Section III
Principles of design and aerodynamics

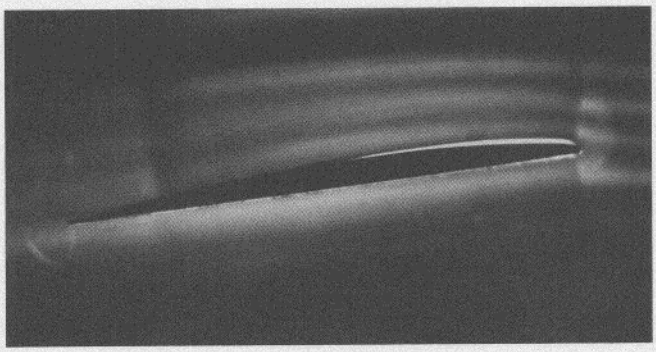
1 Principles of the Tasar rig

a) Evolution

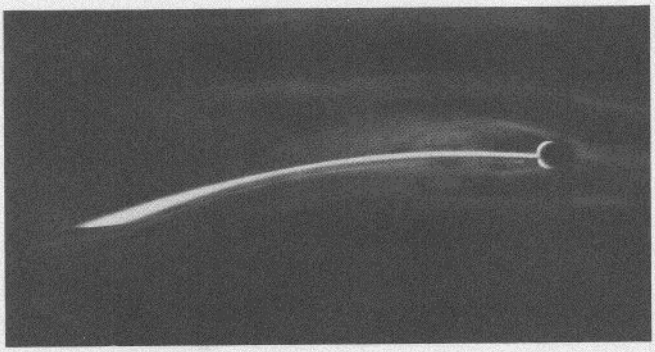
The most significant advance in recent decades in the art of handling sailboats has been the use of tufts and leech ribbons to indicate, visually, the way wind flows over rigs. Four practical advantages quickly followed the introduction of tufts.

First came the recognition of the essentially different sail shapes and airflow patterns which sail fastest in each wind strength and on each point of-sailing, both in flat water and in waves.

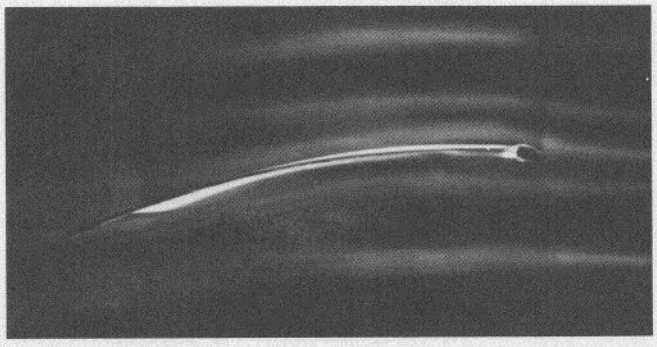
The next step was the most important; a tremendous increase in rig power and efficiency.



Airplane wing
turns air cleanly and efficiently



Conventional mast
blemishes flow and spoils efficiency



Over-rotated mast
smoothes and restores efficiency

Fig.22

Tufts showed the turbulent areas behind conventional masts. We systematically developed mast shapes which, when rotated until they lined up with the sailcloth, would smooth the airflow and thus created the modern overrotating rig (Fig.22). We then further refined these mast shapes so that the wind would follow more deeply curved sails, and thus again substantially increased the power available from this rig.

In the earliest rigs (and still today in most stiff catamaran rigs) the mast would rotate automatically as pressure on the sail would pull the back of the mast across during a tack.

The final step was to work out a very flexible rig, matched to sail and battens, that could be completely controlled by the crew to produce any shape desired with one suit of sails while also providing the ability to completely flatten the mainsail to shed unwanted power in strong winds.

While the flexibility of the mast is a key factor in the tremendous efficiency of the rig, it produces a second effect which is also highly desirable. Look up your mast on the windward side when the mast is rotated and you will notice that the top of the mast curves gently (cusps") up to windward and is held in a 'set" in that position. Conventional, non-rotating masts in dinghies are virtually uncontrollable above the jib hoist and fall off to leeward when they feel like it resulting in a loss of power. If the boat is a powerful boat with lots of sail, this "falling-off" is necessary as the wind increases and the trick is to find a mast that does it at the right time to match a particular crew weight. This is not easy as the right time in smooth water is not necessarily the right time in waves even though the wind velocity is the same

In a Tasar, designed for use without trapeze and with a correspondingly small sail area, we want absolute control of the power and with this 'cusping" to windward of the mast we never "lose" the top off to leeward. Instead we use the boom vang to progressively flatten the sail thus reducing the power up there and then let the top of the sail fall away ("twist") until we are able to "stream" this part of the sail straight in line with the wind, all the while the mast remaining cusped to windward.

Because of this "set" in the mast, it was therefore necessary to develop a manual method of rotating the mast, all of which is a long way of explaining why the Tasar mast does not tack itself automatically

The boat you are sailing represents the state of the art today but its rig is the result of fifteen years of continuous development in the areas above.

b) Role of the boom vang

The key to the Tasar's ability to sail in almost all conditions lies in the crew's ability to produce a "fuller" or a "flatter" mainsail at

will. Flattening the mainsail however means bending the mast and there are two ways to do it. One extreme is to pull down on the main-sheet only (vang slack) and the other extreme is to use only the vang (mainsheet slack) Both flatten the sail because both bend the mast, but the effect is quite different.

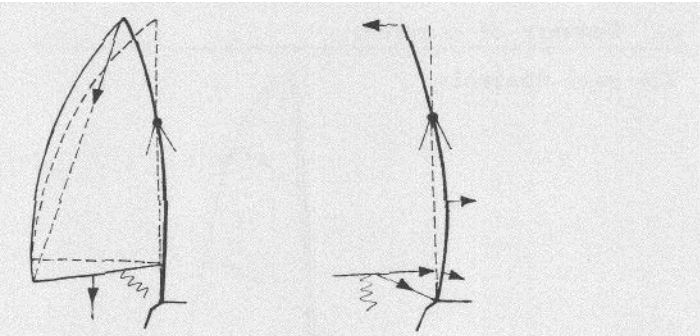


Fig.23a
Mainsheet tight, vang slack

Fig.23b
Vang tight, mainsheet slack

Fig.23a shows the mainsail being flattened with mainsheet only. It is obvious that the top of the mast is being pulled back by the leech of the sail only. However, when the exercise is repeated as in Fig.23b with vang alone, at least half of the applied force pushes the lower mast forward. Since the mast is fixed at the hounds, the top mast must move back part of the way due solely to this forward vang thrust at the deck. The other half of the vang tension is naturally transmitted to the leech and this leech tension produces the remaining bend in the top section. However, by using the vang alone we have now managed to flatten the sail with less leech tension than when using the mainsheet alone.

It should also be apparent from the two diagrams that bending with the vang also produces more curvature (and therefore flattening the sail) in the lower mast area - the area of the jib slot.

The boom vang, therefore, should be thought of as a method of controlling the fullness or flatness of the mainsail - particularly the upper part - and if you have any doubts about this try it on shore by changing the setting from the two-dot to the three-dot setting and observe the upper mainsail.

c) An introduction to "twist"

Twist is a term used to describe the progressive falling away or opening" of the upper leech of a sail relative to the bottom.

Note in the three diagrams that the boom is

still on the center line of the boat but the top is more and more "open" relative to the bottom (Fig.24). Obviously the amount of "twist" is a function of the amount of tension applied to the leech and we have just seen in the paragraph on the boom vang that maximum leech tension and therefore minimum twist is obtained when tension is applied with mainsheet alone and vang slack (Fig.23b)

In practice, increasing twist is used in increasing winds while at the same time decreasing the fullness.

To produce more twist and less fullness we therefore use progressively more boom vang while at the same time slackening the mainsheet. As we slacken the mainsheet, however, the boom will tend to go to leeward at the same time so we use the traveler to pull the blocks on the car to weather until we return the boom to the vicinity of the center line. In Fig.24 we have exaggerated the angle of the mainsheet to demonstrate this.

Finally, maximum twist and a flat sail is produced by full boom vang (three-dot), very little mainsheet tension and, again, traveler to windward. With the rig set up this way (Fig.24c), the top part of the sail will be flat and "streaming" like a flag, straight into the wind, thereby contributing practically no heeling force.

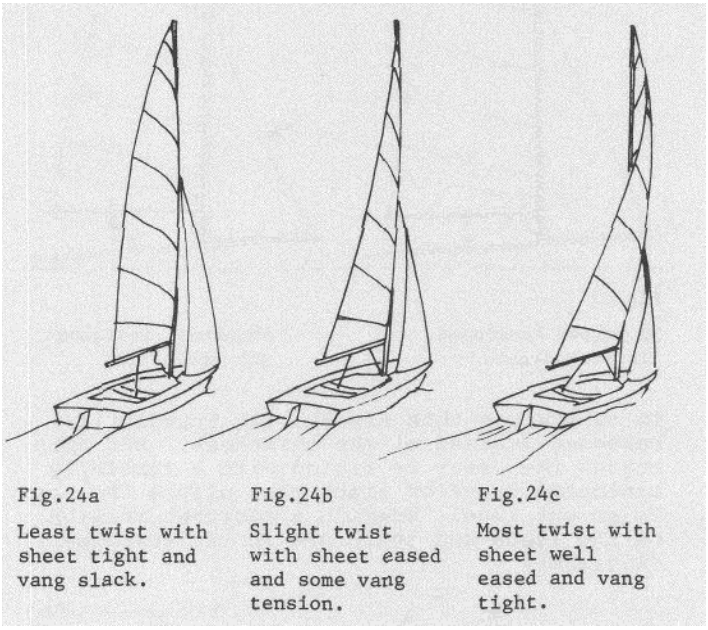


Fig.24a
Least twist with sheet tight and vang slack.

Fig.24b
Slight twist with sheet eased and some vang tension.

Fig.24c
Most twist with sheet well eased and vang tight.

d) The role of the traveler

The traveler allows you to control the in and out position of the boom relative to the center line without having to touch the mainsheet.

(The Tasar is set up so that the traveler controls are immediately "to-hand" which suggests that the traveler is a control that gets more use than the mainsheet.)

In a well sailed Tasar this is the case but, for most people, it takes a bit of time to get used, to this practice and for this reason we suggested in the opening sections of the manual that the traveler be left stationary and just the mainsheet be used. We suggest that you start to use the traveler more and more instead of the mainsheet, but start out doing so in moderate airs and work up to a breeze.

The Tasar is light, sailed without a trapeze and therefore reacts almost instantly to changes in wind strength. Unless the crew can compensate quickly for a sudden puff, the boat will heel over and speed, performance and pleasure are all sacrificed.

There are two ways to react to this puff

(after, of course, luffing slightly into the wind.') - either the mainsheet can be released

thus twisting off the top of the main or the traveler can be released which does not increase twist but, so to speak, opens the whole door. Both accomplish a righting effect but the traveler is quicker, more responsive and easier to operate.

Far more importantly, however, if the main-sheet is released, even before the top of the sail twists off, the tension on the forestay will decrease and the jib luff will sag making the jib fuller at precisely the instant you want the jib to stay flat (Fig.25.)

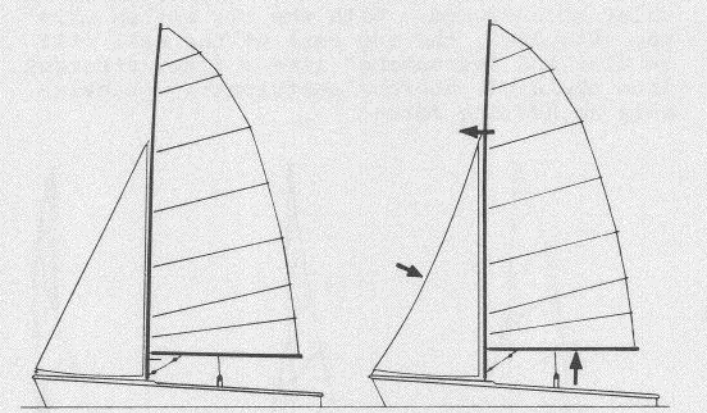


Fig.25

Mainsheet tensioned: jib stay tight.

Mainsheet released: jib stay sags.

To counteract this effect, the traveler is released instead of the mainsheet. For this reason the Tasar is fitted with a carefully contoured traveler track that allows the boom to go out level, keeping a constant tension on the leech and therefore on the forestay (Fig. 26b)

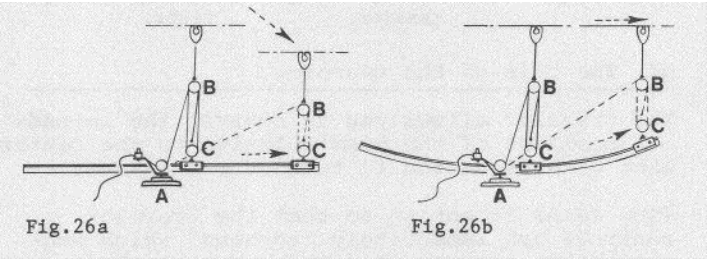


Fig.26a Fig.26b

(With the swivel block position fixed at (A), the track must be curved up at the ends to counteract the shortening of the distance between Blocks B and C or the action of easing the traveler will pull the boom down tightening the upper leech, Fig.26a). This

method of spilling power is particularly suited to the Tasar which does not have an overlapping jib. Other classes of boats with large genoas are not able to use this method as effectively because releasing the traveler closes the slot between genoa and mainsail.

e) Summary of controls

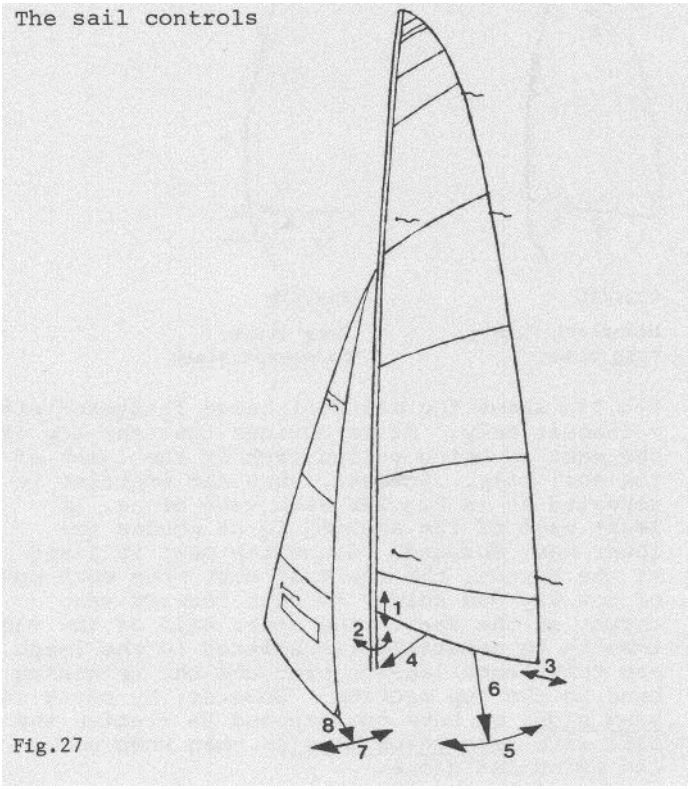


Fig.27

1	Downhaul-	eliminates diagonal wrinkles
2	Rotation Lever -	aligns mast with sail
3	Outhaul -	controls fullness (camber) of lower mainsail
4	vang	controls camber of upper mainsail
5	Main Traveler-	controls mainsail angle
6	and Mainsheet and twist	
7	Jib Travelers-	controls jib angle and
8	and Jib Sheets twist	

2 Introduction to tufts and leech ribbons

a) Tufts

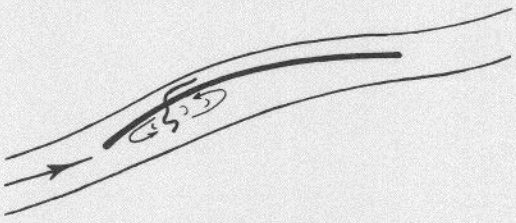


Fig.28a

Angle of attack too close to wind - windward tuft in "separated" area.

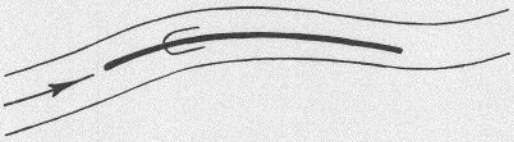


Fig.28b

Correct angle into wind - both tufts stream

Fig.28c

Angle of attack too broad - leeward tuft in "separated" area.

The basic principles of tufts as applied to both jibs and mainsails are illustrated above and the effects shown can be created either by the heading of the boat or by the wrong trimming of the sails.

b) Leech ribbons

Fig.29a

Leech ribbon streaming - means air on back of sail has stayed "attached" right out to the leech.

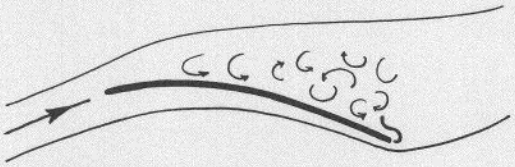


Fig.29b

Leech ribbon collapsed - means air on back of sail has "separated" before leech.

c) Location of tufts and ribbons on Tasar

1. Jib tufts - one on each side, close to the luff. One set is high, one is low near the window.

2. Main tufts - one on each side - one set high, one set low.

3. Leech ribbons - 3 already sewn to the sail at points shown on diagram.

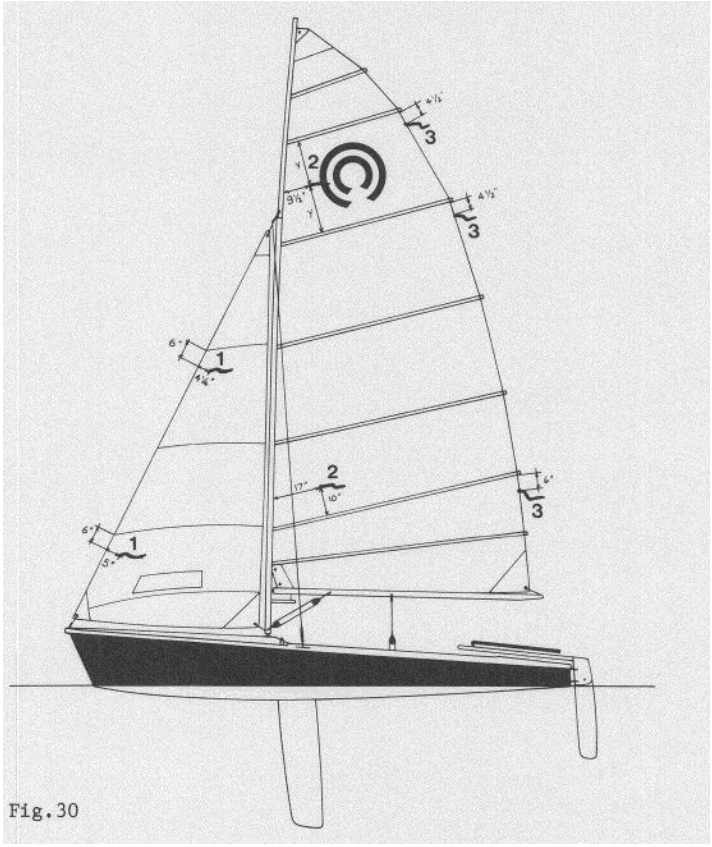


Fig.30

NB. Positions for all tufts are punched into the jib and mainsail by the computer. Use the tufts supplied in the number packet and attach at the points so marked. (This diagram is also on the number packet.)