for backlogging, lost sales and quantity discounts. Tersine and Price (1981) discuss the temporary price discounts case. Solutions to finite horizon cases where costs are time-dependent are presented by Lev and Weiss (1990) and Gascon (1995). Wilson (1934) contributed a statistical approach to find order points, thereby popularizing the EOQ formula in practice. This method determines a single point or quantity and assumes a constant demand. But, when the demand rate varies from period to period the results from the EOQ formula may be deceptive.The technique which performs optimally in a situation with variable demand was first suggested by Wagner and Whitin (1958) in their well known paper. They used dynamic programming to solve the problem, perhaps forced by the recursive nature of the computations. Their work was based on some important theorems established in their paper (Grewal, 1999). However, the Wagner-Whitin algorithm is quite limited when the finite rolling horizon is large, because a dynamic programming based algorithm requires a tremendous amount of CPU computing time. To fix the problem, Silver and Meal (Silver, Pyke & Peterson, 1998) developed a heuristic for the time-phased inventory model in 1969. There are several well-known dynamic lot size heuristics existing.

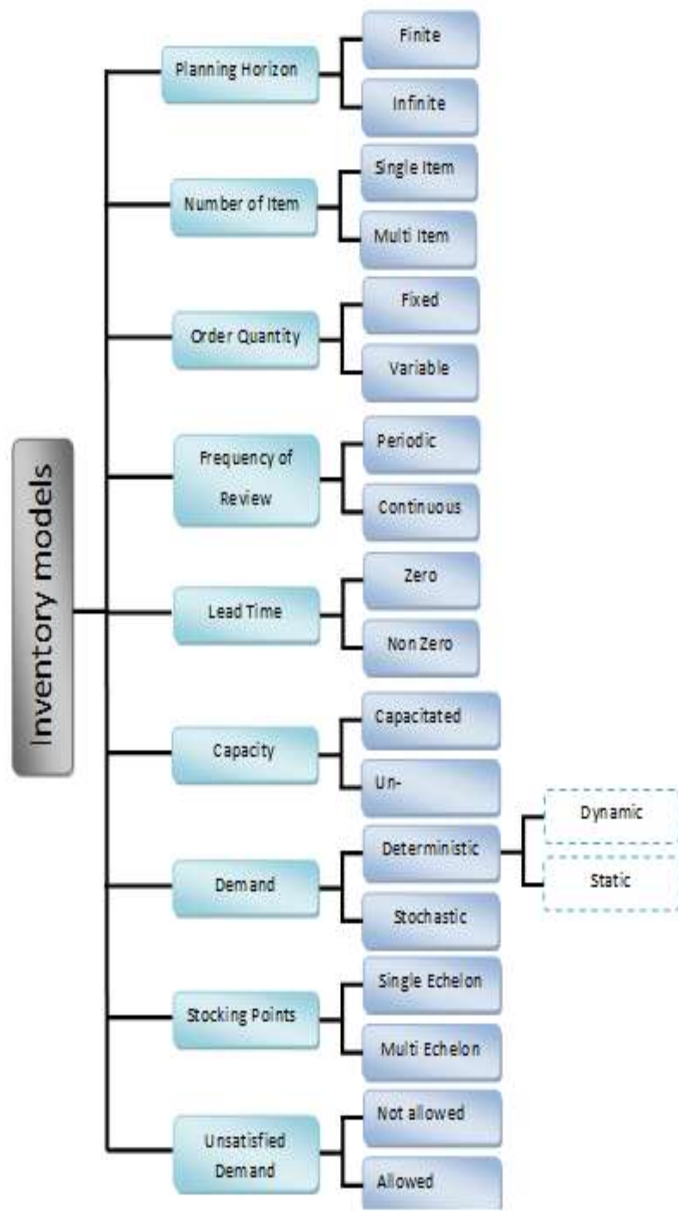

Fig.1. Classification of inventory model

About[1]-Department of Industrial & Production Engineering, BUET, Dhaka-1000email: hafiz.ullah_sharif@yahoo.com.
telephone: +8801671538788
About[2]-Department of Industrial & Production Engineering, BUET, Dhaka-1000.email: sparveen@ipe.buet.ac.bd
telephone: +8801817617860

All of these heuristics use. forward programming to develop the procedures The Silver-Meal (SM) heuristic guarantees only a local minimum for current replenishment. The least unit cost (LUC) heuristic is similar to the Silver-Meal heuristic except that instead of averaging costs over periods, it averages costs over units. The Part-Period algorithm (PPA) is a heuristic lot size approach that determines order sizes by balancing ordering costs and holding costs.

II. Uncapacited Dynamic Lot Sizing Model

1) Single Item

Lot sizing problems have been an area of active research starting from the seminal study of Wagner & Whitin (1958) (Mohammadi et al. 2009) developed an O (T^2) dynamic programming algorithm for an uncapacitated model where the production and holding cost are linear, and the unit production costs, unit holding costs and the setup costs are the same for all periods. The algorithm can give optimal solutions in reasonable run times when the number of periods is not large enough. Veinott (1963) showed that even if production and inventory costs are general concave functions, the problem is still solvable by an O (T^2) dynamic programming algorithm. Zangwill (1969), Gupta and Brennan (1992) (among others) generalized the WW-procedure to solve the problem when backlogging is allowed. Martel and Gascon (1998) proposed an algorithm to solve the problem when inventory holding cost is a percentage of the product cost. Whitin (1958) approach has drawbacks from the practitioner’s standpoint. Therefore, the natural question to ask is, “Is there a simpler approach that will capture most of the potential savings in the total replenishment and carrying cost?” A number of researchers (Diegel 1966, DeMatteis 1968, Mendoja 1968(The Part Period Balancing heuristic), Gorham 1968(The Least Unit Cost Heuristic), Silver & Meal 1973, Donaldson 1977, Groff 1979, Karni 1981, Wemmerlöv 1981, Brosseeau 1982, Freeland &Colley 1982, Boe & Yilmaz 1983, Mitra at el. 1983, Bookbinder & Tan 1984, Baker 1989, Coleman & McKnew 1990, Triantaphyllou 1992, Teng 1994, Hariga 1995, Goyal Hariga & Alyan 1996, and Zhou 1996) have suggest various decision rules, some of which have been widely used in practice(Wee 1995,Ting & Chung 1994, Bose, Goswami & Chaudhuri 1995, Hariga & Ben-Daya 1996). Federgmen and Tzur (1994) proposed a forward algorithm to solve general dynamic lot sizing problems. They assumed that the planning horizon could be divided into n periods. The proposed algorithm is a forward algorithm with sequential determination of the last setup j period and the minimum cost in the period. The procedure is similar to the classical shortest path. It showed that the proposed algorithm is about 3 times faster than the classical Wagner-Whhin's algorithm when the period is set as n. Federgmen and Tzur showed that an optimal zero-inventory ordering policy exists. The results confirm Chung's research. However, if the planning horizon can be divided into n period, instinctively, zero inventories can be achieved easily. Aggarwal & Park (1993) show that for concave cost economic lot size problems, the dynamic programming formulation of the problem gives rise to a special kind of array, called a Monge array. Then show how the structure of Monge arrays can be exploited to obtain significantly faster algorithms for these economic lot size problems. Loparic, Pochet &Wolsey (1999) examine a variant of the uncapacitated lot-sizing model of Wagner-Whitin involving sales instead of fixed demands, and lower bounds on stocks. Two extended formulations are presented, as well as a dynamic programming algorithm and a complete description of the convex hull of solutions. Richter & Sombrutzki (2000) studied the reverse Wagner-Whitin’s dynamic production planning and inventory control model and some of its extensions. In such reverse (product recovery) models, used products arrive to be stored and to be remanufactured at minimum cost. For the reverse model with given demand the zero-inventory-property of optimal solutions is proved, the corresponding Wagner-Whitin algorithm is presented and the stability of optimal solutions is discussed for the case of a large quantity of low cost used products. Furthermore, the model of the alternate application of remanufacturing and manufacturing processes is analyzed. Taşgetiren & Liang (2003) find order quantities which will minimize the total ordering and holding costs of ordering decisions. A binary particle swarm optimization algorithm and a traditional genetic algorithm are coded and used to solve the test problems in order to compare them with those of optimal solutions by the Wagner and Whitin algorithm. Aksen, Altınkemer & Chand (2003) introduce a profit maximization version of the well-known Wagner–Whitin model for the deterministic uncapacitated single-item lot-sizing problem with lost sales. Costs and selling prices are assumed to be time-variant, differentiating their model from previous models with lost sales. A forward recursive dynamic programming algorithm is developed to solve the problem optimally in O (T^2) time, where T denotes the number of periods in the problem horizon. The proposed algorithm can solve problems of sizes up to 400 periods in less than a second on a 500 MHz Pentium® III processor.DeToledo & Shiguemoto (2005) propose an efficient implementation of a forward dynamic programming algorithm for problems with one single production center. Next, the authors studied the problem with a production environment composed of several production centers. For this problem two algorithms are implemented, the first one is an extension of the dynamic programming algorithm for one production center and the second one is an efficient implementation of the first algorithm. Radzi, Haron & Johari (2006) introduce neural network approach to solve the single level lot-sizing problem. Three models are developed based on three well known heuristic techniques, which are Periodic Order Quantity (POQ), Lot-For-Lot (LFL) and Silver-Meal(SM). The planning period involves in the model is period where demand in the periods are varies but deterministic. The model was developed using MatLab software. Back-propagation learning algorithm and feed-forward multilayered architecture is chosen in this project. algorithms for some special cases to solve an explicit description of the convex hull of solutions to the uncapacitated lot-sizing problem with backlogging, in its natural space of production, setup, inventory and backlogging variables. The authors identify valid inequalities that subsume all previously known valid inequalities for this problem. Conventional approaches for solving the production lot size problems are by using the differential calculus on the long-run average production-inventory cost function with the need to prove optimality first. Chiu (2008) presents a simple algebraic method to replace the use of calculus for determining the optimal lot size. Their study refers to the approach used by Grubbström & Erdem(1999) and extends it to the model examined by Chiu &Chiu (2006). This paper demonstrates that the lot size solution and the optimal production-inventory cost of an imperfect EMQ model can be derived without derivatives. Salvietti & Smith (2008) extend the ELSP to include price optimization with the objective to maximize profits. A solution approach based on column generation is provided and shown to produce very close to optimal results with short solution times on a set of test problems. Gutiérrez et al. (2008) address the dynamic lot size problem assuming time-varying storage capacities. They divided planning horizon into T periods and stock outs are not allowed. For each period, Gutiérrez et al. consider a setup cost, a holding unit cost and a production/ordering unit cost, which can vary through the planning horizon. Although this model can be solved using O (T^3) algorithms, they Show that under this cost structure an optimal solution can be obtained in O (T log T) time. They also show that when production/ordering unit costs are assumed to be constant (i.e., the Wagner–Whitin case), there exists an optimal plan satisfying the Zero Inventory Ordering (ZIO) property.Enyigit (2009) study proposes new heuristics that consider demand and purchasing price uncertainties simultaneously when all the costs are constant over time, which was the classical dynamic lot sizing problem for which the optimal solution can be obtained by the Wagner-Whitin algorithm. Purchasing decisions are made on a rolling horizon basis rather than fixed planning horizon. Well known Least Unit Cost and Silver-Meal algorithms are modified for both time varying purchasing price and rolling horizon. The proposed heuristic is basically based on a cost benefit evaluation at decision points. Gaafar, Nassef & Aly (2009) was applied simulated annealing (SA) is to find the solution of the deterministic dynamic lot-sizing problem with batch ordering and backorders. Batch ordering requires orders that are integer multiples of a fixed quantity that is larger than one. The performance of the developed SA heuristics compared to that of a genetic algorithm (GA) and a modified silver-meal (MSM) heuristic.Okhrin & Richter (2009) minimize the total inventory cost only with respect to the lot size restrictions, and not the sum of setup cost and inventory cost, as in mainstream models. They formulate the single item dynamic lot sizing problem with minimum lot size restriction and elaborate a dynamic programming algorithm for its solution. The preliminary computational results show that the algorithm is highly efficient and determines optimal solutions in negligible time.

Chandrasekaran et al. (2009) were investigated economic lot scheduling problem using time-varying lot sizes approach. The process of finding the best production sequence consists of two-phase implementation of Meta heuristics. In the first phase, they propose a GA that makes use of the proposed new lower bound to arrive at the good set of production frequencies of products for ELSP without/with backorders. In the second phase, the best sequence of part production is achieved by using the above set of frequencies and employing a GA and an ant-colony algorithm. Computational experiments reveal the effectiveness of the two-phase approach over the conventional single-phase approach.Vargas (2009) presents an algorithm for determining the optimal solution over the entire planning horizon for the dynamic lot-size model where demand is stochastic and non-stationary. Sankar (2010) investigates an EPL (Economic Production Lotsize) model in an imperfect production system in which the production facility may shift from an in-control state to an out-of-control state at any random time. The basic assumption of the classical EPL model is that 100% of produced items are perfect quality. This assumption may not be valid for most of the production environments. More specifically, they extend the article of Khouja & Mehrez (1994). The proposed model is formulated assuming that a certain percent of total product is defective (imperfect), in out-of-control state.

2) *Multi Item*

The main concern of this class of problems is to determine production or procurement lots for multiple products over a finite (in the case of dynamic demand) or infinite (in the case of static demand) planning horizon so as to minimize the total cost, while known demand is satisfied. The total relevant cost generally consists of setup costs, inventory holding costs, and production or procurement costs. When no capacity restrictions are imposed, the multi-item problem is relevant when joint setup/order costs exist. In the constant demand case, this is known as the Economic Order Quantity with Joint Replenishment (EOQJR) problem. This problem has the same assumptions as those of the classical Economic Order Quantity (EOQ), except for the major setup/order cost. The objective is to determine the joint frequency of production/order cycles and the frequency of producing/procuring individual items so as to minimize the total cost per unit of time. The EOQJR problem occurs, for example, when several items are purchased from the same supplier. In this case, the fixed order cost can be shared by replenishing two or more items jointly. EOQJR may also be attractive if a group of items uses the same machine. Van Eijs et al. (1992) distinguished between two types of strategies used by the algorithms proposed to solve this problem: the “indirect grouping strategy” and the “direct grouping strategy”. Both strategies assume a constant replenishment cycle (the time between two subsequent replenishments of an individual item). The items that have the same replenishment frequency form a “group” (set of items that are jointly replenished). The algorithms that use the “indirect grouping strategy” assume a constant family replenishment cycle (basic cycle). The replenishment cycle of each item is an integer multiple of this basic cycle time. The problem is then to determine the basic cycle time and the replenishment frequencies of all items simultaneously. A group is (indirectly) formed by those items that have the same replenishment frequency. An optimal enumeration procedure to solve this problem is found in Goyal (1974.a) and Van Eijs (1993). Unfortunately, the running time of those procedures grows exponentially with the number of items. Recently, Wildeman et al. (1997) proposed an efficient optimal solution method based on global optimization theory (Lipschitz optimization). The running time of this procedure grows linearly in the number of items. On the other hand, heuristic methods for the problem are discussed by Brown (1967), Shu (1971), Goyal (1973, 1974.b), Silver (1976), Kaspi and Rosenblatt (1983, 1985, 1991), Goyal and Deshmukh (1993) and Hariga (1994). The replenishment cycles of individual items in “the direct grouping strategy” are not imposed to be an integer multiple of a basic cycle. The problem is to form (directly) a predetermined number of groups that minimizes the total cost. Heuristics that use this strategy can be found in Page and Paul (1976), Chakravarty (1981) and Bastian (1986).

Based on a simulation study, Van Eijs et al. (1992) showed that the “indirect grouping strategy” slightly outperforms the “direct grouping strategy” and that it requires less computer time. Zangwill (1966) showed that there exists an optimal policy in which the schedule of each item is of Wagner and Whitin type. All the existing approaches for the LPJS in the literature make use of this property to generate solutions for the problem. The algorithms suggested by Zangwill (1966), Kao (1979), Veinott (1969) and Silver (1979) are based on different dynamic programming formulations of the problem. However, all these procedures fail to solve problems with practical dimensions due to high memory and extensive computational effort requirements. Branch and Bound procedures are proposed by Erenguc (1988), Afentakis and Gavish (1986), Kirca (1995), Robinson and Gao (1996). The lower bounds in Erenguc (1988) are computed by ignoring the major set-up costs and solving independent uncapacitated single item lot-sizing problems. In Afentakis and Gavish (1986), lower bounds are obtained by applying the Lagrangean relaxation method. By solving the linear relaxation dual of a new problem formulation, Kirca (1995) proposed an efficient way to obtain tight lower bounds. The same idea was exploited also by Robinson and Gao (1996) to obtain the lower bounds, but instead of solving the linear relaxation to optimality, the authors use a heuristic dual ascent method to solve the “condensed dual” of the relaxed problem. Different kind of heuristic methods were also proposed to solve the LPJS. See Atkins & Iyogun (1988), Chung & Mercan (1992), Federgrum & Tzur (1994), Joneja (1990) (who proposed a bounded worst case heuristic) among others. Some optimality conditions were proposed by Haseborg (1982).

III. Capacited Dynamic Lot Sizing Model

The dynamic lot sizing problem with constrained capacity has received considerable attention from both academics and industry during the past two decades. Specifically, the problem is that determining lot sizing for a single item when time is discretized into periods (e.g. days, weeks, months) and each time production is initiated, a setup cost is incurred. A holding cost is incurred for each unit of inventory that is carried from one period to next. The objective is to minimize the total costs, while ensuring that all demand is satisfied on time. Many optimal and heuristic techniques have been developed for variation of this problem (Baker et al. 1978, DeMatteis 1968, Florian & Klein 1971, IBM, Lambrecht 1976, Silver & Dixon 1978, Silver & Meal 1973,).Several methods have been proposed for the solution of the multi item DLSP (Dzielinski 1965, Eisenhut 1975, Lambrecht & Vanderveken 1979, Lasdon & Turjung 1971, Manne 1958, Newson 1975, VanNunen & Wessels 1978). Most of these techniques either cannot guarantee the generation of a feasible solution or are computationally prohibitive. Dixon (1979) has shown that even the two item problem with constrained capacity is NP-hard, so this class of problems is extremely difficult to solve reasonable amount of time.

a) Single Item

Love (1973) discussed the production capacity and bound storage capacity for formulating the inventory systems. The cost function is formulated as a piecewise concave function. The algorithm searches for an optimal schedule in which the bounds on production are zero or infinite. An algorithm under inventory bounds with satisfying exact requirements is also presented. It is demonstrated that these algorithms are applicable in capacity constraints. Erenguc & Aksoy (1990) develop a branch and bound algorithm for solving a deterministic single item nonconvex dynamic lot sizing problem with production and inventory capacity constraints. The production cost function is neither convex nor concave. The algorithm finds a global optimum solution for the problem after solving a finite number of linear knapsack problems with bounded variables. Sandbothe &Thompson (1990) consider the lot size model for the production and storage of a single commodity with limitations on production capacity and the possibility of not meeting demand, i.e., stockouts, at a penalty. The forward algorithm is shown in the worst case to be asymptotically linear in computational requirements, in contrast to the case for the classical lot size model which has exponential computing requirements. Two versions of the model are considered: first, in which the upper bound on production is the same for every time period; and second, in which the upper bound on production is permitted to vary each time period. Diaby et al. (1992) develop several optimal/near-optimal procedures for the Capacitated Lot-Sizing and Scheduling Problem (CLSP) with setup times, limited regular time and limited overtime. Diaby et al. formulate a mixed-integer linear programming model of the problem and solve it by Lagrangean relaxation. Their results show that large problems can be solved in reasonable computer times and within one-percent accuracy of the optimal solutions. The authors solved 99 × 8 (i.e., 99 items and 8 periods), 50 × 12 and 50 × 8 problems in 30.61, 36.25 and 12.65 seconds of CDC Cyber 730 computer time, respectively. Sandbothe &Thompson (1993) consider the lot size model for the production and storage of a single commodity with limitations on production capacity and storage capacity. There is also the possibility of not meeting demand. Chung, Flynn & Lin (1994) studied the capacitated single item dynamic lot size problem. The problem is to find an optimal production schedule that minimizes the setup, manufacturing, and inventory holding costs subject to the production capacity and the demands that need to be delivered on time. Dynamic programming and the branch and bound search procedure are used to find the solution to the problem. Although the problem is a NP problem, they claimed that the algorithm could solve moderately size problems in a reasonable time.Chen, Hearn & Lee (1994) develop a new dynamic programming method for the single item capacitated dynamic lot size model with non-negative demands and no backlogging. This approach builds the optimal value function in piecewise linear segments. It works very well on the test problems, requiring less than 0.3 seconds to solve problems with 48 periods on a VAX 8600. Problems with the time horizon up to 768 periods are solved. Empirically, the computing effort increases only at a quadratic rate relative to the number of periods in the time horizon. Similar work is done by Florian et al. (1980) and by Bitran & Yanasse (1982). An exact algorithm for this problem is discussed by Karmarkar et al. (1987). Many authors proposed polynomial algorithms to solve the constant capacity version of the problem. Florian & Klein (1971) presented an O (T^4) dynamic programming algorithm based on the shortest path method to solve the constant capacity case with concave costs. Their algorithm can deal with the backlogging situation. Jagannathan & Rao (1973) extended Florian & Klein's results to a more general production cost function which is neither concave nor convex.Fleischmann & Meyr (1997) addresses the problem of integrating lot sizing and scheduling of several products on a single, capacitated machine which is known as GLSP (General Lot sizing and Scheduling Problem). Continuous lot sizes, meeting deterministic, dynamic demands, are determined and scheduled with the objective of minimizing inventory holding costs and sequence-dependent setup costs. As the schedule is independent of predefined time periods, the GLSP generalizes known models using restricted time structures. Three variants of a local search algorithm, based on threshold accepting, are presented. Computational tests show the effectiveness of these heuristic approaches and are encouraging for further extensions of the basic model.Hoesel & Wagelmans (1997) proposed a more efficient O (T^3) dynamic programming algorithm to solve the constant capacity, concave production costs and linear holding costs case. Hill (1997) reduced the constant capacity problem. An O (2^T) dynamic programming algorithm, proposed by Baker et al. (1978), Florian et al. (1980) extended Florian and Klein's (1971) dynamic programming algorithm to the problem with arbitrary capacities. However, the required computation time becomes substantially larger. Kirca (1990) offered improvements to their algorithm. Lambert and Luss (1982) studied the problem in which the capacity limits are integer multiples of a common divisor and devised an efficient algorithm. In the case of a general cost function, Pochet (1988) proposed a procedure based on polyhedral techniques in combination with a branch and bound procedure. Chen et al. (1992.b) proposed a dynamic algorithm for the case of a piecewise linear cost function with no assumption of convexity or concavity, where arbitrary capacity restrictions on inventory and backlogging are allowed. Other contributions for restricted versions of the problem are found in Bitran and Matsuo (1986), Chen et al. (1992.a), Chung and Lin (1988) and Chung et al. (1994).Shaw & Wagelmans (1998) consider the Capacitated Economic Lot Size Problem with piecewise linear production costs and general holding costs, which is an NP-hard problem but solvable in pseudo-polynomial time. The running time of their algorithm is only linearly dependent on the magnitude of the data. This result also holds if extensions such as backlogging and startup costs are considered. Moreover, computational experiments indicate that the algorithm is capable of solving quite large problem instances within a reasonable amount of time. For example, the average time needed to solve test instances with 96 periods, 8 pieces in every production cost function, and average demand of 100 units is approximately 40 seconds on a SUN SPARC 5 workstation. Gutiérrez et al. (2003) address the dynamic lot size problem with storage capacity. As in the unconstrained dynamic lot size problem, this problem admits a reduction of the state space. New properties to obtain optimal policies are introduced. Based on these properties a new dynamic programming algorithm is devised. Superiority of the new algorithm to the existing procedure is demonstrated. Furthermore, the new algorithm runs in O (T) expected time when demands vary between zero and the storage capacity. This new approach is conceptually more understandable than the one proposed previously by Love (1973). Moreover, the computational results indicate that the algorithm introduced in this paper is almost 30 times faster than Love's procedure.

Pai (2003) studies on capacitated lot size problem and found most of them were based on the assumption that the capacity is known exactly. In most practical applications, this is seldom the case. Fuzzy number theory is ideally suited to represent this vague and uncertain future capacity. So the author was applied fuzzy sets theory to solve this capacitated lot size problem.Liu et al. (2004) formulate the single-item inventory capacitated lot size model with lost sales. They assumed that the costs are time variant. Some new properties are obtained in an optimal solution and a dynamic programming algorithm was developed to solve the problem in O (T^2) time.Enns & Suwanruji (2005) reviwe some research on lot sizing problem and found that mostly assumed single echelon systems. Even when multiple echelon systems have been used, capacity constraints are seldom considered. However, in manufacturing capacity constraints can lead to significant queuing effects. Commonly used lot sizing policies like Lot-For-Lot (LFL) and Period Order Quantity (POQ) do not take these effects into account. They compares these policies with a Fixed Order Quantity (FOQ) policy, within which lot sizes are based on minimizing estimated lot flow times at capacity-constrained machines. Simulation is used to study a small production and distribution network using time-phased planning. Results show that the FOQ policy performs better than both LFL and POQ when inventory levels and delivery performance are of concern. Song & Chan (2005) consider a single item lot-sizing problem with backlogging on a single machine at a finite production rate. The objective is to minimize the total cost of setup, stockholding and backlogging to satisfy a sequence of discrete demands. Both varying demands over a finite planning horizon and fixed demands at regular intervals over an infinite planning horizon are considered. They have characterized the structure of an optimal production schedule for both cases. As a consequence of this characterization, they proposed dynamic programming algorithm for the computation of an optimal production schedule for the varying demands case and a simpler one for the fixed demands case.Brahimi et al. (2006) state-of-the-art of a particular planning problem, the Single Item Lot Sizing Problem (SILSP), is given for its uncapacitated and capacitated versions. First classes of lot sizing problems are briefly surveyed. They reviewed various solution methods for the Uncapacitated Single Item Lot Sizing Problem (USILSP) and presented four different mathematical programming formulations of the classical problem. They discussed different extensions for real-world applications of this problem. Complexity results of the Capacitated Single Item Lot Sizing Problem (CSILSP) are given together with its different formulations and solution techniques.Heuvel & Wagelmans (2006) consider the capacitated lot-sizing problem (CLSP) with linear costs. They derive a new O (T^2) algorithm for the CLSP with non-increasing setup costs, general holding costs, non-increasing production costs and non-decreasing capacities over time, where T is the length of the model horizon. Heuvel & Wagelmans show that in every iteration they do not consider more candidate solutions than the O (T^2) algorithm proposed by Chung & Lin (1988). They also develop a variant of our algorithm that is more efficient in the case of relatively large capacities. Numerical tests show the superior performance of new algorithms compared to the algorithm of Chung & Lin (1988).Hardin, Nemhauser & Savelsbergh (2007) analyze the quality of bounds, both lower and upper, provided by a range of fast algorithms. Special attention is given to LP-based rounding algorithms.Pochet & Wolsey (2007) consider the single item lot-sizing problem with capacities that are non-decreasing over time. When the cost function is non-speculative or Wagner-Whitin and the production set-up costs are non-increasing over time. When the capacities are non-decreasing, they derive a compact mixed integer programming reformulation whose linear programming relaxation solves the lot-sizing problem to optimality when the objective function satisfies i) and ii). The formulation is based on mixing set relaxations and reduces to the (known) convex hull of solutions when the capacities are constant over time. They illustrate the use and effectiveness of this improved LP formulation on a few test instances, including instances with and without Wagner-Whitin costs, and with both non-decreasing and arbitrary capacities over time.Haugen, Olstad & Pettersen (2007a) extend the results for capacitated lot-sizing research to include pricing. Based on a few examples, the new version appears to be much easier to solve computationally. Including price can modify demand as well as production schedule. The authors found a feasible solution easily due to model assumptions (form of demand), unlike CLSP.Haugen, Olstad & Pettersen (2007b) introduce a simple heuristic for a quadratic programming sub problem within a Lagrangean relaxation heuristic for a dynamic pricing and lotsize problem. They introduce price constraints within the framework of dynamic pricing, discuss their relevance in a real world market modeling, and demonstrate their applicability within this algorithmic framework.Berk, Toy & Hazır (2008) consider the dynamic lot-sizing problem with finite capacity and possible lost sales for a process that could be kept warm at a unit variable cost for the next period t + 1 only if more than a threshold value Q_t has been produced and would be cold, otherwise. Production with a cold process incurs a fixed positive setup cost, K_t and setup time, S_t, which may be positive. Setup costs and times for a warm process are negligible. Berk, Toy & Hazır develop a dynamic programming formulation of the problem; establish theoretical results on the structure of the optimal production plan in the presence of zero and positive setup times with Wagner–Whitin-type cost structures. Chubanov, Kovalyov & Pesch (2008) study a generalization of the classical single-item capacitated economic lot-sizing problem to the case of a non-uniform resource usage for production. The general problem and several special cases are shown to be non-approximable with any polynomially computable relative error in polynomial time. An optimal dynamic programming algorithm and its approximate modification are presented for the general problem. Fully polynomial time approximation schemes are developed for two NP-hard special cases: Cost functions of total production are separable and holding and backlogging cost functions are linear with polynomially related slopes, and all holding costs are equal to zero. Wakinaga & Sawaki (2008) consider a dynamic lot size model for the case where single-item is produced and shipped by an overseas export company. They explore an optimal production scheduling with the constraint of production and shipment capacity so as to minimize the total cost over the finite planning horizon when the demands are deterministic by a dynamic programming approach. Wakinaga & Sawaki extend a dynamic lot size model to the case of incorporating shipping schedule into the model. And they deal with the model with backlogging and no backlogging, respectively. They also presented some numerical examples to illustrate optimal policies of the developed model under several demands and cost patterns.Akbalik et al. (2009) presents a new class of valid inequalities for the single-item capacitated lot sizing problem with step-wise production costs (LS-SW). They first provide a survey of different optimization methods proposed to solve LS-SW. Then, flow cover and integer flow cover inequalities derived from the single node flow set are described in order to generate the new class of valid inequalities. The single node flow set can be seen as a generalization of some valid relaxations of LS-SW. A new class of valid inequalities they call mixed flow cover, is derived from the integer flow cover inequalities by a lifting procedure. Pan, Tang & Liu (2009) address the capacitated dynamic lot sizing problem arising in closed-loop supply chain where returned products are collected from customers. The capacities of production, disposal and remanufacturing are limited, and backlogging is not allowed. It is shown that the problem with only disposal or remanufacturing can be converted into a traditional capacitated lot sizing problem and be solved by a polynomial algorithm if the capacities are constant. A pseudo-polynomial algorithm is proposed for the problem with both capacitated disposal and remanufacturing. Ng, Kovalyov & Cheng (2010) present a better solution of the first fully polynomial approximation scheme (FPTAS) for the single-item capacitated economic lot-sizing (CELS) with concave cost functions which was first developed by Hoesel & Wagelmans (2001), Chubanov et al. (2006) later presented a sophisticated FPTAS for the general case of the CELS problem with a monotone cost structure. The ideas and presentation of their FPTAS were simple and straightforward. Its running time is about n^4/ε^2 times faster than that of Chubanov et al., where n is the number of production periods and ε is the anticipated relative error of the approximate solution.Konstantaras & Skouri (2010) were considered a production-remanufacturing (used products are collected from customers and are kept at the recoverable inventory warehouse for future remanufacturing) inventory system, where the demand can be satisfied by production and remanufacturing. The cost structure consists of the EOQ-type setup costs, holding costs and shortage costs.

b) Multi Item

Barany, Roy, & Wolsey (1984) gives the convex hull of the solutions of the economic lot-sizing model is given. In addition, an alternative formulation as a simple plant location problem is examined, and here too the convex hull of solutions is obtained. It is well-known that the economic lot-sizing model is well-solved by dynamic programming. On the other hand, the standard mixed integer programming formulation of this problem leads to a very large duality gap.Thizy & Chen (1990) show that the multi-item capacitated lot-sizing problem, which consists of determining the magnitude and the timing of some operations of durable results for several items in a finite number of processing periods so as to satisfy a known demand in each period, is strongly NP-hard. They compare this approach with every alternate relaxation of the classical formulation of the problem, and show that it is the most precise in a rigorous sense. Wagelmans, Hoesel, & Kolen (1992) consider the n-period economic lot sizing problem, where the cost coefficients are not restricted in sign. In their seminal paper, H. M. Wagner and T. M. Whitin proposed an O (n^2) algorithm for the special case of this problem, where the marginal production costs are equal in all periods and the unit holding costs are non-negative. It is well known that their approach can also be used to solve the general problem, without affecting the complexity of the algorithm. Wagelmans, Hoesel, & Kolen present an algorithm to solve the economic lot sizing problem in O (n log n) time, and we show how the Wagner-Whitin case can even be solved in linear time. Our algorithm can easily be explained by a geometrical interpretation and the time bounds are obtained without the use of any complicated data structure. Furthermore, they show how Wagner and Whitin's and their algorithm are related to algorithms that solve the dual of the simple plant location formulation of the economic lot sizing problem.Kirca & Kökten (1994) give a framework for a new heuristic approach for solving the single level multi-item capacitated dynamic lot sizing problem is presented. The approach uses an iterative item-by-item strategy for generating solutions to the problem. In each iteration a set of items are scheduled over the planning horizon and the procedure terminates when all items are scheduled. An algorithm that implements this approach is developed in which in each iteration a single item is selected and scheduled over the planning horizon. Each item is scheduled by the solution of a bounded single item lot sizing problem where bounds on inventory and production levels are used to ensure feasibility of the overall problem. The performance of this algorithm is compared to some well-known heuristics over a set of test problems. The computational results demonstrated that on the average their algorithm outperforms other algorithms. The suggested algorithm especially appears to outperform other algorithm for problems with many periods and few items.

DeSouza & Armentano (1994) presented a multi-item capacitated lot-sizing model includes a setup time for the production of a lot of an item. The production of items in a given period is constrained by a limited regular time and a limited overtime. Moreover, the production level of any item in a given period is also limited. This problem is tackled by a Cross decomposition based algorithm which can provide an optimal solution or a near optimal solution if computational time is restricted.Hindi (1995) addressed the problem of multi-item, single-level, dynamic lot sizing in the presence of a single capacitated resource. A model based on variable redefinition is developed leading to a solution strategy based on a branch-and-bound search with sharp low bounds. The multi-item low bound problems are solved by column generation with the capacity constraints as the linking constraints. The resulting sub problems separate into as many single-item; uncapacitated lot sizing problems as there are items. These sub problems are solved as shortest path problems. Good upper bounds are also generated by solving an appropriate minimum-cost network flow problem at each node of the branch-and-bound tree. The resulting solution scheme is very efficient in terms of computation time. Its efficiency is demonstrated by computational testing, the efficiency with which the low bound problems are solved and the frequent generation of good upper bounds; all of which leading to a high exclusion rate.Sox

(1997) describe a formulation of the dynamic lot sizing problem when demand is random and the costs are non-stationary. Assuming that the distribution of the cumulative demand is known for each period and that all unsatisfied demand is backordered, the problem can be modeled as a mixed integer nonlinear program. An optimal solution algorithm is developed that resembles the Wagner-Whitin algorithm for the deterministic problem but with some additional feasibility constraints. They derive two important properties of the optimal solution. The first increases the computational efficiency of the solution algorithm. The second property demonstrates that the lot sizes used in the rolling-horizon implementation of this algorithm is bounded below by the optimal lot sizes for a stochastic dynamic programming formulation.Although there is a significant amount of literature on the capacitated lot sizing problem, there has been insuficient consideration of planning problems in which it is possible for a lot size, or production run, to continue over consecutive time periods without incurring multiple setups. While there are papers that consider this feature, they typically restrict production to at most one product in each period. Sox & Gao (1999) present a set of mixed integer linear programs for the capacitated lot sizing problem that incorporate setup carry-over without restricting the number of products produced in each time period. Efficient reformulations are developed for finding optimal solutions, and a Lagrangian decomposition heuristic is provided that quickly generates near-optimal solutions. The computational results demonstrate that incorporating setup carry-over has a significant effect on both cost and lot sizes.Ozdamar & Bozyel (2000) consider the CLSP is extended to include overtime decisions and capacity consuming setups. The objective function consists of minimizing inventory holding and overtime costs. Setups incur costs implicitly via overtime costs, i.e., they lead to additional overtime costs when setup times contribute to the use of overtime capacity in a certain period. The resulting problem becomes more complicated than the standard CLSP and requires methods different from the ones proposed for the latter. Consequently, new heuristic approaches are developed to deal with this problem. Among the heuristic approaches are the classical HPP approach and its modifications, an iterative approach omitting binary variables in the model, a GA approach based on the transportation-like formulation of the single item production planning model with dynamic demand and a SA approach based on shifting family lot sizes among consecutive periods. Computational results demonstrate that the Simulated Annealing approach produces high quality schedules and is computationally most efficient.

Omar & Deris (2001) addresses heuristic decision rules for the situation of a deterministic linearly increasing and decreasing demand patterns with a finite input rate. They determine the timing and sizing of replenishment so as to keep the total relevant costs low as possible. They extended the Silver-Meal heuristic method and found the penalty cost is very low.Degraeve & Jans (2003) found that Dantzig-Wolfe decomposition for the Capacitated Lot Sizing Problem (CLSP), which was proposed by Manne in 1958, has an important structural deficiency. Imposing integrality constraints on the variables in the full blown master will not necessarily give the optimal IP solution as only production plans which satisfy the Wagner-Whitin condition can be selected. They propose the correct Dantzig-Wolfe decomposition reformulation separating the set up and production decisions. This formulation gives the same lower bound as Manne’s reformulation and allows for branch-and-price. Column generation is speeded up by a combination of simplex and subgradient optimization for finding the dual prices. The results show that branch-and-price is computationally tractable and competitive with other approaches. Finally, they briefly discuss how this new Dantzig-Wolfe reformulation can be generalized to other mixed integer programming problems, whereas in the literature, branch-and-price algorithms are almost exclusively developed for pure integer programming problems.Karimi, Ghomi & Wilson (2003) consider single-level lot sizing problems, their variants and solution approaches. After introducing factors affecting formulation and the complexity of production planning problems, and introducing different variants of lot sizing and scheduling problems, they discuss single-level lot sizing problems, together with exact and heuristic approaches for their solution. They also conclude with some suggestions for future research.There have been recent advances in using queuing relationships to determine lot sizes that minimize mean flow times when multiple product types are being produced at capacity constrained resources. However, these relationships assume lot inter arrival times are independent, which is not the case in most manufacturing scenarios. Enns & Li (2004) examines the performance lot-sizing optimization relationships based on GI/G/1 relationships when lot inter arrival times are auto-correlated. Simulation and response surface modeling are used to experimentally determine optimal lot sizes for a sample problem. The flowtimes for “optimal” lot sizes determined analytically are found to compare poorly with the best flowtimes obtained experimentally. An approach is then developed that uses feedback during simulation to adjust parameters within queuing heuristics that support dynamic lot-size optimization. Performance using this approach compares well with the best performance obtained using the much more difficult experimental approach.Degraeve & Jans (2004) present new lower bounds for the CLSP with Setup times. They improve the lower bound obtained by the textbook Dantzig-Wolfe decomposition where the capacity constraints are the linking constraints. Dantzig-Wolfe decomposition is applied to the network reformulation of the problem. The demand constraints are the linking constraints and the problem decomposes into sub problems per period containing the capacity and set up constraints. They propose a customized branch-and-bound algorithm for solving the sub problem based on its similarities with the Linear Multiple Choice Knapsack Problem. They present a Lagrange Relaxation algorithm for finding this lower bound. This is the first time that computational results are presented for this decomposition and a comparison of their lower bound to other lower bounds.Young & Sung-soo (2005) were considered the single machine capacitated lotsizing and scheduling problem with sequence dependent setup costs and setup times (CLSPSD). The objective of the problem is minimizing the sum of production costs, inventory holding costs and setup costs while satisfying the customer demands. To handle the problem more efficiently, a conceptual model is suggested, and one of the well-known Meta heuristics, SA approach is applied. To illustrate the performance of this approach, various instances are tested and the results of this algorithm are compared with those of CLPEX. This approach generates optimal or near optimal solutions. Moreover, most of the existing researches cannot demonstrate the real world situations including sequence dependent setup costs and setup times. Federgruen & Meissner (2005) conducts a probabilistic analysis of an important class of heuristics for multi item capacitated lot sizing problems. They characterize the asymptotic performance of so-called progressive interval heuristics as T, the length of the planning horizon, goes to infinity, assuming the data are realizations of a stochastic process of the following type: the vector of cost parameters follows an arbitrary process with bounded support, while the sequence of aggregate demand and capacity pairs is generated as an independent sequence with a common general bivariate distribution, which may be of unbounded support. The authors show that important subclasses of the class of progressive interval heuristics can be designed to be asymptotically optimal with probability one, while running with a complexity bound which grows linearly with the number of items N and slightly faster than quadratically with T.Jodlbauer (2006) developed a non-time discrete approach for an integrated planning procedure, applied to a multi-item capacitated production system with dynamic demand. The objective is to minimize the total costs, which consist of holding and setup costs for one period. The model does not allow backlog. Furthermore, a production rate of zero or full capacity is the only possibility. The result is a schedule, lot-sizes and the sequences for all lots. The approach is based on a specific property of the setup cost function, which allows for replacement of the integer formulation for the number of setup activities in the model. In a situation where the requirements for the multi-item continuous rate economic order quantity, the so-called economic production lot (EPL) formula, are fulfilled, both the EPL as well as the presented model results are identical for the instances dealt with. Moreover, with the new model problems with an arbitrary demand can be solved.DeToledo & Armentano (2006) address the capacitated lot-sizing problem involving the production of multiple items on unrelated parallel machines. A production plan should be determined in order to meet the forecast demand for the items, without exceeding the capacity of the machines and minimize the sum of production, setup and inventory costs. They proposed a heuristic based on the Lagrangian relaxation of the capacity constraints and subgradient optimization. Rizk, Martel & Ramudhin (2006) study a class of multi-item lot-sizing problems with dynamic demands, as well as lower and upper bounds on a shared resource with a piecewise linear cost. The shared resource might be supply, production or transportation capacity. The model is particularly applicable to problems with joint shipping and/or purchasing cost discounts. The problem is formulated as a mixed-integer program. Lagrangean relaxation is used to decompose the problem into a set of simple sub-problems. A heuristic method based on subgradient optimization is then proposed to solve a particular case often encountered in the consumer goods wholesaling and retailing industry. Their tests show that the heuristic proposed is very efficient in solving large real-life supply planning problems.Jian-feng, Yue-xian, & Zan-dong (2006) analyzes the capacitated lot-sizing problem considering an individual machine's production capacity using a two-layer hierarchical method to minimize the sum of the dynamic inventory cost and the overtime penalty cost. The genetic algorithm, the parameter linear programming method, and a heuristic method were used in the developed method. The method uses the genetic operator to define the lot-sizing matrix (the first layer), linear programming to determine eachmachine"s schedule (the second layer) according to the lot-sizing matrix, and the heuristic method to verify the feasibility of the solutions by adjusting them to meet the constraint requirements. The scheduling of machines in a press shop demonstrates the effectiveness of the algorithm. The result shows that the algorithm is convergent.Gaafar (2006) applied genetic algorithms to the deterministic time-varying lot sizing problem with batch ordering and backorders. Batch ordering requires orders that are integer multiples of a fixed quantity that is larger than one. The developed genetic algorithm (GA) utilizes a new '012' coding scheme that is designed specifically for the batch ordering policy. The performance of the developed GA is compared to that of a modified Silver-Meal (MSM) heuristic based on the frequency of obtaining the optimum solution and the average percentage deviation from the optimum solution. In addition, the effect of five factors on the performance of the GA and the MSM is investigated in a fractional factorial experiment. Results indicate that the GA outperforms the MSM in both responses, with a more robust performance. Significant factors and interactions are identified and the best conditions for applying each approach are pointed out.Kämpf & Köchel (2006) investigate the following decision problem. A manufacturing unit has to meet a random demand for N items. At the same time only one item can be manufactured. Manufacturing times are random whereas set-up times are known positive constants but different for different items. Finished production is stored in a warehouse with finite capacity. The availability of raw material is always guaranteed. Demand that cannot be satisfied by items in the warehouse will be backordered in a queue with given capacity. Demand that meets a full backorder queue is lost. The problem now is to define such a manufacturing policy, i.e. a sequencing rule and a lot size rule, which maximizes the expected profit per time unit. Since that problem is too complex for an analytical solution we restrict our search for an optimal policy to simple structured policies, which can be described by a few parameters. To find optimal parameter values we use simulation optimization, where a simulator for the system is combined with a GA as an optimizer. The paper is finished with some numerical examples to show the applicability of the proposed approach. Parveen & Haque (2007) considers the multi-item single level capacitated dynamic lot-sizing problem which consists of scheduling N items over a horizon of T periods. The objective is to minimize the sum of setup and inventory holding costs over the horizon subject to a constraint on total capacity in each period. The current research work has been directed toward the development of a model for multi-item Dixon Silver considering the setup time and limited lot size per setup. Dixon & Silver (1981) presented a simple heuristic which will always generates a feasible solution, if one exists, and does so with a minimal amount of computational effort, but they ignore setup time and the model is hard to implement in practice because of their large computational requirements. The inclusion of setup times makes the feasibility problem Np-complete (Adenso-dfaz & Laguna 2009). Federgruen, Meissner & Tzur (2007) consider a family of N items that are produced in, or obtained from, the same production facility. Demands are deterministic for each item and each period within a given horizon of T periods. If in a given period an order is placed, setup costs are incurred. The aggregate order size is constrained by a capacity limit. The objective is to find a lot-sizing strategy that satisfies the demands for all items over the entire horizon without backlogging, and that minimizes the sum of inventory-carrying costs, fixed-order costs, and variable-order costs. All demands, cost parameters, and capacity limits may be time dependent. In the basic joint setup cost (JS) model, the setup cost of an order does not depend on the composition of the order. The joint and item dependent setup cost (JIS) model allows for item-dependent setup costs in addition to the joint setup costs. They develop and analyze a class of so-called progressive interval heuristics. A progressive interval heuristic solves a JS or JIS problem over a progressively larger time interval, always starting with period one, but fixing the setup variables of a progressively larger number of periods at their optimal values in earlier iterations. Different variants in this class of heuristics allow for different degrees of flexibility in adjusting continuous variables determined in earlier iterations of the algorithm. For the JS-model and the two basic implementations of the progressive interval heuristics, they show under some mild parameter conditions that the heuristics can be designed to be ε-optimal for any desired value of $\varepsilon > 0$ with a running time that is polynomially bounded in the size of the problem. They can also be designed to be simultaneously asymptotically optimal and polynomially bounded. A numerical study covering both the JS and JIS models shows that a progressive interval heuristic generates close-to optimal solutions with modest computational effort and that it can be effectively used to solve large-scale problems.Absi & Sidhoum (2007) address a multi-item capacitated lot-sizing problem with setup times that arises in real-world production planning contexts. Demand cannot be backlogged, but can be totally or partially lost. Safety stock is an objective to reach rather than an industrial constraint to respect. The problem is NP-hard. We propose mixed integer programming heuristics based on a planning horizon decomposition strategy to find a feasible solution. The planning horizon is partitioned into several sub-horizons over which a freezing or a relaxation strategy is applied. Some experimental results showing the effectiveness of the approach on real-world instances are presented. They also reported a sensitivity analysis on the parameters of the heuristics is reported.Hwang (2007) considers a dynamic lot-sizing model with demand time windows where n demands need to be scheduled in T production periods. For the case of backlogging allowed, an $O(T^3)$ algorithm exists under the non-speculative cost structure. For the same model with somewhat general cost structure, the authors propose an efficient algorithm with $O(\max\{T^2, nT\})$ time complexity.Absi & Sidhoum (2008) address a multi-item capacitated lot-sizing problem with setup times and shortage costs that arises in real-world production planning problems. Demand cannot be backlogged, but can be totally or partially lost. The problem is NP-hard. A mixed integer mathematical formulation is presented. They propose some classes of valid inequalities based on a generalization of Miller et al. (2003) and Marchand & Wolsey (1999) results. They also describe fast combinatorial separation algorithms for these new inequalities and use them in a branch-and-cut framework to solve the problem. They reported some experimental results showing the effectiveness of the approach.

Sidhoum & Absi (2008) address a multi-item capacitated lot-sizing problem with setup times and shortage costs and demand cannot be backlogged, but can be totally or partially lost. The problem can be modelled as a mixed integer program and it is NP-hard. In this paper, we propose some classes of valid inequalities based on a generalization of Miller et al. (2003) results. They study the polyhedral structure of the convex hull of this model which helps to prove that these inequalities induce facets of the convex hull under certain conditions.Süer, Badurdeen & Dissanayake (2008) considered order, inventory carrying, and labor costs to determine the production schedule and lot sizes that will minimize the total costs involved under capacity constraints. The fitness function for the chromosome is computed using these cost elements. Next, the chromosomes are partitioned into good and poor segments based on the individual product chromosomes. This information is later used during crossover operation and results in crossover among multiple chromosomes. Product chromosomes are grouped into three groups, group 1 (top X %), group 2 (next Y %), and group 3 (last Z %). Product chromosomes from Groups 1, 2 and 3 can only form pairs with chromosomes from group 1. Besides, different crossover and mutation probabilities are applied for each group. The results of the experimentation showed that the different strategies of the proposed approach produced much better results than the classical genetic algorithm.Levi, Lodi & Sviridenko (2008) study the classical capacitated multi-item lot-sizing problem with hard capacities. There are N items, each of which has specified sequence of demands over a finite planning horizon of T discrete periods; the demands are known in advance but can vary from period to period. All demands must be satisfied on time. Each order incurs a time-dependent fixed ordering cost regardless of the combination of items or the number of units ordered, but the total number of units ordered cannot exceed a given capacity C. On the other hand, carrying inventory from period to period incurs holding costs. The goal is to find a feasible solution with minimum overall ordering and holding costs. They show that the problem is strongly NP-hard, and then propose a novel facility location type LP relaxation that is based on an exponentially large subset of the well-known flow-cover inequalities; the proposed LP can be solved to optimality in polynomial time via an efficient separation procedure for this subset of inequalities. Moreover, the optimal solution of the LP can be rounded to a feasible integer solution with cost that is at most twice the optimal cost; this provides a 2-approximation algorithm which is the first constant approximation algorithm for the problem. They also describe an interesting on-the-fly variant of the algorithm that does not require solving the LP a-priori with all the flow-cover inequalities. As a by-product they obtain the first theoretical proof regarding the strength of flow-cover inequalities in capacitated inventory models.Denize et al. (2008) present a proof to show the linear equivalence of the Shortest Path (SP) formulation and the Transportation Problem (TP) formulation for CLSP with setup costs and times. Their proof is based on a linear transformation from TP to SP and vice versa. In our proof, we explicitly consider the case when there is no demand for an item in a period, a case that is frequently observed in the real world and in test problems.

Ferreira, Morabito & Rangel (2009) present a mixed integer programming model that integrates production lot sizing and scheduling decisions of beverage plants with sequence dependent setup costs and times. The model considers that the industrial process produces soft drink bottles in different flavors and sizes, and it is carried out in two production stages: liquid preparation (stage I) and bottling (stage II). The model also takes into account that the production bottleneck may alternate between stages I and II, and a synchronization of the production between these stages is required. A relaxation approach and several strategies of the relax and fix heuristic are proposed to solve the model. Computational tests with instances generated based on real data from a Brazilian soft drink plant are also presented. The results show that the solution approaches are capable of producing better solutions than those used by the company.

Absi & Sidhoum (2009) address a multi-item capacitated lot-sizing problem with setup times, safety stock and demand shortages. Demand cannot be backlogged, but can be totally or partially lost. Safety stock is an objective to reach rather than an industrial constraint to respect. The problem is NP-hard. They propose a Lagrangian relaxation of the resource capacity constraints. They develop a dynamic programming algorithm to solve the induced sub-problems. An upper bound is also proposed using a Lagrangian heuristic with several smoothing algorithms. Some experimental results showing the effectiveness of the approach are reported.Anily, Tzur & Wolsey (2009) consider a multi-item lot-sizing problem with joint set-up costs and constant capacities. Apart from the usual per unit production and storage costs for each item, a set-up cost is incurred for each batch of production, where a batch consists of up to C units of any mix of the items. In addition, an upper bound on the number of batches may be imposed. Under widely applicable conditions on the storage costs, namely that the production and storage costs are nonspeculative, and for any two items the one that has a higher storage cost in one period has a higher storage cost in every period, They show that there is a tight linear program with O (mT^2) constraints and variables that solves the joint set-up multi-item lot-sizing problem, where m is the number of items and T is the number of time periods. This establishes that under the above storage cost conditions this problem is polynomially solvable. For the problem with backlogging, a similar linear programming result is described for the uncapacitated case under very restrictive conditions on the storage and backlogging costs. Computational results are presented to test the effectiveness of using these tight linear programs in strengthening the basic mixed integer programming formulations of the joint set-up problem both when the storage cost conditions are satisfied, and also when they are violated.

Madan et al. (2010) present a heuristic for the Capacitated Lot-Sizing (CLS) problem without set-up time considerations and no backordering option. The CLS problem is formulated as a mixed integer-programming problem with an underlying fixed charge transportation problem structure. This formulation is flexible enough to handle different types of production capacity such as regular time capacity, overtime capacity and subcontracting. They also present a new Lower Bound Procedure for the multi-item CLS problems. Narayanan & Robinson (2010) proposes two heuristics, for the capacitated, coordinated dynamic demand lot-size problem with deterministic but time-varying demand. In addition to inventory holding costs, the problem assumes a joint setup cost each time any member of the product family is replenished and an individual item setup cost for each item type replenished. The objective is to meet all customer demand without backorders at minimum total cost. They propose a six-phase heuristic (SPH) and a simulated annealing meta-heuristic (SAM). The SPH begins by assuming that each customer demand is met by a unique replenishment and then it seeks to iteratively maximize the net savings associated with order consolidation. Using SPH to find a starting solution, the SAM orchestrates escaping local solutions and exploring other areas of the solution state space that are randomly generated in an annealing search process. The results of extensive computational experiments document the effectiveness and efficiency of the heuristics. Over a wide range of problem parameter values, the SPH and SAM find solutions with an average optimality gap of 1.53% and 0.47% in an average time of 0.023 CPU seconds and 0.32 CPU seconds, respectively. The heuristics are strong candidates for application as standalone solvers or as an upper bounding procedure within an optimization based algorithm. The procedures are currently being tested as a solver in the procurement software suite of a nationally recognized procurement software provider

IV. Conclusion

In the present paper, we reviewed the literature on single level single-resource lotsizing models. Although research on capacitated lotsizing started some fifty years ago, lotsizing problems are still challenging because many extensions are very difficult to solve. Finally, the interaction between modeling and algorithms will play an important role in future research. The inclusion of industrial concerns lead to larger and more complex models and consequently more complex algorithms are needed to solve them. Solution approaches for integrated models will be based on previous research on the separate models. Existing knowledge about the structure and properties of a specific subproblem can be exploited in solving integrated models. Many more opportunities are still unexplored. This research field thus remains very active.

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Application of Pulse Compression Techniques to Monostatic Doppler Sodar

[1]A.Nagaraju,[2]A.Kamalakumari,[3]M.Purnachandra Rao

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***Abstract*: An active phased array Doppler sodar with distributed low peak power transmit modules requires pulse compression to provide high sensitivity and fine range resolution. A long transmitted pulse, however, has accompanying problem of near range blind zone. A pulse compression Doppler sodar transmits coded long pulse and compresses the echo-signal resulting in fine range resolution. Barker-coded pulses with matched filter were examined in relation to uncompressed pulses to determine the performance and benefits of pulse compression. The pulse compression technique reduces the peak transmitted power compared to the classical transmission for the given range. The technique also permits the suppression of sidelobes to levels that are acceptable for operational and research applications.**

I. INTRODUCTION

A Doppler sodar transmits a short pulse of duration τ (typically a few tens of milli-seconds) of intense sound (typically 20 W) up into the atmosphere at a pulse repetition time T of a few seconds (typically 2 – 8 seconds). The upward propagating sound gets scattered in all directions due to temperature and wind fluctuations occurring at a scale equal to half the transmitted wavelength. In the case of monostatic Doppler sodars, where the same antenna is used for both transmission and reception, the backscattering is due to temperature fluctuations alone. The Doppler shift of the echo-signal is used to deduce the wind components. In a tri-axial monostatic Doppler sodar, three antennas oriented in the three directions are used to deduce the total wind vector profile. The typical height coverage of the classical Doppler sodar systems is about 1 km from ground and with a range resolution of about 30 m. This pulse duration τ multiplied by the transmitter power gives the energy sound. In principle, the energy is required to be as high as possible to cover larger height range. This is usually achieved by either increasing the transmitted power or increasing τ. High-power transmitters present problems because it requires high-voltage power supplies beside reliability problems and safety issues, big size, heavier, more expensive. Pulse compression, in principle, is to send a long pulse in coded form to comply with the demand of more energy and compress it to a narrow sub-pulse at the receiver to improve range resolution. The amount of compression possible is equivalent to the time-bandwidth product ($B\tau$) of the code (Skolnik, 1980). The increase in echo-signal power is proportional to the code length while the range resolution is inversely related to bandwidth.

About[1]-Department of Instrumentation Engineering, Andhra University, Visakhapatnam – 530003
About[2]-Department of Instrumentation Engineering, Andhra University, Visakhapatnam – 530003
About[3]-Department of Systems Design, Andhra University, Visakhapatnam – 530003

II. PULSE COMPRESSION

The transmitted pulse is modulated by using frequency modulation or phase coding in order to get large time-bandwidth product *(Bradley, 1999)*. Phase modulation is the widely used technique in Doppler sodar systems. In this technique, a form of phase modulation is superimposed on the long pulse increasing its bandwidth. This technique allows discriminating between two pulses even if they are partially over lapped. The echo-signal is compressed through a filter, whose output is similar to that of an uncompressed transmission.In the phase coded pulse compression, the long pulse of duration τ is divided into N sub-pulses each having a width τ_0 . An increase in bandwidth is achieved by changing the phase of each sub-pulse. The phase of each sub-pulse is chosen to be either 0 or π radians. The output of the matched filter will be a spike of width τ_0 with an amplitude N times greater than that of long pulse. The pulse compression ratio is $N = \tau/\tau_0 \approx B\,\tau$, where $B \approx 1/\tau_0$. The output waveform extends to either side of the peak response, or central spike. The portions of the output waveform other than the spike are called time side-lobes.
The easiest way to encode the signal is to use a particular type of phase shift keying that makes the carrier phase change only between two values (0 and π) according to a sequence of binary digits. Figure 1 depicts the resulting waveform when a carrier sin(wt) is multiplied by a sequence of bits c(t) composing the code. The total sequence establishes the length of the pulse. The duration of a single symbol/bit is called «subpulse» and is related to the bandwidth of the encoded signal (the shorter the subpulse, the greater the bandwidth). The phase change (0 or π) is obtained at each subpulse τ_0 or its multiples $N\tau_0$. This linear operation instantaneously gives $m(t) = \pm 1 \sin(wt)$.

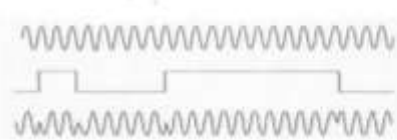

Figure (1) Phase coded waveform

A special class of binary codes is known as Barker codes. The benefit is that auto correlating or match filtering for these codes gives a main lobe peak of N and a minimum peak side lobe of 1. Only a small number of these codes exist. Table 1 lists all known Barker codes and those having a minimum peak side lobe of 1. The longest known Barker codes are of length 13, so pulse compression sodars using these codes would be limited to a maximum compression ratio of 13 (Woodman et al., 1980).

Code length	Coded signal
2	10 , 11
3	110
4	1101 , 1110
5	11101
7	1110010
11	11100010010
13	1111100110101

Table1: Barker code sequences

2.1Range Sidelobes and Weighting: A major drawback to the application of pulse compression is the presence of range sidelobes which tend to smear the returns in range. Suppression of range sidelobes is critical, especially in applications for sodars where the observed targets are distributed in nature and often have strong and steep gradients in reflectivity. Sidelobe suppression, in general, is achieved by tapering the matched filter response by weighting the transmitted waveform, the matched filter, or both in either frequency or amplitude. The weighting is usually applied to the matched filter which causes a loss of signal-to noise ratio (SNR) due to the mismatched section. The following measures are often used to quantify the performance of range sidelobe suppression techniques [Cheong et al, 2006; cohen et al, 1990]. Peak sidelobe level (PSL) is defined as

$$PSL=10\log\frac{\text{peak side lobe power}}{\text{total main lobepower}} \qquad \text{------------ (1)}$$

Integrated sidelobe level (ISL), a measure of the energy distributed in the sidelobes, is defined as

$$ISL=10\log\frac{\text{power integrated over side lobes}}{\text{total main lobepower}} \qquad \text{------------- (2)}$$

Barker cods are biphase codes having the property that after passage through a matched filter, the resulting sequence has sidelobes of unit magnitude (PSL=1/N). Barker codes have the attractive property that their sidelobe structures contain the minimum energy that is theoretically possible and this energy is uniformly distributed among the sidelobes.

III. Methodology

Time domain processing: If we choose to perform signal processing in time domain shown in figure2, we can extract the information from the received encoded signal(x(k)) as follows. As stated before this process is called correlation, it is a sort of weighted moving average of the received signal, the weight being a copy of the encoded transmitted signal(y(k)) stored inside the correlation processor (Nathanon, 1999). It is possible to demonstrate that the correlation gives an output shortened in time, or «compressed», reducing the actual duration of the pulse to one subpulse length (neglecting the sidelobes). The position of the maximum and its amplitude give information about distance and reflecting properties of the target. Multiple echoes can be resolved if the time separation between two near received signals is greater than the subpulse length. The actual detection of an echo is obviously determined also by other factors noise, transmitted power, the attenuation due to the path and the reflecting characteristics of the targets, etc. In discrete time processing the correlation ($\rho(x, y)$) of the received signal x(k) with the discrete-time version of the coded transmitted signal y(k) can be written as

$$P(x, y) = x(k)*y(k) \qquad \text{----------(3)}$$

Such a time domain process was developed by means of a MATLAB DSP tool box. The I (real) and Q(imaginary) streams of coded transmitted signal were combined in order to obtain the real amplitude of the received signal. Then a correlation was performed, in a system that used the Barker code. The processing power gain in decibels due to this correlation operation is about $G_C=20\log\sqrt{N}$ (dB).

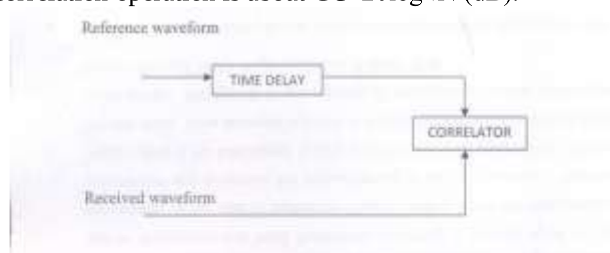

Figure (2): Matched Filter implementation using Correlation processor

As we can see the figure 3 the Barker code of length 7 , the peak is positive in phase and the sidelobes are negative in phase. And this is because the coded transmitted wave is positive and negative in phase.

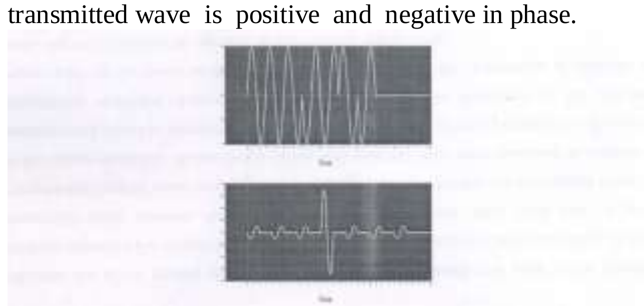

Figure (3) Coded transmitted signal and matched filter outputs of Barker code length7

IV. Implementation

The simulation process uses the correlation function of MATLAB DSP toolbox for the measurement of range to a target using sodar. The MATLAB DAQ tool box supports the device objects *analog output*(*AO*) and *analog input*(*AI*) (Mehrl and Hagley,1998; Hagley and Mehrl,2001).To send the Barker coded signal from sound card speaker out terminal the DAQ tool box helps to create the device object(*AO*) by calling appropriate function. Here the sodar antenna (active transducer) transmits the Barker coded acoustic signal y(k) into space. When the target is illuminated by the sodar, some of the signal energy is reflected back and returns to sodar receiver. The received echo signal x(k) can be modeled using simulator as follows

x(k) = ay(k-d)+v(k) --------------------(4)

The first term in equation 4 represents echo of the transmitted signal. The echo is very faint because only a small fraction of the original signal reflected back. The delay of *d* samples accounts for propagation time required for the signal to travel from transmitter to the target and back again. The second term in equation 4 accounts for random atmospheric noise. The objective of this simulation for processing the received signal x(k) whether or not an echo present. If echo is detected, then the distance to the target(R) can be obtained from the *delay d* can written as

$$R = \frac{Cd\tau 0}{2} \qquad \text{------------ (5)}$$

The Barker coded transmitted signal with pulse length 100 msec and pulse repeat ion time of 4 sec is used for creating a received signal of attenuation factor a=0.5 and atmospheric white noise v(k) with standard deviation σ =0.05.Normalized cross-correlation of x(k) with y(k) is computed using MATLAB DSP tool box functions. Received signal is shown in figure 4 ,it was found that it is not at all apparent whether x(k) contains a delayed and attenuated echo of un coded y(k) much less where it is located in case of classical transmission. In case of normalized cross correlation of x(k) with Barker coded y(k) the presence and location of an echo are evident as shown in figure 5.Using MATLAB *max function* the time of flight in this case is observed at d=280.24 and the range of the target can be found using equation 5 is 680.58m.

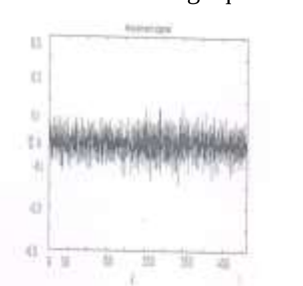

Figure (4)Received signal x(k) of un coded Signal y(k)

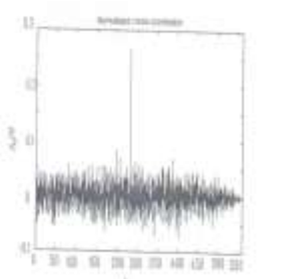

Figure (5) Normalized cross-correlation of y(k) with x(k)

V. Results

Using the method described above, Barker codes were incorporated for testing the basic functionality of Doppler sodar system using simulation under controlled conditions. The central frequency (f0) was 2000Hz, two chips of equal length centered on f0 and spectral width is two times the equivalent bandwidth of the binary code was used for compression. Transmitted power, spectral width are calculated for uncompressed and compressed pulses at same resolution in order to evaluate the error performance .The 7-bit barker code provides a range resolution 2.43m compare to un coded transmitted pulse of range resolution of 17.01m. The table2 shows range resolutions and sidelobe levels for various Barker code lengths.

Barker code length	ΔR for 100 msec pulse length(τ)	Effective pulse width after compression(τ0)	Sidelobe level (dB)
2	8.5m	50msec	-6.0
3	5.66m	33.33msec	-9.5
4	4.25m	25msec	-12.0
5	3.4m	20msec	-14.0
7	2.43m	14.28msec	-16.9
11	1.55m	9.09msec	-20.8
13	1.3m	7.69msec	-22.3

Table2: Barker codes of different lengths and associated ΔR, τ0 and sidelobe levels

VI. Conclusions

A successful modification of the Doppler sodar system was presented that produces an increase in range resolution through pulse compression. The simulator incorporates Barker phase codes with matched filter (correlation processor) which decreases the average transmitted power compare to classical transmission. A major drawback to the application of pulse compression is the presence of range sidelobes which tend to smear the returns in range This highlights the need of explore other code/filter combinations that can suppress ISL even further. This can be achieved by changing code type, code length, filtering method or any combination of these. However, as code length increases, the Doppler tolerance of the signal decreases as moving targets can begin to significantly alter the phase of the signal causing additional errors.For long range detection the energy has to be high which means longer pulses, and for high resolution the subpulse width has to be very small. Then the use of long codes with small subpulse width is crucial. By extending this idea we can implement wave multiple layers to be able to have Barker code of lengths larger than 13. Each layer will be either 2, 3, 7 or 11. In this way Barker code length will be the multiplication of Barker code length of each layer. So by using two layers barker code, barker code of lengths 2*2, 2*3, 2*7, 2*11, 3*3, 3*7, 3*11, 7*7, 7*11 and11*11 can be implemented. Consequently another main achievement for the proposed technique is Barker extension.

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Software Aided Battery-Operated Wheel Chair

Osman YILDIRIM

GJRE-F:Classification (FOR) 280399p

Abstract— **The aim of this study is to give the software consideration of a low cost battery-operated wheelchair and also to introduce the easy application of PIC programming and the specifications of a commonly used Microcontroller Microchip PIC16F877. In this paper, we have described a software application of a battery-operated wheel chair. The proposed system is meant to give simple and clear interface programming data to potential designers. The calculating values (the maximum direction values such as right-left and reverse motion) which are favorable for the user have been detected in the experiments. Herewith the user's easier control of the vehicle has been maintained. It is noted that modern motion control software may be applied to reduce such problems as grounding, shielding, susceptibility, structuring related wheelchair.**

KeyWords: Wheelchair, Motion Control, Flowchart, Microcontroller

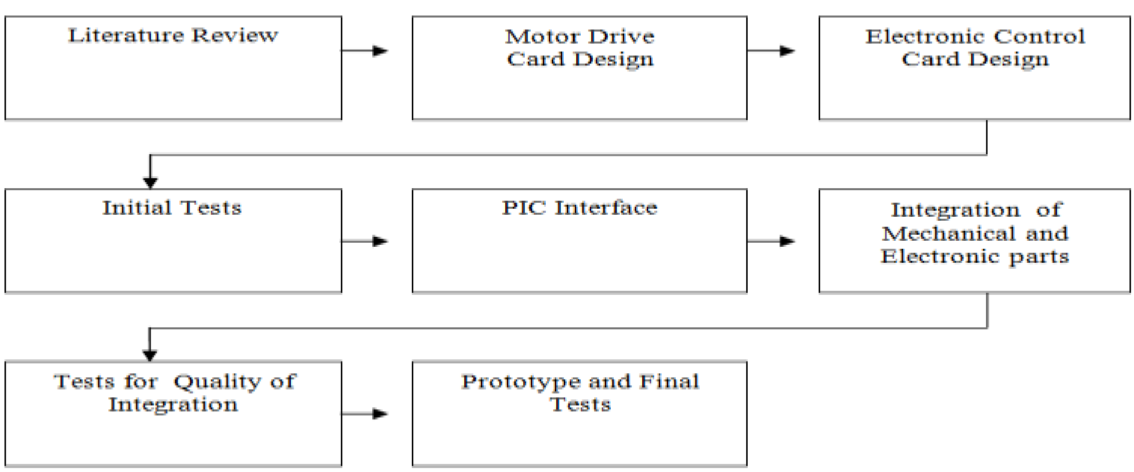
I. INTRODUCTION

Wheel chair design may be very complex in terms of stability and dynamic situations. A model has been developed for wheelchair including teering geometry, frame geomety, frame mass and distribution, factors depending on the wheelchair user and factors coming from environment (Cooper, 1993). Dynamic load analysis is extremly important for hightech design of a wheelchair. VanSickle and Cooper (1996) proposed a methodology to determine the dynamic loads acting on a wheelchair.Programming languages differ according to their implementation fields. For instance languages used in engineering are Pascal and C. Fortran; Languages for data bases are XBASE and ORACLE whereas for artificial intelligence Prolog and Lisps are used. Additionally, awk, pyton and javascript are used fas scripting programmes. For instance in Unix operating system C system is used with a ratio of 80 %; within the rest the machine language is applied. Within the programming languages, whatever the target is, the simplest methods are meant to be used. There are two types of wheelchairs, namely battery operated wheelchairs and manual ones. Battery-powered wheel chairs are useful in providing mobility especially for those who have upperlimb impairment as well as lower limb impairment. The design considerations and implementation details of a battery-powered wheel chair prototype is given by using the control unit of a wheelchair ranging from programmable logic devices to embedded personal computers (Yildirim, 2010).
Ultrasonic sensors may be mounted to the wheel chair system to aid in the navigation of the wheelchair (Yoder, Baumgartner and Skaar, 1996). Wheelchair user can automatically be guided.It is accepted that the optimal control devices and wheelchair mounted robot will not be ready for potential wheelchair users in the short run. The wheelchair mounted robot with electronic equipments will make life easy for disabled people (Cherry, Cudd and Hawley, 1996).

II. SOFTWARE AND GUIDANCE FLOWCHART

Battery-Operated wheel chair guidance flowchart to reach the prototype is depicted in Fig.1. After literature review on battery-operated wheelchairs, the motor drive circuit and control circuit can be designed. Initial tests can be applied to measure the performance of both electronic cards. In case of achieving good results, the experimental model can be finalized.

Fig.1 Battery-Operated Wheel Chair Guidance Flowchart



About-Istanbul Kultur University, School of Vocational Studies, Incirli Campus, Bakirkoy, Istanbul, Turkey, o.yildirim@iku.edu.tr Fax:+902125613328; Phone:+902124984962

In order to integrate the mechanical constraction of a wheelchair with electronic control cards, PicBASIC compiled by IC-PROG programmer software can be created as an interface. Some tests can be repeated to measure the performance of the overall system in order to reach prototype.As shown in Fig. 2, the battery-operated wheel chair is mainly composed of a joystick, a control unit, motor driver unit, motor, and batteries. The wheel chair is powered by two permanent magnet dc motors, each having a power rating of 250W and a voltage rating of 24V. The system is energised by two 12V sealed lead-sulfur batteries, each with a charge capacity of 40Ah. The batteries are connected in series to obtain a 24V supply. An electromechanical relays will make the motor rotate in one direction changing operation. This operation requires careful programming in case the relay states are controlled by PIC programming. Moreover, the control process has been performed according to PIC programming. The flow chart is shown in Fig.3. Motor wheel chair consists of two forward slack wheels and two wheels connected to a motor which is natural magnetized DC motor at tail

Fig.2. Experimental Battery-Operated Wheel Chair System

Output information is obtained by evaluating the input information as shown in the flow chart.

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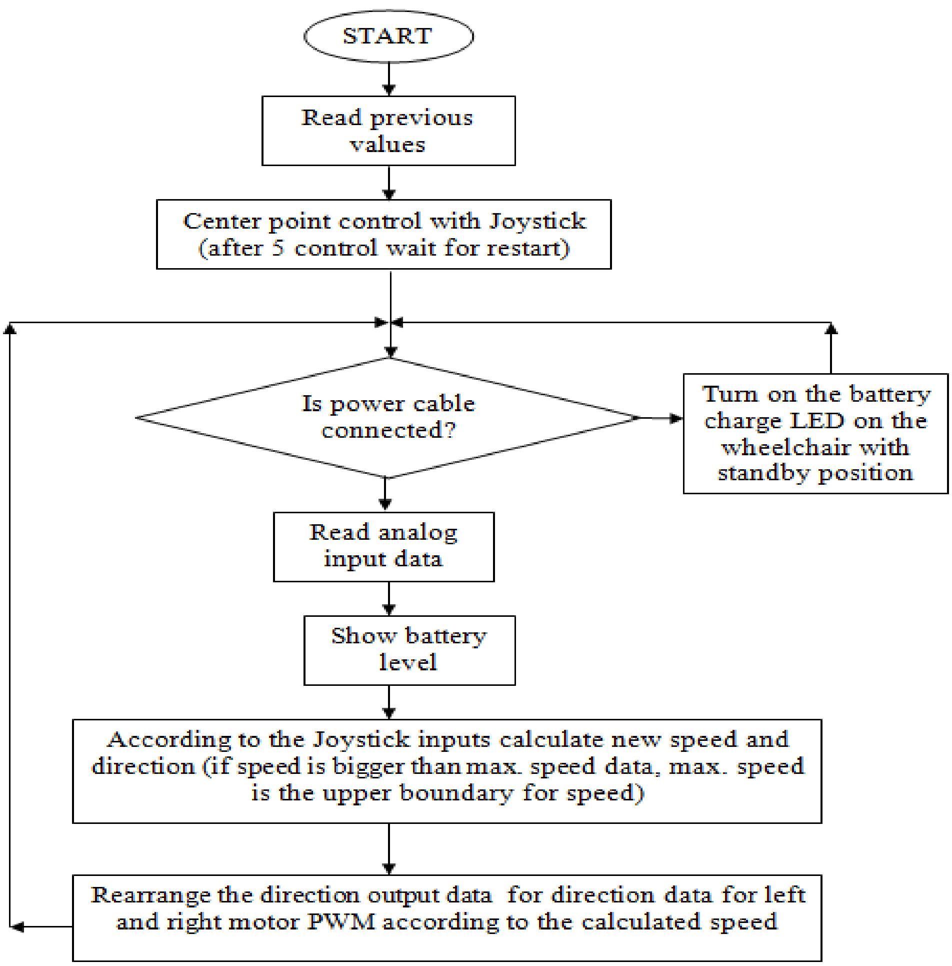

Fig.3 The Flowchart for Software

When energy is supplied for the program, firstly primary values of the device (such as maximum speed PWM, total right and total left) which were calculated before or were detected by experiment (the values such as right, left, forward and backward of the joystick) are adjusted.The joystick's position, whether in the midpoint or not is tested at the sub procedure of control. If the program does not detect the midpoint, it will indicate "fault" message in battery display led and it will not work unless it is restarted. Hereby the joystick's getting out of order in time or the motion of vehicle with an oncoming information caused by a disconnection has been inhibitted. In the further step, the program enters in an infinite circle and works in this circle until it is turned off. It checks whether the battery cord is plugged or not and if plugged, it makes the vehicle stay still and it indicates its being charged via display leds. In the next step, the analog information defined above are obtained with ADC in PIC 16F877.The analog information given by the user with a joystick is evaluated by a microcontroller. It supplies the required direction and speed output for the propulsion of the motor. PIC 16F877 is used as a microcontroller. As it is well-known, the PIC16F877 microcontroller includes 8kb of internal flash Program Memory, a large RAM area and an EEPROM. The program is designed in PicBASIC and compiled by using IC-PROG programmer software and AN 589 programmer.Input information can be listed as; (1) Joystick forward–backward information (analog), (2) Joystick right–left information (analog), (3) Maximum speed adjusting pot information (analog), (4) Battery charging plug information(digital), and (5) Battery level information (analog). On the other hand, output information can be given as; (1) Right motor forward information (digital), (2) Right motor backward information (digital), (3) Right motor PWM information (digital), (4) Left motor forward information (digital), (5) Left motor backward information (digital), (6) Left motor PWM information (digital) and (7) Battery level information 'with 5 LED lights'(digital).

III. CONCLUSION AND CONCLUDING REMARKS

In this paper, we have described a software application of a baterry-operated wheel chair. The objective of the proposed system is to give simple and clear interface programming data to potential designers of the wheelchair. The calculating values (the maximum direction values such as right-left and reverse motion) which are favorable for the user have been detected in the experiments. Herewith the user's easier controlling the vehicle has been maintained. It is noted that modern motion control software may be applied to reduce such problems as grounding, shielding, susceptibility, structuring related wheelchair. Direction and velocity control of wheelchair can be managed by means of modern software programs.

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Simulation and Comparative Analysis of LMS and RLS Algorithms Using Real Time Speech Input Signal

GJRE-F:Classification (FOR) 080110

Komal R. Borisagar [1] and Dr. G.R.Kulkarni[2]

***Abstract* - In practical application, the statistical characteristics of signal and noise are usually unknown or can't have been learned so that we hardly design fix coefficient digital filter. In allusion to this problem, the theory of the adaptive filter and adaptive noise cancellation are researched deeply. According to the Least Mean Squares (LMS) and the Recursive Least Squares (RLS) algorithms realize the design and simulation of adaptive algorithms in noise canceling, and compare and analyze the result then prove the advantage and disadvantage of two algorithms .The adaptive filter with MATLAB are simulated and the results prove its performance is better than the use of a fixed filter designed by conventional methods.**

KEY WORDS: Adaptive filters, Adaptive algorithm, RLS, LMS.

I. INTRODUCTION

In the process of digital signal processing, often to deal with some unforeseen signal, noise or time-varying signals, if only by a two FIR and IIR filter of fixed coefficient cannot achieve optimal filtering[2]. Under such circumstances, we must design adaptive filters, to track the changes of signal and noise. Adaptive Filter is that it uses the filter parameters of a moment ago to automatically adjust the filter parameters of the present moment, to adapt to the statistical properties that signal and noise unknown or random change [1], in order to achieve optimal filter. Based on in-depth study of adaptive filter, based on the least mean squares algorithm and recursive least squares are applied to the adaptive filter technology to the noise, and through the simulation results prove that its performance is usually much better than using conventional methods designed to filter fixed.

II. ADAPTIVE FILTERS

The so-called adaptive filter, is the use of the result of the filter parameters a moment ago, automatically adjust the filter parameters of the present moment, to adapt to the unknown signal and noise, or over time changing statistical properties, in order to achieve optimal filtering [3]. Adaptive filter has "self-regulation" and "tracking" capacities.

About[1]- [1]Atmiya Institute of Technology and Science,Research Scholar in Kadi Sarva Vishwavidyalaya, Sector - 15, Near KH - 5, Gandhinagar - 382 015.Gujarat - INDIA
E-mail: komalborisagar@yahoo.com Ph: +91 9925041416
About[2]- Principal, C.U.Shah College of Engineering & Technology, Wadhwan - Gujarat, India
E-mail: grkulkarni29264@rediffmail.com Ph: +91 9427665745

Adaptive filter can be divided into linear and nonlinear ad adaptive filter. Non-linear adaptive filter has more signal processing capabilities. However, due to the non-linear adaptive filter more complicated calculations, the actual use is still the linear adaptive filter[2]. As shown in Figure.

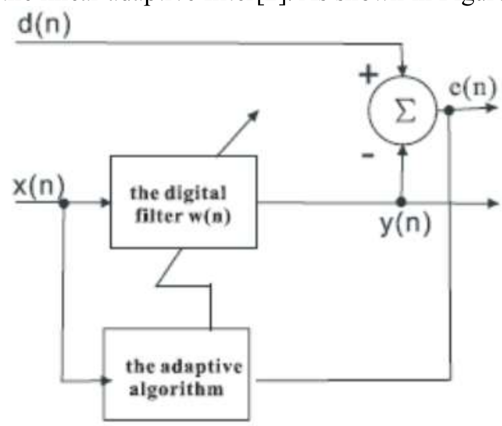

Figure 1: Adaptive filter scheme

The figure above is given the general adaptive filtering display: digital filter carries on filtering on the input signal x(n) , produce output signal y(n). Adaptive algorithm adjusts the filter coefficient included in the vector w (n), in order to let the error signal e(n) to be the smallest. Error signal is the difference of useful signal d(n) and the filter output y(n). Therefore, adaptive filter automatically carry on a design based on the characteristic of the input signal x(n) and the useful signal d(n)[4]. Using this method, adaptive filter can be adapted to the environment set by these signals. When the environment changes, filter through a new set of factors, adjusts for new features[3] .The most important properties of adaptive filter is that it can work effective in unknown environment, and to track the input signal of time-varying characteristics [5]. Adaptive filter has been widely used in communications, control and many other systems. Filter out an increase noise usually means that the contaminated signal through the filter aimed to curb noise and signal relatively unchanged. This filter belongs to the scope of optimal filtering[6], the pioneering work started from Wiener, and Kalman who work to promote and strengthen. For the purpose of the filter can be fixed, and can also be adaptive. Fixed filter designers assume that the signal characteristics of the statistical computing environment fully known, it must be based on the prior knowledge of the signal and noise. However, in most cases it is very difficult to meet the conditions; most of the practical issues must be resolved using adaptive filter. Adaptive filter is through the observation of the existing signal to understand statistical properties, which in the normal operation to adjust parameters automatically [7], to change their performance, so its design does not require of the prior knowledge of signal and noise characteristics. Adaptive filter is used for the cancellation of the noise component which is overlap with unrelated signal in the same frequency range[2].

(i) LMS Algorithm

The LMS is the most used algorithm in adaptive filtering. It is a gradient descent algorithm; it adjusts the adaptive filter taps modifying them by an amount proportional to the instantaneous estimate of the gradient of the error surface. It is represented in following equations. [2]

$$y(n) = \hat{\mathbf{w}}^H(n).\mathbf{u}(n)$$
$$e(n) = d(n) - y(n)$$
$$\hat{\mathbf{w}}(n+1) = \hat{\mathbf{w}}(n) + \mu \cdot \mathbf{u}(n) \cdot e(n)$$

(ii) RLS Algorithm

The RLS algorithm performs at each instant an exact minimization of the sum of the squares of the desired signal estimation errors[3]. These are its equations: To initialize the algorithm $\mathbf{P}(n)$ should be made equal to δ^{-1} where δ is a small positive constant[2].

$$y(n) = \hat{\mathbf{w}}^H(n).\mathbf{u}(n)$$
$$\alpha(n) = d(n) - \hat{\mathbf{w}}^H(n-1)\mathbf{u}(n)$$
$$\pi(n) = \mathbf{u}^H(n).\mathbf{P}(n-1)$$
$$k(n) = \lambda + \pi(n).\mathbf{u}(n)$$
$$\mathbf{k}(n) = \frac{\mathbf{P}(n-1).\mathbf{u}(n)}{k(n)}$$
$$\hat{\mathbf{w}}(n) = \hat{\mathbf{w}}(n-1) + \mathbf{k}(n).\alpha^*(n)$$
$$\mathbf{P}'(n-1) = \mathbf{k}(n).\pi(n)$$
$$\mathbf{P}(n) = \frac{1}{\lambda}\left(\mathbf{P}(n-1) - \mathbf{P}'(n-1)\right)$$

III. Simulation Results

(a) Noise reduction with LMS

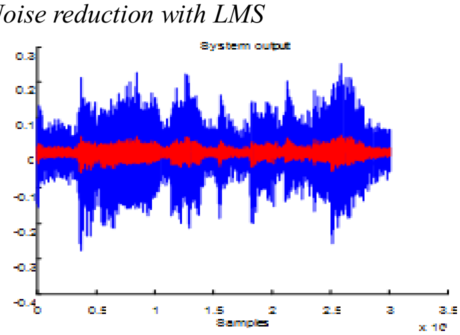

Figure 2 : True and Estimated output

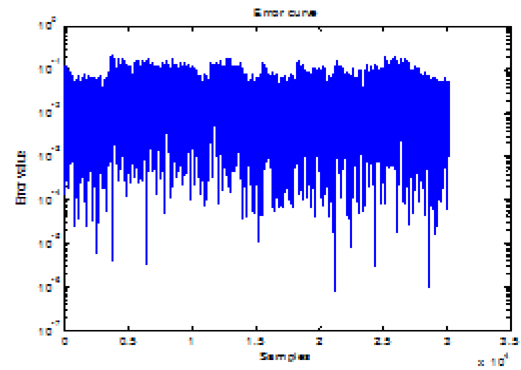

Figure 3: Error Curve

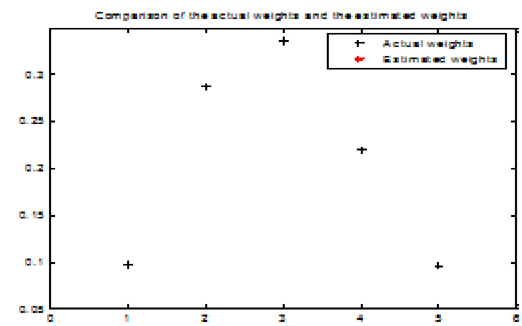

Figure 4: plot of estimated weights and filter weights

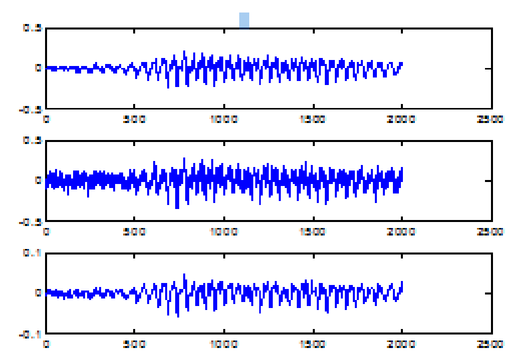

Figure 5 : Original wave , noisy wave and filtered wave

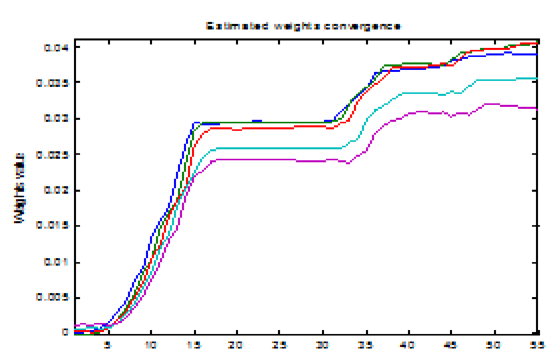

Figure 6 : Coefficient convergence estimate

(b) Noise reduction with RLS

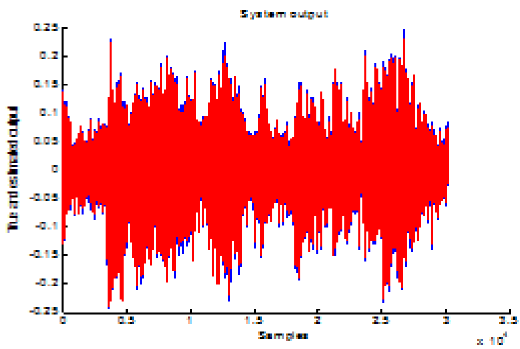

Figure 7: True and Estimated output

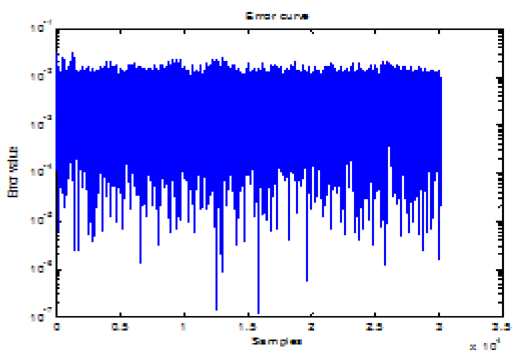

Figure 8 : Error curve

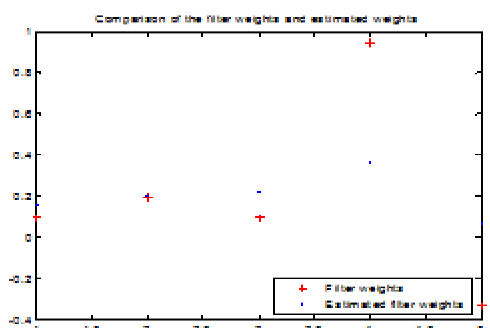

Figure 9: plot of estimated weights and filter weights

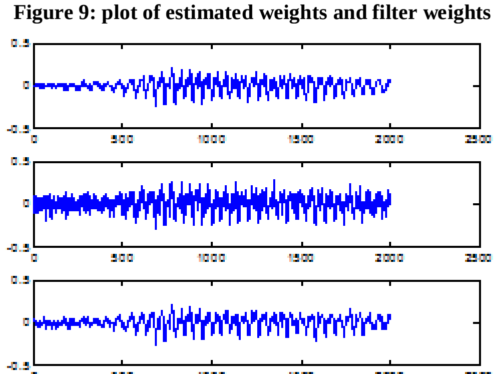

Figure 10: Original wave , noisy wave and filtered wave

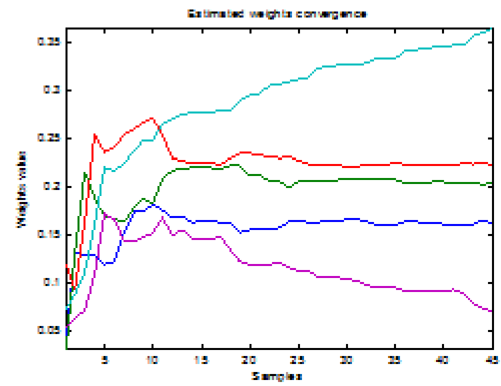

Figure 11: Coefficent convergence estimate

IV. COMPARATIVE ANALYSIS OF LMS AND RLS ALGORITHMS

The simulation results are achieved using real time speech input signal in MATLAB environment. The simulation results show that more than LMS algorithm and RLS algorithm in the area to cancel the noise has very good results, to complete the task of noise reduction. LMS filters filtering results is relatively good, the requirements length of filter is relatively short, it has a simple structure and small operation and is easy to realize hardware. But the shortcomings of LMS algorithm convergence rate is slower, but the convergence speed and noise vector there is a contradiction, accelerate the convergence speed is quicker at the same time noise vector has also increased. Convergence of the adaptive for the choices of gain constant μ is very sensitive. The noise signal and signal power when compared to larger, LMS filter output is not satisfactory, but we can step through the adjustment factor and the length of the filter method to improve. RLS algorithm filter the convergence rate is faster than the LMS algorithm, the convergence is unrelated with the spectrum of input signal, filter performance is superior to the least mean squares algorithm, but its each iteration is much larger operation than LMS. The required storage capacity is large, is not conducive to achieving a timely manner, the hardware is also relatively difficult to achieve the task of noise reduction.

V. CONCLUSION

Adaptive filtering is an important basis for signal processing, in recent years has developed rapidly in various fields on a wide range of applications. In addition to noise cancellation, adaptive filter the application of space is also very extensive. For example, we know areas that the system identification, adaptive equalizer, linear prediction, adaptive antenna array, and many other areas. Adaptive signal processing technology as a new subject is in depth to the direction of rapid development, especially blind adaptive signal processing and use of neural networks of non-linear adaptive signal processing, for the achievement of intelligent information processing system, a good prospect.

VI. FUTURE WORK

The application can be extended for the noise reductin in the speech for the hearing aids in the noisy environment like crowd noise, car noise, cockpit noise, aircraft noise etc. With modified RLS and LMS algorithm convergence speech can be increased as per the real time requirement fast algorithm can be developed.

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Bandwidth Improvement of S-Shape Microstrip Patch Antenna

GJRE-F: Classification (FOR) 100501

[1]Pawan Singh, [2]D. C. Dhubkarya
[1]M.Tech (Student), [2]Head of Department
[1-2]Department of Electronics & Communication Engineering
Bundelkhand Institute of Engineering & Technology, Jhansi (U.P.)

[1]pawanpri@gmail.com, [2]dcd3580@yahoo.com

***Abstract*-A survey of S-shape microstrip antenna elements is presented, with emphasis on theoretical and practical design techniques. The bandwidth of S-shape microstrip antenna is increased by using a tuning stub. The S-shape antenna is first studied by a modal-expansion (cavity) technique and then is fully analyzed with bandwidth equations. This paper presents the analysis of the bandwidth & its improvement with the help of the numerical method. And results expressed that there is no energy loss in the propagation of wave.**

I. INTRODUCTION

Microstrip antennas are being increasingly used for aerospace applications because of their low weight, low volume and conformal nature. The most commonly used microstrip antennas are rectangular and circular disc antennas. However, other microstrip antennas are also being considered, depending on the application [1].

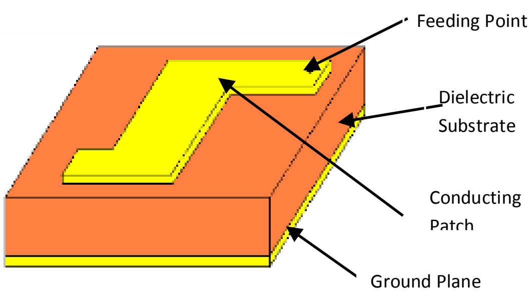


Fig. 1. S-shape microstrip antenna

In order to meet the requirement for mobile or personal communication systems, microstrip antennas with reduced size and broadband operation are of particular interest. Among various feeding mechanisms, the compact broadband microstrip antennas directly matched to a 50Ω coaxial line is also of importance, for its usefulness in integration with microwave integrated circuits. For this purpose, we present in this paper several related designs of microstrip antennas to broaden the operating bandwidth and reduce the overall size of the antenna. Here we discuss the S-shaped patch antenna. The S-shaped patch antenna reported here has a size about half that of the rectangular patch, with larger beamwidth but smaller bandwidth [2] shown in Fig.1.

II. BANDWIDTH OF S-SHAPE ANTENNA

The bandwidth of an antenna is defined as "the range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard." The bandwidth can be considered to be the range of frequencies, on either side of a center frequency (usually the resonance frequency for a dipole), where the antenna characteristics (such as input impedance, pattern, beamwidth, polarization, side lobe level, gain, beam direction, radiation efficiency) are within an acceptable value of those at the center frequency [3].Bandwidth as referred to S-shape microstrip antennas may take one of several meanings. The usual definition of the bandwidth, $\Delta f = Q/f_o$ is not extremely useful by itself. There is usually an impedance matching network between the antenna radiating element and its input port which must be considered. A more meaningful measure of bandwidth is that band of frequencies where the input VSWR is less than a specified value, usually 2:1, assuming that a unity VSWR is obtained at the design frequency. The bandwidth may then be expressed in terms of Q [4].

$$BW = \frac{VSWR - 1}{Q\sqrt{VSWR}} \qquad (1)$$

As now we have simulated the antenna parameters in the IE3D software [6] and the response is shown in Fig. 2., we shall study the radiation parameters. After this response from the range of the frequencies we can see that the operation point is at 2.1GHz for this design. The antenna is well matched to 50Ω at 2.1 GHz. In the Fig. 2. shown the VSWR which are less the value of 2.

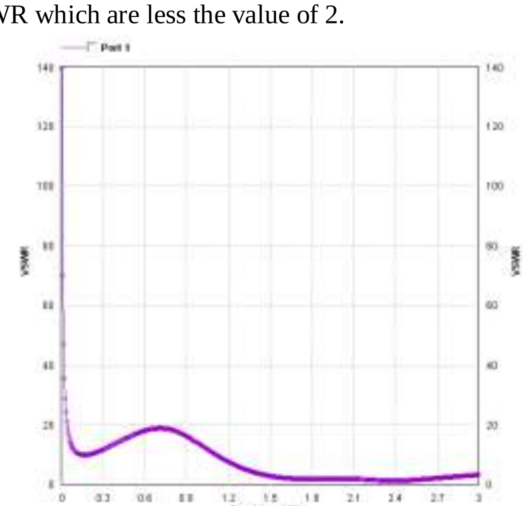


Fig. 2. VSWR of S-shape microstrip antenna

he simulation is run and is completed which gives the S-Parameters of the simulated structure. The S-parameters can be seen in the Fig. 3.

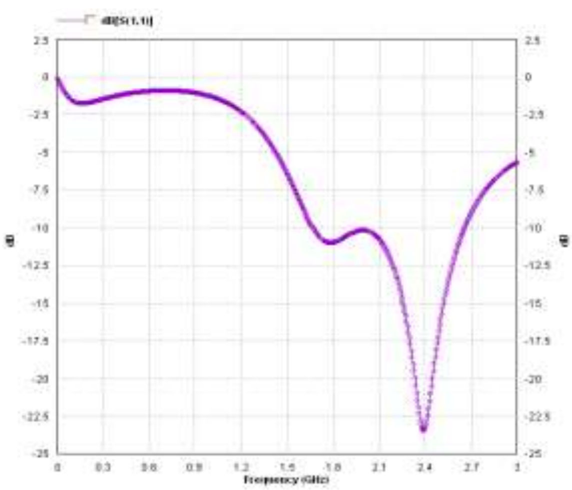


Fig.3. Return loss for the feed located

We can observe from the above Fig.3. the return loss is -10.6dB at 2.1GHz. The negative return loss here depicts that the antenna have not many losses during the transmission

III. BANDWIDTH IMPROVEMENT OF S-SHAPE ANTENNA

In [5] an expression relating the bandwidth B and the resonator quality factor Q of a simple RLC circuit was derived. This relationship is dependent on the degree of matching desired, as given by $R_{norm} = R_{\max} / Z_o$, where $R_{\max}$ is the maximum (resonant) resistance for a parallel RLC with a system impedance Z_o of and the acceptable mismatch as given by the maximum standing wave ratio S and is written as

$$Q = \frac{1}{B}\sqrt{\frac{(SR_{norm}-1)(S-R_{norm})}{S}} \qquad (2)$$

The bandwidth B is defined as $(f_2 - f_1)/f_r$ where f_1 and f_2 are the frequencies where VSWR (f_1) =VSWR (f_2)=S and f_r is the resonant frequency. An expression for the impedance of a parallel RLC resonance about a narrow band of frequencies can be approximated as

$$Z_{pric}(f_r + \Delta f) = R_{pric} - jX_{pric}$$

$$\cong \frac{R_{norm} - 2jR_{norm}Q\left(\frac{\Delta f}{f_r}\right)}{1 + 4Q^2\left(\frac{\Delta f}{f_r}\right)^2} \qquad (3)$$

where $\Delta f = f - f_r$ or the frequency shift from resonance.In (2) and in the following expressions, it is assumed that the antenna input impedance is close to the system impedance such that additional matching to the input feed line is not necessary. This requirement is not overly restrictive when considering EM coupled antennas since the input impedance can be made near 50 (for a 50- system) through proper choice of substrate thickness and feed height or slot size.Therefore, an antenna at resonance results in $1/S < R_{norm} < S$ and the frequency for which $R_e(Z_{pric}) = 1/S$ gives the maximum possible band edge $\Delta f_{\max}$, which is found (3) to be

$$\frac{\Delta f_{\max}}{f_r} = \frac{1}{2Q}\sqrt{SR_{norm} - 1} \qquad (4)$$

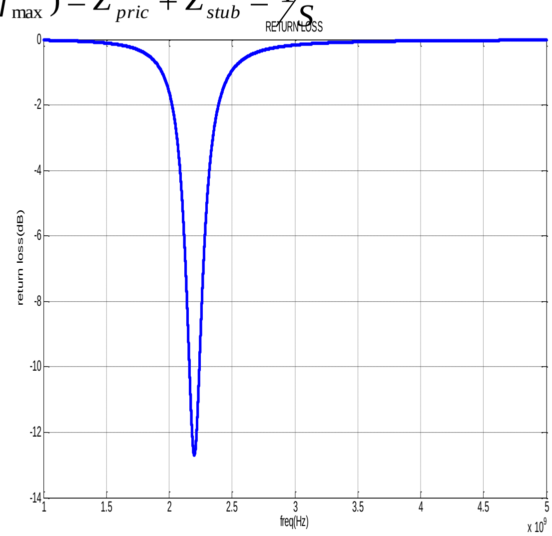
At this band edge, if a reactive matching network were to present the conjugate reactance of (3) so that

$$Z_{stub}(f_r + \Delta f_{\max}) = jX_{pric} \qquad (5)$$

then the total input impedance of the parallel RLC network and a reactive load would be

$$Z_{Total}(f_r + \Delta f_{\max}) = Z_{pric} + Z_{stub} = 1/S$$
(6)

In (5) and (6), an assumption that a symmetric impedance locus



is obtained about f_r such that a solution for one band edge is adequate. Therefore, (4) represents half the achievable bandwidth and the total new bandwidth is

$$B_{new} \cong 2\frac{\Delta f_{\max}}{f_r} > B \qquad (7)$$

This improvement in bandwidth can be found using (2), (4), and (7).

IV. COMPARISON BETWEEN THEORETICAL EXPERIMENTAL RESULTS

We have designed the S-shaped microstrip patch antenna at frequency 2.1 GHz. This patch antenna is simulated by IE3D software, version 12.6. [6] We have observed that from following Fig. 3. shows that Return loss with frequency of antenna is found to be -23.33 dB at resonant frequency 2.4 GHz.Bandwidth of these antenna is 0.20db.At all centre frequencies value of VSWR 1.15 at 2.4 GHz which is less than 2 is shown in Fig. 4. Smith chart which is a polar plot of the of the complex reflection coefficient determine the input impedance of the designed antenna in our simulated result it is closed to 50 ohms.

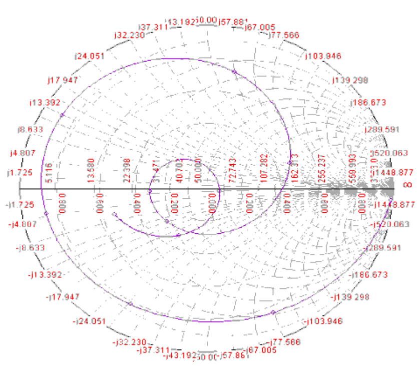


Fig. 4. Smith chart of the proposed antenna

In the theoretical analysis that patch antenna is gives the -13db return loss at 2.1GHz operating frequency shown in Fig. 5. and bandwidth is 0.19db. But in simulated result that return loss is decreases shown in Fig. 3. So that results presented that bandwidth is increases without losses. Table.1. shows the comparative value of bandwidth.

Fig.5. Return Loss by matlab

Table.1. Comparison between theoretical & simulated result

Configuration	**Theoretical (db)**	**Simulated (db)**
S-shape	0.19	0.20

V. CONCLUSION

The bandwidth of S-shape microstrip antenna is increased by using a tuning stub. Basic design equations were derived to aid in the optimization using EM simulation. This basic procedure of enhancing the bandwidth of EM coupled antennas from proper design of the stub is shown to achieve better performance due to efficient utilization of the available circuit structures.Experimental results gives the better response such as return loss, VSWR, smith chart & bandwidth. These parameters presented that the losses are minimum during the transmission. And its bandwidth is improved by using the bandwidth equation.

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Informal Tips for writing a Engineering Research Paper to increase readability and citation

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Techniques for writing a good quality Engineering Research Paper:

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
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- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

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- Insertion a title at the foot of a page with the subsequent text on the next page
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· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

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- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
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Approach:

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- Resources and methods are not a set of information.
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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.

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- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
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Topics	Grades		
	A-B	C-D	E-F
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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