Research Appendix

Contemporary Research

"Back pain amongst school children and physical risk factors in schools."
Sam Murphy and Peter Buckle.
Robens Centre for Health Ergonomics,
University of Surrey.

"A comparative study of three different kinds of school furniture."
Aagaard-Hansen and Storr-Paulsen.
University of Copenhagen, Denmark 1995.

"The effects of ergonomically designed school furniture on pupils' attitudes, symptoms and behaviour."
Linton, Hellsing, Halme and Akerstedt.
Dept. of Occupational Medicine Orebro, Sweden 1994.

"Effect of work station design on sitting posture in young children."
Marschall, Harringtonm and Steele.
University of Wollongong, Australia 1995.

"Adjustable tables and chairs correct posture and lower muscle pain in High School students."
Hanninen and Koskelo.
University of Kupio, Finland 1999.

"Changing standards for school furniture."
Ergonomics in Design.
A.C. Mandal, April 1997.

Original Sources of Research

"The Seated Man."
A.C. Mandal.
Dafnia Publications, Copenhagen, Denmark 1974.

B. Akerblom "Standing and Sitting Posture."
A. B. Nordiske Bokhandeln. Stockholm 1948.

"Alterations of the lumbar curve."
The Journal of Bone and Joint Surgery Vol35A no.
J. J. Keegan. 3 July 1953.

"Sitzhaltung Sitzschaden, Sitzmobel."
Hans Schoberth. Springer Verlag 1962.

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October 2005

BackCare
The Charity for Healthier Backs
www.backcare.org.uk

BackCare (registered as the National Back Pain Association) is an independent national charity that helps people manage and prevent back pain by providing information, promoting self help, encouraging debate and funding research into better back health.

For further information contact **BackCare**
16 Elmtree Road, Teddington, Middlesex, TW11 8ST
t: +44 (0)20 8977 5474 f: +44 (0)20 8943 5318
info@backcare.org.uk www.backcare.org.uk

Useful sources of further information:

STAGE systems
Q-Learn adjustable classroom desks and chairs
www.qleam.co.uk

BESA
(British Educational Suppliers Association)
www.besa.org.uk

FIRA
(Furniture Industries Research Association)
Ergonomics Unit
www.fira.co.uk

Design Council
Design Campaign: Learning
www.designmyschool.net

teachernet
Teacher Net Children's Seating Centre
www.teachernet.gov.uk

Your Back in the Future

How school furniture is ruining our children's physical health

The Comfort Zone

Are you sitting comfortably? If you're one of millions of students throughout the world, the answer is probably no. And what's more, the chairs and desks you're using today are almost certainly storing up the back and muscle problems you'll suffer tomorrow.

In countries around the world, up to half the working populations are believed to be suffering from some sort of back complaint.

Every year sick pay, medical treatment and rehabilitation for back problems consume vast amounts of money - a situation that's perfectly avoidable. It's all because we don't pay enough attention to the design of the chairs, desks and workstations in our schools and in the places where we spend most of our working days.

Between the ages of 5 and 16, children are likely to spend around 15,000 hours sitting down. That often means sitting in chairs unsuited to their needs and working at mismatched desks and tables. Research suggests that up to 60% of school pupils complain of back pain at one time or another. Ergonomists, physiotherapists and health specialists know that good posture starts from a very early age. And good posture is not just the key to skeletal and muscular health, but also a stimulus to concentration and the way we approach our time in the classroom. If we don't take more care over the desks and chairs we use, we'll be storing up generations of unnecessary pain, suffering and medical costs that can be avoided.

So what's gone wrong? This summary takes a hard look at the gulf between what ergonomics research is telling us and the ways we tackle the problem. And it makes some practical suggestions for re-thinking the way we design our classroom and office furniture.

About this booklet...

This booklet draws upon research findings from many contemporary sources and has also been inspired by 'The Seated Man' a study by Dr A.C. Mandal first published in 1974.
I thank Dr Mandal for his guidance and advice.

Patrick Redsell Suffolk 2005

What the researchers say:

"...traditional school furniture will, for all children, at the age when they are growing and building their posture, result in poor posture, with bad back support. These factors indicate the creation of back problems seen in many people..."
Professor X Philip, University of Grenoble.

"...static posture during lessons may increase the likelihood of upper back and neck pain..."
Murphy and Buckle, University of Surrey.

"...more attention needs to be paid to how ergonomic improvements can be introduced into new school furniture..."
Linton, Hellsing, Halme and Akerstadt, Orebro Medical Centre - Sweden.

"There is a significant body of evidence from high quality research conducted over the last twenty five years that a handful of simple measures need to be implemented to prevent and manage the epidemic of back pain in our schools.

Above all, in the furniture we design and supply, we should improve posture by providing:

- A height adjustable 5° to 10° forward sloping or rounded seat or seat insert.
- A height adjustable sloping desk for reading and writing."

'Back Pain in Children and Young People'
A review of current thinking on prevention and management (2005).
Alan Gardner FRCS
Consultant Spinal Orthopaedic Surgeon
Liz Kelly M.Sc
Healthy Schools Coordinator

Right Angles Means Wrong Ways

In most of our schools, current best practice is to encourage children to sit in the most upright position they can manage. Let's call it the 'three right angles' approach. Here's how it goes - back straight, head up look forward.

1. Seat flat, with thighs at 90° to the spine to make the first right angle.
2. Knees bent at 90° to keep your lower legs straight - making the second right angle.
3. And finally, feet bent at the ankle another 90° so they rest flat on the floor, making the third right angle.

And to help us to "sit up straight", we're usually given flat or backward sloping seats with vertical backs and flat tables that we tuck our legs under. Take a look at the relationship between Figure 1 and the all too familiar Figure 2.

Fine if your body is alert and you need to look straight ahead for a short while. But what happens if you need to read or write? You have to bend forward over the table to get your eyes in the right position, placing your head in an awkward position, curving your spine, imposing unnecessary pressure on the discs in your back and flopping your arms across the table. And this "slump" goes on hour after hour, day after day, year after year in our schools. So in creating 'three right angles', we've encouraged completely the wrong way to sit.

It's a tragedy that common sense tells us to re-arrange our bodies out of the "upright" sitting position we've been given into a new and thoroughly damaging way of sitting and working. So isn't it time we did something about it?

Fortunately for teachers and education administrators, the back problems caused by such an unnatural and unhealthy sitting position don't tend to appear until we are between the ages of 13 and 16 and worsen in the years after we've left school. Otherwise we could insist that our schools and education service take greater responsibility for the potential long-term damage they do to our bodies by not furnishing our classrooms with suitable furniture.

Fig. 1

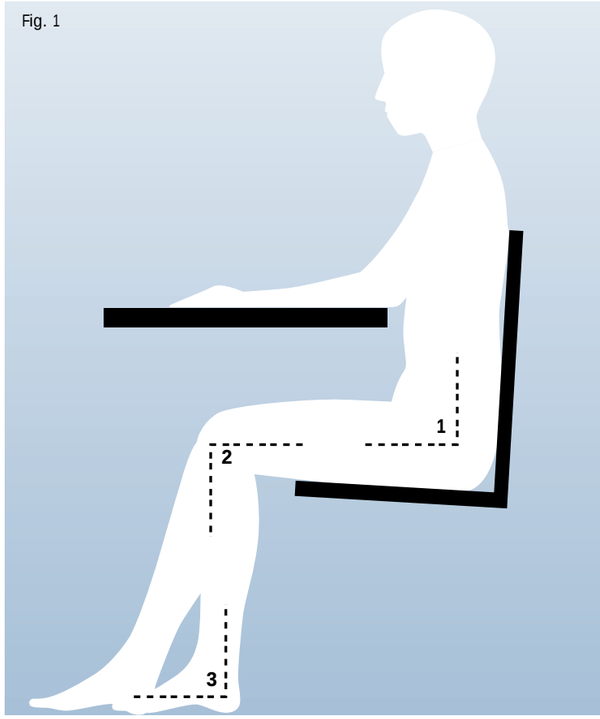


Fig. 2

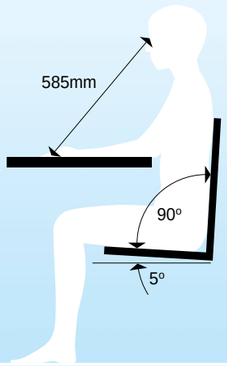
The Sitting Up Straight Problem

Note for readers - the next two pages (4 and 5) provide a brief analysis of the 'sitting up straight problem' and the harm it does, in words and pictures. It makes fascinating reading, but you can also move directly to the research findings and recommendations by going to page 10.

The 'Right Angles' sitting position

✗ Potentially harmful posture

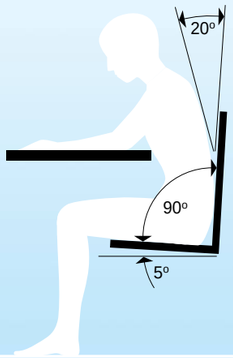
Principally, the right-angled sitting position is a backwards-inclined resting position. Eyes are a long way from the book. So you have to bend your neck into an unnatural position to see properly. And the right-angled sitting position loads both the hip joints and the lumbar region in extreme positions. It's neither a natural nor a comfortable way to sit for any length of time.



Working from the 'Right Angles' position

✗ Potentially harmful posture

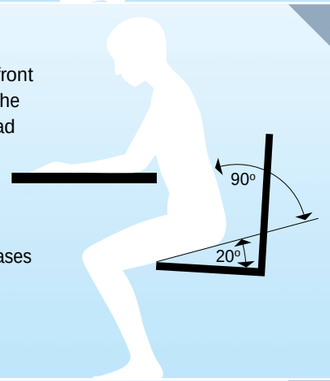
As soon as you have to begin reading or writing, your eyes need bringing closer to the work you are doing. To do so, you bend the lumbar region. The bending tends to be localised in the 3rd, 4th and 5th discs, because the rest of the back is pretty inflexible. Even with a limited bend, muscles, joints and ligaments are overstretched and the back begins to round. There's also backwards pressure on the lower discs. And to make things more awkward, the extreme flexion of the neck is a very tiring position to hold for any length of time.



Round back, cut legs

✓ Seeking better posture

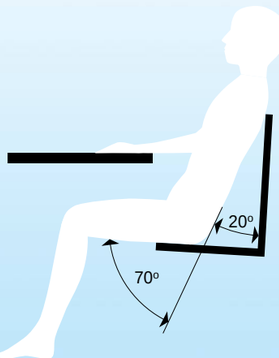
To avoid rounding our backs, most of us move to the front of the seat, so that our thighs slope about 20º below the horizontal. By bending our necks, we can bring our head down closer to the work we're doing. But in doing so, the front edge of the seat cuts into the muscles of the thighs and restricts the flow of blood to the legs. The hip can flex comfortably to around 60º before the normal lumbar curve starts to flatten, which then increases the loading on the disc and stretches the adjacent supporting muscles and ligaments. After a while, we end up with a sore back and numbness in the legs.



The resting position

✓ Seeking better posture

For resting, lectures, discussion and viewing films, the posterior slides forward on the seat. The effect is to reduce the bend in the hips from about 90º to about 70º and get the hip joints into the 'resting' 45º angle. But however smooth the seat surface of the school chair; our instinct is to tip backwards so that we can increase the grip in the backward sloping seat. Something we can see in action in almost any classroom.



✓ Seeking better posture

The 'Tip Trick'

As children, we all discovered for ourselves the trick of tipping forward on the legs of the chair. But because doing so often brings a reprimand, we lose sight of why we did it in the first place. By tipping the seat 20º forward, we can avoid both bending and heavily loading the lower back. Besides, it feels so much more comfortable, because it's closer to an ideal balanced position. Although the photograph shows someone sitting too far back in the chair for good posture, she is subconsciously seeking a better position.

The Research

What we know is that the days of our ‘hunter gatherer’ existence when we spent much of our time upright on our feet, body in balance, legs supporting our weight are long behind us.

Over many generations most of us have moved to an everyday existence that involves a sedentary way of being - bent over books or machine technology; working on close focused tasks that usually require us to be seated or hunched over what we are doing. If the journey has taken us from the ‘homo sapiens’ of our origins to the ‘homo sedens’ we are today, more’s the pity that the recognition of our seated needs has lagged so far behind the social changes we’ve undergone.

Not that there’s been any lack of research findings to guide us. Scientists like Akerblom, Keegan and Schobert have set down detailed research that’s scarcely penetrated the walls of the scientific community. Most of the discoveries centre on what happens when we move from a standing to a seated position.

Far from our hips moving through 90º as we sit down, research has shown that it’s a much more complicated process, with a large proportion of the bending coming from a flattening of the lumbar curve at the base of the spine.

The appendix at the back of this summary gives more links to the research findings.

The critical thing here is that if we don’t take into account the needs of this lumbar curve and continually ask ourselves and our children to force our bodies forward into the stooping position - “the slump”, we exert enormous pressure on the lower discs of the spine and on their supporting ligaments.

Interestingly, it’s in this area of the back that most of the problems and pain we encounter is found.

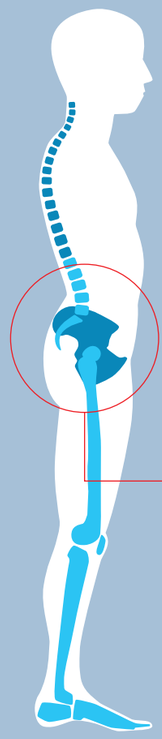
So what can we do about it?

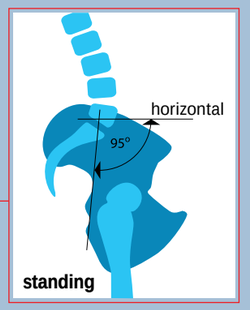
An explanation of how conventional seating can damage the lower spine...

Standing

When standing upright, the base of the spine is curved (left). This is referred to as the lumbar curve.

When we are forced to adopt the three right angles seating position (right) the base of the lumbar curve flattens...



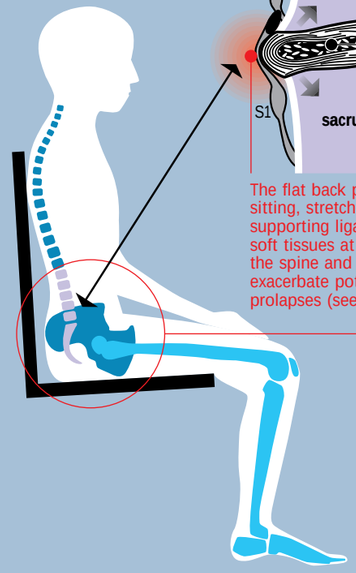


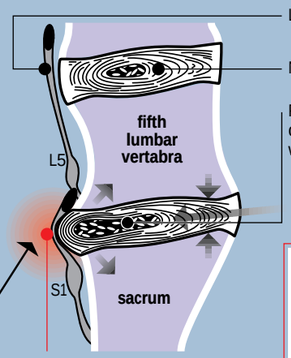
Summary...

Standing upright results in an even distribution of weight between the back and the front of the spine, which is comortable.

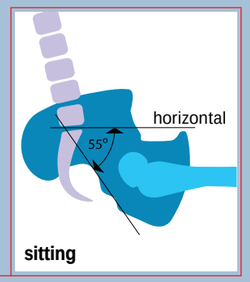
Right angle sitting position

...This can result in discomfort or - as we are becoming more sedentary - permanent damage. Here’s why...





The flat back posture when sitting, stretches the supporting ligaments and soft tissues at the back of the spine and may also exacerbate potential disc prolapses (see diagram)



Summary...

Sitting flattens the lumbar curve transferring the weight forward, which stretches the muscles at the back of the spine and loads the discs at the front, which encourages fidgeting in an effort to minimise disconfort and the onset of back pain.

Taking a Different Angle

One of the problems of the upright ‘three right angles’ sitting position is that no healthy child could sit in it for more than a few minutes at a time. It isn’t in fact a perfect work position, but a position for looking straight ahead and listening. And even then, it’s only bearable for a short while. Which is why most people shuffle forward on the seat to change the angle of spine to body from 90º to a more open angle.

Now think about what happens when we begin to read or write. In the upright ‘three right angles’ position, you’re nowhere near close enough to the book or papers on the flat desk to read or write efficiently and comfortably. To do that, you have to bring head and book closer together. How do you do it? By bending the upper part of your body and forcing the head and neck down. And there’s how you’ll stay until the reading or writing is completed.

What’s happening is that our bodies are being forced into an uncomfortable and harmful position.

Like this...

...and this

So what most of us try to do is to compensate, to get into a much more comfortable relationship between chair, desk and work. Intriguingly, what we seek is the perfect position set out in the research of the ergonomic scientists.

Here’s how it goes....

Tip and Tilt

Children often tilt forward on the front legs of their chair when working at a table (Fig 3). In doing so, they place their thighs at an angle of about 30° below the horizontal, while the hip joints bend at about 60° and their backs remain straight, with the lumbar curve intact.

The same children find out how to tip and tilt their chair into a better seating position instinctively, without any instruction. And how do we reward them? By telling them to sit up straight and stop messing about. Good for the health of the chair legs, disastrous for the health of the child.

But in truth this 'tip and tilt' approach is a better way to sit and a better way from which to rise back to a standing position. Tipping forward to change the angle of legs, back and spine is also a way that many people with back problems ease the pain they're suffering from.

So if we're to learn from the instinctive experience of our children - and we want a better relationship between chair, desk or table and work position - shouldn't the furniture we provide in our classrooms provide posture more like that shown in Figure 5?

Fig. 3

Harmful posture: Flat desk top and horizontal seat.

Fig. 4

Healthier posture: Inclined desk top and forward sloping seat.

Fig. 5

Horse Sense

The solution is to put to better use the scientific understanding that's right under our nose.
We need to reach consensus on an ideal seated work position and put that consensus into practice, so that the chairs, desks and tables we design and use will take care of our bodies in the best possible way. There's no excuse for failing in this duty of care. We owe it to ourselves and to children around the world to use the knowledge we have to save the pain and grief of back problems for future generations.

So where do we begin? It may seem strange to say it. But without doubt, the best sitting posture is obtained on horseback. The hip joints are in the resting position with a bend of 45°, the hip joints and the spine are not loaded in an extreme way and a perfect balance position is achieved and maintained. In addition, the saddle slopes downwards, so your spine takes up the right position to acknowledge the needs of the lumbar curve. Sitting upon a horse requires you to get your body into balance - but comfortably so. Interestingly, horse riding is sometimes used in the treatment of back pain.

Try convincing a rider that it would be more comfortable and practical to sit in the 'three right angles' position - to 'sit up straight' as we demand of our school children. Imagine the awkwardness, impracticality and discomfort.

How interesting then that potters, piano players and people like textile weavers often use forward-sloping seats to give them both the perfect 'in balance' sitting position and the freedom to move as they need.

Interesting too that architects, illustrators and designers recognise the importance of a sloped surface on which to write draw and read. Having your work surface sloped from back to front brings your eye and hand into much more natural, direct and comfortable contact with the work you're doing. So there are some indisputable clues here about an ideal seated working position - forward sloping seat, sloped working surface, legs at 45°.

What can we learn?

Back straight, legs slope

Perfect posture

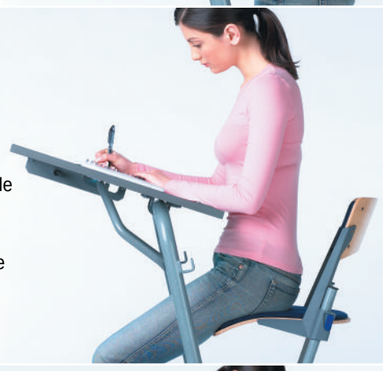
Body in balance

Tipping the Balance

We know from research that children have found out how to get the best from their existing classroom furniture, and have obviously had sufficient body sense to protect themselves from the worst encroachments on their physical health. But it is during school age that bones are so soft that long-term stretching or squashing can easily deform them. And it's when we are in school that most of the damage is done, even if the real problems appear later in life. But there are some straightforward recommendations that we can adopt to improve the situation straightaway.

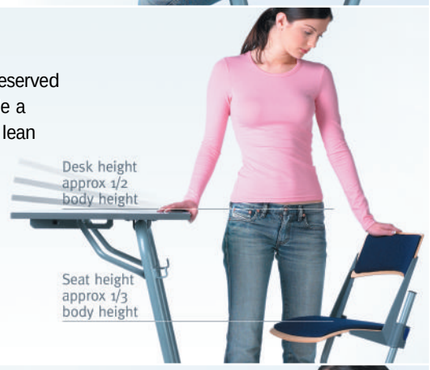
Sloping tabletops.
Old-style school desks had a top that sloped 10°, so that the working position was 10° correspondingly less rounded. With a slope of 10° - 20° as on the Victorian standing desk, most people will have a perfect posture for writing and reading. And what's more the book and papers would be almost at right angles to the line of vision.

Higher chairs.
We seem to have been making chairs lower and lower to achieve the perfect right angle between body and spine at a time when pupils have been growing taller and taller. The lower the seat, the worse the angle of sitting. Though the ideal chair height depends on the height of pupil and table or desk, we should aim for a starting height of about 47 cm. The rule of thumb is that chairs should be at least one third of our body height. We should also give seats a forward slope of between 5° and 15°. So forward sloping seats and height adjustable chairs and tables would fit the bill perfectly.

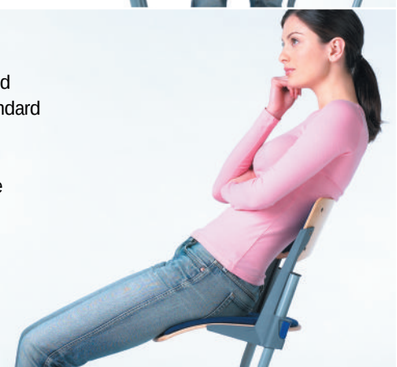


Higher tables.
If the upright desk is coming back into use, it's a well-deserved return to important values, because it really does provide a better work position. Here's a useful formula. When you lean forward to write, your elbow should be in contact with the surface of the table. For most of us, that means having tabletops up to 20 or 30 cm higher than they are in most conventional furniture.

As a guide, tables need to be at least half body height.



Forward sloping or tilting seats.
The experience of the horse rider, musicians and others allied to the research findings and our natural instinct to tip a standard chair forward onto its front legs gives us a clear message. Forward sloping seats place our spines into the best and straightest position and allow our legs to form the 45° angle that takes pressure off the lower discs and ligaments. They allow us to balance our bodies in the ideal resting position.



Conclusion

Research findings suggest that there are several causes of lower back pain in children and adolescents.

The most significant seems to be inappropriate furniture at school or in the home. And there's no doubt that inappropriate furniture causes poor posture.

But there are other factors. Inactivity, sitting too long and being overweight add to the equation. As does carrying heavy bags or even adopting the "slouched" position as a way of looking "cool" amongst your peers.

And here's the knock on effect. Lower back pain appears to affect health, well being, academic achievement, motivation and behaviour. Back pain may therefore be part of a vicious circle of stress, poor behaviour, low self-esteem and low attainment.

What can we do?

There is a significant body of evidence from high quality research conducted over the last twenty five years that a handful of simple measures need to be implemented to prevent and manage the epidemic of back pain in our schools.

Above all, in the furniture we design and supply, we should improve posture by providing:

- **A height adjustable 5° to 10° forward sloping or rounded seat.**
- **A height adjustable sloping desk for reading and writing.**

Final thoughts

If experience teaches us anything it is that there's often a yawning divide between the theoretical approach to designing classroom furniture and the real need. Perhaps it's because 'designers' seldom talk to 'consumers'. How often do we ask the children who use the furniture we design what they think? And how easy it is for us to slip into the 'one size fits all' standardised approach, doing what we've always done, because it's the easiest way to do it.

What's needed is a radical change in the way we think about and design classroom furniture and a sustained initiative to put into practice the lessons we've learned not only from ergonomics research but also from the practical ways in which we observe our children using the furniture we give them.