CONFORMATION: A QUESTION OF PURPOSE

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The Samoyed -- hunter, herder and hauler -- or so he is advertised. Is he really a "triple threat" dog? A jack of all trades? Or is he simply a mediocre performer at a variety of odd jobs? Those are startling questions, and providing a comprehensive answer would require an in-depth examination of a large number of factors. A broad consideration of these questions would fill a large volume, and that's obviously not the intent of this article. What is intended, is to consider these tasks in the light of the requirements of conformation that each task imposes on the dog, and try to determine whether or not a single dog could function effectively at more than one of these jobs.

We should keep in mind that all domesticated dogs originated as hunting companions to man. None of the arctic breeds are very far removed from their predatory wolf-like forebears, and their closest relatives are the modern field and gun dogs - the retrievers, spaniels, setters and pointers.(1) We should also note that man, the hunter, preys on game ranging from hares to bears, and in the hunt he employs dogs as diverse as the Borzoi and Beagle. The manner of employment and hunting techniques are equally diverse. The Samoyed then, without going into the details of conformation, should be accepted as at least being physically able to hunt. Can he also function effectively as a draft dog? Or a herd dog? These draft and herding functions appear to impose some considerable conflict of requirements of conformation, so let's examine those requirements in some detail.

The tasks that we want to examine all involve *movement*. A dog may keep a wary eye on a grazing reindeer herd while pausing momentarily, but the real work -- bringing back strays, moving the herd to new grazing land, or harrying predators -- all involve constant motion. Likewise, the draft dog doesn't get his load from here to there while sitting on his backside howling at the moon. The load moves when he does. The manner and type of movement required then, is the heart of this analysis. So, before proceeding to the examination of the specific tasks, let's briefly review the basic structure of the dog's running gear and his manner of locomotion.

The trot is the basic working gait of many dogs including the sled dog and the herd dog. The trot is a simple two-time gait with support coming from diagonal pairs of legs -- right front and left rear, and then left front and right rear. The essential sequence is illustrated in the four parts of figure 1. In figure 1A the dog is shown just starting a single stride, and the sequence ends in figure 1D with the dog ready to start a stride with the opposite diagonal pair of legs.

The sequence illustrated and described, represents a single stride by the dog which succeeded in moving him forward by roughly two feet. That accomplishment required an incredibly intricate sequence of coordinated contractions and relaxations of dozens of muscles. The entire sequence would take place in about a tenth of a second for a dog at a fast trot. This then, exemplifies the dramatic importance of neuromuscular coordination. If these dozens of muscular actions are not accomplished in perfectly timed synchronization, the result will be loss of power and speed, and wasted energy. A muscle that relaxes a split second too soon allows a joint to go lax, or one that contracts a split second too soon is opposing the contraction of some other muscle. Either of these conditions will result in momentary loss of momentum and unnecessary muscular strain. Regardless of what task we ask of a dog then, neuromuscular coordination is a primary requirement for a smooth, fluid, efficient movement. It is a quality that is difficult to describe or quantify, but it's importance cannot be overstated.

There are some other biological factors involving bones and muscles which we should keep in mind also. First, as bones are made larger in diameter, relative to their length, they become less dense, more porous, and more brittle.(2) Therefore, even though a task may require that a dog be heavy of frame, he should never have boning that is massive. Secondly, muscles have more strength as they become thicker and broader, relative to their length, but at the same time they lose some reflex quickness as well as metabolic efficiency.(3) Therefore, a very thickly muscled dog will be slower and consume more food than a more finely muscled individual of the same body weight, presenting a dilemma requiring compromise in many instances.

Turning now to our herd and sled dogs, let's try to figure out what special requirements of conformation are required by each task. The first thing is to provide a definition of the tasks themselves. For the herd dog that's relatively easy. In the context of the arctic dog, the only other domestic animal of any economic importance is the reindeer. The reindeer is a relatively large member of the deer family which ranges from Kamchatka in eastern Siberia westward across northern Asia and northern Europe to the Scandinavian Peninsula.(4) These are migratory animals ranging far into the arctic tundra in summer, and into the sub-arctic forests in winter. Year-around domestic herds were maintained by the Samoyeds at least as far north as Kolguyev Island in the Barents Sea (5) and by the Lapps at the northern end of the Scandinavian Peninsula.(6) The manner of utilizing the reindeer varies from the hunter who simply follows the migration of the wild herds, to the organized management of domesticated herds. The hunter of the wild herds would utilize dogs for transport and hunting, while the managers of the domesticated deer would want a dog for control and protection of his herd.

Our herd dog, then, must be able to cover a lot of ground efficiently, following the herds in their continual wanderings or driving them to new grazing lands, rounding up stragglers, and keeping the herd together. As the reindeer is capable of considerable speed over rough and uneven terrain, our dog must be of sufficient size, and of proper build, to cover rough ground

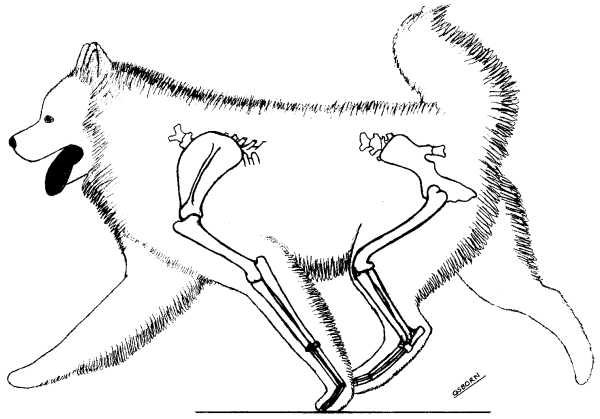

Figure 1A The dog is shown in-between strides. One stride has just been completed which involved a diagonal pair of legs consisting of the left front leg and the right rear leg. In this figure the right leg has completed its power stroke and is extended behind the dog in the "follow-through" position. The left front leg has supported and lifted the body as well as supplying forward thrust and is shown ready to leave the ground in the follow-through also. The dog, at this instant, is almost airborne and is being carried forward in a downward arc by its weight and momentum. The opposite diagonal pair of legs, right front and left rear, have been swung well forward ready to catch the weight of the dog's body on its downward arc.

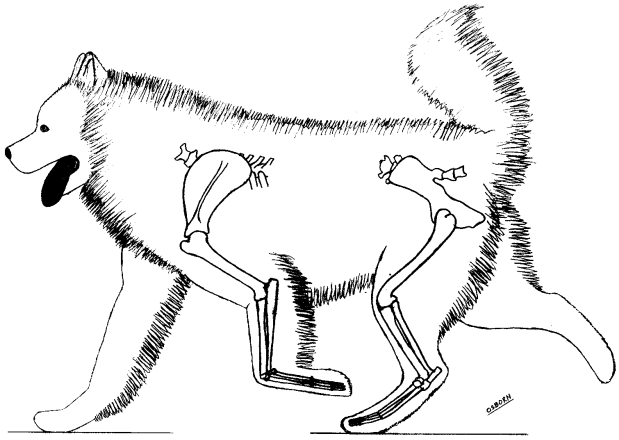

Figure 1B The forward and downward momentum shown in the previous figure has been caught by the diagonal pair of supporting legs, and the body is being drawn forward and upward by the muscular action of these supporting legs. The right foreleg is moving into the locked-elbow position to provide a rigid prop which will force the dog's weight upward, and the muscles behind the upper arm and shoulder blade are contracting to draw the dog's weight forward over the supporting column of bones. The left hind leg, in its forward position, is supporting considerable weight at this point, but is not attempting to lift that weight. This hind leg is remaining in the flexed position and the muscles behind the femur are contracting with great force to draw the pelvis forward. At the same time, the legs on the opposite diagonal have completed their follow-through and are now being drawn upward into a flexed position and starting their forward swing.

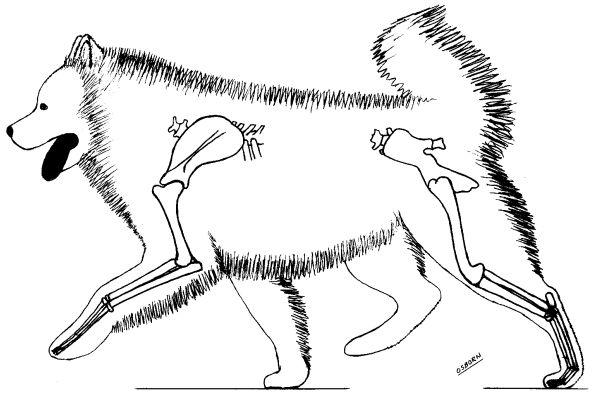

Figure 1C This illustrates the "instant of push". The supporting right front leg has succeeded in lifting the body, and at the same time the body has been drawn forward far enough that most of the dog's weight is bearing on the supporting front leg. The muscles of the upper arm and shoulder are providing substantial forward drive. The left rear leg has now been relieved of the most of the body weight, and by getting the pelvis forward, ahead of the hind foot, the leg has started to straighten. In the straighter position, the muscles have a better mechanical advantage, so that now, as the hind leg straightens out behind the dog, comes the moment of maximum forward thrust. It will be noted in this figure, that the opposite diagonal pair of legs are now highly flexed and well along their forward path in preparation for the next stride.

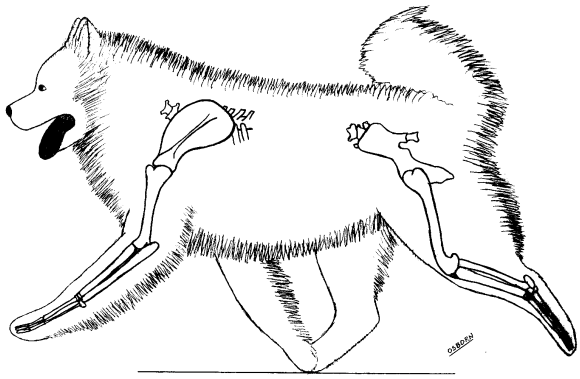

Figure 1D Shown here is the completion of the stride with the right front and left rear legs having lost traction and contact with the ground, but continuing their rearward arc of travel in the follow-through action. The opposite diagonal pair have now reached the point of full forward extension, and the dog's movement is by momentum, with the downward arc of travel to be caught to start the next stride.

at a fast trot and must have very great stamina. In keeping out of the way of the active and sometimes aggressive reindeer, and in coping with wild predators, our dog must have very good reflex quickness and a high degree of nimble mobility for sharp starts, stops and turns. In short, he must be of at least medium size with good length of leg; he must have great agility, and be capable of a fairly fast sprint; and he must be a tireless trotter over great distance.

Specifying the capabilities of the sled dog is not so straight-forward due to the many possible combinations of load, speed and number of animals employed. At one end of the scale would be a lone arctic traveler, off on a few days journey with the load consisting of the sled, driver, a few personal belongings, and a few day's worth of supplies -- a total load of perhaps as little as 250 pounds. Add another passenger and supplies for a longer trip and the load may go up to 500-600 pounds. For moving an entire household, or engaging in commerce, we get into the requirements of heavy freighting, with loads as large as can be handled by any available sled and team -- perhaps three quarters of a ton or so. With this wide variation in loads and speeds it would seem prudent to define two separate types of draft dogs -- one for heavy freighting and slow speeds and one for lighter work at higher speeds.

Any sled dog pulling a significant load obviously has to have considerable muscular strength and be rather substantial in size. In the heavy freighting dogs, these considerations probably outweigh all others. The dog should not be so huge and bulky as to preclude a continuous all-day effort, every day, but load moving ability is the primary requisite. For the light-to-medium load, it should be moved at a fair rate of speed and this would portend a smaller and more moderately built animal. Our light freighting dog then should have a combination of strength, speed and endurance, where no one of these qualities is unduly compromised for the sake of another. A team of heavy freighting dogs should be able to move a load of perhaps 1200 pounds 25 to 30 miles per day under good conditions, and the lighter team night be expected to do at least twice that mileage with a load of 400 pounds or so. The dogs must all have the stamina to work continually hour after hour, day after day, at the most grueling task, in the world's harshest environment.

As to the details of size and conformation, let's first examine the requirements of the heavy freighting dog. To start with; how big? This is determined by the interrelationships of three factors: (1) The number of dogs to be employed, (2) the amount of weight that can be moved by each dog and, (3) the total weight of the load. Considering the first of these, the number of dogs that have been used has varied all the way from one to a couple of dozen. The very large teams however are almost totally unmanageable and most drivers working every day would prefer to deal with 12 or less. On the other hand, if too few dogs are used, then the injury or loss of a single animal might jeopardize the whole team. The amount of weight to be drawn per dog can have wide variations also. Experience would indicate, however, that we can reasonably expect a dog to work all day at a modest speed drawing a sled weight of about one to one-and-one-half times the dog's own body weight. They are capable of very much more than this for short stretches, but considering a variety of terrain and conditions, this would seem a safe bet. This would indicate a weight range of 80 to 100 pounds for our heavyweight. Ten to twelve eighty-pounders could haul a 1200 pound load, or the same load might be handled by as few as 7 or 8 dogs of the one-hundred-pound class. In either of these cases, the loss of one dog would not impair progress very much, and the team could still make good headway even with the loss of two members.

The nature of the work performed dictates the general build of the dog, and for our heavy freighting animal we obviously require that the dog be rather heavy of frame and very well muscled, particularly in the loin and hindquarters. It should not, however, be so bulky and heavy as to preclude a free easy trot, load and conditions permitting. The height will probably be in the range of 25 to 28 inches at the withers. With a dog this tall and considering the need for stability against a heavy load, the dog should not be excessively high on the leg. Elbows set at one half the total height would be about right, and the elbow should be at the lowest point of the chest. The overall outline of the dog would be nearly square, but with the moderate leg length, the body, from sternum to tip of pelvis might be a bit longer than the total height of the dog.

The conformation of the running gear is obviously one of the more important considerations. In front, the heavy freighting dog should have a long well laid back shoulder blade, with a long upper arm set at right angles to the shoulder blade. In the rear, he should have a moderately flat croup (pelvis), a moderately long upper thigh, moderate angulation at the stifle joint, and a hock set as low as possible.

Now, that description might raise a few eyebrows, so let's examine those requirements in some detail. By way of example, let's look at the human athlete for a moment. Consider, if you will, three professional athletes, all of about the same height. One is a cross-country runner. He is slimly built, and runs in a nearly upright posture, using the longest possible strides. The next man is a short distance sprinter. He will have a bit more muscle, will run in a slightly more pitched forward position, and will use a somewhat shorter stride than the long distance man. Our third athlete is a heavily built offensive guard on the football team. He lunges across the line in a posture that's more nearly prone than upright, and will drive his weight into his opponent using very short, very rapid, choppy steps. Note that the distance that can be covered by each of these men is directly proportional to their length of stride. Note also that the amount of force produced by each

one is *inversely* proportional to his length of stride. And furthermore, note that as more force is required, the farther behind the man is the arc of his stride.

These same principles apply to our dogs. If we want a dog to cover great distance, then he must be slimly built,, move with the longest possible stride, and the arc of stride should be balanced under his body. If we want the dog to exert great power, then he must shorten his stride and put the arc of the stride behind him, throwing his weight into the load. This same point can be illustrated by referring back to figure 1A. In this figure we see the dog in between strides, nearly airborne, carried along only by his momentum. Now, if this dog were hitched to a heavy load, that momentum would be absorbed by the load and his forward progress would cease as soon as the rearward drive of the legs stopped. Our draft dog then, must use short quick steps to maintain continuous momentum, and must keep his feet behind him so that his body weight against the load helps to maintain a steady forward push. He will further that action by extending the neck and lowering the head to put his weight as far forward as possible. Now, how do these principles get translated into specific requirements of conformation?

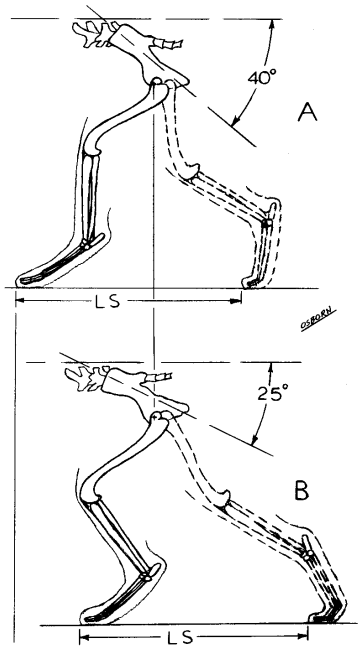

Figure 2 Shown here is the position of the stride with two different pelvic angles. In both A and B the length of stride (LS) is the same, as is the arc transcribed by the femur relative to the pelvis. It is noted, however, that the flatter pelvis of B puts the arc of stride much further behind the dog.

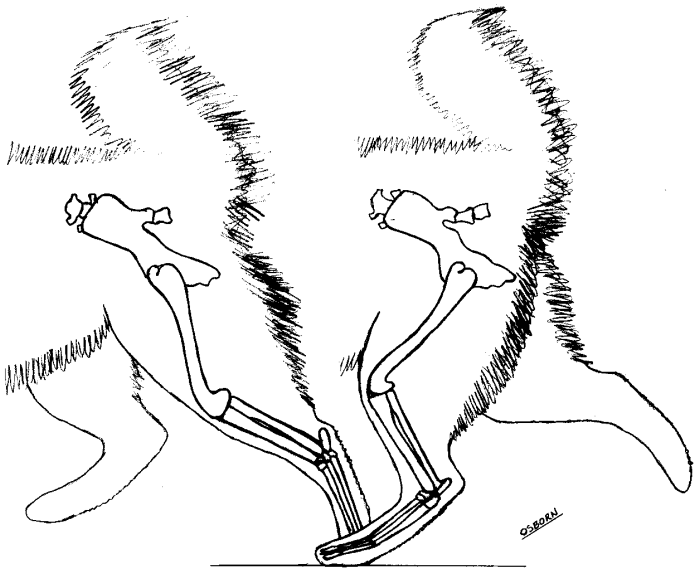

Figure 3 Illustrating the two extended positions of the rear leg.

The angular structure of the dog's hindquarters starts with the pelvis. Figure 2 illustrates this fact by comparing the arc of stride of the steeply set pelvis in figure 2A, with the flatter pelvis of 2B. The total arc of travel illustrated is the same for both, but the steeply set pelvis extends the forward arc of travel under the dog, and correspondingly limits the rearward arc of travel. The flatter pelvis of figure 2B puts a greater part of the arc of travel behind the dog. To move with power, the dog must have good rear extension and this is accomplished, in part, by a pelvis set at a moderately flat angle. The flatter pelvis also permits a longer upper thigh for a given degree of angulation, a fact which is useful in this case. The normally accepted pelvic angle for overall efficiency is about 30° with respect to the horizontal.[7] However this should be considered an upper limit for our draft dog, and an angle tending more toward 25° would probably be in order.

Next of concern in the rear assembly is the upper thigh. This member is the most important in the entire assembly. Its arc of travel is the greatest component in determining the dog's length of stride, and the muscles that lie along it are more important than any other in providing forward drive.

Referring to figure 3, it can be seen that in its more forward position, the hind leg is highly flexed. The dog must draw his body forward from this position by contracting the muscles behind the femur which are connected to the pelvis and the lower end of the femur. This pulls the pelvis forward and reduces the angle between the femur and the pelvis. The larger this angle is, the greater the mechanical disadvantage of the muscle, and the greater muscular effort that is required. The draft dog, under heavy load will not reach as far forward as the dog shown is figure 3 because he will not have sufficient muscular strength to overcome this highly flexed position. With the dog having moved to the more forward position of figure 3, he is shown having drawn himself forward with the hind leg now behind him. As the angle between the femur and pelvis is reduced, the drive from the hind foot is more directly in line with the load (through the femur and pelvis) and now he is gaining further movement by straightening the stifle and hock joints. The muscles that straighten these joints also work at a mechanical

disadvantage which is increased by the flexed position of these joints. From all this it can be seen that the dog's greatest thrust of power occurs just as the leg straightens -- and this must occur behind the dog far enough that the power is transmitted in as straight a line as possible from the foot to the load. Obviously this point should not be so far behind the dog that he has lost traction, but he will grip with his toes and allow his bodyline to drop to try to extend himself to this point of peak power.

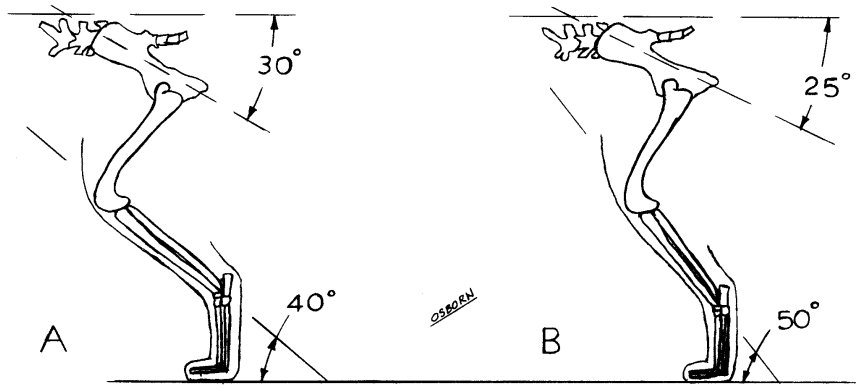

Figure 4 A heavily angulated rear is shown in (A) contrasted with a moderately angulated rear in (B).

With moderate angulation and upper thigh as long as is practical, the bones below the stifle joint must be shortened, and they must be shortened proportionately. The hock joint is activated by muscles lying along the lower thigh, and if these muscles are shortened too much there will not be sufficient action in them to straighten the hock joint. Also these muscles work at a mechanical disadvantage which increases with the length of the bones below the hock. Thus by keeping the hock low to the ground, we can both insure that it can be straightened, and decrease the strain on the activating muscles. The greater leverage of a high hock gives more speed, but the lower one increases strength and endurance. Figure 4 shows the general rear structure of our moderately angulated power dog contrasted to a more highly angulated rear assembly.

The front assembly offers some contrasting considerations as compared with the rear. In a freely moving dog, the main job of the front is to catch and direct the forward momentum, and relift the dog's weight on each stride. Pulling a heavy load however, almost all of the momentum is being absorbed by the load, and with the slower shorter stride, the front is freed of part of it's usual job and will be used to help drive the dog forward. He will lock the elbow into a prop for lifting his weight, and draw his body forward using the muscles between the shoulder blade and upper arm to flex the shoulder joint, while at the same time the muscles lying to the front of the ribcage will contract to rotate the shoulder blade forward. Note now, that whereas the rear assembly starts out in the flexed position and must straighten out to exert thrust, the front leg starts out in the extended (straight) position and flexes to exert thrust. Thus the main thrust from the front comes as the triceps contract between the upper arm and shoulder blade, and their mechanical advantage increases as this angle is made smaller. Thus, as the shoulder blade and upper arm are laid back more, the dogs driving power is increased. As these bones are made more angular in their relationship, their length increases, as does the length (and therefore strength) of the attaching muscles. Now, we normally ask for a well-angulated front for the sake of a long stride in quest of speed and endurance, but it is clear that these features are equally desirable on our draft dog, but for entirely different reasons. One of the rare instances in which we can we the best of both worlds!

It goes without saying that the dog we are describing must have sound feet. All of the weight of this large animal is borne by the feet, and all of his considerable power starts at the foot and is transmitted through the legs and body to the load. The hare foot, with it's longer two central digits, is capable of a bit more traction, while the more compact (cat) foot is easier to produce with consistent soundness and is less prone to injury. These differences are minor however, and the most important thing is that the foot be made as large and thick and strong as possible.

That then, pretty well completes the picture of the heavy freighting dog.

The same principles discussed in establishing the structure of the heavy freighting dog apply also to the light freighting dog, and, indeed, to all dogs. They are all subject to the same laws of leverage and the same biological constraints, and they all use the same manner of locomotion. For other tasks, however, we ask for a different set of performance characteristics and therefore we must make some trade-offs and compromises to achieve that different type of performance.

We have specified that a team of light freighting dogs be able to make fifty or more miles per day with a 400-pound load. With the speed required, the load weight for each dog must not exceed his own body weight. That indicates a size of forty to sixty pounds, so that a team of 10 to 12 dogs of the forty-pound size could handle the 400-pound load, and 7 or 8 sixty-pounders could do the same job. Whereas our heavy freighting dog worked mostly at a walk, the lighter dog must work at a trot and be capable of substantial speed, load and conditions permitting. This portends a dog that is not only smaller than the heavy freighting dog, but he is of lighter build and must have a comparatively longer stride. He is still a draft dog, however, and on no account should he be finely built or "rangy". The longer stride should come from slightly longer legs and increased rear angulation. To accommodate this longer stride

without interference, he most have a little longer coupling Overall, he should have a slightly compact, muscular body, with a deep chest and good rib spring. The leg length should be a bit more than half the total height, and the overall length of body should be slightly longer than the total height. In front, the well laid-back shoulder and long well angulated upper arm are standard. The increased hindquarter angulation should come from slightly longer bones of the upper and lower thighs, but by no means must this be extreme. The actual degree of angulation should be somewhere in the middle of the two examples illustrated in figure 4.

This conformation then should theoretically give us the desired balance of power, speed, and ground covering ability that we seek in the light freighting dog.

The herd dog presents a rather different picture than either of the draft dogs. He is required to propel only his own body weight, but must do so with great agility and considerable speed over long distances. Size is determined by the degree of speed required and the rough nature of the terrain to be traversed. A very small dog will not do, but a dog of about 20 inches in height would probably be entirely adequate providing he is equipped with good length of leg. The length of leg not only provides for facile movement over rough ground, but also extends the length of stride for endurance and provides the leverage of longer leg bones (and muscles) for good sprinting speed. The longer legs also provide the capability to bring the hindquarters up under the body for quick stops and turns.

The body should be finely drawn and "racy", but not without good depth of chest. In overall proportions, the depth of body should probably be about 40% of overall height with the elbows and stifles set somewhat below the body line. The body will have good length, but because of the length of leg, the overall proportions of length versus height will appear nearly square.
The well laid back shoulder and long upper arm are still the standard in front, and the hindquarters obviously require somewhat more angulation than either of the draft dogs. We should probably go back to the 30º pelvis for our herd dog, or even slightly steeper, because he requires more forward reach with the hindquarters. A somewhat longer hock is useful here too for greater speed, but because of the requirements for endurance it should still be on the moderate side.

Throughout this analysis the author has deliberately avoided any reference to specific breeds or standards, but in the case of the reindeer herd dog, nature has provided us with a model so perfect that the comparison is irresistible. The coyote. That's right, the much maligned coyote, *Canis Latrans*, is the perfect model for the dog we seek to herd reindeer. The typical adult coyote is about 21 to 23 inches tall, weighs about 25 to 35 pounds and is virtually a carbon copy of the herd dog description offered above. Moreover, his performance is all we could ask for. He is, pound-for-pound, one of the best trotters found in nature, with an endurance over rough ground that is legendary. He is capable of sprinting speeds in excess of 40 MPH[6], and is agile enough to dine regularly on the darting jackrabbit. It is not proposed that we try to domesticize the coyote, but rather to use him as an example of the performance, and therefore the conformation, that we want in the ideal herd dog.

We have now been through the analysis of three separate tasks -- heavy freighting, light freighting, and reindeer herding. We have derived the requirements of conformation for the type of dog to provide optimum performance at each of these tasks. We have seen that each of these tasks impose different requirements of performance (strength, speed, etc.), and these differences in performance require corresponding differences in size and conformation.

Now, where does our Samoyed fit into the picture? Which, if any of these tasks could HE perform effectively. For purposes of comparison, let's briefly summarize the essentials of conformation of the Samoyed. The historical size range of the breed is 20 to 24 inches in height with corresponding working weights of 35 to 60 pounds. He has a body of medium length with a deep chest, well sprung ribs and strong loin. He is 55 percent leg, and somewhat longer than tall. He is (or should be) well muscled. The Samoyed should have a 45-degree shoulder in front with a long upper arm, and a well bent stifle and sharply defined hock in the rear.

It is apparent that the Samoyed is NOT a heavy freighting dog. Although the largest members of the breed do approach the height range of the heavy draft dog, his weight is at best 20 pounds short, indicating that his overall size and build is substantially lighter than required for this job. He has somewhat more leg and a higher degree of rear angulation than can be used effectively at the task of heavy freighting.

Some might argue that the Samoyed, in his "Finest Hour", was used as a heavy freighting dog by some of the polar explorers, and that survivors of these expeditions represent more than 50 percent of the foundation stock of the modern breed. It should be noted however that these expeditions were "one-shot" affairs which "consumed" the teams through planned attrition rather than using them continuously over a normal lifetime. And, most of the men of these expeditions expressed a preference for a larger draft animal.

Well, then how about the Samoyed as a light freighting dog? Here, he would seem to fit in rather nicely. The general size and build is proper, although some of the smaller and more finely built individuals in the breed might be of marginal value for this purpose. We wouldn't want any more rear angulation, or any less muscling than he has, but a medium size or larger Samoyed conforming in every way to the written standard is not very far from the ideal light freighting dog.

The Samoyed as a reindeer herd dog? That's not so easy to answer. The general run of the breed is more heavily built -- heavier by almost a factor of two, than is required of the herd dog. However, it is not too difficult to imagine the smaller and more finely built members of the breed as being able to perform this job very effectively, even though their size and conformation is somewhat less than optimum for the task. On the other hand, the larger and more heavily built members of the breed had best stay out of reindeer herds. They'll wander too near a calf and wind up skewered on Momma's antlers! And why feed a 50-pound dog to do a job that would be better performed by a 25-pound one? Considering the breed on the whole, we would have to concede that he could probably do the job of herding reindeer, but that his performance and efficiency would certainly be less than optimum.

This entire analysis has been predicated on the idea of considering the OPTIMUM conformation required of each task, and there is good reason for this approach. There are, however, some qualifying factors that should be recalled. The arctic represents a harsh and bitter environment, demanding a tenacious struggle for existence of all who would live there. In this environment, dogs were kept by the natives because, and only because, they were essential to existence. The most valuable animal was the one who could be of the most use, most often, at the greatest variety of tasks. Food supplies were rarely abundant and never dependable, and in times of famine the dogs were left to fend for themselves -- or even themselves became food for a starving family. "Selection by starvation" tended to evolve the smallest and most metabolically efficient animals that could effectively get the job done. Among primitive people this scramble for existence inveighed heavily against the natural evolution of special-purpose dogs -- unless we consider them "Specialists" in survival.

Our Samoyed is a survivor. He is therefore a successful predator and hunter ...and... his services at one or more tasks must have been indispensable to the Samoyed people who kept him. Hunter? Yes. Sled dog? Yes. Herd dog? Maybe.

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