

# Use of Human Power in the Developing World

Rev. Dr. Jason K. Moore

Department of Mechanical and Aerospace Engineering  
University of California, Davis

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## Introduction

History

Human Power

## Machine Design

Transforming Human Motion

Energy Storage

## Real World Applications

Successful Projects

My Projects

Example case

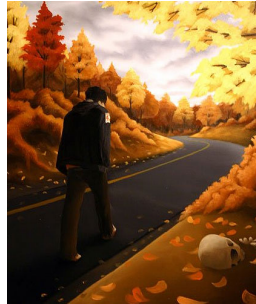
# Historical Uses of Human Power

## Transportation:

- ▶ walking and running
- ▶ hand carts
- ▶ rowing boats
- ▶ bicycle

## Tools:

- ▶ plow
- ▶ water pump
- ▶ food processors
- ▶ lathes, saws, sewing
- ▶ spinning



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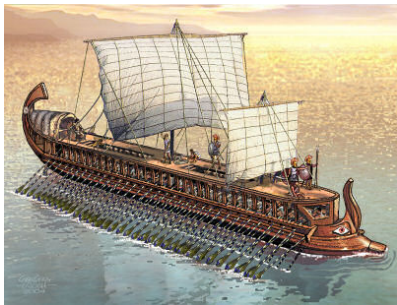
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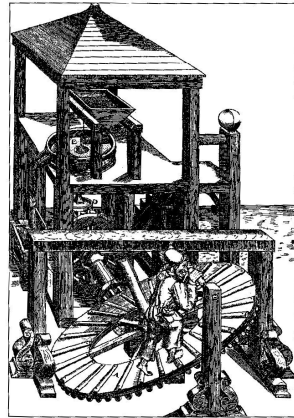


Figure 1.3  
Inclined treadmill powering a mill. (From Gnudi and Ferguson 1987.)

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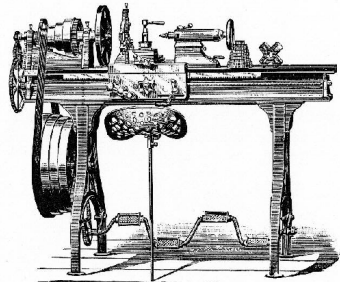
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Screw Cutting Engine Lathe No. 6.

13 Inch Swing



When ordering lathes, be particular to state clearly whether mounted with foot power or counter shaft; if with foot power, state whether self-gate or treadle.

Figure 1-24

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# The Human Machine

- ▶ We are energy transformers!

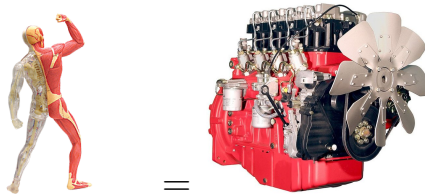


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- ▶ We digest our fuel (food) to supply our brain and muscles with the energy need to think and move.
- ▶ About as efficient as an Internal Combustion Engine (ICE)



# Energy and Power

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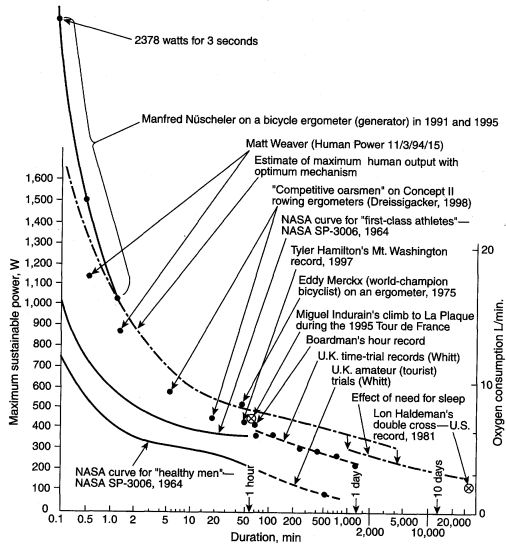
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Power

$$Power = \frac{Work}{Time} \text{ (Watt = } \frac{Joules}{Seconds} \text{)}$$



**Figure 2.4**  
Human power output, principally by pedaling. Curves connect the terminations through exhaustion of *constant-power* tests. (Data collected by Dave Wil-

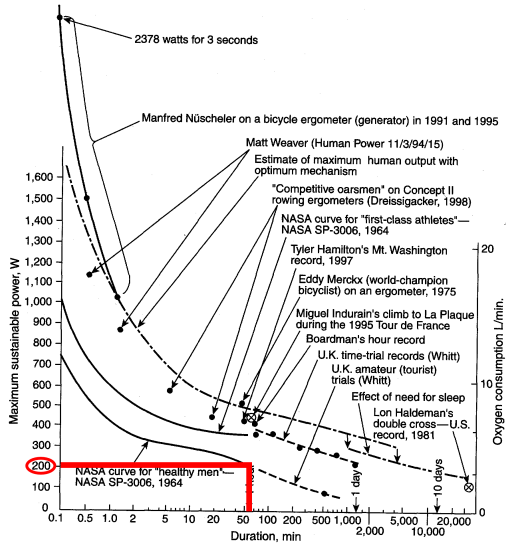


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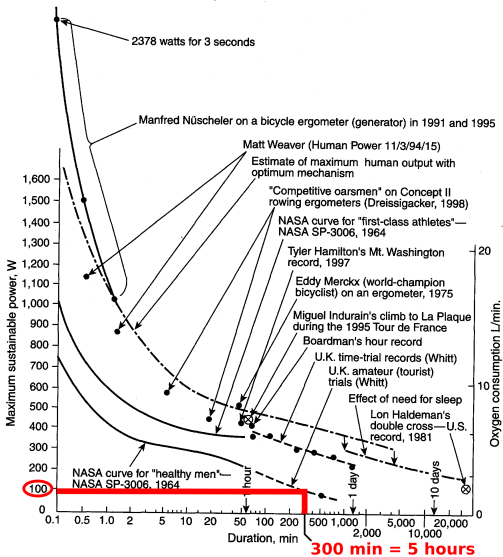


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- ▶ Pedaling and rowing: most efficient at moderate to high power.



## How efficient are we?

Thing	Efficiency
Human (food to mechanical)	18% to 26%
IC Engine	theoretical maximum: 35%, reality: 18% to 20%
Electric motors	65% to 95%
Transmissions	75% to 99%

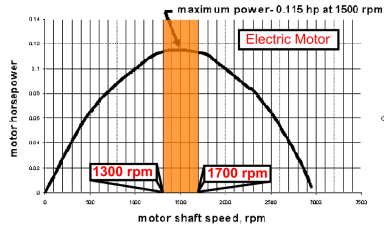
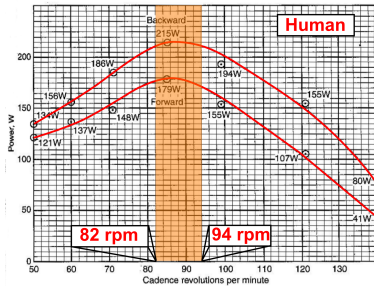
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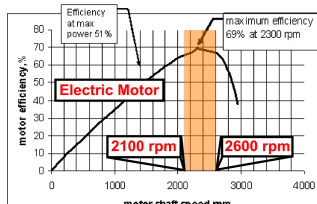
### Efficiency

Efficiencies stack by multiplication!

# Pedaling Rates

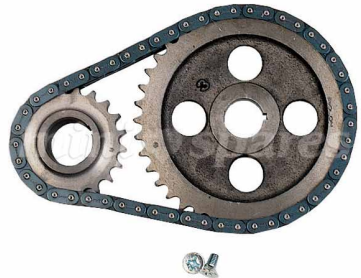


Wilson2004



# Pedaling to Rotational

- ▶ Chain drives: 90%+
- ▶ Shaft drives: 80-90%
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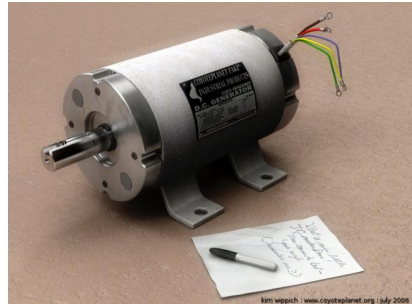
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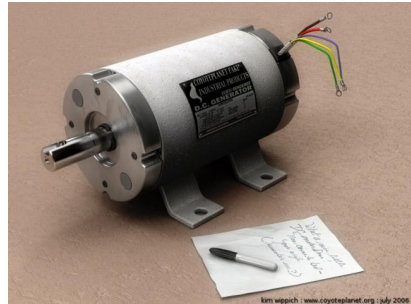
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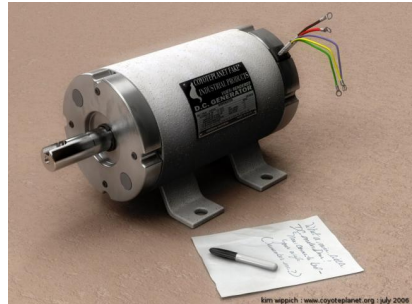
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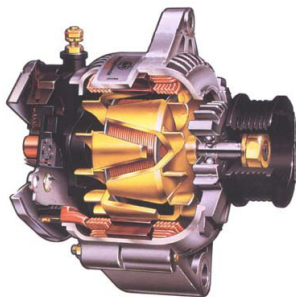
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- ▶ Rotational generators are most common: 65-95%
- ▶ Difficult to find low speed generators
- ▶ DC generators: voltage is proportional to the speed
- ▶ Alternators: minimum excitation needed, but easy to find



# Energy Storage Types

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- ▶ They all act as an energy buffer

# The Bicycle



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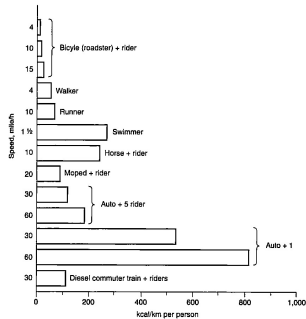


Figure 4.16  
Energy cost of human movement and of the propulsion of various vehicles.

# The Bicycle



[www.alaindelorme.com](http://www.alaindelorme.com)

# Water Pumps





# Kickstart Water Pumps



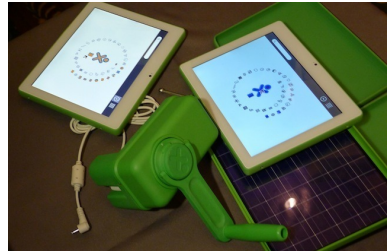
[www.kickstart.org](http://www.kickstart.org)

# The Full Belly Project



[www.thefullbellyproject.org](http://www.thefullbellyproject.org)

# One Laptop Per Child



# Low power electronics



# Rock The Bike



# Green Gyms



# R2B2 by Christoph Thetard



[www.christoph-thetard.de](http://www.christoph-thetard.de)

# iRock Rocking Chair



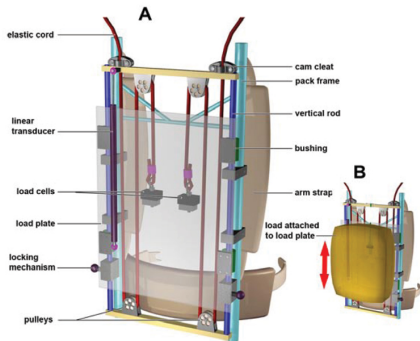
[http://www.treehugger.com/gadgets/  
irock-rocking-chair-charges-your-apple-device.html](http://www.treehugger.com/gadgets/irock-rocking-chair-charges-your-apple-device.html)



# Piezoelectric Dance Floor



# Electricity generating backpack



<http://www.lightningpacks.com>

# ZAmbulance and wheelchairs in Zambia, Africa

- ▶ Short distance transport for patients



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- ▶ Short distance transport for patients
- ▶ Materials are imported and very expensive
- ▶ Only NGO's can purchase and distribute



# Human powered machines in Guatemala

- ▶ Corn grinding for masa



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- ▶ Corn grinding for masa
- ▶ Rope water pump



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- ▶ Corn grinding for masa
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- ▶ Peanut sheller



# UC Davis Human Powered Utility Vehicle



# Mobile Ministry Unit



# Pedal Desk

- ▶ Power a laptop with pedal power
- ▶ Educate students on power usage
- ▶ <http://www.moorepants.info/portfolio/pedal-desk.html>



# How many people does it take to power a home?

[http://www.youtube.com/watch?v=C93cL\\_zDVIM](http://www.youtube.com/watch?v=C93cL_zDVIM)

# Olympic Cyclist Vs a Toaster

<https://youtu.be/S405vo0CqAQ>

# Whipped Cream



VERSUS





[www.moorepants.info](http://www.moorepants.info)

## Resources:

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