Understanding Threads for Scale Rope Making

By Pat Majewski

There is a lot of information available on the internet for making scale rope and rope walks. However, there is much less information to be found that discusses the type of threads/stock to use when making scale ropes. The purpose of this article is twofold; the first is to demystify some of the terminology and the second is to identify what a modeller should consider when selecting the source stock for scale rope making.

Traditionally, linen thread has been used by modellers for rigging and making scale rope as it does not rot like cotton or stretch like nylon. Other thread types can have problems for rigging; for example, silk can depolymerise if it has been exposed to tin or iron during its manufacture or by later contact with those metals. This is why some museums are reluctant to accept models that have been rigged using silk. So, what alternate threads can be used as linen threads are becoming harder to source? This is not to say that linen cannot be found/sourced.

The dilemma facing many modellers, is having enough knowledge to know what to look for, and ask for, when buying thread. That is when most are confronted with a bewildering array of technical terms and jargon. The problem is further complicated in that there is no agreed standard between the various manufacturers for the size (thickness) and grading of thread.

Most of the threads recommended in the linked articles are readily available from sewing and embroidery suppliers, but some may have to be ordered from commercial/industrial sources if you are looking for larger spools or bulk stock. Buying the smaller spools from Quilt or Embroidery shops, or even from craft stores such as Spotlight (Australia), or from haberdashery stores, can be expensive. [1]

Much of the following discussion is sourced from an excellent brochure/data sheet produced by YLI threads called *A Thread of Truth: Threaducation (A factual look at sewing thread)*. This article is available on the YLI website.

The text I have used from the YLI brochure has been lightly edited and, where necessary, modified to better suit a modeller's perspective. I hope that I have maintained the intent and accuracy of their writing in making this adjustment.

[1] Disclaimer. I have no commercial or other association with any of the products or suppliers mentioned in this article. They are listed simply to provide an adequate level of discussion and information.

WHAT MAKES A GOOD THREAD?

All threads begin as simple yarns which are formed by twisting together short fibers or continuous filaments. This process known as 'singling twist' provides the strength and flexibility, which is essential in any good thread. When two or more yarns are combined to make the thread, a 'reverse twist' is applied to add balance.

Several other characteristics can also contribute to the attributes of a good thread that can be used in model making, including:

Elongation: This is the amount a thread stretches before it breaks. The elongation of a thread is determined by the fibre type but can also be controlled by drawing and heat setting of synthetics such as polyester and nylon. Cotton and linen threads have very little, if any, elongation.

Uniformity: Imperfections or defects in thread are thick and thin places that can cause problems. The most common imperfections are knots, slubs, neps, dropped ply, dropped filament and singles kinks; obviously the fewer the better.

Ply Security: This is a thread's ability to stay together during the ropemaking process. The most common type of thread break is caused by a loss of ply security. If the plies open up during the making process, they are much more susceptible to breaking.

Strength: This is the amount of force required to break a thread. This characteristic is measured by: (I have only included the aspects that may be of particular relevance to the modeller)

> Breaking Strength: the force applied to each end of the thread until it breaks, measured in pounds.
>
> Twist: a thread with too little twist may fray and break, one with too much can cause snarling, looping and knotting.

Thread Finish: This is the quality of the thread after further processing. For scale rope, less, or no, fuzz is the desired result.

ALL THREAD IS NOT CREATED EQUAL

To effectively compare one thread to another, or to identify the best thread for your needs, you will need to provide the supplier with the appropriate information. While I have found most salespeople very helpful, either in person or by telephone/email, having a basic understanding of what you need will greatly assist your discussions. Some of the key information the supplier may need to better assist you includes:

- Thread type, including the raw material – whether natural, regenerated or man-made fibre.
- Thread Construction – staple length (long or short with long better suited to scale rope making), the number of plies etc.
- Thread finish – soft, glace etc .
- Thread size – both thread thickness, and length (type of holder).
- Breaking strength.
- Colours range available, or the ability to take colour.
- Colour fastness.
- UV stability.

Thread Types

Spun Threads

Throughout most of the twentieth century, cotton thread was the standard sewing thread both industrially and in the home. When synthetics were developed, it was only natural to attempt to emulate the characteristics of cotton. All spun threads are made up from staple fibres that are spun into single yarns and then plied to make a thread.

However, the staple lengths of the fibres utilised can have an important effect on the quality, strength, and performance of the thread produced. As a general rule of thumb, the longer the staple length of the fibres, the better the quality of thread produced.

Spun threads will have a more fuzzy surface, which gives them a soft hand and good lubricity characteristics. They offer excellent scale rope making performance but lack the strength of continuous filament threads.

Core Spun Threads

This process seeks to achieve the strength of continuous filament threads with the performance of spun thread. Core spun thread features a continuous filament polyester core covered with cotton or polyester fibres. Two or more of these composite yarns are then twisted to form the thread.

Continuous Filament Threads

This process begins by extruding individual filaments of synthetic material. A singling twist is applied to these unbroken, continuous fibres. They are then brought together, and a finishing twist applied. The result is a strong, consistent thread.

Monofilament Thread

This is a single synthetic filament extruded to a specific diameter. They are available in a number of sizes.

Raw Materials

Natural Fibres

These are further delineated as animal based (wool, silk, hair) and vegetable based (cotton, flax, jute). This article only discusses those fibres commonly used in scale rope making.

Cotton: Pure (100%) cotton is a natural thread with a soft, matte finish. It is a fine continuous strand produced by plying two or more lengths of cotton strands with a tight twist and smooth finish. Cotton thread does not stretch much but it will break if pulled too tightly and will fade with the sun. It is also sometimes bleached which can affect the durability of thread.

Long staple (a single natural fibre) cotton, such as Egyptian cotton, is finer and stronger than regular cotton. It has a softer, stronger, higher lustre finish than normal cotton and generally has fewer slubs (lumps of lint spun into the cotton thread).

Linen: Linen thread is produced from the straw of the flax plant. The fibres, which appear flat like those of cotton, are thicker than cotton fibres and have knots and joints but are very tough. Linen thread can also be bleached white and take dyes more readily than cotton. It is usually supplied unbleached and is superior to cotton thread in both strength and durability.

Silk: Silk thread is the fibre produced as a cocoon covering by the silkworm. Silk thread has great elasticity and strength combined with a fine diameter and it can be permanently stretched. Any silk-based rope should be fully stretched for a period of time before use. Additionally, it has a high UV rating.

One of the disadvantages, for scale rope making, of silk thread though, is its tendency to unravel and 'catch-up'. Apparently, this can be overcome by soaking the thread in polyvinyl acetate, diluted to about three times its original volume with water, followed by drying the thread in air under normal conditions. However, this process may make the thread unsuited to scale rope making.

Regenerated Fibres

These threads are made from cellulose based and include Rayon and acetate.

Rayon: Unlike cotton thread, which is made from a natural resource, and unlike polyester which is made from man-made polymers, rayon (also referred to as viscose rayon) is a mixture of nature and manufacturing. The textbook definition of rayon is 'a manufactured fibre composed of regenerated cellulose'.

Rayon thread does deteriorate over time so attention should be paid to how the scale rope, and the rigged model it is stored. In low humidity regions, rayon threads can be stored in the refrigerator to extend thread life; however, it is harder to put a rigged model in the refrigerator. As such, it is generally avoided, but does have some enthusiastic supporters.

Rayon also has a low UV rating, unless treated with added chemicals. These issues aside, it does make up into a very nice, easily managed scale rope, but it will unravel when cut if not 'set' properly before use (additional twisting applied).

Man-Made Fibres

Again, these are further delineated as Mineral based (glass, metallic), and Synthetic (polyester, nylon, acrylic, elastic, polypropylene). Scale rope makers are obviously interested in the latter.

Nylon: Nylon thread maintains a smooth, knot-free surface and is stronger and cheaper than cotton or linen thread. It has the advantage of being relatively inexpensive and can be manufactured in finer grades. It has been reported that synthetic threads are prone to stretching and are a poor choice for scale rope / rigging.

Polyester Cotton: More correctly, this is known as 'Cotton-Wrapped Polyester' thread. This product could also, equally, be discussed under natural fibres, however, as it has a synthetic core, it is discussed here.

Each yarn is produced by spinning a sheath of cotton around a core of continuous filament polyester. The result is a thread with the characteristics of a top-quality cotton but retaining the advantages of synthetic thread. The polyester core gives this type of thread strength and elasticity, the cotton wrapping gives it a tough, heat resistant surface. However, it may also be prone to stretching due to its polyester core.

THREAD CONSTRUCTION

Earlier discussion informed that all threads begin as simple yarns which are twisted together in a number of plies.

Ply

The number of component yarns that are twisted together to produce a thread is the ply. Two-ply threads, therefore, are simply two yarns which have been twisted together, three-ply threads are three yarns which have been twisted together, and so on.

Twist

Twist is simply the number of turns per centimetre or inch put in the thread. A thread with too little twist may fray and break, one with too much twist can cause snarling, looping and knotting. Balance is the key and a good thread has it.

Twist Direction

'S' twist – Left Hand Lay
'Z' twist – Right Hand Lay.

Note: Yarns and threads are usually identified by the twist direction, but once made up as rope, they are identified by the 'lay' direction.

Thread Finish

After construction, the thread is sometimes finished to enhance its suitability for various uses.

- *Soft:* No further processing is made to change its physical characteristics. It is only dyed and lubricated.
- *Mercerized:* In this process, cotton thread is treated in a caustic solution under controlled tension. This causes the fibres to swell, resulting in a greater affinity for dyeing. Mercerization also increases the lustre and adds some strength.
- *Gassed:* This is the process of passing cotton thread through a flame at high speed to reduce the fuzz is known as gassing. This process also produces a higher sheen.
  Note: Scale rope makers can achieve the same result for fuzzy scale rope by passing it rapidly through a smokeless flame (alcohol fuelled is best), or by passing the thread rapidly over a small hot light bulb (incandescent types are best if still available). In either method, do not stop/pause as you may burn through the scale rope.
- *Glazed:* This is a process in which cotton threads are treated with starches and special chemicals under controlled heat and then polished to a high lustre. The glazed process results in a thread with a hard finish that protects the thread from abrasion and enhances ply security. This is sometimes called 'glace' finish.

THREAD SIZING

There is a great deal of confusion and misinformation surrounding any discussion about the size of thread and how to communicate size to one another. Over the years no clear standard has evolved that is universal in the market.

Common Thread Sizing Standards

In the industrial thread market, the Cotton Count System (NEc) has been the accepted standard utilised in sizing spun threads while the Denier System (Td) has been the accepted standard for filament threads.

Recently, there has been a great deal of support to adopt an universal standard under which all threads can be sized regardless of the thread's construction. The TEX System is that standard but it has yet to be universally adopted.

Sizing Systems

All threads can be produced in different thicknesses and the 'size' of a particular thread is the relationship of its length to its weight. This relationship of length to weight is known as linear density, yarn count, or size. There are many sizing systems used, but they generally fall into two classifications: Fixed Weight and Fixed Length.

A full, and well detailed discussion on these sizing systems can be found in the parent document forming the basis of this article (see earlier link at page 1). Worth noting though are the following two maxims:

IN FIXED WEIGHT SYSTEMS,
THE HIGHER THE NUMBER - THE FINER THE YARN.

IN FIXED LENGTH SYSTEMS,
THE HIGHER THE NUMBER - THE THICKER THE YARN.

THREAD COLOUR

The thread colour is usually identified by a number except for natural colours such as Black, Unbleached (natural) or Ecru. Most stores will have a colour sample chart available (but usually cannot be taken away). Choose the correct colour thread from the outset noting that the colour will probably deepen when several strands are laid up together. To minimise the number of different stocks held, choose a single colour in several sizes; the ropes can then be dyed for their intended use.

It is recommended that scale ropes are dyed after making them up to ensure an even, consistent colouring. A base colour such as natural is most suited; however, ensure that the raw material and type of construction is able to take colour.

THREAD HOLDER/SUPPLY OPTIONS

Threads are provided in various lengths which are determined by their purpose and the thread thickness, which determines how much thread can be physically wound onto the holder.

The larger capacity cones are generally for industrial use and are sometimes not available from your local embroidery or sewing store. However, some outlets, particularly online, will provide these (if available from your referred manufacturer). Spools (in various sizes) or cops are the means by which most threads a scale rope maker will purchase their thread. The amount of thread on a spool is governed by the thread size; the thicker the thread the less wound onto the spool.

Threads can be supplied in the following manner:

Skein:  Spool:  Cop: 

Balls:  Cone:  or 

SOURCES

Now to the second purpose of this article: what threads to use and where can these threads be sourced? [2]

This article does not explore the full range of threads available nor make any recommendations for a particular thread type or brand of thread, or thickness required to make-up your scale rope to a specific size. That subject matter is large enough to warrant another article; and there are some good articles already available on-line.

There are many specialist stores, such as those servicing the sewing, embroidery, crochet and tatting (lace making) markets. These stores will generally stock a wide range of, or all of these thread types. Then there are the larger retail chains such as Spotlight, Lincraft etc here in Australia. There will be equivalent types of stores in most countries. These latter stores generally do not carry as wide a range and, from my experience, the staff are generally less willing to spend time with you in identifying exactly what you need.

Some of the thread manufactures that I have used with good results include: Londonderry (silk), Güttermann, and YLI, DMC Cordonnet (crochet cotton); but, there are many other good brands.

> **Note:** Depending on what lay of rope you intend to make (Left hand [cable), or Right hand laid) you need to start with a thread that is the opposite lay. Be sure to check the twist of the cotton rope you are purchasing.

In-short; you may need to do some further research.

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[2] I have no financial or other interest with the listed companies. Their listing is based only on the fact that they supply, or are agents for, some of the most recommended thread types discussed in the various international model ship forums.