# PYRAMID®

Issue 3/33 July '11

# LOW-TECH


## THE DEADLY SPRING
by Douglas H. Cole

## AT PLAY IN THE FIELDS
by Matt Riggsby

## A KILLING BREATH
by Thomas Weigel

## MEDIEVAL PRISONS
by David L. Pulver

## ROMAN TECHNOLOGY
by Kenneth Peters

STEVE JACKSON GAMES

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*Bogan wæron bysige.*
*(Bows were busy.)*
*– "Song of the Battle of Maldon" (991 A.D.)*

## Article Colors

Each article is color-coded to help you find your favorite sections.

*Pale Blue:* In This Issue
*Brown:* In Every Issue (letters, humor, editorial, etc.)
*Dark Blue:* ***GURPS*** Features
*Purple:* Systemless Features
*Green:* Distinguished Columnists

**Cover Art**
*Denis Loubet*

**Interior Art**
*Greg Hyland*

# In This Issue

In bygone eras, innovators worked tirelessly to improve, invent, and innovate. We're bringing this entrepreneurial spirit to *Pyramid* with an entire issue devoted to *Low-Tech!*

The bow was the firepower of its era. Thanks to *The Deadly Spring,* you can have the same level of intricacy and nuance with bows that gun enthusiasts already enjoy in ***GURPS.*** Whether you like your bows cinematic or realistic, this detailed optional system lets you design amazing weapons to your exact specifications. For those who don't want to mess around with math, it also features 13 ready-to-use bows, from ancient to modern and everything in between. Fire away!

Find yourself *At Play in the Fields* with ***GURPS Low-Tech*** co-author Matt Riggsby as he reveals some optional agricultural rules that build off the foundation laid in ***GURPS Low-Tech Companion 3: Daily Life and Economics.*** Learn how to make money, improve farmland, and determine the ideal combination of crops and farmers to support the local aristocrat and his on-staff band of adventurers.

If you need a place to stay for a while, simply tell the local sheriff what you *really* think of him. You might get to "enjoy" the hospitality of *Medieval Prisons,* in the latest *Eidetic Memory* by ***GURPS Basic Set*** co-author David L. Pulver.

It's one of the most basic ranged weapons, and it can be among the deadliest in the right hands – or mouth. Discover how a blowgun can turn a puff of air into *A Killing Breath,* including ***GURPS*** stats for six blowgun sizes (plus nine types of ammo), an assortment of modifications, three new perks, and three new ***GURPS Martial Arts*** styles.

When in Rome . . . you *really* want to feel like you're in Rome. Kenneth Peters (co-author of ***GURPS Ultra-Tech***) can help. A perfect companion to ***GURPS Imperial Rome*** and ***GURPS Martial Arts: Gladiators,*** *Roman Technology* uses ***Low-Tech*** and its companions to detail the era's delights. It also includes ***GURPS*** stats for nine "new" vehicles. Beware of debunked myths!

Even with all this innovation, we appreciate the classics – as you'll see with this issue's installments of *Random Thought Table, Murphy's Rules,* and other interesting *Odds and Ends.*

Whether you're keeping the fields fallow or the feudal lords free, this issue has insight and information you can use. Create yesterday like there's no tomorrow!

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# From the Editor

## Unusual Innovation and Exotic Experiments

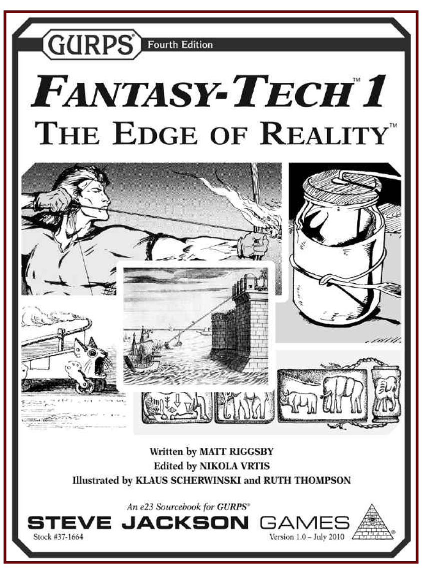
This issue presents one of the crunchiest articles we've ever run in *Pyramid,* with the bow-design rules in *The Deadly Spring* (pp. 4-15). (There's part of me who wants to contrive to do a World War II issue, just so I can title a sequel *Spring-Time for Hitler* . . .)

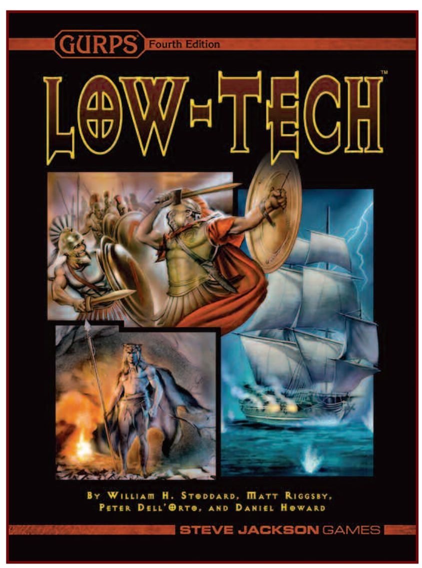
In a lot of ways, the crunch of that article is a throwback to earlier days of ***GURPS*** game-magazine goodness. I remember the confused delight I felt when I encountered Ann Dupuis' character design rules for horses from *Roleplayer* #21. ("Why on Earth would I ever want this? Hey, it's really cool . . . when can I use them in my game?!") Or the original mass combat rules from *Roleplayer* #30, which have gone on to have a long and healthy career in the ***GURPS*** universe.

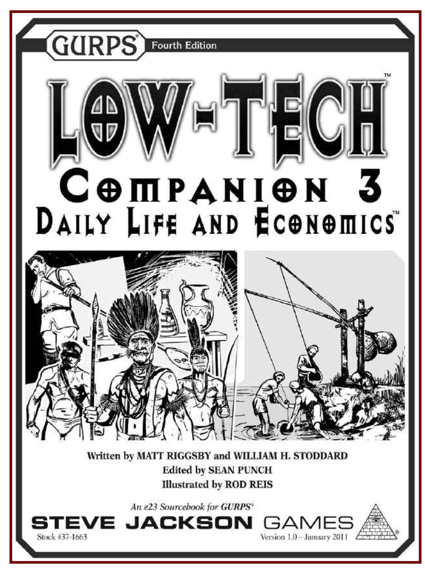
*Pyramid* is the place where we can try new and interesting ideas, and see how they stick. Of course, the important part of that idea is seeing how they "stick" – in other words, how much do you, the magazine-buying audience, like what we're doing? So this month we have a specific nod to the folks who really like crunchy design systems, plus some historical goodness, advanced agricultural rules, and a greatly expanded *type* of weapon that should open up all kinds of possibilities. Hopefully something there appealed to everyone . . . now we just need to figure out what to do more of!

## Write Here, Write Now

The best way to make your thoughts known is via the written word (unless you're my wife, in which case letting me know while I'm rooting around the refrigerator is a better bet). You can join the public discussion about this issue at **forums.sjgames.com.** Alternatively, you're always welcome to write us privately at **pyramid@sjgames.com.** We love to hear from you!



# The Deadly Spring

## by Douglas H. Cole

The bow and arrow in various forms has been used as a tool for survival for tens of thousands of years, and war for at least the last 5,000. Favored by woodland elf and Mongol horde, the bow is well represented in both fiction and reality.

This highly optional system (modeled on the engineering mechanics of beam bending) provides a way to generate variant ***GURPS*** game statistics for bows of most kinds. The design sequence is as follows:

- Choose the draw force, working length of the bow, and target draw length.
- Choose the bow components and materials.
- Select the cross section and shape of the bow staff; decide if you're building a compound bow or crossbow (or both!).
- Perform calculations to see if the bow can meet the design goals; adjust aspects if it's impossible to build. This may require some iteration!
- Select an arrow appropriate to the bow's desired use.
- Derive the game statistics.

When the design is finished, you'll have game statistics for the bow based on simplified real-world physics. For those who don't want to deal with the math to devise their own, a selection of over a dozen new sample bows is described on pp. 13-14.

Note that bows generated with this system have a "flatter" damage curve than the bows from standard ***GURPS:*** bows with low draw weight tend to be a bit higher in damage, while the higher draw weight bows are lower, especially using the "realistic" scale. Crossbows – with short draw lengths and heavy, inefficient limbs – see damage drop remarkably (though accurately). To compensate, archers can invest in Strongbow (***GURPS Power-Ups 2***, p. 7) and ST, Lifting ST, or Arm ST to draw the heaviest bow they can, especially if using an *optional* rule that cuts down aiming time if you pull at max force. The design system allows flexibility in bow design, with only the physics of springs and strength of materials as speed bumps.

> ### *Bow Terms and Evil Math*
>
> For a handy reference to terms related to bows, crossbows, and arrows, visit "Online Glossary of Archery Terms," *Wikipedia,* at **en.wikipedia.org/wiki/Glossary_of_archery_terms** and *The Crossbow Defined* at **thebeckoning.com/medieval/crossbow/xbow-def.html.**
>
> Bow design uses many complicated equations. A spreadsheet can help facilitate the process.

## Force and Distance

Bows are described with a draw weight (or force, F, in pounds) at a draw length (L, in inches): 45-70 lbs. at 28" draw are hunting bows, 100-160 lbs. at 30-32" draw might be suitable for a Mongol war bow, while 1,250 lbs. with a 7" draw might be a heavy, steel-limbed crossbow.

### *Draw Weight*

A bow may be drawn with both hands at up to 2.5 × Basic Lift (ST equal to the square root of 2 × F). A ST 14 bow is thus up to a draw weight of about 100 lbs. – considered low-end for an English war bow!

Crossbows and footbows may be drawn manually at a draw weight of up to 8 × Basic Lift (ST equal to the square root of 5/8 × F). The use of mechanical devices can increase this, and historical steel crossbows could have over 1,000 lbs. draw!

Lifting ST (p. B65) lets the archer draw a stronger bow by increasing his ST directly. Strongbow and Crossbow Finesse (***Power-Ups 2***, p. 7) increase drawing power through efficiency of movement and training. When figuring this improvement, *optionally* increase Basic Lift when calculating the allowed draw weight by 15% at DX+1 and 30% at DX+2 *instead* of increasing ST, keeping the bonus constant regardless of ST.

In standard ***GURPS,*** a bow's ST is used to determine damage. With the new system, ST is only used to rate if you can draw and hold aim – the interaction between draw length, efficiency, and arrow weight is too complicated for damage to be based only on ST, especially for crossbows.

#### Readying Time

An English longbowman would typically fire his war bow at a rate of roughly 10 arrows per minute, or six seconds per arrow. The most realistic way to model this in ***GURPS*** is as two Ready maneuvers to draw and nock an arrow, two Ready maneuvers to pull the very powerful longbow, one second to Aim, and finally one more to Attack.

As an optional rule, drawing a bow requires one Ready maneuver for each multiple of 2 × Basic Lift draw weight for the bow, or fraction thereof – up to the maximum values of of 2.5 × Basic Lift for a hand bow, and 8 × Basic Lift for a footbow or crossbow. This is in addition to the Ready maneuver needed to first retrieve an arrow and the second Ready maneuver properly nock it.

For example, an archer with Basic Lift of 34 lbs. would require one second to draw a hand bow of up to 68 lbs., and two seconds up to his maximum of 85 lbs. (for a *total* of three seconds or four seconds to reload). He would take three seconds to cock a crossbow of between 4× and 6× Basic Lift (137-204 lbs.), and require a mechanical device to span a crossbow of more than 272 lbs.

If you need to span a crossbow or siege engine too heavy to load manually, you'll need a mechanical device, such as one of these described in **GURPS Low-Tech** (p. 77):

*Goat's Foot:* Doubles your effective Basic Lift (not ST) but increases time to Ready by ×2.5. $50, 2 lbs.

*Belt Hook:* Halves the time required to cock a crossbow, due to superior positioning. $25.

*Windlass or Cranequin:* Increases the maximum weight you can span a crossbow by a multiplier (M), but it takes more time to ready. A windlass increases the time required to span a crossbow to 4 × M seconds; a cranequin to 8 × M. Cost is $25 × M for either. A windlass weighs M lbs.; a cranequin half as much.

### Draw Length

A bow design has a *target* draw length, and adjusts the parameters of the bow to attempt to meet it. Due to human size and biomechanics, draw length is usually 28-33". Modern hunting bows are usually specified at a 28" draw length, English longbows were drawn to about 30" based on the length of recovered arrows, and some Asian styles were drawn well past the face to 32-33". If designing a footbow, 60% of the archer's height is reasonable. A man-portable crossbow usually has 25-50% of the draw length of a typical bow (about 7-16"), while historical pistol-crossbows are probably only 4-8".

Humanoid creatures of alternate Size Modifiers multiply draw length by the same multiplier used for height: a SM +2 giant would pull to about 56"; a SM -2 halfling would pull a bow with a 14" draw.

### Bow Length

Choose the total length of the bow, and decide what percentage of the that length is the bow's *working* length (L); the remainder (R) does not flex appreciably, and is called a Riser. The nonworking parts of the bow add to max draw length and weight, but not energy storage.

## Material Construction

A *self-bow* is a bow made of a single piece of *wood*; a bow made out of a single piece of steel (or dragon bone) might make a fine bow, but is not referred to as a self-bow. A composite bow is manufactured from many materials. Historical composite bows might use wood, sinew, animal horn, and fish-bladder paste adhesive, cured over the better part of a year. Modern recurve bows are often fiberglass/wood laminates; compound bows are a mixture of carbon fiber composites and metal alloys.

Choose a likely material from the *Bow Materials Table* for the *working* parts of the bow. If making a composite (for example, a sinew-backed hickory bow), simply take the average of each of the density (ρ), breaking stress (B), and elastic modulus (E). Note that sinew *must* be averaged with another material.

### Bow Materials

Some materials are more common and effective than others for natural bow-making, and are listed in bold on the *Bow Materials Table* (below). Strong crossbows are more likely to use steel for their limbs, especially TL4 and later. Common arrow shaft materials are ash, birch, cedar, oak, and bamboo, as well as aluminum and carbon fiber tubes. Any material can be used to attempt a bow, so long as the materials properties are known. The GM is left to determine the properties of things like Essential Wood (***Magic***, p. 164) or bioplas (*Memory Materials* from ***Ultra-Tech***, p. 90).

### Bow Materials Table

| *Common Name* | *Density (ρ; lbs./in.$^3$)* | *Breaking Stress (B, lbs./in.$^2$)* | *Elastic Modulus (E, lbs./in.$^2$)* | *Buckling Constant (A)* | *Bow Cost/lb.* | *Arrow Cost/lb.* |
|---|---|---|---|---|---|---|
| Aluminum 7075-T6 (for arrow shafts and bow risers) | 0.101 | 72,500 | 10,400,000 | 0.72 | $50 | $14.30 |
| Apple (Horse Apple, Hedge Apple, **Osage Orange**) | 0.034 | 19,250 | 1,682,000 | 0.95 | $65 | $6.90 |
| Ash, Birch, or **Elm** | 0.023 | 13,000 | 1,560,000 | 0.87 | $46 | $9.30 |
| Aspen or Poplar | 0.014 | 8,250 | 1,260,000 | 0.77 | $38 | $12.50 |
| **Bamboo** | 0.035 | 21,750 | 2,610,000 | 0.84 | $52 | $10.30 |
| Carbon fiber composite | 0.070 | 275,500 | 16,965,000 | 0.34 | $637 | $33.60 |
| Cedar | 0.012 | 7,000 | 972,000 | 0.81 | $41 | $11 |
| Fiberglass | | | | | | |
| E-glass standard fiberglass | 0.054 | 253,750 | 6,525,000 | 0.65 | $1,827 | $16.80 |
| S-glass high-strength fiberglass | 0.072 | 341,000 | 7,690,000 | 0.70 | $2,111 | $14.90 |
| **Hickory** | 0.032 | 19,500 | 2,100,000 | 0.88 | $56 | $9 |
| **Horn** | 0.047 | 18,000 | 384,000 | 1.20 | $180 | $1.10 |
| Ironwood (Black) | 0.043 | 25,800 | 2,990,000 | 0.86 | $52 | $9.60 |
| Maple (Red, Sugar) | 0.022 | 14,500 | 1,740,000 | 0.81 | $55 | $11 |
| Maple (Silver) | 0.018 | 9,000 | 1,150,000 | 0.89 | $38 | $8.70 |
| Mulberry | 0.023 | 11,000 | 1,170,000 | 0.95 | $45 | $7.10 |
| Oak | 0.025 | 13,775 | 1,680,000 | 0.87 | $45 | $9.30 |

## Bow Materials Table (Continued)

| Common Name | Density (ρ; lbs./in.³) | Breaking Stress (B, lbs./in.²) | Elastic Modulus (E, lbs./in.²) | Buckling Constant (A) | Bow Cost/lb. | Arrow Cost/lb. |
|---|---|---|---|---|---|---|
| Pine (White, Red, Longleaf), Cherry (Black) | 0.019 | 12,250 | 1,595,000 | 0.79 | $51 | $11.90 |
| Silver | 0.373 | 60,000 | 12,000,000 | 1.05 | $1,000 | $1,000 |
| **Sinew** | 0.047 | 20,000 | 400,000 | 1.19 | $214 | $1.20 |
| Steel (TL3) | 0.281 | 105,000 | 30,450,000 | 0.70 | $13 | $15.10 |
| Steel (TL4) | 0.281 | 145,000 | 30,450,000 | 0.70 | $25 | $15.10 |
| Steel (TL5) | 0.281 | 217,500 | 30,450,000 | 0.70 | $55 | $15.10 |
| Steel (TL6) | 0.281 | 319,000 | 30,450,000 | 0.70 | $119 | $15.10 |
| Steel (TL7) | 0.281 | 464,000 | 30,450,000 | 0.70 | $252 | $15.10 |
| Walnut (Black) | 0.020 | 14,750 | 1,682,000 | 0.80 | $64 | $11.60 |
| Willow (Black) | 0.015 | 6,200 | 725,000 | 0.96 | $36 | $6.80 |
| Wrought Iron (TL2) | 0.274 | 43,500 | 28,000,000 | 0.72 | $2 | $14.20 |
| Wrought Iron (TL3) | 0.274 | 72,500 | 29,000,000 | 0.71 | $7 | $14.70 |
| **Yew, European** | 0.024 | 15,000 | 1,320,000 | 0.93 | $71 | $7.60 |

# Shape, Carve, Glue, Tiller

A bowyer works his craft from a raw form, carving or gluing the pieces together to form the bow stave. During this process, the overall shape and cross section of the bow is defined.

## Cross Section

The ***GURPS*** bow designer must decide the overall cross section of his bow, by exercising judgment in choosing first the gross cross section (round or D-section/rectangular) and then the width-to-thickness ratio for that profile. Truly circular profiles use round, with n = 1. The D-section bow is approximated as a square (n =1), though it is smoothed. The value of n may vary from roughly 0.5 (thicker than they are wide) to as high as 10 (bladelike); values much less than 1 are rare. The higher n, the more the working limbs flex under load, which is good for max draw length but bad for efficiency, as more energy goes into accelerating the limbs on release. Designers often tweak n, the actual thickness (t), and the working length of the bow (L) to arrive at the desired draw length and efficiency. Some specific examples are provide in the *Sample Bow and Arrow Summary Table* (p. 13).

A D-section bow is usually taken from a wedge of raw wood, with a natural tree ring forming the back of the bow. Round bows are made of naturally circular materials such as some animal horns or bamboo.

## Straight Bow

A straight bow is a bow stave with little bending in the limbs when unstrung. The classic example is the English longbow, though the Japanese *yumi* is effectively a composite straight bow. It is asymmetric, though not curved strongly enough to be considered a true recurved bow.

## Recurve Bow

Bending the limbs away from the archer when a bow is unstrung increases the energy stored in the bow. A recurved bow adds 15% more potential energy to the drawn bow, increases cost by 25%, and divides the effective breaking strength of the material by 1.3. (This isn't *strictly* true; it represents a multiplier to effective strain, but is expressed as a reduction in breaking strength.)

## Reflex Bow

A reflex bow has the limbs curving sharply away from the archer, so much so that they may even touch when the bow is unstrung. It has a much steeper force-draw curve than a recurve bow, and stores 30% more energy. Most wooden bows will fail when strained from its undrawn state to full draw; divide the effective breaking strength of a reflex bow by 1.6. Cost increases by 50%.

Most natural reflex bows are of *composite* construction, using horn/sinew for their huge allowable strain to failure. Some reflex bows are sinew/wood/horn; treat these as sinew/wood composites, since the back and core do most of the load-bearing.

## Compound Bow

The compound bow uses pulleys and cams to alter the mechanical advantage during the draw. At the end of the stroke, the cams fully engage and deliver a reduction in draw force, called *let-off*. The compound bow increases the stored energy in a bow by 60%, and reduces the Basic Lift required to hold the bow at full draw; Min ST is 2/3 of the bow's rated ST (a 60% let-off). Cost is increased by 100% over a straight bow. Do *not* reduce breaking strength of the component materials.

A compound bow may have a significant portion of the bow (35-65%) as a nonworking *riser.* In addition, the cable-and-pulley system increases the available draw length with smaller limb deflection.

## Crossbows

By mounting a bow sideways affixed to a support structure, the archer uses his entire body to span the bow, and to aim without straining. Design a crossbow by first designing the bow's limbs normally – you may certainly build a compound crossbow. Then add the weight of an *additional* riser of appropriate construction, strength, and length (usually 28-36", the same as the draw length of a bow, though pistol crossbows might be much shorter).

# Full Compass: Bending the Bow Stave

The next section details the calculations needed to validate a design. A spreadsheet can automate many of the calculations, to lower the mathematical burden and ease optimizing designs.

## *Bow Thickness (t)*

The minimum bow thickness ($t_{min}$) is the thickness (t) where bending under load (F) reaches a point where anything thinner overstrains (breaks) the bow. The minimum number will yield the highest allowed draw length; thicker limbs are chosen if deflection is too high, while a shorter bow might also be an option! It is possible that the calculated deflection (below) is not physically possible due the simplifications in the math. If the minimum thickness creates a deflection larger than 50% of the working length of the bow, it's nonphysical, and the limbs must be thicker or shorter, or have lower width-to-thickness ratio (n); see *Cross Section* (p. 6). If possible, find a combination with a deflection less than 35%; it keeps the design honest. Nonetheless, some reflex designs undergo amazing deflection in normal use!

The minimum thickness of the limb is equal to the *cube root of* [(k × F × L)/(8 × B)].

For a circular bow, k is exactly 64/π, or approximately 20; for a rectangular section, k = 12/n, where n is the width-to-thickness ratio of the working limbs. F equals the draw weight, in pounds. L equals the total length of the working limbs, in inches. B equals the breaking strength of the working limbs, in $lbs./in.^2$ (which can be found on the *Bow Materials Table* (pp. 5-6).

*Designing the ultimate bow . . .*

## *Deflection (δ)*

Deflection is how far the ends of the bow move when the bow is pulled to full weight and draw. It is described by the equation for the bending of a beam into a *circular* segment. This equation is usually applied to small deflections, but is much simpler than the more general case; as George Box said, "all models are wrong, some are useful."

$$\delta = (k \times F \times L^3)/(32 \times E \times t^4)$$

Here, E equals the elastic modulus of the bow material (see the *Bow Materials Table*, pp. 5-6), in $lbs./in.^2$. The variable t equals the thickness of the bow in the bending direction, from back to belly, in inches.

## *Maximum Allowed Draw Length ($D_{max}$)*

This value determines how far the combination of deflection and staff length would allow you to pull a bow. The equation allows for a nonworking riser (which will lengthen the allowable draw), and the impact of a compound bow's pulley system (which lengthens the effective bowstring length as the pulleys get closer to each other).

$$S = p \times (R + L) - (p - 1) \times \{R + [2 \times L \times \sin(\theta/2)]/\theta\}$$

Here, R equals length of riser, in inches; R + L is the total length of the bow. The variable p equals number of loops of string, usually three in a compound bow and one in a regular bow. Working string length (S) equals total bow height (R + L), if p = 1. L is the working length of the bow.

θ equals the angle subtended by the chord of the circle made by bending the working parts of the staff, ignoring the riser. It is approximately equal to 8 × δ/L for δ/L less than 10%. Look up δ/L on the *Nasty Transcendental Equation Table*, below, for deflections larger than 10% of the bow's length.

$$D_{max} = \delta + \textit{square root of} \left(\frac{S^2}{4} - \left[\frac{R}{2} + \frac{L \times \sin(\theta/2)}{\theta}\right]^2\right)$$

For a fully working straight bow, S = L and R = 0.

### Nasty Transcendental Equation Table

Look up δ/L on the table below to find the extent to which your bow stave is turning into a circle! As the angle of the bow gets closer to a semicircle (3.14 radians, or 180º), each small increase in δ/L changes θ a great deal. Deflections *greater* than a full semicircle are rare, even for highly reflexed composite bows, though they can be done – the stiff tips (*siyahs*) on some ancient composite bows allow exactly this!

The equation for δ/L > 10% is δ/L = [1 - cos(θ/2)]/θ; this can be solved numerically in a spreadsheet if you don't want to use the table.

| *Deflection/Length (δ/L)* | *Theta (θ)* |
|---|---|
| 0.01 | 0.08 |
| 0.02 | 0.16 |
| 0.03 | 0.24 |
| 0.04 | 0.32 |
| 0.05 | 0.40 |
| 0.06 | 0.48 |
| 0.07 | 0.56 |
| 0.08 | 0.64 |
| 0.09 | 0.72 |
| 0.1 | 0.81 |
| 0.11 | 0.89 |
| 0.12 | 0.97 |
| 0.13 | 1.06 |
| 0.14 | 1.15 |
| 0.15 | 1.24 |
| 0.16 | 1.33 |
| 0.17 | 1.42 |
| 0.18 | 1.50 |
| 0.19 | 1.60 |
| 0.20 | 1.70 |
| 0.21 | 1.80 |
| 0.22 | 1.90 |
| 0.23 | 2.00 |
| 0.24 | 2.10 |
| 0.25 | 2.22 |
| 0.26 | 2.33 |
| 0.27 | 2.45 |
| 0.28 | 2.58 |
| 0.29 | 2.71 |
| 0.30 | 2.85 |
| 0.31 | 2.99 |
| 0.318 | 3.14 |

## *Oops . . . It Didn't Work*

It's (very) possible to build a design that doesn't "close," where the actual deflection is too large, the draw length is too short, or the selection of materials makes the bow too heavy. Either try a material with a higher maximum strain, lengthen the limbs, or try a lower draw weight bow that is recurved or reflexed to get the desired energy output from the design. Designing with many independent interacting variables is a tricky business!

# Nonworking Limbs: Risers

Many real-world designs, including compound and Olympic recurve bows, have a center section of material that is designed to *not* deflect. Called a "riser," this section allows shorter working limbs while increasing the length of the string, lengthening the draw and reducing deflection. Calculate the working parts of the bow, represented by the length L, ignoring the riser. A riser of height R increases the total length (H) of the bow. Design the stock of a crossbow the same way as a riser. It adds a nondeflecting chunk of weight to the weapon.

Choose the riser/stock material as you would a normal bow; riser materials should ideally be very stiff (high elastic modulus). Then choose the allowable deflection in the material (δ/R) – this is usually a *very* small number, such as 0.02% to 0.1% of riser length. Choose the width ($w_R$) of the riser in inches, and calculate the required thickness ($t_R$) that will provide the allowed deflection:

$$t_R = \textit{cube root of } \{[F \times R^2]/[4 \times E \times w_R \times (\delta/R)]\}$$

Calculate the thickness of a crossbow stock the same way, except instead of the riser size, R, use the crossbow draw length, D. Be sensible: a bow will likely not be designed with a 0.5" width and 20" riser depth, even though it's the most efficient use of mass.

The weight of the riser is

$$\text{Riser Weight} = \rho \times w_R \times t_R \times R$$

For a crossbow, replace the riser size (R) with the length of the crossbow stock from end to end to calculate weight; this will often be 28-36"; pistol crossbows will be smaller. The riser size must be larger than the draw length (D).

## *Bow Weight*

The weight in pounds of the bow stave will be simplified as a function of the length and cross section.

$$\text{Weight} = (\rho_W \times L \times t^2 \times c) + \text{Riser Weight} + \text{Stock Weight}$$

Here, $\rho_W$ is the average density of the working bow limbs in lbs./in.$^3$. L and t are the length and back-to-belly thickness of the working bow staff in inches. The variable c depends on the cross section of the bow: c = 0.785 for a round bow, and c = n (the width-to-thickness ratio) for rectangular or D-section bows.

## *Stored Energy*

The Joules of potential energy (PE) stored in the bow, some of which will be used to propel the arrow, can be expressed as

$$PE = F \times D \times Z$$

Here, F and D are draw force (lbs.) and draw length (in.). Z is the modifier for the bow shape and construction; Z = 0.057 for a straight bow; 0.065 for a recurve bow; 0.073 for a reflex bow, and 0.090 for a compound bow. (The energy is expressed in Joules because the author has an admittedly irrational dislike for the foot-pound.)

## *Bow Efficiency*

The efficiency of a bow is the ratio of the energy launched in an arrow to the energy initially stored in the bow during the draw. After bending a bow to full draw, releasing the string accelerates the limbs of the bow as they snap back to the braced shape, accelerating the bow rather than the arrow.

The equations for bow efficiency assume that the moving bits of the bow have an "effective mass," as if a virtual arrow were launched alongside the deadly one. The equation below is educated guesswork, not based on first principles. A bow with *working* density ρ (lbs./in.$^2$), and t and L in inches has effective mass:

$$M_e = 37 \times \rho \times t^2 \times \textit{square root of } (n/L)$$

Efficiency (η) is expressed as:

$$\eta = 1/(1 + M_e/M_a)$$

$M_a$ is the mass of the arrow (a ***GURPS*** standard arrow weighs 0.1 lbs.); $M_e$ is the effective mass.

The kinetic energy in the arrow is:

$$KE = \eta \times PEwro$$

## *Bow Damage*

Standard ***GURPS*** bows' damage ranges from thr to thr+5 depending on bow type. As little as 1d-1 damage can penetrate the DR 4 of a mail shirt; this can be delivered by anything from a ST 11 (60-lb.) short bow to a ST 5 (12.5-lb.) composite bow. This leads to an odd image of European battlefields strewn with arrow-studded bodies of warriors wearing mail armor. In reality, arrows were only that effective against unarmored opponents, and the bows used were certainly more powerful than 60 lbs.

A 9mm pistol bullet inflicts an average of 9 points of damage (2d+2 pi); a ST 19 composite bow in the standard ***GURPS*** system can equal this performance – and do impaling damage to boot! The bullet delivers over 580 Joules of energy, while a 128-lb. (ST 16) bow with 65% efficiency might deliver 135J.

An arrow has roughly a quarter of the bullet's energy, and – treated as a firearm – should have roughly half the penetration potential: 1d+1. A ST 16 yew bow designed using this system might be 128 lbs. draw, 30" draw length, 78" fully working limbs, n = 1, 1" thick, weighing 2 lbs. Efficiency with a 0.17-lb. war arrow is 61%; the bow delivers 134J.

Neglecting the diameter of the arrow shaft for the sake of simplicity, bow penetration will be proportional to the square root of kinetic energy**.** Convert KE to damage using one of the following methods:

- Cinematic scale: Damage (points) = *square root of* (Kinetic Energy)/1.75.
- Realistic scale: Damage (points) = *square root of* (Kinetic Energy)/2.5.

Convert points to dice at 3.5 per die, keeping only whole number adds; e.g., 4.4 points of damage is 1d, while 4.6 points is 1d+1. Cinematic scale matches the damage of a ST 16 longbow from ***Basic Set*** (p. B275) at 1d+3 (6.5 points of damage; 130J). Realistic scale sets that same bow at only 1d+1 (4.5 points of damage), scaling better with higher energy firearms.

## *Range*

***GURPS*** assumes that bows are going to be used for typical adventuring purposes: punching holes in nasty creatures and armored men. The standard arrow in ***GURPS*** is 0.1 lbs. – this might be equal to a 31" aspen shaft 31/64" in diameter with an unbarbed light war point. The maximum range of an arrow of energy KE (Joules) and mass $M_a$ (lbs.) is:

Range (yards) = $0.34 \times KE/M_a$

Changing the mass of the launched arrow *also* changes the efficiency of the bow: Lower weight arrows travel farther, but the bow puts more energy into accelerating its own limbs! The square root of $(5.28 \times KE/M_a)$ is the velocity (V) of the arrow in yards per second – you'll need this number to figure the bow's accuracy.

*Example:* A Korean *hwal* is reported to shoot flight arrows (0.044 lbs.) to roughly 380 yards. Designed as a reflexed 70-lb. bow of 5:1 cross section (k = 2.4; n = 6), 32" draw, and a 60" total length, the construction is a bamboo/sinew composite for the limbs, with a bamboo/horn riser; 88% of the bow is assumed to be working. The calculated thickness is 0.44" (and 2.4" wide). The 7.35" riser is 0.8" wide and 1.04" thick. The final bow weighs 2.3 lbs., and is 33% efficient with a 0.044-lb. arrow. The KE of the arrow is about 50.5 Joules, reaching 390 yards – fairly close. The key was materials selection: the bamboo/sinew composite proved the right mix of stiffness, strength, and density.

## *Accuracy and Bulk*

*Bulk* is a function of the length of the bow.

Bulk = $9 - 9 \times \log_{10}(L + R + Stock)$

Here, L and R in inches. *Stock* is the length of a crossbow stock, in inches. Round fractions normally.

A bow's *accuracy* combines the speed of the arrow and the length of the bow: Longer, stable bows shooting fast arrows will be more accurate.

Acc = $3 \times \log_{10}(V) - Bulk/2 - 7.5 + C$

Here, V is the arrow velocity in yards per second; remember that Bulk is a negative number. C is -1 for a foot bow, 0 for hand bows and pistol crossbows, and 1 for a two-handed crossbow. Minimum Acc is 0, maximum 4.

As an option, also compare your actual ST *including* Strongbow to the ST of a hand or foot bow. When aiming, if your ST is equal to the ST of the bow, take a -2 penalty to skill; decrease the penalty by 1 for every +1 ST until the penalty is zero. In addition, you may only hold an Aim maneuver for as many seconds as your ST, Lifting ST, or Arm ST exceeds that of your bow. Most powerful bows are drawn and released into an area, not used for sniping; crossbows do not suffer from this liability.

*Arrow Travel*: An arrow might take many seconds to reach a distant target. ***GURPS Tactical Shooting*** has a nifty rule for modeling reduced skill for projectiles that take a while to get to their target (*Bullet Travel*, ***Tactical Shooting***, p. 32) – making the rule quite pertinent.

## Nerf Bows

The rescaling of damage to match the scaling of firearms seems like it makes bows pitiful. Not true. A 200-lb. (ST 20) yew longbow firing an armor piercing barbed war arrow weighing 0.23 lbs. will do 1d+2(2) imp using the realistic scale, and 2d+1 (2) on the cinematic scale . . . both very respectable penetrations even against hardened armor, and devastating against cheaper stuff. Rescaling actually helps very *light* bows. A 35-lb. (ST 9) fiberglass bow will deliver an aluminum hunting arrow at 1d imp on the cinematic scale closest to the *Damage Table* (p. B16), an improvement over the 1d-1 imp for a regular bow of that ST. A 14 J arrow from a pixie bow would still do 1d-2 imp!

Where damages *do* get a bit odd is for crossbows. Short draw lengths and heavy, inefficient limbs mean that a steel-limbed ST 28 crossbow (1,250 lbs. draw, 7" draw length) might only do 1d+1(2) imp damage – light crossbows of "only" a few hundred pounds draw will be even lower. While surprising, this is historically accurate; an actual 740-lb. draw medieval crossbow (ST 22) test-fired a 0.08-lb. bolt at 140' per second: only 33 Joules (1d-1 imp)! Longbows were described as out-ranging crossbows in period writings. The advantages of the crossbow are similar to those of firearms: easy to aim, easy to train, and the weapon could be readied beforehand. Fired from a mount, anyone could aim and squeeze the lever.

## *1/2D Range*

All projectiles lose velocity as they travel through the air. Arrows, being long and thin, concentrate a lot of mass behind a relatively narrow cross section: a 0.22-lb. war arrow has twice the sectional density (weight divided by frontal area) of a .50 caliber machine-gun bullet! When that war arrow plunks itself into the ground (or its target) 250 yards down range, it may only have lost 15-30% of its starting velocity (and thus 15-30% of its damage).

A simplified calculation for arrow 1/2D range (in yards) is:

1/2D = $750 \times M_a/d_o^2$

For $d_o$, see *Arrow Shafts* (p. 10). The 1/2D Range may equal or even exceed the max range of the arrow, especially for heavy war arrows. In this case, the arrow does full damage for its entire range.

Alternately, lose -1 damage *per die* for every $430 \times M_a/d_o^2$ yards of range, providing more granularity in damage at long range. This allows a real trade-off: Heavy war arrows have short range but good damage retention; flight arrows have long reach, but arrive with anemic damage.

## *Cost*

Bows are priced per pound of total weight, based on the material components of the bow. Look up the cost per pound for each part of the bow: limbs, riser, and stock (for crossbows) and sum the individual costs. Cheap bows are available for ×0.7 of listed cost, at -1 Acc (minimum Acc 0), while fine (accurate) bows are ×4 cost.

A well-designed riser costs less than a flexible limb, as does a crossbow support stock. Divide the cost for riser material by 5, and crossbow stock by 10.

Base material cost for limbs, risers, and stocks varies with the energy storage capability per pound (cost/lb. = $B^2/[100 \times E \times \rho]$). This makes fiberglass and carbon fiber bows *very* expensive . . . which they would be if these miracle materials were available at TL3! Divide TL7 costs for carbon fiber and fiberglass materials by 5, and TL8 by 10 as manufacturing improves. Use these prices as guidelines for magical materials that mimic the function of high technology.

Bow shape also plays a role in cost. Increase the entire cost of a recurve bow by ×1.25, a reflex bow by ×1.50, and a compound bow by ×2.

# Arrows

The ***GURPS*** standard arrow weighs 0.1 lbs. and has no armor divisor or barbs. Consider this a 30” aspen shaft, 0.5” in diameter (or a 36” long, 0.4” diameter bamboo shaft with 0.057” walls), with a light, unhardened broadhead or bodkin point (p. B277).

For a custom-designed arrow, first build the shaft, then add an arrowhead.

## *Arrow Shafts*

Arrow shafts are ideally matched to the bow from which they will be shot. Using a form of Euler’s buckling equation to solve for a required thickness, an arrow’s outer diameter ($d_o$) is:

$d_o$ = *fourth root of* $[(F \times \Sigma^2)/(A \times E_a)]$

Here, F is the draw force, Σ is the shaft length in inches, and $E_a$ is the elastic modulus of the arrow material. $A = 1.25 \times \exp(-5.4 \times 10^{-9} \times E_a/\rho)$, with $E_a$ and ρ (density) in units of lbs./in.$^2$ and lbs./in.$^3$, respectively.

An arrow of this diameter will weigh (in lbs.):

$M_a = \pi/4 \times \rho \times \Sigma \times d_o^2$

The arrow diameter is a fairly weak function of the bow’s draw force. For simplicity, it is reasonable to assume a 0.375” solid arrow diameter for a bow of 50-100 lbs., and 0.5” for a bow of 100-200 lbs.

Carbon fiber or aluminum tubes can be thinner and lighter, ideal for fast flight or hunting arrows; bamboo is naturally a hollow tube. If hollow arrows are desired, the equation can be solved with a spreadsheet: $d_o^4 - d_i^4 = F \times \Sigma^2/A \times E$; $d_o$ and $d_i$ are the outer and inner shaft diameters, respectively. Thus, for the mass of the hollow shaft, $M_{a,\ hollow} = \pi/4 \times \rho \times \Sigma \times (d_o^2 - d_i^2)$.

### Cost

Arrow shafts are priced per pound of shaft weight, where cost/lb. equals E/(7,200,000 × ρ); aspen is a reference costing $1 for a 0.08-lb. arrow shaft. Artificial hollow arrows (such as aluminum or carbon fiber, but not bamboo) are ×5 cost. Arrows may additionally be made fine (accurate) at ×4 cost, and you must use an accurate arrow to get a bonus from a fine (accurate) bow!

A war shaft will typically be made of dense wood, able to be shot from powerful bows and retain velocity well. Ash was a popular choice in England, and “arrow bamboo” is named for its most common use. Hunting, target, and flight shafts tend to be lighter, both for convenience and the materials’ faster and flatter shooting – cedar is considered an excellent material for a flight shaft, as are tubular synthetic arrows.

## *Sample Arrow Shaft Table*

| TL | Shaft Type | Material | Length (in.) | Outer Diameter (in.) | Inner Diameter (in.) | Weight | Bow Draw Weight (ST) | Cost |
|---|---|---|---|---|---|---|---|---|
| 0 | Flight Shaft, War Bow | Cedar | 29 | 0.450 | solid | 0.055 | 145 (17) | $0.60 |
| 0 | Hunting Shaft | Cedar | 29 | 0.361 | solid | 0.036 | 60 (11) | $0.40 |
| 0 | Hunting Shaft, Heavy | Aspen | 29 | 0.393 | solid | 0.049 | 100 (14) | $0.60 |
| 0 | War Shaft* | Aspen | 31 | 0.483 | solid | 0.08 | 98 (14) | $1.00 |
| 0 | War Shaft | Ash | 31 | 0.393 | solid | 0.086 | 145 (17) | $0.70 |
| 0 | War Shaft, Historical | Ash | 31 | 0.500 | solid | 0.140 | 98-200 lbs. (14-20) | $1.30 |
| 0-1 | Flight Shaft | Bamboo | 34 | 0.355 | 0.272 | 0.049 | 90 (14) | $0.50 |
| 3 | Wolfsbane Bolt | Silver | 18 | 0.323 | solid | 0.550 | 1250 (50) | $550 |
| 6 | Hunting/Target Shaft, Modern | Aluminum tube | 28 | 0.344 | 0.306 | 0.057 | 160 (16) | $4.10 |
| 8 | Flight Shaft | Carbon fiber tube | 19 | 0.157 | 0.106 | 0.015 | 72 (12) | $2.50 |
| 8 | Hunting Bolt | Carbon fiber tube | 22 | 0.344 | 0.304 | 0.033 | 175 (19) | $5.50 |
| 8 | Hunting Shaft, Modern | Carbon fiber tube | 28 | 0.295 | 0.23 | 0.057 | 72 (12) | $9.60 |
| 8 | Target Shaft, Modern Olympic Men’s | Carbon fiber tube | 28 | 0.197 | 0.148 | 0.028 | 50 (10) | $18.80 |

* This is the ***GURPS*** standard arrow shaft; add a light war point (p. 11) to get the 0.1-lb., $2 ***GURPS*** standard arrow.

## Arrowheads

Aside from the standard broadhead or bodkin points, a number of other options exist. The list of arrowheads is not comprehensive; other types can be found in ***Low-Tech,*** p. 73. To use those, choose an appropriate arrowhead weight. Standard arrows are impaling with no armor divisor, and cost $50/lb. Apply the following modifiers to cost for alternate types: cr is ×0.7, pi is ×0.8, cut is ×0.9; armor divisors are ×0.8 for (0.5), and ×4 for (2).

*Cost*: Arrowheads should be treated as costing $50 per pound for no armor divisor and imp damage type. Armor-piercing (AP) arrows cost $200 per pound; field points are $35. Modern hunting broadheads are $500 per pound, but may be treated as fine for the purpose of breakage, and feature replaceable blades if they *do* break.

### War Point

The war point is a deadly point meant to kill people, monsters, or monstrous people. These tips are purpose built to penetrate armor and rend flesh; only soldiers or troublemakers would need them!

War points are often barbed (see ***Low-Tech***, p. 73), and may be hardened steel as well. Metallurgical studies of period barbed broadhead war arrows found them constructed of hardened steel – enabling a (2) armor divisor.

Metallurgically, it's *possible* to build a "bodkin" style point that is hardened, fairly lightweight (0.02–0.045 lbs.), and has an optimal shape for penetrating metal armors. This "lozenge" style bodkin is historically accurate in shape, but testing of extant period examples does not reveal metal microstructure or composition consistent with high hardness. However, Hugh D.H. Soar in *Secrets of the English War Bow* describes "late bodkin" arrowheads that show corrosion patterns that would be expected on hardened steel or case-hardened iron; medieval bills of sale for arrowheads called out specific heat treatments for different prices . . . so the record is mixed. The GM may allow hardened arrowheads, or not, at his discretion. Because it's *possible* to build such arrowheads, they may have existed in limited use, or they could be normal in other worlds and times.

If armor-piecing arrowheads *are* allowed, the purchase of TL3 or TL4 metal armor that is very fine (hardened) should remove one step of armor divisor; TL5+ fine (hardened) armor would also qualify. This keeps the historical record intact: war arrows were known to be a threat versus poorly maintained or wrought-iron armor, but expensive and high-quality mail and plate available at the same time period was excellent protection against this threat. "Armor piercing" is relative: If the penetrator and armor are of the same high-quality metal and hardness, there's no advantage for either one.

### Flight and Target Heads

A flight arrowhead is a long-range missile built for harassment fire. A flight arrow can be *very* light: less than 0.05 lbs. A flight arrow will thus mount a bodkin or target point of very low weight (0.01-0.02 lbs.). Field and target points have a (0.5) armor divisor and do pi damage if less than 0.4" in diameter, or pi+ if 0.4" or greater. A fine arrow with 0.015-0.02-lb. head can claim one level of hardened, removing the (0.5) armor divisor but still doing pi damage – a decent weapon for massed volleys of harassing fire at extreme range. If you'd rather have a long-range war shaft, use a lightweight flight shaft and a light war point.

Flight arrows are typically made of woods with a high modulus to density ratio. These would include cedar, poplar, aspen, redwood, and spruce.

## Arrowhead Table

| *TL* | *Style* | *Damage Type* | *Armor Divisor* | *Weight* | *Cost* | *Notes* |
|---|---|---|---|---|---|---|
| 0 | Field or Target | pi | (0.5) | 0.015 | $0.50 | Bullet or field point |
| 0 | Hunting Broadhead | imp | (1) | 0.045 | $2.25 | Standard hunting broadhead |
| 0 | Hunting Broadhead, Heavy | imp | (1) | 0.09 | $4.50 | Wide cut for really heavy game |
| 0 | War, Light | imp | (1) | 0.02 | $1 | Unhardened square point; standard ***GURPS*** arrowhead |
| 0 | War, Light, Barbed | imp | (1) | 0.05 | $2.50 | Unhardened barbed war arrow |
| 0 | War, Heavy | imp | (1) | 0.05 | $2.50 | Heavy arrowhead for powerful bows |
| 0 | War, Heavy, Barbed | imp | (1) | 0.075 | $3.75 | Unhardened barbed war arrow |
| 4 | War, Light, AP | imp | (2) | 0.025 | $5 | Hardened lozenge shaped bodkin |
| 4 | War, Light, Barbed, AP | imp | (2) | 0.05 | $10 | Hardened Type 16, low-end weight range |
| 4 | War, Heavy, AP | imp | (2) | 0.055 | $11 | Hardened lozenge-shaped bodkin |
| 4 | War, Heavy, Barbed, AP | imp | (2) | 0.075 | $15 | Hardened Type 16, high-end weight range |
| 7 | Hunting Broadhead, Modern | imp | (1) | 0.015 | $7.50 | Modern alloy razor |

*King Olaf, hearing the noise, said "What broke, then?" Einar replied, "Norway, King, from your grasp." "Not yet," said Olaf, "take my bow."*

*– Snorri Sturluson, "Olaf Tryggvason's Saga"*

### Hunting Broadhead

A hunting arrow is a mix of a fast, flat shooter and a broad, sharp edge made for cutting flesh and viscera. As game animals are typically not wearing a coat of plates, shafts can be light and fast, mounting unhardened heads. Modern hunting broadheads are sometimes made from aircraft grade aluminum alloy (also steel and – inevitably – titanium) and can weigh 0.009-0.015 lbs.; replica medieval broadheads range from 0.015-0.067 lbs., with larger heads being used for larger game. These arrowheads are typically not hardened purposefully, though the very sharp cutting edge qualifies for a (2) armor divisor vs. fabric and flexible non-metal armors (this includes modern materials like Kevlar and Spectra, both of which are highly vulnerable to knives and arrows). These arrows keep their impaling damage type, but halve the hit points of the target for the purposes of blow-through and overpenetration.

# Sample Bows and Arrows

The design system can be very complicated, since many independent variables can be changed to come up with a design. Some sample bows, and arrows to go with them, appear below, with design details following the table. All damage listings use the *cinematic* scale; the *realistic* scale is listed in the descriptions below.

> *Straightway he unwrapped his bow, of the polished horn from a running wild goat he himself had shot in the chest once . . . The horns that grew from the goat's head were sixteen palms' length. A bowyer working on the horn then bound them together, smoothing them to a fair surface, and put on a golden string hook.*
>
> *– Homer,* ***The Iliad***

*Bamboo/Sinew Reflex Bow:* An example of a Korean reflex bow. Made of a composite of sinew on the back, a bamboo core, and a horn belly, such bows could fire flight arrows a very long way. The bow is designed by ignoring the horn in the belly, and concentrating on the sinew/bamboo of the back and core. Pulling 70 lbs. at 32" draw, the overall length of the bow was usually about 60" unstrung, and 90% working. Bow thickness is 0.44", n = 5, and the riser is constructed of bamboo/horn composite of 0.88" width and 0.07% allowed deflection. The traditional arrow was bamboo, 33" long, with a heavy barbed AP arrowhead. The arrow shaft has $d_o/d_i$ of 0.38"/0.25". Realistic damage would be 1d(2) imp.

*Compound Crossbow:* A 175-lb. draw weight fine (accurate) three-loop compound crossbow with a 17" power stroke. The design is built as a 27" total length, 90% working carbon fiber span with n = 2.2 and 0.22" thick limbs. The riser and stock are both E-glass, with 1.25" width and 37" stock length, designed to deflect no more than 0.02% under load. The riser has a built-in stirrup. The arrow is built as a 20" fine (accurate) carbon fiber shaft with $d_o/d_i$ of 0.34"/0.25" with a modern hunting broadhead. Velocity with this arrow is 300' per second, while calculated velocity with a 0.057-lb. arrow is 368' per second (real-world data: 375' per second). Cost is $827 (real-world MSRP $750). Realistic damage with the designed arrow is 1d+1 imp.

*Compound Hunting Bow:* Representative of many mass-production compound bows made today. Draw weight is 70 lbs. at 28", and the bow is 48" of total length, only 35% working, and with three loops to the string. Most bows are fine (accurate). The limbs are carbon fiber 0.125" thick, n = 4. The riser is aluminum, 0.82" thick and 1.71" deep, with allowed deformation of 0.04% (chosen to match the bow's real-world weight of about 4.5 lbs.). Firing a typical hunting arrow, an aluminum tube 30" long, with $d_o/d_i$ of 0.344"/0.31", the bow is 77% efficient. Realistic damage is 1d+1 imp, and velocity is 310' per second. Cost for the limbs is reduced for TL, yielding $383.

*Dwarven Compound Steel Footbow:* The soldiers of mad King Sterick the Red died before the footbow archers of Balish Axemaster without a single sword being swung. Masters of metalwork, they mount the finest dwarvish steel (TL5, ×4 to limb cost) limbs, mounted with pulley and cam systems never sold to humans. It is of fine (accurate) quality, with 75% of the bow working. The riser is of ironwood, 1.4" wide, 2.19" deep, and 0.07% deflection. The compound setup is conventional, with three loops. It fires fine (accurate) ironwood arrows 31" long and 0.53" in diameter, with heavy barbed armor-piercing points to a maximum range of 527 yards; the heavy arrows retain full damage potential their entire flight. Realistic damage is 2d+2(2) imp.

*Elm Shortbow:* Representative of a small hunting bow likely to be used by farmers rather than warriors. Elm is not a great bow material, and historically would be ignored in favor of yew wherever a choice was possible. The design is a 52" elm straight bow, pulling 50 lbs. at 24" draw. In order to draw to 24", the firer must use a rectangular cross-section bow design; n = 2.5 with 0.495"-thick fully working limbs provides sufficient flex (if barely). The bow typically fires a 26" poplar shaft 0.40" in diameter, fitting a hunting broadhead. Realistic damage is 1d-1 imp.

*Horn Reflex Footbow:* The extreme flexibility of natural horn (straight bow, round shape, n = 1) makes for a powerful footbow. This is a 200-lb. bow, only 57" long with a 42" draw (60% of the height of 70" tall man). The entire bow is "working," and the thickness was chosen as 1.15" The arrow is cedar, 45" long and 0.66" in diameter, with a light, armor-piercing arrowhead. Realistic damage is 1d+1(2) imp.

*Japanese Yumi Longbow:* A composite of bamboo and mulberry, it has two unique features. The first is the asymmetric nature when strung, which allows easier maneuverability; as well, the archer grips it at one of the vibrational nodes for the bow. The second is that it is deeper than it is wide, with 1.07" thick limbs and n = 0.6. Otherwise, it is designed as a straight, fully working bow 90" long, pulling 90 lbs. at 34". It fires a 36"-long bamboo shaft ($d_o/d_i$ of 0.40"/0.21") with a heavy barbed war point. Realistic damage is 1d imp.

*Medieval Crossbow:* This is the crossbow described in *Nerf Bows* (p. 9). A TL4 steel-limbed straight bow, 34" and 100% working. The limbs have n = 4.8 and are 0.38" thick. It is a 740-lb. draw at 7.5", and has a 36"-long oak stock, 1.5" wide and 1.8" deep, deflecting a maximum of 0.07%. Cinematic damage with the 0.08-lb. arrow it was tested is 1d. Using the design system, a heavy AP war point on an ash shaft 14" long and 0.6" in diameter (0.15 lbs.) is much more efficient, and delivers 65 Joules for 1d+1(2) imp. Realistic damage is 1d-1 imp for both.

## *Sample Bow and Arrow Summary Table*

| TL | Weapon | Type | Material (Bow; Riser/Stock) | Length* | Shape | Draw | Thickness (n) | Energy | Arrow/Head |
|---|---|---|---|---|---|---|---|---|---|
| 0 | Elm Shortbow | Bow | Elm limbs | 52 (100%) | Straight | 24 | 0.495 (2.5) | 45 J | 26-in. aspen or poplar (0.4/0) hunting broadhead |
| 0 | Japanese Yumi Longbow | Bow | Bamboo/mulberry limbs | 90 (100%) | Straight | 34 | 1.073 (0.6) | 113 J | 36-in. bamboo (0.4/0.21) heavy, barbed war arrow |
| 0 | Yew Longbow | Bow | Yew limbs | 78 (100%) | Straight | 30 | 1 (1) | 144 J | 31-in. ash (0.47/0) heavy, barbed war arrow |
| 0 | Yew Regular Bow | Bow | Yew limbs | 68 (100%) | Straight | 30 | 0.925 (1.1) | 146 J | 31-in. ash (0.47/0) heavy, barbed war arrow |
| 1 | Bamboo/Sinew Reflex Bow | Bow | Bamboo/sinew limbs; bamboo/horn riser | 60 (90%) | Reflex | 32 | 0.44 (5) | 103 J | 33-in. bamboo (0.38/0.25) heavy, barbed, AP war arrow |
| 1 | Horn Reflex Footbow | Footbow | Horn limbs | 57 (100%) | Reflex | 42 | 1.15 (1) | 255 J | 45-in. cedar (0.66/0) light, AP war arrow |
| 1 | Osage/Sinew Regular Flatbow | Bow | Osage orange/sinew limbs; osage orange riser | 53 (90%) | Recurved | 28 | 0.56 (3) | 93 J | 31-in. cedar (0.52/0) light war arrow |
| 3^ | Dwarven Compound Steel Footbow | Footbow | Steel (TL5) limbs; ironwood riser | 70 (75%) | Compound | 30 | 0.364 (3) | 574 J | 31-in. ironwood (0.53/0) heavy, barbed, AP war arrow |
| 4 | Medieval Crossbow | Crossbow | Steel (TL4) limbs; oak riser | 34 (100%) | Straight | 7.5 | 0.38 (4.8) | 65 J | 14-in. ash (0.6/0) heavy, AP war arrow |
| 8 | Compound Crossbow | Crossbow | Carbon fiber limbs; E-glass riser | 27 (90%) | Compound | 17 | 0.22 (2.2) | 197 J | 20-in. carbon fiber (0.34/0.25) hunting broadhead |
| 8 | Compound Hunting Bow | Bow | Carbon fiber limbs; aluminum 7075-T6 riser | 48 (35%) | Compound | 28 | 0.125 (4) | 137 J | 30-in. aluminum 7075-T6 (0.344/0.31) modern hunting broadhead |
| 8 | Modern Pistol Crossbow | Crossbow | E-glass limbs; aluminum 7075-T6 riser | 27 (100%) | Recurved | 11 | 0.28 (3) | 68 J | 15-in. carbon fiber (0.29/0.17) hunting broadhead |
| 8 | Olympic Recurve Target Bow | Bow | S-glass limbs; aluminum 7075-T6 riser | 59 (50%) | Recurved | 28 | 0.17 (6) | 52 J | 29-in. carbon fiber (0.34/0.31) field/target |

* The value in parentheses is the working percentage of the bow.

An average person would need a cranequin or windlass with a ×5 multiplier to span this bow.

*Modern Pistol Crossbow:* Based on a real-world design, this 150-lb., 11” draw pistol crossbow uses E-glass fully working recurved limbs mounted to an aluminum body with a built-in stirrup. The span is 27”, and the limbs are rectangular cross section with n = 3. The aluminum stock is 21” long and 1.4” wide, designed for 0.02% deflection under load. The cost comes out to $99, including reductions in limb cost due to being TL8. The arrow is a 15” carbon fiber tube with $d_o/d_i$ = 0.29/0.17” with a modern broadhead. The real-world version can be had for $80. Realistic damage is 1d-1 imp.

*Olympic Recurve Target Bow:* Used in modern Olympic competition for target archery, this fine (accurate) bow pulls 50 lbs. at 28%, and is 50% working. The limbs are S-glass, 0.17” thick, and n = 6. The aluminum riser is 0.7” thick with 0.01% deflection. It shoots fine (accurate) 29” carbon fiber arrows ($d_o/d_i$ of 0.34”/0.31”) with target points that cost nearly $20 each. Already an accurate bow, Olympic shooters usually take it further, adding stabilizers and aiming devices (see ***High Tech***, p. 201) and customize the bow to themselves (*Weapon Bond*, ***Power Ups 2: Perks***, p. 9). Realistic damage is 1d-1(0.5) pi.

*Osage/Sinew Regular Flatbow:* An example of a sinew-backed bow, this bow is 53” long and 90% working, pulling 110 lbs. at 28”. It would make an excellent general purpose bow for hunting game and the occasional goblin. Osage orange is already among the best bow woods, and sinew backing makes it better, allowing the bow to take substantial recurve. Limbs are 0.56” thick (n = 3).The riser is also osage, 0.9” thick and 0.9” deep with 0.07% deflection, and represents a nonworking handle. It is designed to fire a 31” cedar arrow 0.52” thick, tipped with a light war point. Realistic damage is 1d imp.

*Yew Longbow:* The famous “crooked stick” of the British isles, this bow is on the lighter side of those found on the wreck of the *Mary Rose*, which averaged about 145 lbs. and 78” long. This sample design is 78” as well, pulling 128 lbs. at 30” draw. Limbs are 1” thick and fully working (n = 1). It will cast its arrow 244 yards . . . well within expectation for a bow this size. Realistic damage is 1d+1 imp.

*Yew Regular Bow:* This bow is designed as a shorter version of the yew longbow. Pulling 128 lbs. at 30”, the fully working limbs are 0.925” thick, with n = 1.1. Slightly thinner and slightly flatter, this allows the yew bow to be shortened to 68”. It fires the same arrow (31” ash shaft, 0.47” diameter, heavy barbed war point) as the yew longbow. Realistic damage is 1d+1 imp.

*The shadow of a million bows lie across the vast plains of inhabited time . . .*

*– Gordon Grimley,* ***The Book of the Bow***

## *Sample Bow and Arrow Statistics Table*

| TL | Weapon | Damage* | Acc | Range | Weight | RoF | Shots† | Cost | ST (Draw Weight) | Bulk | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **BOW (DX-5)** | | | | | | | | | | | |
| 0 | Elm Shortbow | 1d(1) imp | 1 | 168/168 | 0.8/0.09 | 1 | 1(2) | $35/$2.82 | 10 (50) | -6 | |
| 0 | Japanese Yumi Longbow | 1d+2(1) imp | 2 | 202/202 | 1.8/0.19 | 1 | 1(2) | $88/$4.93 | 14 (90) | -9 | |
| 0 | Yew Longbow | 1d+3(1) imp | 2 | 244/244 | 1.9/0.2 | 1 | 1(2) | $133/$4.92 | 16 (128) | -8 | |
| 0 | Yew Regular Bow | 1d+3(1) imp | 1 | 247/247 | 1.5/0.2 | 1 | 1(2) | $109/$4.92 | 16 (128) | -7 | |
| 1 | Bamboo/Sinew Reflex Bow | 1d+2(2) imp | 1 | 234/234 | 2.3/0.15 | 1 | 1(2) | $434/$15.77 | 12 (70) | -7 | |
| 1 | Horn Reflex Footbow | 2d+2(2) imp | 1 | 367/406 | 2.8/0.21 | 1 | 1(4) | $748/$7.07 | 12 (200) | -7 | |
| 1 | Osage/Sinew Regular Flatbow | 1d+2(1) imp | 2 | 280/312 | 2/0.1 | 1 | 1(2) | $318/$1.89 | 15 (110) | -7 | |
| 3^ | Dwarven Compound Steel Footbow | 3d+3(2) imp | 2 | 528/528 | 8.2/0.37 | 1 | 1(4) | $11,086/$71.36 | 16 (400) | -8 | |
| 8 | Compound Hunting Bow | 1d+3(1) imp | 3 | 431/686 | 4.5/0.07 | 1 | 1(2) | $390/$11.30 | 12 (70) | -6 | [1] |
| 8 | Olympic Recurve Target Bow | 1d(0.5) pi | 3 | 298/384 | 5.5/0.05 | 1 | 1(2) | $648/$23.10 | 10 (50) | -7 | |
| **CROSSBOW (DX-4)** | | | | | | | | | | | |
| 4 | Medieval Crossbow | 1d+1(2) imp | 3 | 150/150 | 9.1/0.15 | 1 | 1(13) | $177/$11.86 | 22 (740) | -8 | [2] |
| 8 | Compound Crossbow | 2d+1(1) imp | 4 | 645/645 | 5.2/0.1 | 1 | 1(4) | $847/$48.40 | 11 (175) | -7 | |
| 8 | Modern Pistol Crossbow | 1d+1(1) imp | 2 | 255/255 | 3.8/0.09 | 1 | 1(4) | $99/$9.90 | 10 (150) | -6 | |

* Listed damage values are cinematic; see weapon descriptions for realistic damage values.

† Standard number of Ready maneuvers are given. For more-accurate values, see *Readying Times* on pp. 4-5.

### Notes

[1] Requires ST 12 to draw, but only ST 9 to hold at full draw.

[2] A ST 12 archer requires a windlass with M = 3.25 to ready the crossbow in the allotted time. (M = 740/8 × Basic Lift).

# Bibliography

These resources should prove the most useful to those who want to explore this topic further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## About the Author

Douglas H. Cole has been roleplaying since 1981, and playing ***GURPS*** since 1988. He has been an active playtester for both Third and Fourth Editions, and acted as lead playtester for ***GURPS High Tech*** and ***GURPS Tactical Shooting***. Douglas and his wife have been training in Hwa Rang Do since 2002, and grappling since 2004. He is an avid target shooter and movie-watcher. He enjoys postponing woodworking and home-improvement projects. Douglas has earned two doctorates: a real one from Northwestern University in materials science and engineering, and a cool one in ***GURPS*** Ballistics from Illuminati Online University. He currently manages the clean room development for a major HDD company.


### *Acknowledgements*

Sean Manning provided excellent feedback and commentary on the working drafts. As always, many thanks to the Hellions: Michele Armellini, Rupert Boleyn, Nigel McCarty-Eigenmann, Shawn Fisher, Jason Levine, Onno Meyer, Ken Peters, David Pulver, Sean Punch, and Hans-Christian Vortisch.


*One of the Trachinians told him, "Such was the number of the barbarians, that when they shot forth their arrows, the sun would be darkened by their multitude." Dieneces, not at all frightened at these words, but making light of the Median numbers, answered, "Our Trachinian friend brings us excellent tidings. If the Medes darken the sun, we shall have our fight in the shade."*

*– Herodotus,* ***The Histories***

# At Play in the Fields

## by Matt Riggsby

***GURPS Low-Tech Companion 3: Daily Life and Economics*** presents the broad outlines of subsistence agriculture, but obviously much more is involved in growing things than mere personal survival. What can I grow that *isn't* just in support of a hand-to-mouth existence, players may ask? How can I get more and better farmland? How much does it all cost, and how much can I get for it? This article presents some potential answers for the GM and players who want to get their hands dirty with more details about agriculture.

## Value of Produce

While most items have a set price through the ***GURPS*** system, the precise value of agricultural produce is something that is left, to some extent, up to the GM in ***Low-Tech Companion 3***. This is in large part because the price of agricultural produce – particularly grain – was enormously variable, even relative to other commodities. Although long-term inflation was very low through much of history, prices for agricultural products in any given year could shift in a wide range around a median value as a result of local weather conditions (early and late frosts, too much or too little rain, etc.), unusual insect activity, fungal blights, and so on. This effect would be particularly evident in the most primitive and most fragmented societies. Improved shipping and marketing efficiency in more technologically advanced (or simply politically and economically stable) regions – for example, settled periods for China and the Roman Empire, later Medieval England – could go some way toward flattening out purely local problems, but regional and national productivity and prices were still subject to variation as a result of overall weather patterns. Other environmental factors have a differential impact on crops as well, though on levels of detail ***Low-Tech Companion 3*** doesn't go into. For example, wheat and barley don't grow as well in cool climates as oats and rye, making them less common and therefore relatively more expensive in such areas.

Cultural preference is another significant factor. For instance, beef was a preferred meat in parts of western Europe but despised in much of India, where chicken was a prized meat (at least among meat-eaters). Western cheeses would be thrown out in the Far East, and the pork so dearly loved in China would be dreaded by many in the Muslim world and ancient Israel. All of this has an impact on the prices of any given type of produce, and makes it difficult to speak of even a *typical* price of, say, a pound of pork at a given TL, as opposed to in a particular place or time.

Yet another factor to consider is overhead to bring goods to market. What a pound of grain sells for depends on where you are. The charge for agricultural produce, particularly grain, at the point of sale in town can easily be twice what the farmer was paid for it in the countryside. ***GURPS Low-Tech*** prices items for the likely point of sale to adventurers, which is in town. The suggested fee of $1 per pound for grain in ***Low-Tech Companion 3*** is a sale price to an adventurer feeding his horse at a stable or other urban establishment. The farmer who sold it likely gets $0.50 per pound, with the rest going to carters, merchants, and/or mill owners along the way. Theoretically, the prices of other goods should be altered as well, depending on whether they're sold in the city or the countryside, but the cost-to-weight ratio for most goods is such that the price increase usually becomes a fraction of the base price, not a multiple.

### Why Wasn't This in *Low-Tech*?

Some of this material was cut from ***Low-Tech Companion 3,*** and some of it never even made it into the initial manuscript. The reasons why break down into two categories:

*Space.* A great deal could be written on the topic of low-tech agriculture. Indeed, libraries could be filled with the books already written on the topic. However, you have to stop somewhere. The focus was on individual survival and the most widespread subsistence crops, extending the hunting and gathering rules into the Neolithic and beyond. Things like group efforts and money-making crops, though certainly interesting, didn't make that particular cut.

*Accuracy.* Material in ***GURPS Low-Tech*** and its companions is, to the best of our ability, drawn from historical literature and scholarship. However, the sources used provided more coverage on some subjects than others. Some of the figures presented in this article are notably more speculative than those making the first cut. If you find yourself thrown through a time warp, don't count on us for quotes on the price of sugar!

So, then, what's it all worth? It depends. The suggested grain price of $1 per pound quietly avoids specifying *which* of several possible grains under cultivation in any given area might cost that much, and what the others might cost relative to that. After all, there's no one historically accurate answer. The table (below) lists some suggested *base* values for agricultural products. However, most prices should be modified in several ways.

First, since these are base prices for the point of sale in a large market, grain prices should be halved for where they are produced. For example, a farmer is likely working from a base price of $0.50 for a pound of barley or $1 per pound of soy beans. The prices of fruits and vegetables (see *Lesser Crops,* p. 19) may be similarly changed. Inherently more expensive items – such as meat, wine, and oils – may be adjusted by $0.50 to $1 per pound if desired.

Second, many items are subject to luxury pricing. Culturally preferred produce gets at least +1 CF (wheat, for example, often commands better prices than oats), while particular delicacies (goose liver, pork belly, fat-enriched sausages) may get even higher alterations; luxury pricing rules may come into play here (***GURPS Low-Tech***, p. 37). Likewise, crops that aren't as well-liked (such as oats, potatoes, and corn in much of late-TL4 Europe) may get a negative CF. Finally, the GM may adjust prices for agricultural produce on at least an annual basis to reflect that year's weather. Prices *might* move upward slowly between harvests as supplies start to run low, though there is some question as to whether or not this was a typical historical occurrence.

| ***Product*** | ***$/lb.*** |
|---|---|
| Potatoes* | $0.25 |
| High-yield crop (barley, corn, rice) | $1 |
| Low-yield crop (wheat, legumes, oats) | $2 |
| Animal products | $8 |
| Preserved meat (salt cod, jerky, etc.) | $18 |

* For other tubers, the base price should be the same as the nutritional equivalent of high-yield grains. For example, two pounds of taro provides similar nutrition to a pound of grain, so its base price should be $0.50 per pound.

# Other Economic Crops

Although the following crops have historically been less important for subsistence, they constitute important economic commodities. Almost all of these crops are labor-intensive, requiring a large effort to plant and harvest, to say nothing of extensive processing to the primary yield. This means that – despite the value of the crops – they're out of the reach of the average farmer, who would have to choose between making an investment in high-value crops that will be realized in a few years and growing something to eat *now*. Therefore, they're typically the province of larger landholders, who can organize enough surplus labor to get things started and reap the benefits later. Between that, the inherently desirable qualities of the crops in question, and the limited geographical range in which most of these crops can be produced, they are notably subject to luxury pricing.

## *Almonds*

Almonds were domesticated in the Near East by 3000 B.C. and quickly spreading to areas with similar climates. Like most other orchard crops, almonds take some time to begin production; in this case, about four years. They produce nuts for another 15-20 years. Almonds have proved quite versatile. They may be eaten as-is, crushed into a meal or paste, or soaked and heated to produce a "milk."

*From our point of view, it is a merciful dispensation that has limited the number of plants we have got to treat with, for the handling of these is already complicated enough, but at the same time it is a curious fact that so little of the vegetation of the world is of food value to the human race, or to domestic animals.*

*– Primrose McConnell,* ***Crops: Their Characteristics and Cultivation***

## *Olives*

Olives are the fruit of a long-lived evergreen that grows best in warm coastal climates. Though olives can be consumed after curing (they're naturally extremely bitter and must be fermented or processed with brine), their primary use is to produce an edible oil, which makes up about half of an olive's weight, though the efficiency of extraction varied through time.

Olive trees take close to a decade to reach maturity once planted (50-100 trees per acre). However, once they start, they don't stop for a very long time. Production slows somewhat as the trees age, but they will reliably bear fruit for more than a century. A handful of trees that are still being harvested are over 1,000 years old. Entire generations of olive growers can go without ever planting a tree.

Once harvested, olives destined for oil production are crushed and pressed multiple times, sometimes with hot water poured in to help extract more oil. Each successive pressing produces a lower quality of oil; the price in the *Economic Crops Table* (p. 18) is an average across pressings. For every gallon of oil, the process also generates 8-10 lbs. of oil-rich pressings as waste suitable for fuel (see ***GURPS Low-Tech,*** p. 27).

## *Sugar Cane*

Sugar is an extremely valuable commodity, but sugar cane requires a very warm climate and a lot of water, limiting the range in which it can be cultivated. It is also *very* labor-intensive to process. Cane was first cultivated in Polynesia, making its way to India by the first millennium B.C., and into the Mediterranean by the Middle Ages.

Like bamboo, sugar cane is related to grasses, and likewise grows quickly. When it is ready for harvesting, a year or so after planting, stands can be over 10' tall. After the first year, canes can be harvested up to 10 times, with diminishing returns.

Mature canes are cut with heavy blades and, as quickly as possible (the sugar content declines after cutting), pressed. The cane juice is boiled and put into open molds to solidify into cakes, essentially identical to modern jaggery and piloncillo. In addition to the listed labor for harvest, cane requires its weight in wood or half its weight in charcoal for processing.

## Economic Crop Production

The *Economic Crops Table* (below) lists the crops on pp. 17-19 with values for how much they produce, how much work it takes to get a final product out of them, and how much they sell for.

*Yield:* Production of a final product per acre of land, after all processing. This means, for example, oil rather than raw olives, etc.

*Planting:* Man-days of effort per acre to plant the crop. Almost all of these crops will produce multiple harvests from a single planting; see individual descriptions for life spans. However, crops that are not ready for harvest in the course of a year require half of the planting labor annually for routine tending unless otherwise noted.

*Harvest and Processing:* Man-days of effort per acre to harvest an annual crop *and* process it into its salable form.

*Base $/Unit:* A base price from which prices in the campaign may be derived, as per the discussion under *Value of Produce* (pp. 16-17).

### Economic Crops Table

| Crop | Yield | Planting | Harvest and Processing | Base $/Unit | Notes |
|---|---|---|---|---|---|
| Almonds | 350 lbs. | 7 | 12 | $3 | [1, 2] |
| Olives | 220 gallons | 7 | 16 | $11.25 | [1, 2, 3] |
| Sugar | 325 lbs. | 8 | 40.4 | $14 | [4] |
| Tea | 440 lbs. | 7 | 23 | $36 | [2, 5] |
| Tobacco | 500 lbs. | see notes | see notes | $12 | [6] |
| Vines | 700 gallons | 7 | 16 | $5 | [2, 5] |

#### Notes

[1] This crop alternates between good and bad years. The listed productivity is for a good year; reduce yield to half the following year, then back to full productivity the next.

[2] Trees and vines are relatively easy on the soil. Roll for environmental decay only when such crops are replanted.

[3] Production technologies improve through time. Increase yields by 10% per TL over 1.

[4] Processing technology improves significantly over time. Increase yields by 50% per TL over 1. However, production also falls off in any given stand with successive harvests. Reduce yield by 2d% for each year after the first harvest; this is cumulative until the next planting.

[5] Because of pruning and/or training requirements, an amount of labor equivalent to the planting labor must be spent on the crop during years where it is not actively harvested.

[6] Tobacco takes the same time to plant as grain at any given TL and three more man-days to harvest and process. Production increases by 25% for every TL over 1.

### Tea

According to a dubious tradition, tea was discovered around 2700 B.C., though it is not clearly documented until the fourth century B.C. It probably originated in the area around northeastern India and southwestern China. Tea plants prefer moderately warm climates, a great deal of water, and high altitudes. The better varieties grow slowly, possibly being harvested every two years. Depending on the variety, a tea plant can live 50 to 100 years. Left alone, a tea plant can reach 60' in height, but aggressive trimming keeps cultivated plants to about waist height. A tea plantation usually looks like a hillside densely packed with low, decorative hedges.

Tea is another very labor intensive crop. It is planted, heavily trimmed after a year or two of growth, and only harvested after three or four years. New leaves are harvested in the spring (only a few ounces per plant) and processed in facilities that are, as far as possible, climate controlled. Leaves begin to oxidize once they are cut, but the process can be stopped by heat, usually delivered by steam or pan-cooking. Green teas undergo a minimum of oxidation, while black teas are fully oxidized. Leaves are also dried, and may be pressed into bricks for easy packaging and transport. In addition to the labor necessary to harvest and process it, tea requires half of its weight in wood or a quarter of its weight in charcoal for cooking and maintaining the drying environment.

### Tobacco

The beginnings of tobacco are unclear. It probably originated in South America, and it was used widely through the Americas by 2,000 years ago, if not earlier. It is cultivated much like any other crop, planted and harvested annually. Once harvested, it is put up to age for up to two months, depending on the specific type of tobacco and the desired texture and flavor.

Although it's inedible, tobacco is the one crop in this list that can be grown without a massive investment of time and labor relative to subsistence crops. In the short term, this means that anyone who can get away with growing tobacco would be a fool not to, since it brings in a much higher price than grain. Over the long run, though, it can lead to overproduction and price crashes, as happened in 17th-century Virginia.

### Vines

For most of history, "vines" meant "grape vines," and "grapes" meant "wine." Vines were first domesticated around 6000 B.C. in eastern Turkey and spread quickly from there.

Vines and olives have many similarities. They enjoy very similar climates, to the point where they were often grown on adjacent patches of land. Their fruit can be eaten more or less directly, but is far more often processed into a more valuable and longer-lasting product.

Vines take a considerable amount of time to come to fruition (four to seven years) but once they do start producing, they do so consistently for the better part of a century. Grapes are harvested annually, crushed, and stored to ferment into wine. Young vine leaves can be harvested for use as an edible green, though their nutritional value is near-trivial.

# Lesser Crops

A great many crops aren't covered either in the ***Low-Tech*** series or here: most fruit trees, ground nuts, squashes, leeks and onions, edible greens, and so on. Most supply a fraction of the protein and calories of grains and animal products, and they're less valuable as trade goods, but they can provide important additional nutrients and interesting variety to the diet. Moreover, cultivating small quantities of less valuable crops can be a way of getting extra produce and possibly income while managing time (see *Timing,* below). Other crops grow in different cycles and enjoy different kinds of weather. For example, fields of cucumbers (which take about two months between planting and maturity) and eggplant (which take up to three) might be worked in between the end of grain planting and the beginning of the grain harvest. These guidelines will allow the GM to come up with plausible values for economically less significant crops.

Labor to plant and harvest annual crops is generally the same as in ***Low-Tech Companion 3*** (p. 10). Yields are often two to five times as many pounds per acre as grains and legumes, in the same ballpark as tubers. However, prices per pound are one-half to one-fifth as much. Likewise, most crops have a fraction of the nutritive value; it takes 3-4 lbs. of fruits and vegetables to substitute for 1 lb. of grain. Ignore seed-to-productivity ratios; they're essentially meaningless for non-grain crops.

For orchard crops, almonds and (to a lesser extent) olives and grape vines offer a good model. Fruit trees produce several times as much by weight for a fraction of the base cost per pound. For tree crops destined to become alcohol (for example, date palms or apples), remember that 1 lb. of fruit produces about a pint of finished beverage, or a gallon for every 16 lbs. of fruit.

Other grains can be modeled directly on the ones in the *Agricultural Productivity Table* (***Low-Tech Companion 3,*** p. 10). Most grains not listed there have productivity per acre in the general range of wheat and oats. While less popular for productivity than corn and barley and less popular for taste than wheat, each has localized advantages.

Here are some examples of reasonably common crops that are not grown as widely as staples.

## *Dates*

Date palms – a common food-growing tree in the Near and Middle East – produce around 700 lbs. of fresh fruit per acre, but like many fruit-growing trees have alternating yields. Dates may be eaten fresh, but they are often dried or turned into a wine; use harvest labor for vines if the harvest is intended to make wine or for almonds if it's intended to be dried and eaten whole. Date palms do not necessarily need to be cultivated. Wild-but-productive groves in Mesopotamia provided food for the poor and during famines.

## *Millet*

Millet was one of the first grains to be domesticated, and is still farmed widely through Africa and southern Asia. This crop grows well in dry conditions, but has significant problems with excessive moisture. It can be ready to harvest in as little as two months after planting. This is useful if farmers need to plant multiple crops per year (if, for example, a catastrophe wipes out a crop planted earlier) or if uncertain weather conditions make longer-growing crops a risk. Use the same yield per acre as wheat.

## *Rye*

Though it originated in Anatolia, rye has historically been popular in northern Europe and northwestern Asia. Rye is very resistant to cold. It may be planted in the fall, providing ground cover that prevents erosion, and harvested in the spring. In many areas, it even grows slowly through the winter, becoming active when the temperature rises above freezing, providing a harvest not long after the weather turns warm again. Use the same yield per acre as oats.

> *The best time to plant a tree was 20 years ago. The next best time is now.*
> *– Chinese proverb*

# Timing

The timing of planting and harvests were perennial issues for debate in low-tech societies. In most environments, the grain that provides the bulk of the food supply must be planted and harvested at specific times of year, and trying to work outside of those limited windows results in diminishing returns, if not an outright loss. Planting a crop too early in the spring may mean that it's killed by a late frost, while planting too late may mean that the almost-ready harvest is destroyed by early frosts or seasonal storms.

The harvest was a particular issue. Once a crop turns ripe, it becomes particularly attractive to vermin, and left too long in the field, it becomes overripe. Moreover, stalks become dry and brittle, leading to losses from breakage and wind. Consequently, a farmer would be less worried about how much land he could plow and more about how much he'd be able to harvest before loses in the field started to eat into his already-precarious livelihood. Estimates suggest that labor requirements for the harvest in some places were significantly *greater* than 100% of what was usually available; employment of migrant farm labor goes back deeply into history.

To reflect the importance of timing, the GM may keep track of planting and harvesting on a weekly basis. It takes most grains three to four months to mature and be ready to harvest. At the point a field becomes ready, the farmer has a week to harvest it without loss. This requires 75% of the total harvesting labor. This reflects the labor necessary to cut, bind, and store the grain; the remainder of the labor goes into threshing and separating grain from chaff, which can be delayed somewhat. When the harvest is late, the field loses 1% of its yield each day of the first week, 2% each day of the second week, 3% for the third week, and so on. Other crops may be subject to this rule on a case-by-case basis.

## Supervision

Though farming might be pursued as an individual task, many farmers (most hired workers and slaves, and some semi-free peasants) were under someone else's supervision, while many others were part of a farming community which acted in concert. For example, a local nobleman or council of village elders might decide when to start the season's plowing or when to renew hillside terraces. This limits the impact of any individual farmer's personal skill.

In any farming community, anyone may try to get advice from another (more experienced) farmer. If he can be induced to give advice, a person with a higher Farming skill may roll against his Teaching or Leadership skill. If the roll succeeds, the person seeking advice gets +1 to his next roll against Farming skill.

If a farmer should consult with a plausible rogue with a *lower* Farming skill, the adviser still rolls against his Teaching or Leadership skill. If he succeeds, the farmer takes his bad advice and gets -1 to his next Farming roll. If the roll fails, the farmer is unconvinced and takes no penalty.

Large plots of land managed by wealthy landlords may be under the supervision of an experienced caretaker. Likewise, farmland around a village may be divided into individually worked plots, but the timing and character of the work is supervised by communal agreement or the direction of a small group of leaders. In either case, the individual farmer may make job rolls based on his own skill (perhaps modified for advice; see above), but the supervisor or a community leader makes rolls to determine changes in environmental quality.

# Improving Land

Many kinds of terrain are unsuitable for cultivation, such as forests, dry steppes, swamps, hills, or areas with poor soil or other plants already in the way. However, the quality of the land (see ***Low-Tech Companion 3,*** pp. 4-5 and 11) can be modified so that they can be successfully farmed with these techniques.

## *Clearing (TL0)*

Uncultivated areas may be prepared for cultivation by uprooting large plants and plowing small ones under. The GM must determine the quality of land once cleared. Clearing an acre of small plants costs $160 in labor. Clearing forest is much more difficult, since trees are much harder to kill and subsurface stumps must be pulled up as well. Clearing an acre of typical forest costs $1,050 at TL0 or $425 at TL1+. For extremely dense forest or very hard wood, costs increase to $1,800 at TL0 or $650 at TL1+.

## *Controlled Burning (TL0)*

Done correctly, burning not only clears the ground for planting, but also returns nutrients to the soil for a short-term fertility boost. Plant matter is burned slowly and carefully, essentially reduced to charcoal rather than simply set alight in a huge blaze. The stubble left over from harvesting fields already under cultivation may be burned and plowed under, giving a +2 to rolls to resist losing quality for that year. If land with light vegetation is cleared by burning, the bonus applies to its first year under cultivation.

Fully overgrown land may be burned for a greater fertility boost. Land that was previously forest but is cleared for cultivation by controlled burning has an environmental quality one step higher than usual for its first year. For example, land that would otherwise be typical quality would count as good (do not roll for a drop in environmental quality for that year). Land that has become overgrown to the point of becoming forest and cleared by burning repeatedly (see *Fallow*, below) may become *terra preta*, a black, charcoal-rich soil that retains nutrients well. For every five cycles of burning forest on the same land, the land gains +1 to resist losing quality as a result of long-term use, to a maximum of +5.

A controlled burn costs twice as much as clearing and requires a successful Farming roll. On a failed roll, it only counts as clearing and provides no fertility boost; on a critical failure, the farmer also suffers 1d damage from burns.

## *Fallow (TL0)*

Land damaged by long-term farming can become more fertile again, but it must be left alone to do so. In most cases, the natural action of animal habitation and varied plant growth restores nutrients to the soil, slowly repairing damage done by farming. Land that has been fallow for two or more years after being farmed gains +1 to resist a reduction in land quality the next year it is cultivated, or +2 for four years or more. This is cumulative with any bonuses for burning.

Left unfarmed long enough, land can even recover lost levels of environmental quality. In most environments, land that has lost quality because of farming recovers one lost step every 10 years it is left completely alone or used for light grazing (pigs and cattle qualify; sheep and goats do not), until it reaches the environmental quality of the land around it.

Local conditions can cause this to vary. For example, land subject to regular natural freshwater flooding will recover lost quality as quickly as one step per year; flood plains are generally excellent farmland, but it's very hard on houses. However, in particularly dry environments, land that has been under irrigation for decades (artificial irrigation leads to slow but long-term damage from soil salinization), and land in regions where soil is naturally poor in nutrients (rain forests and areas with naturally thin soil), recovery can take 20 to 40 years per step.

Land left fallow long enough to recover any quality must typically be cleared. If it has been fallow for long enough to recover one step of quality, treat as clearing small plants.

Land left fallow long enough to recover two or more steps must usually be cleared as though it were forest, though the GM may decide that the environment only supports small plants. Some societies deliberately practiced very long fallow systems with the intention of letting wood grow, harvesting it, and clearing it for a few years of farming.

### *Draining (TL1)*

Unmodified swamps are largely unsuitable for agriculture. However, earthen dams may be used to block off water for some small areas, or deep channels may be cut to redirect the flow of water from larger patches of wetlands. Draining land costs at least $1,800 per acre. At the GM's option, it may also require the use of water-moving devices to pump water out (see ***Low-Tech Companion 3,*** p. 17). Because of the quantity of organic material in the soil and presumably plentiful water nearby, drained swampland is usually at least typical quality and is often higher.

### *Irrigation (TL1)*

Many dry plains become high-quality farmland if given enough water. Dry land provided with artificial irrigation improves environmental quality by at least one step, though, as with clearing land, the GM must ultimately determine the quality of new land brought under cultivation. Digging irrigation ditches costs $600 per acre. However, irrigated fields must be adjacent to bodies of water or other irrigated fields, and those must typically be equipped with water-moving devices.

### *Terracing (TL1)*

Although trees and vines grow well on hillsides, slopes starting a little under 10° are nearly impossible to cultivate with other crops. In addition to typically thin soil and excessive drainage, it's very difficult to plow on a slope. However, in areas where the soil and climate are otherwise suitable for agriculture, the construction of terraces converts a slope into a stepped series of narrow fields. For example, a 30-degree slope might combine 6' walls with 12' wide areas of field. The steepest historical terraces were built on mountainsides with nearly 70-degree slopes; a 10'-foot-tall terrace would have flat patches about 4.5' wide.

Terraces are usually built by an entire community working together . . . typically only when absolutely necessary, given the enormous investment of labor. The cost to make terraces depends on slope, as shown in the table below.

| *Slope* | *Cost per Acre* | *Slope* | *Cost per Acre* |
|---|---|---|---|
| 10° | $26,150 | 45° | $148,000 |
| 15° | $40,400 | 60-70° | $260,000 |
| 30° | $89,000 | | |

## Death and Taxes, Minus the Death

Now that the individual farming character know what he can do to support himself, what about the people who depend directly on farmers? If a landlord supports his daily expenses with an income derived from the fields around his villa, how does that income translate into areas, populations, on-call adventurers, and so on?

In any sustainable arrangement, farmers must make at least the bare minimum required to pay their cost of living (henceforth, CoL). A Status -1 farmer – appropriate for a serf, sharecropper, or similar worker – spends $300/month in CoL, or $3,600/year. In addition to that, reserves for the next year's planting must be accounted for. Excess value might be traded by the farmer, taxed, paid in rent, or appropriated by raiders; frequently, it's a combination.

Since agricultural produce in the countryside may suffer a -0.5 CF (see *Value of Produce,* pp. 16-17), the GM may use this rule to bridge the gap between the farming rules and jobs/CoL: Grain may be applied to a farmer's CoL at a rate of 1 lb. per $1; grain consumed as part of the farmer's CoL also counts as $1 worth of income, regardless of what the grain's market value might be. Other crops may be used the same way, with a quantity of that crop with a nutritive value equivalent to 1 lb. of grain counting as $1 against CoL and $1 of income. That is, 1 lb. of legumes or 4 lbs. of potatoes can be treated as $1 against CoL. In the confines of a commune, plantation, or rural village, others may benefit from this, accepting subsistence crops as payment in kind. This means that the value of a peasant farmer's CoL is equal to 3,600 lbs. of grain, just barely sufficient to feed a family of five (or a family of six, if some members of the household are very young or very old and eat a bit less) with a little left over to trade locally for goods the household can't produce itself.

Although that's the minimum a farmer *must* produce, the GM must set a number of parameters to determine how much he *can* produce. These include:

- What crops are available and preferred locally.
- Local environmental quality.
- Seed/harvest ratio.
- Length of growing and harvest seasons. This is mostly important to determine the number of harvests of subsistence crops per year (typically two) and labor requirements for the vital harvest season, but also has an impact on the production of lesser crops.
- Availability of labor.

Consider an unremarkable set of circumstances in a particular TL3 setting: productivity for labor and harvest is as listed in the *Agricultural Productivity Table* (***Low-Tech Companion 3,*** p. 10), yields are 4:1 (that is, a quarter of any year's harvest should be reserved for the next year's planting), there's enough time for two plantings and harvests of grains and similar subsistence crops per year, and harvests need to be completed over the span of four weeks. In this setting, a "classical" three-field rotation is followed, so there's one harvest of barley and one of legumes.

Having established those conditions, some numbers can be shaken out: After a quarter of the crop is put aside for next year's planting, an acre of barley *effectively* produces 660 lbs. of grain, while an acre of legumes provides 262.5 lbs. Considering the 75% of labor that *must* be performed during the harvest season, a farmer can harvest just under a quarter of an acre per day (that is, about 0.232 acre); during those four weeks, he can harvest a hair under 6.5 acres. That's about 4,287 lbs. of (effective) barley and 1,705 lbs. of (effective) legumes, or a total of about 5,992 lbs. Since he needs only 3,600 lbs. for his CoL, that leaves a surplus of 2,392 lbs. This requires a total of 19.5 acres of land (6.5 for each season's crop, plus 6.5 left fallow that year).

Just what happens to that surplus depends on the campaign. In the countryside, the crop's owner might sell the surplus of 2,392 lbs. of low-value grain for $1,196. If all of that goes to the farmer, it bumps up his income to $4,796/year, which is significantly over the income for the serf/sharecropper job, $3,960/year at TL3. However, depending on how onerous the farmer's obligations are, some or all of that surplus may go to someone else.

Assuming that the farmers in question get income equivalent equal to the serf/sharecropper job description ($3,960/year at TL3), the farmer's full annual income is equivalent to 4,320 lbs. of grain; 3,600 can be consumed directly as produce, the remainder is sold at $0.50/lb. If the rest goes for rents and taxes, that's still 1,672 lbs. of grain per year, worth $836 to the farmer or other rural resident who sells it for cash rather than consuming it directly. However, perhaps the farmer – and many like him – support a minor aristocrat whose "job" provides income for a Wealthy character. A typical income for that wealth level ($3,500/month or $14,000/year) requires about 17 farmers working a total of 331.5 acres, or about half a square mile. However, if the farmers are the aristocrat's property and get *no* income in excess of their CoL or if taxes are simply punishingly high (that is, the aristocrat gets all $1,196 per farmer per year), the number drops to about 12 farmers.

In this scenario, five farmers can produce enough surplus beyond the serf/sharecropper wage to completely support two other full-time farmers, or *four* who grow subsistence crops for one of the two growing seasons. This is significant when considering high-value economic crops that require little tending once planted and are only harvested once annually. If a number of farmers are all working for the same landlord, he may have them some of them growing subsistence crops full-time for local consumption and the others growing subsistence crops for one season and looking after economic crops for the next. Under the example conditions, a set of nine farmers might produce a total of $7,526 of grain for their master. However, they could instead be organized to produce $13,067 worth of almonds, $27,720 worth of olive oil, $33,637 worth of sugar, $32,667 worth of wine, or an astonishing $102,845 worth of tea. Of course, there's significant year-to-year variability in most of those crops (alternating yields for fruit, and every-other-year harvests for tea), several of those crops have additional overhead, and not every landlord's fields are happily situated enough to produce such wealth.

Once underlying conditions are changed, total production and surpluses change as well, often significantly. Land quality and TL have significant impacts, but there can be other considerations as well:

- Lesser crops such as squash, onions, and the like are economically minor, but can be very significant to those living on the edge of subsistence. A single acre of lesser crops can increase a farmer's income by perhaps $200 to $300 per year.
- Planting more than can be harvested with maximum return can still be profitable, and it may be necessary on poor land. During the first week, a farmer can still reap about 95% of what he would otherwise. That figure drops to 80% through the second week, 56% through the third, and a mere 23% through the fourth.
- A hidden assumption is that all farmers work the same (or similar) year-round job and consume the same CoL. Though that's a useful abstraction for PCs, variation in a real economy can be much greater. Seasonal laborers were vital to the harvest in some places. Likewise, some households may have a larger ratio of productive adults to largely unproductive children and the elderly, producing more but consuming proportionately less. However, since this isn't ***GURPS Demographics***, the GM must work out those details on his own.

## *Sample Production*

For anyone who doesn't want to do all this math, here are some sample levels of productivity per farmer, which can be used to devise larger estates. Presuming enough farmers are available to produce crops in this fashion, they can support others who live on the land, which frees up those individuals to grow and/or harvest economic crops, support soldiers and aristocrats, and otherwise generate resources to pay adventurers (or keep them in a lifestyle to which they've grown accustomed).

*TL1:* Grows a mix of barley, wheat, and legumes (a 2:1:1 ratio) on a two-field rotation using 6.22 acres per growing season. Produces 4,242 lbs. of grain/year, with an annual surplus above sharecropper pay of 552 lbs. Seven of them can support one full-time farmer growing economic crops, or two just harvesting them.

*TL2:* Same productivity, but because of higher pay at TL2, produces only 282 lbs. of surplus. Thirteen farmers can support one full-time farmer growing economic crops, or two harvesting them.

*TL4:* Grows wheat and legumes (3:1 ratio) on 6.78 acres total. Produces 6,673 lbs. of grain/year, with an annual surplus above sharecropper pay of 2,027 lbs. The excess grain is predominantly high-value wheat, so it sells for $1,689. Five full-time farmers support one full-time farmer growing economic crops, or two harvesting them.

*TL4 (rice):* As the previous example, but grows rice instead. Produces 11,444 lbs./year, with an annual surplus of 6,494 lbs., which sell for $5,412. Completely supports another farmer raising economic crops or two part-time harvesters.

*Fortunately, there were very few trees on this part of the land. It was covered mostly with a low undergrowth of weeds and pawpaw bushes, which did not require so much exertion as the cutting down of trees.*

*– James Dabney McCabe,*
***Planting the Wilderness***

# About The Author

Matt Riggsby was invented in the late 1960s, rumored to be a spinoff of America's Cold War nuclear program. Later developments involved applications in the social sciences and medical equipment. The consumer version is currently installed for home use with a fully compatible wife, son, and several dogs.

# Eidetic Memory

## Medieval Prisons

### by David L. Pulver

In my experience, throwing adventurers in prison for an extended period is an exercise in futility. The average player values his character's freedom to the point where his hero will die before surrendering, or – like a wild animal – gnaw his own legs off in order to escape . . . or perish trying. Even so, medieval adventurers do sometimes manage to get themselves knocked unconscious (or drunk) and wake up in a dungeon, or – more often – find an urge to break someone else out of durance vile.

The stereotypical view of a medieval prison is a lightless rat-infested cell underneath a keep, perhaps next to a torture chamber, in which a prisoner would be tossed. In reality, most felons would spend only a short time in jail before facing the local lord or court's swift justice and punishment: fines, humiliation, whipping, branding, mutilation, torture, exile, or execution. Incarceration wasn't a punishment as such (with the exception of political prisoners, who might rot indefinitely as long as holding them hostage was useful).

While the view of short-term jails is accurate for dungeons maintained by a local feudal lord, not everyone was under the jurisdiction of a feudal magnate with the power of justice. Some rural areas might be subject to royal justice, in which case the prisoner would have to rot in jail for weeks or months under the supervision of a local sheriff until a roving commissioner or justice arrived to try the case. Sometimes these were late in coming, resulting in overcrowded jails! In larger towns and cities – where most professional thieves and adventurers tend to get into trouble – a powerful merchant-dominated middle class had their own priorities. In Europe from about 1300, purpose-built prisons began to be constructed in towns and cities. These establishments were significantly different from the typical lord's dungeon or county jail, but also unlike modern-day penitentiaries.

Society in Medieval Europe did not generally consider prisons to be a place of rehabilitation. They were primarily intended as a way to hold law breakers awaiting trial or to coerce individuals to pay their debt to society, in a very literal sense. Often the majority of prisoners were imprisoned for debt, either because of defaulting on loans or taxes, or – just as often – because they were fined for committing other crimes that did not warrant death (such as robbery, assault, or fraud) and were either unable to pay or chose not to bankrupt themselves. For example, if a malefactor owed someone $20,000 but didn't want to pay or bankrupt his family, a fine would be commuted to prison time and he'd be classed as a debtor to the state. In prisons of TL3 societies, many such prisoners were middle or upper class (Status 1-2), as poorer individuals tended to be subject to summary justice. Over time, however, the rise of stronger central governments tended to lead to prisons being used as dumping ground for the dregs of society, so by TL4, prisons often held many more poor people.

> *A prison is a home of care, a place where none can thrive;*
> *A touchstone true to try a friend, a grave for one alive.*
>
> *– Inscription on Edinburgh's former Tolbooth prison*

## Ancient Prisons

Information on prisons in the ancient world and early medieval period is scarce. Little is known about Babylonian prisons except their existence, probably for political prisoners and hostages. Prison also existed in ancient Egypt (TL1); unlike many ancient peoples, they preferred corporal punishment (beatings) and imprisonment over the death penalty. In the Biblical period, the pharaoh maintained a prison in a converted granary, where most of its inmates were foreign troublemakers, war captives, and convicted government officials. They were forced to perform heavy labor and served lengthy sentences.

In classical Greece and Rome, prisons did not have a huge role – death, exile, fines, or slavery were preferred – but some existed. In Athens from at least the sixth century B.C., public officials ran prisons *(phylake)* that had some modern features, including regular visiting hours. They were mainly used to hold those condemned to death (as executions were often delayed due to lengthy religious holidays), and – much as in the later medieval period – as a place people would be confined if they owed fines to the state or to private debtors.

### *Typical Fees Charged by a Medieval Prison (TL3)*

Garnish (avoid being stripped and tossed in common cells): $60-120.
Visitors: $2/visitor.
Tub of water for bathing: $1 each.
Renting a private cell: $75/week.
Renting a furnished room: $145/week.
Bedding and clean sheets: $35/week.
Cleaning woman to visit cell: $7/week.
Heating, in winter: $2/night.
Lighting, per night: $2.
Prostitute: $7/night.
Rent of a workbench or other space to allow an artisan to ply his trade while imprisoned (if his family provides the tools): $10/week.
Pay guards to cook any food your friends brought you: $1/meal.
Pay to visit cell of a prisoner of opposite sex: $2/night.
Meals or drink: 2-5× usual costs of similar meal outside the prison.
Leave prison after sentence served: $500+.

Foreign criminals were also jailed while awaiting trial (as they were a flight risk). The common nickname of Athens' city prison was the *desmoterian* ("place of chains"). While some prisoners had freedom of movement, it was common for them to be chained up or put in stocks, or head or neck braces, to restrict movement.

In Republican Rome, the major – and for a long time, only – state prison *(carcer)* was the *latumiae* on Capitoline hill, located near the forum and courts. Lower magistrates had the authority to imprison common proletariat citizens there if guilty of minor crimes such as disturbing the peace, assault, petty theft, or slander. The prison may also have been used for torture (inflicted mainly on slaves, often as part of interrogation). The upper classes received house arrest, unless their crimes were severe enough to warrant exile or death. High-status capital offenders could end up in the adjacent and much-feared Tullianum. Condemned prisoners sat in this dark, smelly underground chamber – originally a cistern – before authorities carried out the sentence (generally strangulation). Most of the time, it held important political prisoners or captive war leaders. The latter were sometimes kept there until they could appear in a Roman triumph, then executed.

Major provincial towns also had prisons, based either on the Roman or Greek models. A typical facility was an underground dungeon about the size of a dining room, accessed by a ceiling trapdoor. Dozens of prisoners would be confined there for lengthy periods with no exercise or release, minimal food, and no sanitation. One contemporary account records that jailers tossed weapons down and urged prisoners to commit suicide, either for amusement or to avoid having to feed them.

The Roman Empire saw considerable growth in the number of prisons in conjunction with the centralization of authority and spread of Roman law and citizenship to the provinces. Governors built substantial prisons by the late Empire. Similar to the facilities used to house gladiators, these were gated compounds with thick walls, a dungeon, and a security detail (often ex-gladiators or retired soldiers). The main floor had outer cells with barred windows, for prisoners awaiting trial or who warranted favored treatment. Far less appealing were the inner cells or underground dungeons, where disfavored incarcerated inmates – often in stocks – endured total darkness and terrible filth. Which cell someone ended up in often depended on bribing the jailer.

Eventually, the Empire passed some edicts to impose minimum standards. For example, prisoners who still awaited trial were not to be chained so heavily that it would injure them, and they could not be kept in worse cells. The laws required judges to inspect prisons, see that guards weren't taking bribes, and make sure that jailors distributed rations paid for at public expense. The edicts also allowed regular visits, with many prisoners hoping for extra food or clean clothes from their friends and family (or in the case of persecuted minorities – such as Christians – organizations of coreligionists). Jailers always insisted on their cut!

# An Urban Prison

While country jails were run by officials appointed by feudal lords or royal sheriffs, prisons were run by the municipal government. The chamberlain or warden in charge often purchased the position in hopes of making a profit, or was appointed to it with the expectation that he would minimize any expenses. A typical prison in a sizable town could house anywhere from 100 to 1,000 inmates (the higher numbers only in large city states or capitals). A mid-size prison might have the following staff, who in an adjacent building or elsewhere in the town:

- A chamberlain or chief warden.
- A prison chaplain or priest and one or two assistants (friars, for example).
- One warden for each of the three to five wards.
- Four to eight guards (surprisingly few – the city watch would be called up; the guards dealt with any riots).
- A caretaker to look after the better rooms and the offices of the staff.
- A notary or clerk to keep records.
- A physician to maintain a sick ward and visit the better-off inmates for a fee.

Medieval prisons were normally located in the middle of town, right next to the courthouse. They were sturdy buildings (serving as a symbol of civic pride), but were not especially secure.

Instead of being isolated behind high-walled compounds, the barred windows and doors of the prison faced directly into the town's surrounding streets. Prisoners could usually beg passers by for alms or food, touch relatives, toss messages out, or accept packages, all without much supervision. Anything that could fit through bars or be tossed up through a window could enter.

Visitation was fairly easy. The warden and guards checked guests for weapons, but few restrictions were placed on who may visit or how often. Lawyers, priests, and charity workers could get in free; others, including family, payed a fee. Vendors or private contractors also stopped by regularly, selling food or other services to the richer prisoners; in a typical medieval prison, there was no such thing as a free lunch. (See *Typical Fees Charged by a Medieval Prison,* p. 24, for a list of costs.)

Prisons were divided into a number of wards: one with fairly clean, private cells; one with multi-prisoner cells that had, perhaps, some straw bedding or benches; and one with numerous prisoners crammed together. Those kept in cheaper cells or the poorest wards were chained, although they usually had some freedom of movement. Where an inmate ended up doesn't depend on his crimes, his sentence, or even his status, but rather on how much rent he (or, more often, his friends, family, or employer) was willing to pay.

Prisons had a separate woman's ward, but as female inmates were typically fewer in number, they had fewer options available. Often women were jumbled together in the same ward, regardless of their ability to pay. A large prison might also have a sick ward for the insane and/or ill prisoners, sometimes both.

## Prison Life

A newly arrived prisoner was delivered to the warden and guards by the local authorities, who searched him for weapons or anything else suspicious or dangerous (incendiaries, etc.). The captive, or more often, his lawyer or a family member, was expected to pay garnish, typically $60-120 to the warden and guards. If prisoner or his agents could come up with the money, he was allowed to bring a modicum of possessions (about Light encumbrance). He was then sent to a cell befitting the fee he paid. As a prison didn't provide uniforms, the convict wore his own clothes. If the captive couldn't pay, he was stripped and tossed in one of the poor wards, often in a cesspool. They might throw him some rags or what was left of any possessions after the guards distributed them.

Because the main reason for imprisoning someone was debt, the authorities had little interest in spending money on their inmates' upkeep. Instead, prisoners were forced to pay for their own food, lodging, and just about any other services they wished to enjoy.

Medieval prisons did not have catering staffs or much in the way of kitchens. Most prisoners subsisted on food brought to them by friends or family (paying a fee to the warden for each delivery). Those wretches with nothing were looked after by town charities, or survived by leaning through the barred windows and begging passersby for scraps or coins. Either way, without money, rations rarely amounted to more than bread or slops and water, fought over by other prisoners. For those lucky enough to have outside connections, vendors typically arrive to deliver food once a day in the afternoon.

The prison had no organized recreational facilities, no prison yard for exercise, no weight room, no library, no work program. There were daily religious observances (such a mass said by the chaplain) and perhaps weekly or biweekly visits from priests or religious charities. The main entertainment tended to be gambling with dice or knucklebones, fighting or shaking down other prisoners, and scrawling graffiti on the walls . . . along with booze and prostitution for those who could afford it!

Although alcohol was usually officially banned, many wardens were tolerant. Guards could be bribed to allow in alcohol (or tobacco and other stimulants, depending on the period and region). In fact, some medieval prisons were known to have bars, run by the wardens, serving cheap wine at a massive mark-up.

Conjugal visits were possible. . . if the warden was paid for the privilege. Unless the town was cracking down on vice, wardens usually allowed prostitutes to ply their trade (in exchange for a cut of the profits). Although male and female inmates were segregated in different wards, guards commonly arranged liaisons in exchange for sexual favors or money.

Poor diet and hygiene bred diseases, especially cholera, scurvy, and typhus. Even in the best cells, prisoners shared their rooms with lice, cockroaches, rats, and toads. During an epidemic, city prisoners were among the first to die.

## Getting Out

Some prisoners were imprisoned for a limited duration or were awaiting trial, but many were kept until their friends or relatives raised enough to pay whatever debt they were jailed for. It was also customary to charge prisoners an additional fee to leave the prison; inmates who had served their sentence or paid off their debts might still languish for years after that if they couldn't pay the exit fee! However, towns often pardoned a few inmates on major feast days like Easter or Christmas (usually only after they've served six months or more) or in honor of special occasions like a coronation, military victory, or royal birth.

Escape was possible. The average prison had only a half dozen guards, and lacked heavy security. Weapons weren't supposed to be brought in, there was plenty of opportunity to smuggle items, such as dagger. The main deterrent to escape was the threat of outlawry; most towns had laws that encouraged summary execution for escapees. For many citizens unaccustomed to traveling beyond their own town, prison seemed a safer bet than life in exile.

Adventurers, of course, may feel differently!

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## About the Columnist

David L. Pulver is a Canadian freelance author. An avid SF fan, he began roleplaying in junior high with the newly released ***Basic Dungeons & Dragons.*** Upon graduating from university, he decided to become a game designer. Since then, David has written over 70 roleplaying game books, and he has worked as a staff writer, editor, and line developer for Steve Jackson Games and Guardians of Order. He is best known for creating ***Transhuman Space,*** co-authoring the ***Big Eyes, Small Mouth*** anime RPG, and writing countless ***GURPS*** books, including the ***GURPS Basic Set,*** *Fourth Edition,* and the recent ***GURPS Spaceships*** series.

# A Killing Breath

## by Thomas Weigel

The blowgun is often dismissed. Compared to a bow, it has less power, less range, and requires at least as much expertise to use accurately. Nor do there seem to be as many options!

On the plus side, blowguns are lightweight, very nearly silent (far quieter than archery), exceptionally accurate . . . and historically, poisons have balanced out the lack of power. Additionally, its options allow for great variety.

## Blowguns

In the real world, blowguns come in a variety of sizes and shapes, and with numerous modifications. The list below should offer enough variety for any blowgun expert. The Blowpipe on p. B275 is similar to a practice fukiya, which is treated as a Small Blowgun with a mouthpiece (p. 27).

An entry in small caps indicates a weapon that appears below. Other entries are functionally similar enough to one of these weapons to use the same statistics, even if they differ radically in appearance. For details, read the entry.

**Blowgun** – *Universal.* A narrow tube that turns a sharp, hard breath into projectile force. It can be quite effective against small animals even without poison.

**Fukiya** – *Japan.* Classified as a form of archery in Japan, and practiced as a competitive sport, a competition-legal fukiya is a Blowgun, usually with the mouthpiece modification (p. 27). Treat fukiya suitable for practice as Small Blowguns.

**Huge Blowgun** – *Universal.* Like a Blowgun, but roughly four yards long. Usually carried vertically, then dropped down to aim, this weapon is unwieldy, but does maximize range and power. The Matis tribe ("Jaguar People") of the Amazon rainforest use this regularly; it is otherwise quite rare.

**Large Blowgun** – *Universal.* Like a Blowgun, but roughly as tall as the user. Most blowguns at low TLs (such as the Cherokee, Malaysian, Indonesian, and Amazon blowguns) are of this size.

**Metsubushi** – *Japan.* A blowgun optimized for blowing powder in an enemy face. The majority of metsubushi are Small Blowguns with the powder pipe modification (p. 27), although some as large as Blowguns exist.

**Mouth Blowgun** – *Universal.* A tube small enough to conceal in the mouth or contain entirely in a palm. Most examples in the real world are Japanese and associated with ninja (who use metsubushi powder, ground glass, or several small needles).

**Small Blowgun** – *Universal.* Like a Blowgun, but a bit shorter. Useful for closer-range action, as it is not quite as bulky, but loses some force and accuracy to breath loss.

**Tiny Blowgun** – *Universal.* Like a Blowgun, but much, much smaller. Equivalent to a very large drinking straw, it has dreadful accuracy and range, as the ammunition leaves the pipe before much breath can be used.

**Toy Blowgun** – *American.* Available in some stores (but restricted in some places as a weapon), a toy blowgun may be a Small Blowgun or a Blowgun, almost always with the mouthpiece modification (p. 27) and less accuracy (reduce Acc by 1; minimum 0).

*Quiet, lightweight, and exceptionally accurate . . .*

### *Blowgun Table*

| TL | Weapon | Damage | Acc | Range | Weight | RoF | Shots | Cost | ST | Bulk | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Mouth Blowgun | 1d-6 cr | 0* | ×1 | 0.1 | 1 | 1(5) | $5 | 1 | 0 | 1-3" long. |
| 0 | Tiny Blowgun | 1d-5 cr | 0* | ×1.5 | 0.5 | 1 | 1(2) | $10 | 1 | -2 | 1' long. |
| 0 | Small Blowgun | 1d-4 cr | 1 | ×2 | 1 | 1 | 1(2) | $20 | 2 | -4 | 3' long |
| 0 | Blowgun | 1d-3 cr | 1 | ×3 | 1.5 | 1 | 1(2) | $30 | 3† | -6 | 4-5' long |
| 0 | Large Blowgun | 1d-3 cr | 2 | ×4 | 2 | 1 | 1(2) | $60 | 4† | -8 | 6'+ long |
| 0 | Huge Blowgun | 1d-2 cr | 3‡ | ×5 | 4 | 1 | 1(3) | $120 | 6† | -10 | 12'+ long |

* Too small to effectively brace.

‡ Very accurate! If applying *Harsh Realism for Ranged Weapons* (***GURPS Low-Tech,*** p. 75), round final Acc up!

*One time when giving a little demonstration in my home for some visitors, and using only my short, five-foot blowgun, I shot a dart completely through a music book twenty sheets thick on the other side of the room. I thought I blew only a tiny puff of air, as the idea was to merely show how the blowgun worked.*

*– Reginald Laubin and Gladys Laubin,* ***American Indian Archery***

# Using Blowguns

Blowguns require two hands to reload, but can be fired with one or two hands. For models with a † in the ST requirement, one-handed use requires 1.5 times the listed ST (or twice the ST, to avoid a readiness penalty).

In addition to a maximum range, blowguns have a minimum range: C for Mouth Blowguns and Tiny Blowguns, 1 for Small Blowguns and Blowguns, 2 for Large Blowguns, and 4 for Huge Blowguns. Targets closer than this cannot be attacked. An attack *at* minimum range is at +2 to hit, but can be parried directly by knocking the blowgun aside! This damages the blowgun and does not suffer the usual penalties for parrying missile weapons.

Blowguns are effectively silent beyond a yard or two. When trying to locate an attacker by sound, treat a blowgun as a bow, but with an additional -4 (or worse, at the GM's option) to the Hearing roll.

# Blowgun Modifications

The basic statistics above assume blowguns made of a soft wood just thick enough to support itself (DR 1), and that the blowgun is little more than a shaped and smoothed pipe. There are a number of ways to improve on this:

*Tech Accessories* (TL 5+; varies): Blowguns are mostly a low-tech weapon, but there are a number of higher-tech accessories. Of particular interest are the bipod, improved visibility sight, lanyard, patrol sling, reflex sight, rifle sling, shooting stick, tactical light, and targeting laser. See ***GURPS High-Tech***, pp. 155-160 and ***GURPS Ultra-Tech***, pp. 149-152, for a huge variety of useful accessories. Sights are *double* the listed cost and weight – blowguns require *two* sights to be useful, one for each eye.

*Material Strength* (varies): A blowgun can be made of weaker or stronger materials. *Weak* materials (such as wrapped leaves or a lightweight reed) are -0.8 CF. The blowgun has DR 0, and any damage at all (even 1 HP) ruins it. Weight is halved, and minimum ST is ×0.6. *Strong* materials (hardwood, or thin metal at TL1+) are +1 CF. The blowgun has DR 2. Weight is doubled, and minimum ST is ×1.5. *Very strong* materials (thicker metal, TL1+) are CF +3. The blowgun has DR 3. Weight is tripled, and minimum ST is ×2.

*Mouthpiece* (+0.5 CF): A mouthpiece provides a somewhat better seal for the user's breath, and protects against accidentally sucking in (or breathing a powder). Increase damage by +1 and range multiplier to ST by +2 (so ×2 becomes ×4).

*Powder Pipe* (TL 4; +0 CF): The blowgun is specialized for powders. It can *only* use powder ammunition! However, it can be carried casually while loaded, keeps the powder dry in wet conditions, and generally does not require significant work to use. Reloading is very fussy, however, and takes twice as long as normal.

*Sturdy* (+1 CF): The tube's walls are thicker and heavier to maximize the ability to take punishment. *Double* the weight and DR, and increase minimum ST by ×1.5. This cannot be combined with *weak* material strength (above).

*Narrow-Mouthed* (+0 CF). A thin blowgun fires smaller projectiles faster. Reduce damage by -1, and increase the range multiplier to ST by +1. Projectile cost and weight are ×0.25. This cannot be combined with very narrow-mouthed (below) or wide-mouthed (below).

*Very Narrow-Mouthed* (+0 CF). A very thin blowgun (thinner than a narrow-mouthed one). Reduce damage by -2, and increase the range multiplier to ST by +2. Projectile cost and weight are ×0.1. This cannot be combined with narrow-mouthed (above) or wide-mouthed (below).

*Wide-Mouthed* (+0 CF): A wide-mouthed blowgun fires larger projectiles more slowly. Increase damage by +1, and reduce the range multiplier to ST by -1 (minimum ×0.5). Projectile cost and weight are ×4. This cannot be combined with narrow-mouthed or very narrow-mouthed (above).

# Ammunition

The default statistics given for the blowguns on p. 26 assume a bullet (the ***GURPS Basic Set*** blowpipe assumes a short dart). The *Blowgun Ammunition Table* (p. 28) offers some additional options.

Bullets are typically used when darts are not available, or for hunting small birds; spikes (and later, darts) are superior for most purposes, and can be poisoned for larger prey. Powder ammunition is almost exclusively Japanese, and its effectiveness as a weapon is questionable.

A bullet, spike, or dart can also use war point options from ***High-Tech*** and ***Ultra-Tech*** suitable for 10mm rounds that aren't high velocity and don't ignite on firing. Narrow-mouthed (above) reduces diameter to 6.5mm, and very narrow-mouthed (above) makes it 4mm. Wide-mouthed (above) increases diameter to 15mm.

Some good options from ***High-Tech*** include: baton, beanbag, explosives (of various sorts), illumination, liquid, smoke, and tear gas. A wide-mouthed blowgun can also use bursting-cargo poison gas and white phosphorous. The multiple projectile loads option (***High-Tech***, pp. 172-174) are also useful – in particular, multi-flechette (***High-Tech***, p. 174) can be used to simulate a mouth blowgun (p. 26) used by a ninja to spray needles at the enemy. Some of these options require slightly modified activation, as there is no gunpowder explosion.

## *Blowgun Ammunition Table*

| *TL* | *Ammunition* | *WPS* | *CPS* | *Effects* |
|---|---|---|---|---|
| 0 | Bullet | 0.003 | $0.01 | Increase shock penalty from injury by -1 (maximum -5). |
| 0 | Short Spike | 0.05 | $0.05 | 3-6" long. Does imp damage. |
| 0 | Long Spike* | 0.25 | $0.1 | 12" long. Does imp damage, at +1; range ST multiplier at -1. |
| 0 | Very Long Spike† | 1 | $0.2 | 24" long. Does imp damage, at +2; range ST multiplier at -2. |
| 1 | Short Dart | 0.05 | $0.1 | 3-6" long. Does pi- damage. |
| 1 | Long Dart* | 0.25 | $0.2 | 12" long. Does pi- damage, at +1; range ST multiplier at -1. |
| 1 | Very Long Dart† | 1 | $0.5 | 24" long. Does pi- damage, at +2; range ST multiplier at -2. |
| 2 | Rifled Dart | ×1 | ×2 | Acc +50% (round down). |
| 4 | Powder | 0.1 | *varies* | *No* damage; max range is same as minimum; reload 10; +2 to hit! |

* Weapon must be a SMALL BLOWGUN or larger.
† Weapon must be a BLOWGUN or larger.

Some good options from ***GURPS Ultra-Tech*** include: biochemical aerosols, burrow darts, explosives (of various sorts), monochain, and stingray rounds. A wide-mouthed blowgun can also use flares and memory batons.

*A smooth mouthpiece allows for comfort and a tight no-leak seal with the shooter's lips. A smooth muzzle end insures speedy release of the dart from the end of the gun.*

*– Steven M. Watts,* ***Practicing Primitive***

# MARTIAL ARTS

Most real-world uses of blowguns are not martial arts in the normal sense – they combine well with Stealth and Survival, but not so well with bloody melee combat. So consider the following rules *highly* optional, for cinematic and fantasy campaigns.

## *Blowguns in Melee*

Unmodified blowguns are unlikely to survive use as a melee weapon (although Sturdy and *strong* or *very strong* Material Strength change that). Still, desperate times . . .

Treat a TINY BLOWGUN as a BATON; a SMALL BLOWGUN as a SHORT STAFF; a BLOWGUN as a JO if you have ***GURPS Low-Tech*** or ***Martial Arts***, as a SHORT STAFF otherwise; and a LARGE BLOWGUN or HUGE BLOWGUN as a QUARTERSTAFF. All of these uses are at a -2 skill penalty due to the thick, unwieldy grip.

If the blowgun is sturdy (p. 27) and at has least strong material strength (p. 27), use the normal damage for the weapon; otherwise, reduce the damage by -1 and the blowgun takes damage if parried. If the blowgun has weak material strength (p. 27), it breaks on the first use as a melee weapon.

A blowgun can be given a sharp tip (+0.5 CF, change thrust damage to impaling) *or* a weighted head (+1 CF, increase swing damage by +1).

A blowgun martial art might have any of these techniques found in ***GURPS Martial Arts***: Fighting While Seated (p. 83), Ground-Fighting (p. 73), Low Fighting (p. 77), Mounted Shooting (p. 77), Pressure-Point Strike (p. 87), and Retain Weapon (p. 78).

Useful perks from ***GURPS Power-Ups 2*** include Akimbo (p. 5), Combat Vaulting (Great Blowgun) (p. 5), Form Mastery (p. 5), Off-Hand Weapon Training (pp. 16-17), and Technique Mastery (p. 17). Form Mastery is particularly useful in conjunction with the melee skills that can use the blowgun. Three additional perks are given below.

### Breath Mastery

*Prerequisite:* Breath Control.

You've mastered the fast, sharp breath required to propel the blowgun's missile, and have built up substantial diaphragm strength. Increase ST by +1 for purposes of forcefully expelling your breath (notably, range and damage with a blowgun).

The GM may permit multiple levels to increase ST further. Each level is an additional Style Perk (***Martial Arts,*** p. 49). Increasing ST by up to 30% with Breath Mastery is reasonably plausible; more than that is cinematic.

### Iron Pipe*

You can focus your chi into your blowgun, making it more durable for just long enough to make an attack or parry. When using it in this manner, the blowgun is treated as a normal melee weapon, regardless of how flimsy its construction. If DR matters, it has its normal DR +1 or DR 3, whichever is greater. This is a cinematic perk.

### Pipe Grip

You have trained extensively in using the blowgun in melee combat. Ignore the -2 skill penalty due to its grip.

## *Deadly Breath*

**7 points**

This style is a flashy, acrobatic style that is completely inappropriate to realistic campaigns. Practitioners tumble madly across the battlefield, pausing only to blow javelin-like darts at surprisingly close ranges and to deadly effect. Most practitioners also learn unarmed, staff, and sword arts as well.

Many schools also teach parrying blowgun missiles with the off-hand, using the darts as knives or thrown weapons, and making the styles signature jade blowguns.

*Skills:* Acrobatics; Blowpipe; Blowpipe Art; Blowpipe Sport; Breath Control; Jumping.

*Techniques:* Acrobatic Stand; Breakfall; Evade; Feint (Acrobatics); Jump Kick (Acrobatics); Kicking (Acrobatics); Retain Weapon (Blowpipe); Spinning Kick (Acrobatics).

*Cinematic Skills:* Blind-Fighting; Flying Leap; Power Blow; Pressure Points (Blowpipe); Pressure Secrets (Blowpipe); Zen Archery (Blowpipe).

*Cinematic Techniques:* Flying Jump Kick (Acrobatics); Hand Catch (Parry Missile Weapons); Pole-Vault Kick (Acrobatics); Pressure-Point Strike (Blowpipe); Roll With Blow.

*Perks:* Breath Mastery (p. 28); Cotton Stomach; Iron Pipe (p. 28); Pipe Grip (p. 28); Skill Adaptation (Acrobatic Feints); Skill Adaptation (Acrobatic Kicks).

### Optional Traits

*Skills:* Armory (Missile Weapons); Artist (Sculpting); Fast-Draw (Arrow); Knife; Parry Missile Weapons (Off-Hand); Stage Combat; Thrown Weapon (Dart).

## *Pipe-Stalking*

**7 points**

A martial art for small races, pipe-stalking relies on skilled breath control, stealth, and the use of poisons to take down small prey and larger enemies. Pipe-stalkers do not train for direct combat – against most larger humanoids, that means they've already lost!

An ideal fight is one in which the pipe-stalker silently gets within range of a foe, Aims for several rounds or until the foe's back is turned, and then performs an All-Out Attack (Determined) at an unarmored portion of the body, using a poisoned dart. He then remains hidden (if possible) or flees (if not), and waits for the poison to work its way through the opponent's system. In the least ideal fight, the target is armored, and the pipe-stalker follows and waits until the armor comes off. Mythological pipe-stalking heroes are said to have hunted their enemies for years!

The legendary masters of pipe-stalking are practically invisible and silent, can penetrate armor, and can target nerve clusters in larger opponents to stun or even kill them.

*Skills:* Blowpipe; Breath Control; Camouflage; Stealth; Survival; Tracking.

*Cinematic Skills:* Blind-Fighting; Invisibility Art; Light Walk; Mental Strength; Power Blow; Pressure Points (Blowpipe); Pressure Secrets (Blowpipe); Zen Archery (Blowpipe).

*Cinematic Techniques:* Pressure-Point Strike (Blowpipe).

*Perks:* Breath Mastery (p. 28).

### Optional Traits

*Skills:* Fast-Draw (Arrow); Hypnotism; Meditation; Mind Block; Physiology (for various large humanoid races); Poisons; Running; Swimming.

## *Warstaff*

**5 points**

Warstaff is a martial-arts style for wizards. Practitioners are known for their *warstaves,* blowguns sturdy enough for use as staves, and for the spell-bearing darts they use to hit opponents at range.

Practitioners favor long-ranged attacks with Spell Arrow-enhanced darts. Up close, the art focuses on disabling, knocking down, or shoving away the opponent so that the wizard can gain some distance for spell-casting or using the blowgun. The combatant typically favors Defensive Attack (occasionally All-Out Defense if allies are likely to assist), Sweep, and Push Kick.

This style is practical and lacks much in the way of legendary abilities. Some masters have been said to be able to deflect almost anything with their blowguns, however.

*Skills:* Blowpipe; Brawling; Breath Control; Staff.

*Techniques:* Close Combat (Staff); Counterattack (Staff); Disarming (Staff); Feint (Staff); Kicking; Knee Strike; Push Kick; Retain Weapon; Stamp Kick; Sweep (Staff); Targeted Attack (Staff Swing/Leg).

*Cinematic Skills:* Mental Strength; Parry Missile Weapons (Staff); Precognitive Parry; Push.

*Cinematic Techniques:* Fighting While Seated; Grand Disarm; Timed Defense.

*Perks:* Form Mastery (Staff/Large Blowpipe); Pipe Grip (p. 28); Sure-Footed (Uneven).

# About the Author

Thomas Weigel lives in Austin, Texas with his wife and two cats. He has edited and indexed various books for Steve Jackson Games, but usually made his Dodge roll against the writing bug. Unfortunately, the bug got a blowgun.

*Stalking is the chief hunting technique, both for arboreal and ground-dwelling creatures. Monkeys and large birds are usually stalked with the blowgun . . . and darts poisoned with curare (unpoisoned darts suffice for small birds).*

*– Michael J. Harner,* ***The Jívaro***

# Roman Technology

## by Kenneth Peters

*Our ancestors adopted nature as their model; and, in imitation of the divine institutions, invented machines necessary for the purposes of life. That these might be suitable to their different purposes, some were constructed with wheels, and were called machines; others were denominated organs. Those which were found most useful were gradually improved, by repeated experiments, by art, and by the laws which they instituted.*

*– Vitruvius,* ***On Architecture***

The Roman era of the third century is a fascinating period for heroes to explore. Of course, for gamers to know what the third-century Roman Empire was really like, it helps to know what its technology was like. Although this reference doesn't pretend to be comprehensive, it illustrates some of the technical achievements of the TL2 Romans. Together with ***GURPS Low-Tech,*** it should prove useful for many fantasy or alternate-history settings, especially when combined with ***GURPS Imperial Rome***, ***GURPS Martial Arts: Gladiators,*** the *Roma Arcana* setting from ***GURPS Fantasy,*** and many aspects of the *Roma Universalis* world (presented in *Pyramid #3/20: Infinite Worlds* and expanded upon in *Pyramid #3/24: Bio-Tech, #3/27: Monsters in Space,* and *#3/27: Spaceships*).

## Uncommon Knowledge

In a campaign featuring the Empire, some skills need special attention.

### *Archetype Skills*

Some ***GURPS*** skills were not developed or taught in the third century, but the GM *might* allow someone to use the following skills at default.

Archaeology, Autohypnosis, Cloak, Criminology, Cryptography, Hazardous Materials, Intelligence Analysis, Linguistics, Lockpicking, Physiology, and Sociology.

### *Anachronistic Skills*

In addition to the obvious (Computer Hacking, Driving, Electronics Operation, etc.), the following skills do not exist in the Roman world, even at a default.

Anthropology, Bicycling, Biology, Blowpipe, Bolas, Brainwashing, Economics, Forensics, Geography, Geology, Market Analysis, Mathematics (Cryptology and Statistics), Skating, and Skiing.

# Core Technologies

With large markets offering strong demand for Roman goods throughout the Empire, the Romans have become quite good at developing efficient manufacturing techniques. Workshops *(fabricae)* create quantities of standardized armor and weapons – including ammunition – using production-line technologies. Builders are able to stamp out bricks, pipes, and other materials from molds, which allows for quicker completion of construction projects. The Romans also have many labor-saving techniques, such as using "blank" statues that artists refine on-site to customer specifications. Businesses use division of labor and co-locate related industries to reduce transportation costs and duplication of effort.

*All that of art man has,*
*Prometheus gave.*

*– Aeschylus,* ***Prometheus Bound***

## Food

The diet of the average Roman consists primarily of grains, olives, and wine. Vegetables and small amounts of meat round out many meals. Honey is the sweetener most commonly added to food; the Romans are aware of cane sugar but never cultivated it. Fish sauce *(garum)* – roughly equivalent to modern Worcestershire sauce – is a popular flavoring for all sorts of dishes; regional varieties can be found in every point of the Empire. Sauces and strong spices help disguise the smell and taste of rotting foods – there's no access to refrigeration!

A common peasant meal consists of bread or gruel and a type of pesto sauce *(moretum)*, served with diluted wine. The rich can afford exotic foods, and they sometimes show off their wealth by serving outlandish meals with expensive spices – such as lion (shipped in live from Africa or bought from the arenas) served with liberal amounts of pepper imported from India.

# Materials

The Roman Empire covers a large territory, but many techniques and consumer expectations are widely dispersed – creating demand for similar products in every corner of the known world.

## Stone and Earth

There is a huge demand throughout the Empire for all types of decorative stone – especially limestone and marble – that match Roman architectural and artistic tastes. Romans ship marble throughout the Empire for use in statuary and buildings; it is so important for the Emperor's building projects that an entire government bureau (the *ratio marmorum*) exists to guarantee supply. Marble shipments are a substantial percentage of all long-distance ocean trade.

## Earthenware and Brick

Mass-produced terracotta tile, fired clay brick, and red gloss *(terra sigillata)* pottery are among the hallmarks of Roman organization. Terracotta is also used for cheap statues, figurines, lamps, and decorations. Ceramic tiles are used in suspended hypocaust floors.

## Glass

Glass production is a major industry in the Roman Empire, made possible by the development of glassblowing (***Low-Tech***, p. 19). Cheap blue-green glassware blown by hand or into a mold is affordable and common, while those with more discriminating tastes can buy glass in a wide variety of colors and designs. Broken glass is collected and used in mosaics and other decorations. Flat-pane glass windows are available.

### Alexandrian Glass

The Romans made use of a type of optical glass referred to as "Alexandrian glass." In addition to allowing the creation of clear-glass burning lenses (***Low-Tech***, p. 35) and transparent glass windows, the Romans crafted small convex glass mirrors coated with lead on the interior. There is no modern evidence they designed corrective or telescopic lenses.

## Leather

The Empire creates enormous volumes of leather goods – 68,000 goatskins are required just for the tents in a single legion! The Romans have sophisticated tanning methods enabling them to make specific colors and finishes. Footwear, harnesses, and other rugged goods use cattle leather, while clothing, tents, and waterproof containers are made from goatskin. The Romans consider the use of furs to be a barbarous practice, and remove the hair before processing.

## Textiles

Most Roman textiles (see *Fiber*, ***Low-Tech***, p. 23) are produced locally, close to their raw materials. Wool is the main source of Roman woven textiles, but flax is also common. Hemp is primarily used for sailcloth and rope. Cotton is imported from India and grown in Egypt and Mesopotamia. Some luxurious garments use rabbit hair, and cleaning asbestos tablecloths in fire is a popular party trick. Silk is by far the most important textile transported in the Roman Empire (imported from China and India), and was in high demand *everywhere*.

# Mining

The Emperor controls all mineral rights and leases out claims on a profit-sharing basis. Local mine operators *(conductores)* are overseen by the regional imperial agent *(procurator metallorum)*.

## Prospecting

Most knowledgeable Romans believe that metals spontaneously grow in the earth as mixtures of the Platonic elements, and that their composition can be influenced by astrological factors. The lack of geological knowledge means that most uses of the Prospecting skill (p. B216) will be at -2 for area unfamiliarity even a short distance from an existing site.

## Types of Mines

Mining is hazardous, slow, and expensive. By the third century, most deposits on the surface have been worked out in the Roman areas, and miners must excavate with other methods.

*Opencast:* Most open-pit mines are located in areas where surface deposits had previously been worked, and consist of multiple shafts no more than 100' across and 30' in depth. Firesetting and undermining break up ore bodies, and aqueducts or careful releases of dammed water flush away loose rock and soil (known as *hushing*).

*Deep Vein:* Underground mining is dangerous but profitable. Roman underground mines are dug with little planning, resulting in an unmappable maze of tunnels. Galleries are very small; the typical excavation tunnel is a mere 3' × 2'! See ***Low-Tech Companion 3*** (pp. 20-21) for digging rates and other considerations.

## Mining Conditions

Although the mine overseers and technicians live a fairly comfortable life, the same cannot be said for the average miner. Many are criminals (including Christians), slaves, or conscripted locals who work under threat of the lash. Miners that attempt escape are bound in shackles (***Low-Tech***, p. 130) to their work area.

Work in an opencast mine is backbreaking labor, but underground miners faced threats far worse than an angry taskmaster. Deep-vein miners are almost always forced into a kneeling or crawling posture (p. B364). They often work by feel in total darkness (p. B394, experienced miners count as being accustomed) or in the flickering illumination of resinous torches or stone lamps (***Low-Tech***, p. 33).

They breathe air that is – at *best* – mildly toxic (p. B429, usually a daily HT-1 roll to avoid 1 point of toxic damage). At some mines, the mortality rate is so high that there are simply not enough slaves on the market or criminals awaiting sentencing to maintain production.

*The human porter (in Latin* ***saccarius*** *– "sack man") is much more adaptable in every way than a vehicle or pack animal.*

*– J. G. Landels,* ***Engineering in the Ancient World***

## Power

Only a few power sources are available to the Roman Empire: muscle (human and animal), water, and wind. Solar power is employed passively, for drying and heating. Steam see only cursory use. See ***Low-Tech*** (pp. 27-28) for additional information on these sources.

### Muscle

Human muscle provides the power for most devices in the third century. Humans can switch jobs quickly, operate with minimal direction, and are capable of carrying out complex tasks. With the use of simple machines (see *Construction Equipment*, ***Low-Tech Companion 3***, pp. 16-17), their effective physical strength can be multiplied many times over.

The ox and the mule are the most widely employed work animals. Horses are expensive and require too much upkeep to be useful for menial tasks. (In addition, Romans generally avoid eating equines, so they are not very good as emergency food.) The ox is especially useful, since it can subsist on low-quality fodder and has superior pulling ability; note that the breast-strap harness (***Low-Tech***, p. 28) probably does *not* have issues with traction efficiency. Donkeys are cheap and available everywhere, but in industry are only used to power rotary grain mills and saqiyas. See ***Low-Tech Companion 3*** (pp. 14-15) for animal statistics.

### Water

The Roman Empire makes extensive use of water power. Waterwheels are often built to exploit the existing aqueduct networks, as modifying natural streams and rivers is expensive. Undershot wheels are the most common (about 75%). Waterwheels power sawmills, trip hammers, edge crushers, grain mills, and (sometimes) furnace bellows.

### Wind

Although the Greeks and Romans use wind power for sailing, there is no modern evidence of it being harnessed for other forms of useful work. They *are* aware of the basic principles behind windmills, so it's possible that simple devices are in use in a few locations.

## Fuel

Wood and charcoal (***Low-Tech***, p. 27) are the primary sources of chemical energy in the Roman Empire, supplemented by vegetable oils (namely, olive oil) for interior lighting. Peat and small amounts of coal are used in the northern provinces.

# General Equipment

A Roman adventurer can acquire almost any convenience in the city markets, and has access to some TL3 conveniences, such as sulfur matches (***Low-Tech***, p. 35).

## Containers

Trading partners can agree to use any unit of measure, but most people rely on Roman units even in the frontiers of the Empire. A certain degree of error and loss is expected, so it's common for vendors to overdeliver by a small amount to guard against claims of fraud. See ***Low-Tech*** (pp. 34-35) for more information.

### Earthenware Jars

Olives, fish sauce, honey, flour, and even grain are shipped long distances in pitch-coated earthenware jars *(amphorae)*. Typical wine amphorae hold about six gallons, and those used for oil contain about 20 gallons. These are unreasonably bulky and fragile by modern standards. Amphorae are often reused, but they can be converted into urinals, cremation urns, or broken up to create potsherds. Amphorae are stored upright and have carrying handles.

### Wooden Boxes/Barrels

The Romans use large wooden casks made with staves and hoops *(cupae)* for bulk transport of many goods, including beer, wine, and salted meat or fish. Some aficionados prefer wine aged and flavored in certain types of wood. These barrels usually carry 80 gallons or more.

### Pack Saddle (TL1)

Saddlebags (***Low-Tech***, p. 134) can tote a small amount of cargo, but animals expected to bear heavy loads need specialized gear. Simply roping gear onto the animal is inefficient (-4 to Packing).

Pack saddles come in various types, but all help balance the load and prevent chafing. Some can seat a passenger. Elaborate versions with the compartmentalized option (***Low-Tech***, p. 35) can be used to create portable stores and workshops. With horse blanket: $150, 50 lbs.

# Information Technologies

The Greeks and Romans place little emphasis on strictly distinguishing between different skills. The Latin words *ars* ("art" or "technique") encompasses everything from carpentry to geometry. Distinction is social rather than technical. Memorization and rational thought are prized; manual production and performance are seen as imitation. Physical labor and the exchange of money for service are considered vulgar and inappropriate for the upper class.

## Writing and Records

The invention of writing is a monumental technological advance, creating a system of artificial memory that allows large amounts of information to be stored and retrieved.

### Media

Papyrus is the most common writing material used in the Roman world. However, it is relatively fragile and expensive to ship in bulk. For this reason, the Romans use parchment and vellum in many areas. Whitened wooden boards or lead sheets are prefered for public notices, magical charms, and diplomas. In the northern provinces they use notebooks composed of barkcloth.

Everyday writing is done using *tabulae* – wax tablets that are written on using a stylus. Multiple tablets can be bound together to form a book. Potsherds, known as *ostraka,* are used *everywhere* for writing practice, short letters, and shop receipts. See ***Low-Tech*** (p. 46) for additional details.

### Document Format

Scrolls remain the dominant format for written texts in the third century, but they are being displaced by the superior codex (***Low-Tech***, p. 47). Due to the unique manufacture of each book, page numbers and indexes (***Low-Tech***, p. 48) cannot be used as reference for another copy – a problem that would not be solved until the mass production of books centuries later.

### Bookstores and Libraries

The literate population of the Roman Empire is large enough to support a sophisticated and lively book trade, as well as numerous libraries. Even so, books are still produced by hand and tend to be expensive luxuries (see *Hand Copying,* ***Low-Tech Companion 1,*** pp. 33-34). An urban worker may own a battered copy of the *Aeneid* and a few reference books for his trade . . . and count himself lucky!

The price and volume of TL2 codices and scrolls limits most collections to a few dozen works on a handful of subjects, but the major libraries (public and private) could aspire to some fraction of that stored in Alexandria (***Low-Tech Companion 1***, p. 31). Public libraries rarely allow borrowing.

### Movable Type

A tantalizing divergent technology for a Roman campaign is the development of printing blocks (***Low-Tech***, p. 48) or even movable type (***High-Tech***, p. 17). These technologies would have developed out of the standardized imprinting techniques used to mark lead water pipes.

The current consensus is that fixed stamps were used, but even these could have been scaled up for mass printing: possibly pressing into thin lead sheets or wax surfaces instead of using ink on papyrus. The older theory – that the stamps held interchangeable letters – could have led to the development of movable type two TLs in advance!

# Mobility and Transportation

Most trips in the Empire are short, with the bulk of travel and commerce occurring within a few dozen miles of the urban areas. State officials and some merchants may journey longer distances, but such individuals are uncommon. Travel is dangerous, exhausting, and expensive.

### Greek Wheelbarrow (TL2)

It is generally accepted that the wheelbarrow (***Low-Tech***, p. 133) was developed independently in Europe during the 12th century. However, there is some evidence that the Greeks used a type of wheelbarrow as early as the third century B.C. This *monokyklos* was probably a front-wheel cart, perhaps with a neck strap for additional support.

### Handbarrow (TL0)

This is a rectangular cargo platform with carrying handles at both ends. When carrying people, it may be called a litter (***Low-Tech***, p. 136).

### Lectica (TL2)

One of the few types of "vehicle" allowed into a city during the day, rich Romans use litters or sedan chairs (***Low-Tech***, p. 136) to avoid the crush of pedestrians. Both are often enclosed, with leather canopy and cloth curtains at a minimum. Larger versions are treated as *palanquins* (***Low-Tech,*** p. 136), with six or eight porters. Men of high Status make a point of not using a lectica, as they *want* to be seen.

# Travel by Land

Land transportation in the Roman Empire is slow and expensive. Even the best roads can be treacherous, and in many regions the only path is cross-country or over dangerous mountain passes. Even so, the roads outside a Roman city are packed with traveling merchants, wealthy vacationers, local farmers, government agents, and peddlers streaming in and out each day.

## *Roman Roads*

Contrary to popular belief, not every Roman road was paved. Quality of construction, even along a single route, varied based on need and location (especially in proximity to major urban centers). In general, the road system in the Empire counts as Average terrain (see *Roads*, p. B351) under most weather conditions. Road width varies between 6' (in mountain passes) to 30' (right outside city gates), often with a 3-5' dirt strip on each side.

Many roads are dirt paths *(viae terrenae)* cleared of obstructions and improved with drainage ditches and safety grooves to keep carts from skidding. Municipalities and provinces often upgrade the surface of major routes to gravel roads *(viae glareatae)* that hold up much better in the rain.

The famed stone-paved roads *(viae stratae)* are common on the Italian peninsula, but in the provinces, they only link urban centers, ports, and sites of military significance – they are *very* expensive to maintain. These paved roads include conveniences such as stone bridges and tunnels. In a conveniently anachronistic Rome *all* roads will be of this quality.

Before the invention of horseshoes (TL3), draft animals and horses cannot be ridden for long distances on paved surfaces without risk of injury (see *Equines*, ***Low-Tech***, p. 133).

## *Travel Accommodations*

Where possible, travelers arrange for stays at the homes and estates of friends, family members, and other associates. When those are not available, travelers camp near the road (and invite a visit from the local bandits), rent a room at a private home, or stay at one of the numerous inns that dotted the road networks. Use the guidelines for *Inns, Hotels, and Other Temporary Accommodations* (p. B265) to determine cost.

A typical roadhouse *(mansio)* is a two-story structure built near the road. The ground floor contains the stable, blacksmith's forge, office, kitchen, and dining room (heated by air ducts under the floor); the upper floor contains the bedrooms. More elaborate roadhouses have an attached bathing area, while smaller facilities are single-story – the dining area doubles as the sleeping chamber.

All but the smallest town have at least one inn *(hospitium)*. Most urban centers have a selection to choose from, serving any Status level. All offer a decent meal, alcohol, prostitutes, and some sort of entertainment.

*If you're clean and neat, then here's a house ready and waiting for you. If you're dirty – well, I'm shamed to say it, but you're welcome, too.*

*– Advertisement for a Roman Inn*

## *Vehicles*

Roman vehicle design is sophisticated, with many innovations that won't be re-introduced into Europe until TL4. In addition to simple sledges (***Low-Tech***, p. 135) and the lowly oxcart (***Low-Tech***, p. 136), a large variety of two-and-four-wheeled carts and wagons (*vehicula*) – many derived from Celtic designs – are available.

A typical Roman wagon uses spoked wooden wheels that turn independently of the axle (making them easier to steer). Each wheel has "tires" made of iron bands. Lubrication is limited to water, lard, and olive dregs, so wheeled vehicles tend to make a loud screeching noise when on the move and quickly wear out the wheel hubs (reflected in their HT). Braking is either nonexistent or in the form of levering a pole into the ground. Evidence for wheel brakes is limited, but would be convenient in anachronistic campaigns.

Most Roman vehicles have little in the way of shock absorption, and the jolting and jostling causes a loss of 1 FP/hour on Good terrain and 2 FP/hour on Average terrain. Those that can afford it will purchase a model that has a suspension (normally associated with TL4 vehicles); this is a savior for any rider's backside during long trips, and *halves* FP costs (prepared travelers also bring cushions). Treat it as a variation on the expensive modification: +1 CF. Roman carts and carriages can't negotiate Bad or Very Bad terrain (see p. B351).

## *Land Vehicles Table*

Terms and notation are as defined in *Vehicle Statistics* (pp. B462-463).

| *TL* | *Vehicle* | *ST/HP* | *Hnd/SR* | *HT* | *Move* | *LWt.* | *Load* | *SM* | *Occ.* | *DR* | *Range* | *Cost* | *Locations* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TEAMSTER** | | | | | | | | | | | | | |
| 2 | Hooded Car | 30† | 0/2 | 11c | 4/8* | 0.5 | 0.3 | +1 | 1+1 | 1 | F | $250 | 2DE2W |
| 2 | Large Cart | 43† | -2/3 | 11c | 4/8* | 1.7 | 1.1 | +2 | 1 | 1 | F | $500 | 2DO4W |
| 2 | Racing Chariot | 17† | +1/1 | 11c | 4/9* | 0.11 | 0.075 | +1 | 1 | 1 | F | $1,500 | 2DE2W |
| 2 | Small Cart | 11† | +1/2 | 12c | 4/8* | 0.06 | 0.05 | +0 | – | 0 | F | $50 | 2D2W |
| 2 | Traveling Carriage | 40† | -1/2 | 10c | 4/8* | 1.2 | 0.7 | +2 | 1+4 | 2 | F | $4K | 2DO4W |

*Hooded Car (Carpentum):* A light carriage drawn by two mules. The driver and the small cargo area are covered by a roof (of linen, leather, or wood). The *cisium* is similar, but has more comfortable seating instead of cargo (Load 0.2); a small box below the seat stores personal effects.

*Racing Chariot (Biga):* A two-horse racing chariot. Very lightweight with minimal metal components, they could reach speeds that would cause the wheel hubs to glow red and the wheels to catch on fire from the friction! For even faster speeds, a slightly larger chariot can be used that harnesses four horses (*quadriga*).

*Transport Carts (Plaustrum):* Small carts *(plaustrum minus)* often carry little more than a large basket, but they can be yoked to goats or young animals, or pulled by a man. Large carts *(plaustrum maius)* seat a driver and have a roomy cargo area for carrying large casks, lumber, etc.

*Traveling Carriage (Carruca):* A heavy wagon drawn by two, or sometimes four, animals. Many are covered. Wealthy travelers may have one or two in their convoy set up as a sleeping wagon *(carruca dormitoria)* that can hold two in comfort. The *raeda* is similar, but often of simpler construction (-0.5 CF, but -2 Handling) and cheap (***Low-Tech***, p 14).

## A World Without Minutes

*[W]ithout minutes there can be no such measurements as gallons per minute. . . . The day of a businessman cannot be precisely organized, for appointments cannot be set for exact times . . . In the military sphere, movements of troops . . . cannot be coordinated by timing. Athletics events will not be timed, guests will arrive gradually at parties, gladiatorial shows will begin at no precise time . . .*

*– George Houston*

Romans divided the day into 12 hours of daylight and 12 hours of night. The length of each of these hours depends on the season (shorter in the winter, longer in the summer). Units of time below a half-hour are not generally recognized.

# Travel by Sea

Travel by water is immensely cheaper than going by land, even when good roads are available. The cost ratio of sea/river/land transport ranges from 1:5:30 in the interior, to as high as 1:6:60 in frontier.

## Navigation

Roman navigation technology is limited, restricting Mediterranean open-ocean voyages to the months of March through November. Roman captains rely on a periplus (***Low-Tech***, p. 51) and a lead line (***Low-Tech***, p. 52). (It's not clear if Roman sailors used a windrose (***Low-Tech***, p. 51) to any effect.)

## Harbors

Roman harbors use docks equipped with cargo cranes, and major ports have lighthouses to aid navigation. Most harbors also make use of offshore breakwaters. A well-developed port can hold at least 13 ships docked to the quays.

## Ships

The Romans use a number of different boatbuilding techniques, borrowing the best local methods. Most watercraft are plank boats (***Low-Tech***, pp. 140-142).

*Cargo Ship (Corbita):* A generic term, *corbita* refers to a range of civilian transport ships. The version listed in the table below is typical of a larger design, with a square main sail and a smaller foresail. Although not the largest Roman ship available, after the fall of the Empire, vessels of this size did not reappear until the 15th century.

*Celtic Transport (Cogga):* A shallow-bottom seagoing craft that can beach itself during low tides. It is built frame-first with a single square-sail mast. It is probably a precursor to the cog and hulk (***Low-Tech Companion 3***, p. 41).

*Frigate (Liburnian):* Adapted from an Illyrian pirate ship, the *liburnian* is the most common military watercraft. It is used in every corner of the Empire, both on the high seas and along the rivers. Rowers are concealed below the fighting deck. It carries 60 rowers, 16 marines, six sailors, and four officers.

*Cruiser (Trireme):* A heavy Roman warship designed for anti-ship use in the Mediterranean. It carries 170 rowers, 14 marines, 10 sailors, and 10 officers.

## Boats and Ships Table

Terms and notation are as defined in *Vehicle Statistics* (pp. B462-463).

| *TL* | *Vehicle* | *ST/HP* | *Hnd/SR* | *HT* | *Move* | *LWt.* | *Load* | *SM* | *Occ.* | *DR* | *Range* | *Cost* | *Locations* | *Draft* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BOATING/TL (SAILBOAT)** | | | | | | | | | | | | | | | |
| 2 | Cargo Ship | 278† | -3/4 | 12c | 0.05/4 | 600 | 432 | +8 | 20 | 2 | F | $800K | Ms | 7 | |
| 2 | Cruiser | 194† | -2/3 | 12c | 1/5 | 77.4 | 20.4 | +8 | 204 | 3 | F | $500K | 2M2S | 4 | [1] |
| 2 | Frigate | 101† | -1/3 | 12c | 1/6 | 17.6 | 9.6 | +7 | 96 | 3 | F | $200K | 1M2s | 3 | [1] |
| 2 | Transport | 132† | -3/4 | 12c | 0.1/4 | 90 | 72 | +7 | 20 | 3 | F | $150K | Ms | 5 | |

### Notes

[1] Under oars. Under sail, Range is "–" and Move is +0/+1 in a favorable wind.

# Medicine and Surgery

Greco-Roman doctors make great strides in practical application of their art, especially in the treatment of combat injuries. However, third-century medicine is still burdened by misinformation and myth.

## Life Expectancy and Well-Being

The life expectancy of most Romans is about 34 *if* they survive the first year of life . . . many did not. High infant mortality, endemic disease (particularly malaria and tuberculosis), and periodic epidemics keep population growth very low. High Wealth and Status do not guarantee a healthy or long life.

### Health

The prosperity and technical advances of the Roman Empire does *not* extend to increases in physical wellbeing. Many poor citizens are HT 9, and possibly even Unfit. Average health *increases* after the collapse of the Empire, as resources become distributed more equitably.

### Height

The average Roman male living in Italy is about 5'3" tall; women average 5'1". Those that live in the frontier provinces tend to be taller (due to a better diet and lower disease load). Use the lower end of the suggested heights when consulting the *Build Table*, p. B18.

### Gem Spectacles (TL2+1)

Emperor Nero is said to have used a green emerald to help him watch the gladiatorial games. It is within the realm of possibility (hence the TL2+1) that this gem was carved out to create a corrective lens. A gem spectacle must be held in a free hand and is *fragile;* it breaks if the user is struck in the face or the hand holding them. It replaces Bad Sight [-25] with green-tinted Bad Sight (Mitigator, -60%) [-10]. $1,000, 0.25 lb.

### City Hygiene

Roman cities are unhealthy locations (see *Public Health,* ***Low-Tech Companion 1***, p. 28). Concentrated populations, simplistic understanding of effective hygiene (for example, allowing those with contagious diseases to use public baths), and untreatable diseases offset any gains from increased access to medical care, aqueducts, baths, and sewers. Many Roman cities have a Hygiene value of -1 (see ***GURPS City Stats,*** p. 6); Rome itself is -2.

> *There is no modern population – even among the worst-off countries of sub-Saharan Africa – whose growth, longevity, and age structure would even remotely resemble the ancient Roman pattern. Perhaps the best contemporary analogy would be to imagine a population that is even more destitute and desperate than those of Sierra Leone or [Burkina] Faso . . .*
>
> *– Vaclav Smil,* ***Why America is Not a New Rome***

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## About the Author


Kenneth Peters uses his degrees in archaeology and geography for the forces of Good . . . usually. He's written for and playtested various ***GURPS*** supplements and *Pyramid* articles, and looks forward to the day when ***GURPS Imperial Rome*** is updated.

# Random Thought Table

## Low-Tech, High Fun!

### by Steven Marsh, *Pyramid* Editor

When you think about it, last year's release of ***GURPS Low-Tech*** (plus the three ***Companion*** volumes – four if you count ***GURPS Fantasy-Tech***) is somewhat surprising. The ***Basic Set*** for ***GURPS*** *Fourth Edition* came out six years before it, and jillions of folks have played historical and pre-modern campaigns in the intervening time.

So how did they get by without a tech book? Were they running their games without tech? (Unlikely.) Were they winging it? (Perhaps.) Were they making do while they waited for the tech book? (Quite possibly.)

First, the ***Basic Set*** is remarkably complete when it comes to the core items that most adventurers are likely to use. Second, ***GURPS*** players tend to be very well-informed and inquisitive informed and inquisitive, on the whole; many have a good idea of what's possible tech-wise without a specific supplement. In addition, of course, the previous version of ***Low-Tech*** for ***GURPS*** *Third Edition* still contained plenty of usable information.

So if ***GURPS*** gamers could get by for six years without the ***Low-Tech*** titles, why are these supplements so neat, interesting, and useful? Or, in more general terms, why is wrapping your mind around low-tech important? Why is it *fun?*

Here is some insight into answering those questions from your humble editor, who's spent a *lot* of time thinking about low-tech lately.

## Low-Tech Is Limiting

It's unusual to think of "limiting" as being a good thing, but in the gaming world it's crucial. I recently read *Reality Is Broken* by Jane McGonigal, a book audacious in its optimism. (The nutshell version: reality is pretty boring, but it's within our power to make it more like a game and thus be totally awesome.) One aspect that stuck with me is her reiterating and expanding on Bernard Suits' definition of a game: "Playing a game is the voluntary attempt to overcome unnecessary obstacles."

The "unnecessary obstacles" aspect is crucial, and one example provided is golf. The *goal* of golf – put the ball in the hole – is incredibly simple. It would be trivial to pick up the ball, walk over to the hole, and put the ball in the hole. However, it is transformed into a game by the inclusion of unnecessary obstacles (in this case, hitting the ball with a stick on the ground a long distance from the hole). It is the resultant unnecessary obstacles that has kept golf a favorite maddening pastime for generations.

From a gaming point of view, the limitations of technology from bygone ages are similarly enthralling. Today, it's relatively easy to use modern weaponry to kill a fearsome beast (or fellow human). But what about using technology from 500 years ago? Or from two millenniums passed? If a rabid wolf attacked a Viking, who would have the upper hand?

Similarly, transportation and communication technology has come a long way since times of old . . . and those limitations are part of the fun. Recognizing that cross-city communications could take weeks opens up all kinds of gaming ideas, as does the realization that visiting a difficult-to-reach country would probably take *years* rather than hours.

### So Make It Limiting!

Within a game environment, the key to good limitations is that they are *known* (if only to the GM) and *knowable* (they can be figured out). Thus, it's really handy to have solid rules or information on important technology ahead of time; it breaks disbelief if a realistic crossbow is barely able to penetrate leather armor one day, then causes someone in plate mail to explode the next day. Solid guidelines are why the ***Low-Tech*** series is so great for gamers; if they know that the maximum speed for such-and-such a transport method means they won't get to the neighboring kingdom until a day *after* the coerced wedding, they'll need to come up with a new plan.

Similarly, reminding players of the limitations presented by their era's technology is a great way to get them thinking about the problems *and* opportunities they present. Get those gaming muscles flexing!

## Low-Tech Is Evocative

As a thought exercise, envision a medieval knight. Let your mind focus on the elements that most define what "medieval knight" is.

What's the first thing that came to mind? Is it the geopolitical realities that necessitate the rise of a fighting class? The code of chivalry? The complex culture that revolved around the three-pillar system of society?

Or is it the sword and the armor?

Of course, I devised the test, but according to an exhaustive survey of everyone who is me, "sword and armor" ranked most prominently among knightly characteristics. This strikes me as somewhat odd when I really think about it; knights didn't wear their armor or wield their swords all the time. (I've done no research, but I like to envision the reality of the knight's life involving sitting around in moderately nice clothing and eating Ye Coole Ranche Doritoes.)

Of course, humans have thought of tools and tech in direct relationship to proscribed tasks for as long as we've had tech. Envisioning a baseball player is likely to conjure someone holding a bat, even though each player is likely to wield that piece of equipment for just a fraction of each game.

So it goes with nearly all aspects of the low-tech world. Thinking of ancient Rome (pp. 30-36) is likely to conjure images of Roman roads, coliseums, and gladiators – all either direct technological achievements (architecture) or immediately evocative of technology (*gladii* and *quandrentes*).

Of course, technology can be both evocative *and* limiting! I remember early on in our ***Vampire: The Dark Ages*** campaign . . . which, to my chagrin, I now realize was 15 years ago. (This is pertinent to the tale. It was an era when the Internet was tiny, Wikipedia was five years away, and by "laptop" we meant "abacus." Ignorance was the default state.)

In one adventure my hero was trying to come up with a disguise, and I thought I might take a cue from Superman. The following conversation took place entirely via notecards passed back and forth between me and the GM.

"I need a disguise. Did they have glasses back then?"

"Nope."

"Monocles?"

"Nope."

"BLIND PEOPLE?"

"Oh, sure . . . there were lots of those!"

In that one exchange, the medieval world came a bit more alive for me. A sight that is so commonplace in the modern world as to be taken for granted – a sea of bespectacled eyes – was unknown to the era in which we were gaming.

### *So Make It Evocative!*

With a solid enough grasp on bygone tech, it's hard to *not* make the world come alive. Being attacked by different kinds of weapons, seeing strange transportation methods, and coming to grips with alternate forms of social infrastructure are all part of the joys of visiting the past.

One good tip for being evocative is to focus on the ancillary effects of technology. For example, the heroes might need to investigate a disturbance upriver because it's disrupted the flow of the town's important waterwheel. Or maybe a nearby forest has been heavily logged (resulting in strange traveling terrain) because the local warlord is using lumber to assemble war machines.

## Low-Tech Is Continuous

One other aspect of low-tech innovation that's so fun to game with is knowing how things turn out. In modern-day gaming, the GM need to be careful about introducing anything too innovative, disruptive, or anachronistic into the campaign, since we don't know what effect such technology will have . . . or how well it will age. Today's "ultra-tech" can look as quaint as Dick Tracy's radio wristwatch . . . or as impossible as honest-to-goodness flying cars.

However, in gaming set in times past, it's easy to know where technology is going to go, and what will prove to be significant or interesting.

In the aforementioned ***Vampire: The Dark Ages*** campaign, one book I found incredibly useful at the time was *Chronology of the Medieval World.* As the name implies, this book details year-by-year developments of the Dark Ages, with information in each year classified by type. We found the categories devoted to science, technology, and architecture to be invaluable in setting the mood – and for laying long-term campaign groundwork. (In a game where you play immortals, it's useful to be able to allow 10 years to pass, and to have something interesting and factually sound happen in the intervening time.) Thus the entry for 1093 notes the earliest literary mention of a magnetic needle and movable type, the one for 1095 notes that water power was in use at the Abbey of St. Bertin, and so on. It made the world feel much more cosmopolitan to be able to name-drop specific achievements and architectural accomplishments taking place throughout the world – and, of course, it served as an endless source of adventure seeds. (This book came out in the 1970s and is no doubt eclipsed by more modern and electronic resources, but as a "sourcebook" in the pre-Internet era, it was ideal . . . and likely no less accurate than the official sourcebooks we perused that posited a world overrun by secretive vampires.)

*Technology makes a world come alive.*

### *So Make it Continuous!*

With ***GURPS***, applying this tip is trivial. All items have TL ratings listed, so it's easy to introduce a "prototype" item (one TL more advanced than the campaign) a bit earlier than expected. In the same vein, ***GURPS Fantasy-Tech*** contains information on divergent technology and strong ideas on what could have been possible . . . along with some insight on what the results might be.

Otherwise, keep an eye toward the continuity of history, and how to make the ongoing evolution come alive. If gothic architecture is going to make it big in a century, then have the first fledgling construction projects underway in the heroes' lifetime. If some piece of tech is possible but unseen in the region, have its arrival mark interest and discussion.

More so than history, character bios, or social mindsets, technology is arguably the most instrumental aspect of making a low-tech world come alive. By keeping an eye toward what is and isn't possible with pre-modern innovation, gamers will be prepping their passports to the past . . . oh, except something approaching the idea of a "passport" didn't exist until the reign of Henry V, in 1414. *Bon voyage!*

## About the Editor

Steven Marsh is a freelance writer and editor. He has contributed to roleplaying game releases from Green Ronin, West End Games, White Wolf, Hogshead Publishing, and others. He has been editing *Pyramid* for over 11 years; during that time, he has won four Origins awards.

# Odds and Ends

## Tricks of the Anachronists

In this month's *Random Thought Table* (pp. 37-38), we talk about introducing items and ideas a little outside the normal realm of possibility. Two ***GURPS*** rules make implementing this easier.

***GURPS Low-Tech*** (p. 9) has the Anachronistic Skill perk, which permits certain skills before their time (plus the suggestion that the GM might consent to using the perk in other situations).

The ***GURPS Basic Set*** contains rules for *Anachronistic Devices* (p. B478), permitting tech from later TL (in limited circumstances) at *double* the cost and weight per earlier TL introduced.

Of course, those two rules work well together. Just because someone has a *skill* earlier than the rest of the world, it doesn't necessarily mean he has the *tools* to make most effective use of it! It's very likely he'll need to outfit himself with the gear required to utilize his "cutting edge" lore.

Combining these two rules allows the GM to be more generous with the Anachronistic Skill perk, if he wants to. Doubling the cost and weight of the gear necessary to make full use of the perk means the rule-breaker will have to shell out some additional money and inventory space (or leave the heavy stuff back home). Such gear is almost certainly rare – and quite probably custom made or imported from great distances. Reacquiring lost gear can be an adventure itself!

Those who want both the Anachronistic Skill perk and relatively unfettered use of their unusual equipment should consider the Signature Gear advantage (p. 85). Of course, then the player is spending extra points to carve a unique niche for himself in the party – which is both likely to be balanced *and* something that most gaming groups try to encourage. (In fact, for an interesting ***Low-Tech*** campaign, the GM might require all players to pick at least one anachronistic skill and the Signature Gear required to make it work!)

## Murphy's Rules

### by Greg Hyland


Got a *Murphy's Rule* of your own? Send it to **murphy@sjgames.com**

*Next to the Forum is a bookshop, where both doors are plastered with advertisements. These display the titles of the books in stock, and you need only cast a glance at the list. Go in and ask for my book. The owner – his name is Atrectus – will be extremely pleased to get a fine copy of Martial out of his first or second shelf and let you have it for five denarii.*

*– Martial,* ***Epigrams***

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***GURPS*** rules and statistics in this magazine are specifically for the ***GURPS Basic Set,*** *Fourth Edition.* Page references that begin with B refer to that book.