A SUGGESTED BLENDING ROUTE FOR IRON ORE
FROM EL-SEDIDA MINES

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A new blending system by which the iron ore samples
flows into the production line of the new plant of the
company.

The new blending system is designed to handle the
iron ore samples coming from three different sources:
The ore deposit located in the area of 2.4 million metric
tons with a grade of 38% Fe, the ore deposit located in
the area of 1.6 million metric tons with a grade of 45%
Fe, and the ore deposit located in the area of 1.8 million
metric tons with a grade of 41% Fe.

The blending system is designed to handle the iron
ore samples coming from these three sources and to
produce a blend with a grade of 40% Fe.

The new blending system consists of three main
sections:
1. The preprocessing section, which includes:
   - Crushing and grinding the iron ore samples to
   - Size reduction of the iron ore samples to
   - Separation of the iron ore samples into different
   - size fractions.
2. The blending section, which includes:
   - Blending the iron ore samples into a single
   - Blend with a grade of 40% Fe.
3. The storage section, which includes:
   - Storing the blended iron ore samples in large
   - Stock piles.

The new blending system is designed to handle the
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produce a blend with a grade of 40% Fe.

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ABSTRACT

The iron ore deposits of El-Bahariya Oasis at El-Gedida are the only ores used by the iron and steel Company (Hadisolb). These ores are located in three different regions with different contents and quantities: Plateau (39.8 mt., 58.2% Fe), West Valley (60 mt., 50.2% Fe) and N.E. and East Valley (11.98 mt., 48.82% Fe).

Hadisolb requires 6666 mt/D (2.4 mt/Y) of a blend containing Fe > 51%, Cl < 0.6%, Mn < 2.4%, SiO₂ < 0.065% and Al₂O₃ < 0.365%.

Optimization techniques were applied to produce a plan for the use of El-Gedida ores. Calculations for the proper amounts of ore to be blended to suit the cut-off limits for Fe, Cl, and MnO set forth by Hadisolb were made. Other alternatives to maximize the time span of utilization and produce a blend that Hadisolb can treat effectively were searched.

The time to use all three localities to produce a blend satisfying the limit of the set restrictions for Fe, Cl, and MnO is found to be 36.9 years for the Plateau, 59.9 years for the West Valley and 35.9 years for N.E. and E. Valley. Therefore, thirty seven years is the limit set by the consumption of the plateau ore with high Fe and Cl and low Mn contents.

The maximum time to consume all three localities at the same time was found to be forty six and half years, but it will produce a blend having the following composition: 52.85% Fe, 2.65% MnO, 0.5399% Cl, and 6.8% SiO₂. If Hadisolb can treat such a blend chemically or physically to produce its required limitations, it will lengthen the time span of utilization of all these localities by about ten years.

KEYWORDS

Iron ores, Localities, restrictions, optimization techniques, cut-off, blend, material balance, alternatives.

INTRODUCTION

Blending of different streams to produce suitable mixtures or blends is a typical an optimization problem. Himmelblau(1) explained the techniques to set up material balances for the total mass or separate components. Wild (3,4) explained optimization techniques and defined it as finding the best way to do things. This is important in the practical world of production, trade and even politics, where small change in efficiencies can spell the difference between success or disaster, as the stated in the introduction of his book. Dynamic programming is used to solve complex optimization problems (2), where as linear program-
ming may be used to solve simple problems when the suggested routine does not change as the process develops toward completion.

For the sake of initial trials to find the time and composition of blends that will enable Hadisolb to utilize El-Gedidas location for the longest period possible, the problem is simplified by assuming the following condition.

1) Only three (or five) main components are essential to consider, namely, Fe, Cl, and MnO (also SiO₂ and others).

2) The input streams or ores from each locality have constant average composition as shown in Table 1.

3) Hadisolb requires that the blend composition is satisfactory if it contains more than 5% Fe, less than 0.6% Cl and less than 2.4% MnO. Silicon should be less than 8.5% and others less than 36.5% ± 0.5%.

4) The average daily need of iron ores is 6666 t. A set of one equation and five inequalities for material balances for the total mass, and component masses were defined, and written out to be solved for the three unknowns, namely the amount to be repeated daily as the average composition of inputs or outputs may change.

**TABLE 1**

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<tr>
<th>Region</th>
<th>Fe</th>
<th>Cl</th>
<th>MnO</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
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<td>East Valley</td>
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<th>3.2%</th>
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<td>0.47%</td>
<td>3.76%</td>
<td>5.1%</td>
<td>37.47%</td>
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<td>46.62%</td>
<td>0.22%</td>
<td>1.94%</td>
<td>18.2%</td>
<td>37.22%</td>
<td>41.98</td>
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Procedure

The process of mining the ore from all three localities and storing each in a separate storage before feeding each to separate batteries of crushers to grind it to a suitable size and uniform mass of known average chemical composition before feeding to a large mixer or blender is shown in a qualitative flow sheet in Fig. (1).
FIGURE (1) FLOW SHEET

The actual calculations of both the crushing process and blending are not considered here. The efficiencies of these process are assumed to be unity (they should be determined experimentally and considered). The amount of ores produced after crushing should be divided by the corresponding efficiency to give actual daily up - take from each locality, making the time span of use of each locality shorter than is reported here.

CALCULATIONS:

Let the basis be: one day requirement of 6666 t/D

Total mass balance

1) \( x_1 \)  \( +x_2 \)  \( +x_3 \)  6666 t/D

Iron (Fe) balance
2) \( 0.582x_1 +0.502x_2 +0.4982x_3 \geq 0.51 \times 6666 \)

MnO balance
3) \( 0.014x_1 +0.0376x_2 +0.0154x_3 \leq 0.24 \times 6666 \)

C1 balance
4) \( 0.0074x_1 +0.0047x_2 +0.0022x_3 \leq 0.006 \times 6666 \)

SiO2 balance
5) \( 0.032x_1 +0.081x_2 +0.122x_3 \leq 0.085 \times 6666 \)

Al2O3 balance
6) \( 0.3646x_1 +0.3749x_2 +0.3722x_3 \leq 0.085 \times 6666 \)

These are only three unknowns, namely \( x_1, x_2 \) and \( x_3 \) are the amounts of ore fed to the blender from each locality, where 1 refers to the Plateau, 2 refers to West Valley and 3 refers to North - East and East Valley regions, and one equation and five inequalities.
By solving this problem we get

\[ X_1 = 2981.4 \text{ t/D} \]
\[ X_2 = 278.6 \text{ t/D} \]
\[ X_3 = 902 \text{ t/D} \]

The time period of use for each locality (assuming a unit efficiency for the crushing, blending and transporting operations) is as follows:

\[ t_1 = \frac{39.6 \times 10^6}{2981.4} = 36.9 \text{ years} \]
\[ t_2 = \frac{60 \times 10^6}{2782.6 \times 360} = 59.9 \text{ years} \]
\[ t_3 = \frac{11.98 \times 10^6}{902 \times 360} = 36.9 \text{ years} \]

This means that this blending routine will allow Hadisolb to use these locations for a period not exceeding 36.9 years when regions 1 and 3 will be consumed up before region 2.

An increase 34.2% in the ores of both region 1 and region 3 will allow Hadisolb to use ores from the three regions for 39.9 years.

It may be desired to find the maximum time period to consume all three localities at the same time. Then:

\[ t_1 = t_2 = t_3 = t \]
\[ tX_1 = 39.6 \text{ mt} \]
\[ tX_2 = 50 \text{ mt} \]
\[ tX_3 = 11.98 \text{ mt} \]
\[ X_1 + X_2 + X_3 = 6666 \text{ t/D} \]

Therefore:

\[ X_1 = 2365.8 \text{ t/D} \]
\[ X_2 = 3584.5 \text{ t/D} \]
\[ X_3 = 715.7 \text{ t/D} \]

The blend is found to have the following compositions:

- 52.89% Fe,
- 7.50% MnO,
- 0.5389 C1, and
- 6.8% SiOzand allow Hadisolb to use iron ores for 48.5 years.

This composition of the final blend is acceptable to Hadisolb for all elements except MnO which is only 0.28% in excess of its stated limit. If Hadisolb can treat chemically or physically such a blend to bring it to its desired limit it will lengthen the period of use of such locality by 10 years than the previous routine. Another trial for extending the total period of exploitation of the ores was made.

The results are given in Table 2. Table 2 shows the required ore to be found of the same composition of regions 1 & 3 to correspondingly MnO % in the blend.
Required Ore to be found if the same composition & regions 1 & 4 to be used with the total amount in Region 2.

<table>
<thead>
<tr>
<th>Required ore to be found (mt)</th>
<th>Total required iron 1 &amp; 3 or any other 10% to be researched for (mt)</th>
<th>Max. period years</th>
<th>Daily production 2</th>
<th>1 &amp; 3</th>
<th>Mno</th>
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<td>103.20</td>
<td>1630.79</td>
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</table>

Conclusions

1- To use the iron ores from the three regions by ratios which fulfill the limits of the company. In this case it can use the iron ores for only 36.9 years.

2- To use the iron ores of the three regions in ratios so that all of them will be consumed for the same period and in this case the period will increase 10 years, but treated chemically.

3- It was found that if the reserves of both 1 & 2 can be increased by about 50%, the life time of EL Gedida mines will be extended almost by the same ratio.

References

1- Himmelblau, David "Basic Principles and calculation in Chemical Engineering " Prentice - Hall 1974
2- Nemhauser, George L., " Introduction to dynamic programming " Willey 1966
3- Wild, Douglas J., "Optimization seeking methods Prentice - Hall 1964
EXPANDING THE RULE OF INTERCHANGING CAD
DATABASE FOR AUTOMATIC GENERATION OF
NC PROGRAMS FOR ROTATIONAL PARTS

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ABSTRACT

In recent years, improvement in Computer-Aided part programming (CAPP) together with reductions in computing costs, have made the manufacture of the components with the aid of Numerically Control (NC) machine tool more accurate. Now, NC can quickly programmed to machine the majority of the complex forms found in different components. As a result, NC can make an important contribution for increasing the productivity of shape tool makers (in case of extremely complex shapes). The machining of complex shape in case of turning has never been as easy task. This paper describes how the programmer can generate automatically in a systematic way, the required NC program in case of turning components. The developed system analysis the required part drawing to determine the paths to be cut, and how to cut it. Lathing, from facing to cut off and all operations in between, the developed system smoothly perform all tasks required to produce turned parts. Different turning components have been tested, excellent results are obtained, i.e great reduction in the processing and working times. Entry errors are completely avoided. Thus significant savings in cost are obtained.
INTRODUCTION

The machining of complex shape either in case of milling or turning has never been an easy task. Designers always want to manufacture a component whose tooling is full of awkward features, such as sharp corners, deep slots, undefined blends and non analytic doubly curved surfaces. After achieving the best machined finish, the operator resorts hard work to achieve the final detail and desired surface finish. Part programmers is an area where available personnel are in short supply. Therefore, new systems such as the present work and the previous one (AUTOGMC) [1,2] for automatic generation of NC programs for different machining components are most appreciated. A method has presented for exchanging drawing data between different models of a CAD/CAM data base. The need to exchange drawing data between different CAD/CAM data base model is now becoming greater than ever as CAD/CAM use becomes more widespread [3]. This results from the expectation that being able to exchange drawing data without sending prints beyond and a particular company will bring great benefit to industry. The national standards of data exchange such as DXF (Data Interchange File) and IGES (Initial Graphic Exchange Specification) are set to meet this kind of needs. It is important to recognize that the real object of the exchange is not a mere physical picture, but an organized relation between pictures and information about engineering or production objects which is the substantial content expressed in CAD/CAM drawing data base. Even in the case of manual drafting, various kinds of drawing are originally made for the purpose of transferring required information to others, so that a series of tasks from design to manufacture can be shared between a number of people.

THE DEVELOPED SYSTEM

In our previous work (AUTOGMC) [1], a system to generate automatically the NC programs for milling components had been developed. That system overcomes the problems of programming the complex profiles. In the present work, we expand the idea of translating the existing information on the turned components which previously drawn by the aid of AUTOCAD [4], into data which can be processed to generate a complete NC program for that component. The program has a function to determine optimum feed and speed for different cutting conditions. The machining operations include profile, convex and concave radii facing, shouldering, and longitudinal turning are shown in Figure 1.

The NC program is a series of blocks, each showing a set of function and/or co-ordinates [5]. The typical format which has been carried out for the BOXFORD 125 TCL (CNC Lathe) at the Production Engineering Laboratory (PEL), Faculty of Engineering, Mansoura University [5] is as the following:

<table>
<thead>
<tr>
<th>N</th>
<th>G</th>
<th>M</th>
<th>X</th>
<th>Z</th>
<th>I</th>
<th>K</th>
<th>F</th>
<th>S</th>
</tr>
</thead>
</table>


Where:
N: block number.
G: preparatory code.
M: miscellaneous function code.
X: x-coordinate to change depth of cut.
Z: Z-coordinate measured along the axis of the billet.
I: interpolator parameter (additional information as needed).
K: interpolator parameter (additional information as needed).
F: feed rate (mm/min).
S: spindle speed (rpm/min).

Acs commands is shown in Fig. 2.

The use of preparatory codes GO2 and GO3 make it possible to program the tool to move clockwise and counter-clockwise respectively, in a circular arc within a single quadrant. The newcomer/user to part programming is confronted with two problems before being able to use these codes:

1. Roughing the surplus material from the billet, so that the maximum depth of cut is not exceeded, and
2. Calculating I and K parameter values needed for the part program.

USER'S PROCEDURE

The required geometric analysis which performed by the developed system is best demonstrated through the following example:

1. The user starts with drawing the upper half view of the part outline of the workpiece provided that, the vertical distance between the center axis of the workpiece and the x-axis of the screen must be equal to the radius of the bar stock by the aid of a CAD system which in turn has the facility to produce DXF files.

2. The user changes the half part outline of the workpiece into a DXF [1] file from left to right. The DXF file will be changed into data base file by the developed system. Table 1, depicts the first main data base file for the part outline shown in Figure 2.

The developed system extracts the data of Arcs and Lines, and assign these data in a second main data base file. Table 2, illustrates this DBF.

The developed system scans the previous file to determine the maximum value for x or xl-coordinates which represent the Zero point of the NC part program xl = 97.8763 (illustrated in Figure 3). This value will be used to determine the cutting stock length.

The available data in the previous file will be used to determine the number of cut paths and the length of each path corresponds to recommended depth of cut (d = 2 mm. per diameter
recommended in this example) as a rough cutting operation. The length of each rough cutting path will be halved at distance smaller than one millimeter from the actual cutting length. The rough cutting operations will be followed by a finish cutting operation. The required analysis for each part drawing element will be calculated according to the equations shown in Figure 4. In case of finishing operation for arcs found at two quadrant. The developed system divides these arcs into two arcs, and calculate the required data for each sub-arc. All results obtained from the previous calculations will be assigned in a third data base file shown in Table 3.

The developed system uses this DBF for processing these data to generate the NC part program as shown in Table 4. Figure 5 summarizes the process sequence for generating NC part program in case of turning operations.

CONCLUSION

A system for automatic generation of NC programs is developed, offers substantial cost, speed and consistency advantage for NC part programming. It can be implemented and adapted for any lathe machine tool, no doubt that it greatly reduces the range of tasks needed for the NC programming. The system eliminates the repetitive work because the system ability can retrieve data, calculate, and perform the required operation. With this system, entry errors are impossible, great reduction in programming time and program checkout is not necessary.

REFERENCES


Table 1: First Main Data Base File

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Figure 4 Equations for Calculated Tool Paths

\[ \begin{align*}
Y_{\text{new}} &= Y - 2 \\
B &= \frac{(Y_{\text{new}} - C2)}{R} \\
S &= \sin^{-1}(B) \\
X_{\text{new}} &= C1 + R \cdot \cos(S) \\
X_{\text{new}1} &= X_{\text{new}} + 1
\end{align*} \]

\[ \begin{align*}
Y_{\text{new}} &= Y_1 - 2 \\
B &= \frac{(Y_{\text{new}} - C2)}{R} \\
S &= \sin^{-1}(B) \\
X_{\text{new}} &= C1 + R \cdot \cos(S) \\
X_{\text{new}1} &= X_{\text{new}} + 1
\end{align*} \]

\[ \begin{align*}
T &= \frac{(Y_1 - Y)}{(X_1 - X)} \\
Y_{\text{new}} &= Y - 2 \\
X_{\text{new}} &= X_1 - \frac{(Y_{\text{new}} - Y)}{T} \\
X_{\text{new}1} &= X_{\text{new}} + 1
\end{align*} \]

\[ \begin{align*}
T &= \frac{(Y_1 - Y)}{(X_1 - X)} \\
Y_{\text{new}} &= Y_1 - 2 \\
X_{\text{new}} &= X_1 - \frac{(Y_{\text{new}} - Y)}{T} \\
X_{\text{new}1} &= X_{\text{new}} + 1
\end{align*} \]
Input DXF File for Upper Half Part Outline

Change DXF File into DBF File

Extract Information for Arcs and Lines

Generate Data for Tool Paths for a Series of Rough Cuts Followed by the Finishing Turning Operation

Processing for Generating NC Programs

Figure 5 Process Sequence in Case of Turning Operation