IFA Biodiesel Project

Proposal to Establish a Stepping Motor Manufacturing Plant in West Africa

Industries For Africa Foundation
Ring Group
Sweden

"A curious thing about knowledge is the way it retrieves complexity into simplicity and the impossible into the achievable."

Background

The long-term objective of the IFA Foundation is to practically support the establishment of all the industrial resources needed to support the production of a totally "green" Biodiesel produced from oil plants grown in otherwise unusable, or marginal, lands in the African Sub Saharan zone. The specific IFA objective is the annual production of one million tonnes of refined fuel from five hundred thousand Hectares of marginal land in Senegal.

Without local production and support of the needed infrastructure and direct production equipment, it is the Foundations view that any such fuel production would be skewed to the disadvantage of the African peoples.

The production of one million tonnes of Biodiesel results in the co production of two million tonnes of seedcake. The seedcake is in itself viable as a "solid fuel" able to be used to fire the boilers for steam and electric power generation – it can also be used as a fuel for the thousands of agricultural tractors needed. (See IFA Tractor Project)

A further use is as the energy and carbon feedstock for any iron smelting process thereby enabling the "green" tag to be applied to all of the industrial developments needed - from the smelting of iron ore through to the production of tractors, power generating systems and refinery equipment.

Fundamental to all of these developments is the use of CNC machine tools. Recent developments in the use of personal computers to control machine tools at a very low cost have created a window of opportunity for Africa to establish precision machining facilities with a manageable level of capital investment.

The Foundation has released the design rights for a CNC machine tool to the Swedish Company Ring Machine Tools Donso AB. This machine is designed for the western small business and hobby market. One important component for their production is the steady supply of low cost electric stepping motors Such a device is also fundamental to the development of engineering production modules for the whole project - and can be considered the first step for the transfer of knowledge to any local industrialization.

With sufficient forward orders from RMT AB to be viable, a start can be made on creating in one country the "knowledge base" which can in the future supply and support the engineering equipment needed for any serious biofuel production in Sub Saharan Africa.

This paper describes the detailed planning, processes and costs required to establish this first plant in West Africa. One of the many small industries, which need to be established across the Sub Saharan region to achieve the long-term goals of the IFA Foundation - a step toward contributing to the economic development of the region.

1. The Stepper Motor

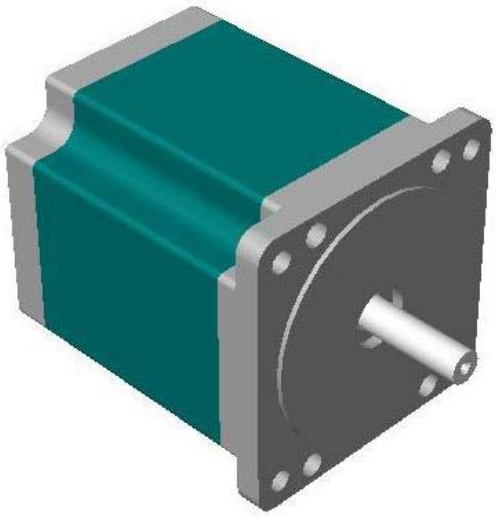
A stepper motor is an electromechanical device, which converts electrical pulses into discrete mechanical movements. The shaft, or spindle, of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. They are the main component enabling a computer to control the motion of any machine tool. More powerful and higher speed servo drive systems are also used for larger systems, however that is a development for any future of a successful company and not necessary to consider at this time.

The principles involved have been known since the development of electrical machinery and steppers have been used for many decades. They are however best suited to digital control and did not become popular until the advent of the digital computer – since when they have appeared in a wide variety of equipment ranging from tiny units in desktop printers to more powerful drives used in computer controlled positioning systems. In one size or another they have become one of the key building blocks in the age of computer-controlled automation.

Steppers are in production in many parts of the world – however, as with all industrial developments, a key part is to have all possible components produced and understood within the structure of the economies concerned.

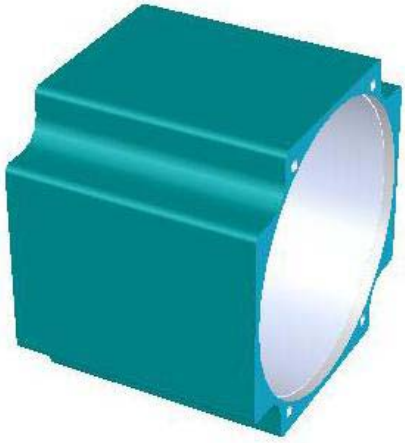
Four standard sizes have been chosen for manufacture and these will cover the majority of the projected applications – commercial viability will be achieved with the one size required by the Swedish RMT AB Company. This size is very common in further European markets, so this business plan will concentrate on that unit alone leaving the remainder as opportunities for significant future growth of the Company.

Specifically the chosen start size is a NEMA 34 (86 millimeter) frame motor as pictured on the following pages at both a complete and component level. Component part descriptions are carried forward to describe the manufacturing and assembly facilities required. Phase one is using imported stock materials with later phases projected where raw materials will be sourced and processed within the African Continent as part of later developments needed for the whole Biofuel project.



The Stator Assembly is made up of the following components.

The Stator Lamination Stack, 110 individual parts pressed from 0.5 mm Silicon Iron sheet.



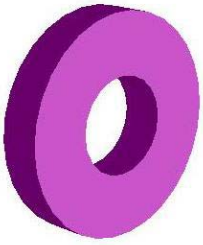
The Motor housing NC machined from cast or extruded Aluminum tubing.

The complete Stator with winding, hand wound with enameled copper wire.

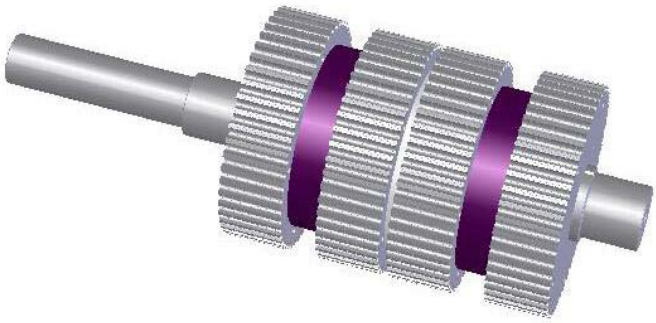
The Rotor Assembly is made up of the following parts.

Rotor Shaft, CNC machined from steel

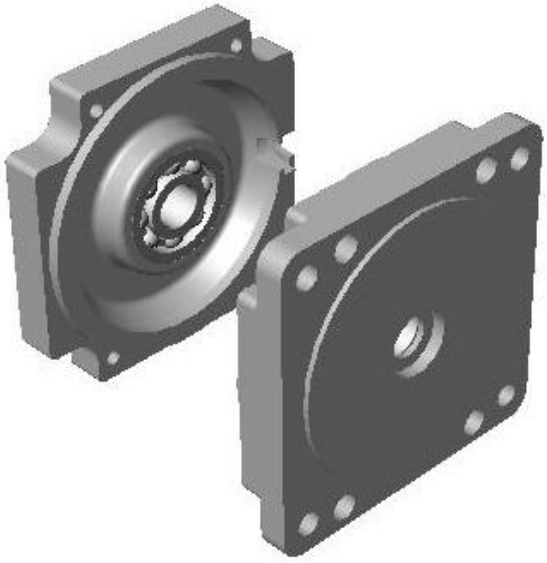
Rotor Lamination Stack – 21 pieces stamped from 0.5mm silicon iron sheet.



Rotor Magnet – Hard Ferrite material.



The Rotor Assembly



Motor end plate and bearing assemblies - machined from aluminum sheet or castings.

2. Motor Assembly

Assembly procedures are largely manual with some purpose made jigs and fixtures to aid in alignment and handling of components. Epoxy impregnation of the stator assembly, magnetizing and testing requires some purpose built equipment.

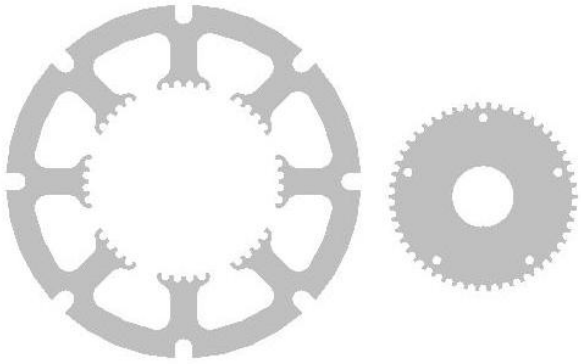
This is relatively low cost equipment to be supplied by the Ring Group for the first generation of motors. A reasonable development of knowledge within the plant will allow future such needs to be locally met in co-operation with the main project design team. The Ring Group will continue to be available to support this venture until this point is reached.

As with any start up plant the initial focus needs to be on teaching the basic steps and establishing an appropriate quality standard for the product.

The initial production assembly rate is to be set at 100 units per week. This could be considered leisurely by competing standards but adequate to achieve viability in these circumstances. Certainly low enough to be manageable through the learning curve everyone will face until staff selection procedures and training can be properly established. Familiarity and developed knowledge will inevitably lead to a situation where serious marketing can be undertaken and production can be ramped up to whatever level this leads to.

3. Component Production Machinery and Tooling required

1. Sheet metal pressings

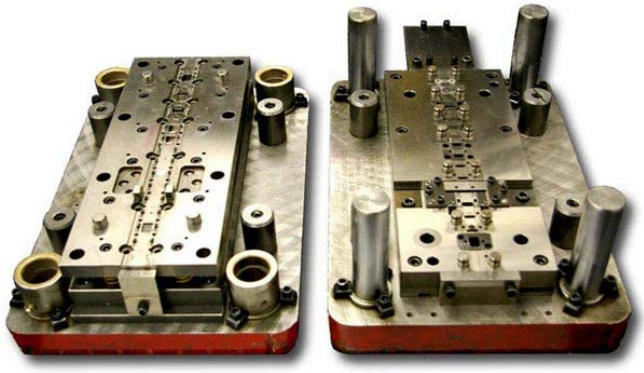


Stator and Rotor lamination pieces

This operation requires the largest single piece of equipment – namely a metal punching power press. The force required to blank the Stator component is around 20 tons; so allowing some margin for larger motors in the future a 45-ton press will be adequate.

A typical press is pictured below - such presses are readily available in the west second hand machinery with a located suitable unit costing 10,000 Euros for the press itself and another 5,000 for the roll feeder and straightener.

The Die Set, or tooling, is a very important part of the process. Before the advent of CNC controlled die cutting machinery such tools were largely hand made by skilled craftsmen. As such they were very time consuming and expensive steps in the process of setting up an operation such as this. Recently CNC has led to high accuracy with a lower skill level, but the capital structure of modern western companies has kept the cost of such operations high.



Punch and Die example (not this product)

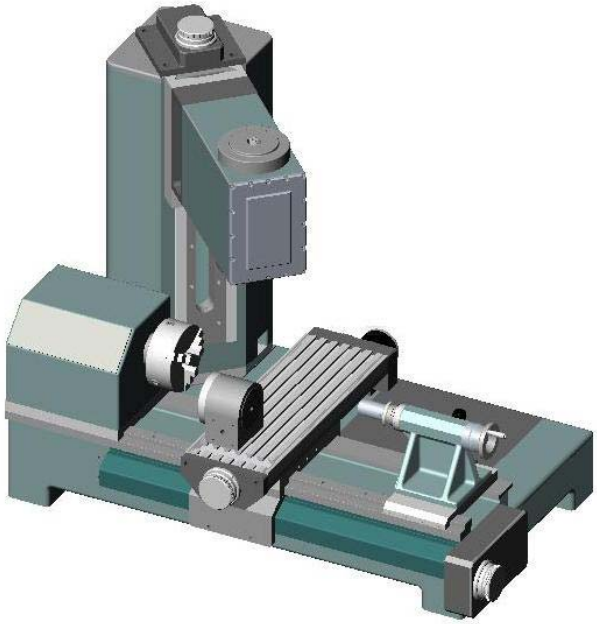
It will not be practical to include any toolmaking capability within this one venture for a considerable time – if ever – so the Ring Group will provide the specific tools needed for the first stepping motor.

Future developments and both emergency and routine maintenance of tools will require access to such facilities, so the Foundation will support the development of this resource within the engineering technician training at a local technical institute – with both skills and equipment.

Such a co-operation between an institute and this company could only have positive benefits in the support of the company within an "economic fit" and play a key part in future ventures that will be started there in the support of the whole project.

2. Turned and Milled Components

The combination CNC milling machine and lathe presently being built by Ring Machine Tools (3D CAD picture below) can provide all the precision machining capability required for the manufacture of the shafts, housings and endplates. Operating this machine will require one computer of medium performance. No product specific tooling is required.



Material for these components can be Aluminum or cast iron and steel – depending on the motors application – so a small foundry capability will be included in the plant equipment to avoid any dependence on stock sized material not readily available.

4. Purchased Components and Materials

Purchased components per unit (USD)

1	60 meters of 0.7 mm magnetic wire.	0.2 Kg	5.00
2	2 x 12 mm Ball Bearing sets	3.50 ea	7.00
3	8 x Mtg screws M4 x 25mm Socket	0.12 ea	1.00
4	8 x Color coded connecting wires 0.5 meters		0.25
5	8 way Molex connector		1.00
6	1 x 12 mm circlip		0.04
7	2 x Ferrite Magnets 35 OD x 18 ID by 7 L. 0.90		1.80
8	0.5 mm Electrical steel (silicon iron)	4.5 Kg	4.50
9	Epoxy		0.50
10	Copperclad FR4		0.50
		Total	21.59

5. Direct Labour and Overheads

Direct Labour (Estimated on 100 units/week 10 people)
(Starting figure only)) 02.00

Overheads (not known at this point – estimated 100% on direct labour) 02.00

Direct Materials and labour then gives a direct cost to manufacture of around 26 USD

6. Capital Equipment Costs

Total capital equipment costs are estimated at 45 000 USD using equipment bought on the second hand machine tool market in Europe with another 5000 USD estimated for shipping to the chosen location.

This equipment includes all the production machinery – CAD/CAM workstation and software.

Assuming a 5-year amortization and a reasonable finance cost the capital recovery will amount to less than 5 USD per unit giving a breakeven price of about 31 USD per unit.

Factory and building costs are not estimated at this time but are not thought likely to be disproportionate. Building area required is estimated to be no more than 150 sq M with the only special consideration being a concrete foundation for the power press and machine tools.

7. Required Skills and Training

Skills can initially be broken down into 4 areas:

- Management and Administration
- Production Operator skills
- Plant, Equipment and Tooling maintenance
- Technical Management and Development

The first is straightforward and represents no more than the normally locally available skills with basic financial and people management.

Likewise Operator training presents no particular difficulty as all tasks are broken into easily managed steps with initial training provided by Ring Group Personnel.

Plant and equipment maintenance does present some more specific difficulties however the skill level required can be taught, for example, to one already skilled to the level of motor car or appliance repair.

Tooling maintenance is a more specialized skill and will need to be developed in co-operation with the nearest Technical Institute willing to undertake such training and support with the IFA Foundations support.

Technical management and ongoing development does require skills to a level probably in excess of that available locally. While the basic knowledge may well be in place with one who has studied engineering at an African University the specific skills will need to be taught or have been learned at a similar production facility somewhere.

It is the Ring Groups view that none of the staff required for such an operation should be foreign, or expatriate, engineers. A suitable Technical Manager therefore will have to be located for training in Sweden during and with the construction phase of this specific proposal.

Many individual skills in the areas of Materials Management and Quality Assurance etc. will need to be developed – this should be supported by technical institute courses with Ring Group assistance.

8. Ownership and Finance

It is specifically against the Groups philosophy to finance any company with any other mechanism but shareholder investment and normal interest institutional loans. High return Venture Capital or similar will not be considered. No company can grow and prosper, while maintaining its original ownership, if the first step to success immediately results in a non-sustainable debt generated simply in order to repay an investor.

Against that the Ring Group and the IFA Foundation have no specific policy regarding ownership - the company simply belongs to its shareholders.

This proposal will result in a company that needs to raise about 50 000 USD to acquire all its capital equipment and a smaller yet to be determined amount to cover its operating costs before the cash flow becomes positive.

Initially sales to Ring Machine Tool AB alone will generate a sales turnover of around 120 000 USD per year estimating a gross margin of about 30 percent on turnover. The full 5000 per year sales would take that to about 200 000 USD with a higher margin.

The precise details of share capital versus Bank finance need to be discussed with interested parties before any decision is made. The Ring group will consider shares for payment of part of that capital need, however no figure is predetermined so ownership is something yet to be determined.

The Foundation and the Group will co-operate to ensure adequate support is available during the start up phase without significant costs - and further co-operate with any Technical Institute to help establish training programs to ensure the required skills are available in the future for this and other enterprises.

We would also strongly recommend the establishment of an apprentice type-training program in the company.

9. Additional Considerations

- Environmental controls

While not a particularly critical clean room operation the temperature range and dust will need to be limited, so consideration will need to be given to this when selecting a suitable site. Likewise with the building materials employed.

- Electrical supply

The plant will require a constant clean supply of electricity with a max demand of about 35 kW. If this proves difficult to provide or limits the selection of possible sites – then consideration should be given to establishing the plant in conjunction with an electrical generation capability proposed by the Foundation as part of the Biofuel project. A simple 30 kW diesel generating set or similar will not provide a satisfactory solution.

- Water Supply

A supply of fresh water is needed to the degree cleanliness can be maintained within the plant and operators can maintain clean sweat free hands during the assembly stages. Small scale pumping and filtration can be incorporated if so needed.

- Transport

Operational transport requirements are not severe with the need to ship less than 500 Kg per week to and from the nearest port of entry. The establishment of the plant will see the need to ship one 40 ft container to the location chosen plus any building materials.

10. Method of Establishment

Suitable engineering resources in terms of equipment and people are not likely to be available in many of the likely areas to actually establish the plant. The Ring Group will therefore undertake the construction of the facility in Sweden where it can be run and tested before being containerized for shipment.

This also provides the opportunity to train the key African personnel to the standard required.

11. Status

Product design is completed and equipment has been located – the Ring Machine Tool AB Company is established and will be demanding motors within 12 months.

This proposal will require 6 months to implement and a further 3 months to production.

A good starting time to forming the company and establishing ownership structure would therefore be now.

Frank Williams Göteborg 2007-10-08

Ring Group
Sweden