'GREENING' YOUR AVIONICS BUSINESS

to Save the Environment — and Money

BY WALTER SHAWLEE 2

The issue of being more careful about waste, energy and pollution is not an abstract political or philosophical topic any longer. More realistically, for most people, it is an urgent economic issue. Energy and material costs are soaring, and one only has to look at something like the United States Drought Monitor map (www.drought.unl.edu/dm/monitor.html) to discover global warming (or more correctly, global climate change) really is with us in an inarguable way. As a result, sometimes it works better to simply frame the business discussion in terms of operating cost savings to get things done within your company — and do the right thing by default.

Energy Wasters

For most facilities, there are centers of energy waste that have been around for a long time and have simply become part of the accepted office landscape, rarely being questioned or examined.

Here are the biggest energy wasters almost everyone has, but which have become largely forgotten:

1. Photocopiers (often consuming up to 1 kw continuously)
2. Laser printers (often consuming 0.6 kw continuously)
3. Incandescent lighting (typically only 2 to 6 percent efficient)
4. Old fluorescent lighting (noisy and only semi-efficient)
5. Poorly glazed windows (huge heat loss/gain areas)
6. Inadequate ceiling insulation
7. Inefficient heating
8. Inefficient or under-rated air conditioning
9. Computers and CRT monitors (large energy consumers)
10. Concrete floors

Because many avionics facilities basically are accidental structures, created out of hangar space or housed in converted older airport buildings, they are classic examples of how old building techniques have come into unhappy collision with modern economic realities.

Many of these buildings have poor insulation values and often have single-glazed windows, uninsulated walls, bare concrete flooring, and little or no ceiling insulation. A poorly constructed building is an ongoing, escalating expense, hard to heat and cool, as well as costly to operate.

A small investment in renovation can yield significant operating savings in heating and cooling, as well as an increase in comfort. The reduction in energy consumption and its associated problems is a welcome bonus.

It helps to have a quick look around your facility and conduct a quick survey so you can discover what could use improvement and how changes could be made. Check walls and ceilings for insulation, and learn how the space is heated and cooled. Check all lighting types and age, and determine how many computers, faxes, printers and copiers are in use.

Avionics shops are electronic-equipment heaven; so, see what loads each

Kill-A-Watt energy monitor

test bench draws with regular work in progress. Use a handy little device like the Kill A Watt, which costs under $30, to make a quick measurement of real power consumption for anything suspect. There also is a power-bar/surge-suppressor version to allow easy monitoring of a computer system or a desktop workstation.

This inexpensive little widget also measures voltage and power factor to 0.2 percent accuracy. It helps to check things like printers and copiers, both idle and running, as the current consumption change can be large. Kill A Watt details are available at www.p3international.com/products/special/P4400/P4400-CE.html.

Once you have a list of what draws power, take a look at your utility bill to see how this is translating into operating costs. Check both electrical and natural gas (or other heating) to see what this really represents per month.

The cost per month gives you a good idea of what turning the lights on each morning really costs you, and if the amount is high enough to justify serious upgrading. It can be difficult to get a fix on true costs if you are part of a larger hangar operation and your consumption is not broken out discretely. Still, it makes good sense to trim wasted energy consumption.

Unless you already are very energy conscious, the one fact you should consider is you almost certainly can cut this consumption by about 50 percent and the cost along with it. Many people can do even better. There are easy and almost no-cost fixes available to reduce energy consumption significantly, and there are more expensive facilities upgrades that need a bit of budget planning to bring big savings.

Everything takes a bit of focus to get results, but it helps to remember these things:

• Operating energy costs are only going to increase, and reliable energy is going to become harder to get.

• A capital expenditure to reduce costs might seem counter-productive, but as soon as you examine it over time, the logic is compelling. You need to take the long view to get the most worthwhile results.

Let's check the easy, low-hanging fruit first. Retrofitting all of your incandescent task and ceiling lights with CFL, or compact fluorescent lights (which just screw right into the same sockets), can provide immediate energy savings of at least 60 percent, sometimes as much as 70 percent, and they run about 10 times longer and give whiter light. This is almost a no-brainer. We did it at our place years ago — back when these lights actually were expensive. Now, they are so inexpensive and work so well, it's hard to understand why anybody would not make this simple change.

Typical enclosed CFL lamp

Keep in mind, there is already legislation in progress to ban the production and sale of incandescent light bulbs for home lighting in the near future. This change only requires unscrewing old bulbs and screwing in new ones — pretty easy so far, and you've just cut consumption by at least 60 percent. Don't forget ceiling pot lights, bathroom lights, closets and the many hidden-lamp locations.

Timers or automatic IR occupancy switches for lights in seldom-used areas, such as washrooms or storage rooms, also can pay big energy dividends, and you would be surprised how much those unattended burning lights cost each year.

If your building has extensive ceiling fluorescent lighting, consider upgrading to instant-on, high-efficiency, T8-style lamps and electronic ballasts. This change can deliver a roughly 20 to 30 percent reduction in energy consumption and eliminates the irritating ballast "buzz" from overhead fixtures.

This is easiest to do during new construction, but I have retrofitted some on my existing circuits, and it was simple and effective. Many older fixtures have seriously degraded, and the savings, noise and illumination improvements are impressive.

If you were sympathetic to the scene in "Joe vs. the Volcano," where Tom Hanks comments on the horrible buzzing, flickering overhead fluorescent lights "sucking the life" out of him, then switching to the new T8 lamps and ballasts is clearly for you.

In addition, inventory how many computers and monitors you have. These are pretty serious energy pigs. A typical desktop and single monitor is about a 450w load, with a bad power factor really wasting

Continued on following page

Continued from page 49

energy. Each laser printer is about a 600w+ load and often has huge spikes during printing.

A single 15A circuit often can run only two computers, or a computer and laser printer, because of poor power factor issues. The waste heat these items generate is considerable and difficult to remove in warmer climates when there are many users in a confined space.

Every two to three computers with monitors is like having a small electric space heater running full tilt year-round. Large CRT monitors are incredibly power hungry and cry out for replacement with larger, more efficient and attractive LCD types, which usually yield about a 60 percent or better energy savings, and they are X-ray and magnetic-emission free. Look for the Energy Star logo on any potential computer gear to get fully power-optimized products.

If your computer budget is tight, here are two changes you can make for no cost:

• Set the (Energy Star) power-saving settings on your systems to blank the monitors and hard drives after 15 minutes of idle time. For Windows machines, right click on the desktop and look in the "Screen Saver" tab; there are power-saving setting there. You also can access these from "Control Panel," and the "Power Options" icon. These changes are significant and, if your budget is zero, it's something you can do for free.

• Turn off unused machines every night when you go home. This single operating change alone can save you two-thirds of your computer energy consumption. Many years ago, there was an aversion to powering-off computer gear because it was believed (and possibly correctly) the start inrush might cause hardware failures. However, those days in the early 1980s are long gone, and modern hardware is capable of being powered-off without any problems.

Let's consider another approach. Rather than field a big, bulky, noisy space-hogging desktop for every user, consider a laptop instead. A typical laptop draws about 30 to 50w, a big saving compared to 450w, and, as a bonus, a laptop has a free built-in UPS. For power users, add a second low-power LCD monitor (many laptops support this function implicitly) and USB2.0 connected external hard drives for huge, lightning-quick disk storage.

Not happy with the keyboard and mouse on a laptop? Add a docking station for ease of disconnection, then plug in your mouse and full-sized keyboard of choice, plus Ethernet or wireless networking.

Many corporations already have adopted this laptop-per-user approach as it makes many more stations possible per 15A branch circuit. It also allows people to take their work home and reduces office cooling requirements.

Think about how this could help you, as it's often better than a 90 percent energy saving. If you are running many older computers and are thinking of upgrading, consider this technique.

There is an often-quoted (but rarely documented) statistic that power consumption in the United States rose 30 percent simply because of computer usage during the past decade. Whether true or not, in a location with several computers, there is no question energy consumption is significant.

Not every individual can use this method, and some applications, such as servers, CAD and image rendering simply mandate more powerful and specialized capability than a laptop can reasonably offer. However, it's worth noting, in most organizations, this is only about 10 to 20 percent of systems. This means a sizeable group of machines are good candidates for this kind of hardware change.

A Copy of a Copy

Let's look at the issue of printing. Use of inkjet printers is the least cost-

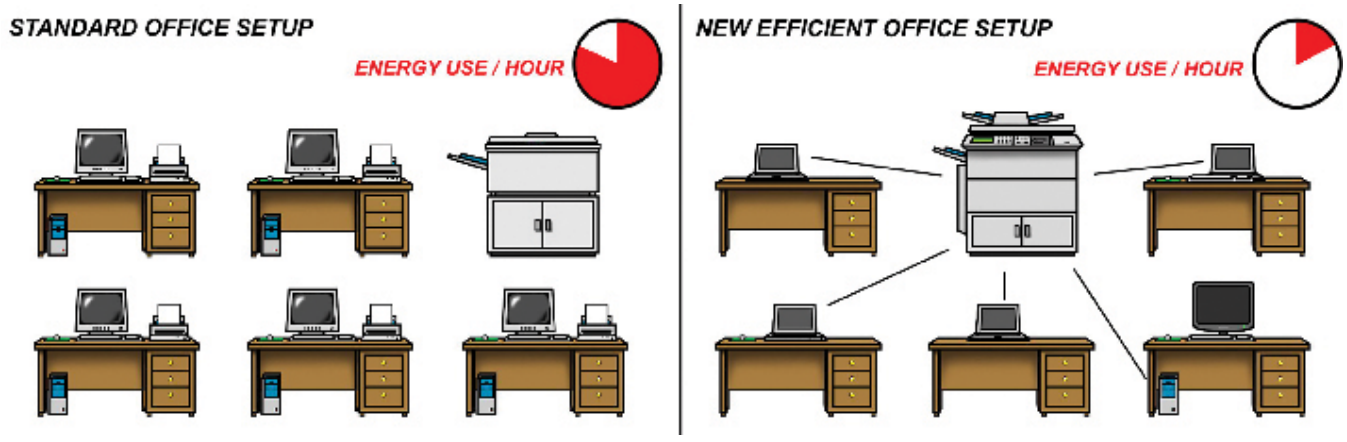

Illustration by Larry Stewart

effective technique in terms of supply cost per page, but it is fairly energy-efficient compared to laser printing (~30 watts versus 500-600+ watts).

A truly optimized strategy now being used in many offices is to upgrade the already-required office copier to a networkable printing system with energy-efficient features. This copier can serve as a low cost per page, high-performance system laser printer. This type of copier can auto-shutdown when not in use, making a big difference in consumption.

The green aspects increase considerably if the copier can duplex, which can cut paper consumption up to 50 percent by printing on both sides. We made this change in our office a while ago, and I really got to test it when I had a 600-page manual to print. It printed in no time, and duplexing cuts the paper bulk in half for many applications.

Where a remote laser printer is needed, consider a new instant warm-up model, which uses far less energy and also can auto-duplex, cutting both paper and energy costs. This laser goes from "ready/sleep" (7w) to "printing" (350w) in about 9 seconds, and it offers a nice way of managing power consumption at remote printing locations. This can be a huge improvement for many laser printers, especially those often left on continuously.

I have been very happy with my new printer model; it was a giant energy savings over my previous laser jet and my office lights no longer flicker when I print.

The Problems of Heating and Cooling

Heating and cooling typically represent about 45 to 50 percent of total energy costs for a building; so, reducing waste heat generation in summer makes cooling much simpler. Attacking this area requires some capital investment, however.

Window glazing is an important area to check. If you don't have efficient, sealed, double-glazed windows, your heating and cooling losses can be large, and this is just as important in warm climates as cold ones. This is expensive to modify, but many people discover the energy savings in a single year can cover the capital costs. Some window companies offer a guarantee of at least 40 percent energy savings from this change alone.

If your budget doesn't extend to this type of investment, drapes and blinds also are effective, but to a lesser degree and they block out natural light. Translucent white drapes are a good choice to maintain light and reduce solar heating, and they also are effective as a heat-loss block in winter when closed.

Adding solar IR-blocking film to your south-facing (or all) windows is one of the most dramatic changes you can make, and it immediately produces a huge temperature improvement if correctly selected. We have used this technique in several offices and in our home, and the results are excellent — as much as a 10-15 degrees C improvement in cooling during summer and a drastic reduction in air conditioning costs. The film also reduces heat loss in winter.

This is not expensive, and it easily can transform uncomfortable sun-facing work areas into usable ones. There are many types of film, and all are not equally effective, so look for spectrally selective film (IR blocking) with good optical transmission to preserve the natural light.

Sticking with the topic of heating and cooling, rewind to the early site examination you did and focus on the ceiling insulation. Considerable heat loss occurs here in winter, as does unwanted heating in summer. If you have no insulation, or only 4 to 6 inches of insulation, it is worth increasing it to a foot, either with bats of pink fiberglass or, less desirably, blown insulation.

You easily can cut your heating and cooling energy costs by 20 to 40 percent just by improving insulation values, although walls are considerably more difficult to fix if inadequate.

Buildings with an elevated peaked roof usually can benefit from rotating roof vents (these are self-powered by escaping hot air), especially in hot climates, to reduce the effects of solar loading on the roof being transmitted to the inside of the building. The inside roof also can be a good candidate for reflective foil (IR reflective) insulation, as can metal building walls in hangars. With up to 97 percent reflectivity, this simple insulation can drastically reduce heat absorption and improve heat retention.

Another clever trick for cold interior locations from long ago is to take 4- to 6-inch diameter PVC pipe and run it from 6 inches above the floor to 6 inches from the top of the ceiling. Install a quiet 15-watt muffin fan in the pipe and let it re-circulate the escaping hot air from the ceiling to the floor. The effect can be amazing, especially by cold doorways or windows.

Adding a second door (after your entry door) to give some static exchange air space (essentially an air-lock), and thus preventing huge temperature swings in the shop area, is another big benefit in colder climates. I learned to really appreciate this when I was working in the Arctic.

Heating or cooling speed and ultimate top or bottom temperatures all are functions of the system capacity, which usually is under-rated in most buildings. However, heating or cooling loss is mainly a factor of the building insulation at night, and insulation and solar absorption during the day. This allows you to make some valuable tests about the building.

To find out your rate of heating

Continued on following page

Continued from page 51

loss (expressed in terms of differential degrees per hour), try this simple experiment: At 8 p.m., shut off the heating and note the outside temperature and inside temperature. At 8 a.m., turn the heating back on and note both the inside and outside temperature.

This gives a 12-hour sample, and one that is essentially free from solar influences. You will see a drop of X degrees over time (divide by the number of hours to get degrees/hour) based on a specific inside-outside differential.

I have conducted some sample tests, and the drop during 12 hours in well-insulated space was only 3.9 degrees C with an inside-outside temperature differential of 22.9 degrees C (average the start and stop temperatures together). Generally, I found cooling rates of between 0.22 degrees C per hour and 0.41 degrees C per hour, depending on the design of the space, windows and floor, for that temperature differential.

If you see large drops, such as 1-2 degrees C per hour, it is an immediate clue your building would benefit from insulation improvement.

Keep in mind, the cooling rate depends on the differential, and the true absolute measure is the above rate divided by the inside-outside differential, or 0.22 degrees C per hour by 22.9 degrees C per hour. From this, you can determine how fast the building loses heat based on how large the inside-outside differential is — an invaluable tool for pinpointing problems and testing to see if your improvements are having any useful effect (something you really will want to know later).

Solar Loading and Some Benefits

Just as a night test can reveal cooling factors, a daytime test can reveal heating factors caused by solar loading of the structure and surrounding air. A light-colored building and roof work best in hot climates; a dark roof is especially problematic as it receives the maximum heating effect of the sun.

There are many ways to moderate solar loading, including planting trees for shade, lightening colors, adding solar film to windows, ventilating roof spaces, and changing roof angles and finishes to reduce solar loading. Windows are an attractive feature and a good source of natural light, but use some care to block excessive solar loading with awnings or film so maximum interior light remains but any unwanted heating effect is minimized.

Your roof and wall locations also might be suitable for direct solar energy capture, both for water heating (and possibly building heating) and for electrical power generation. These techniques have a high capital cost but can be attractive for a remote location where utility connection is difficult or costly.

In Europe, and gradually in North America, there are programs to sell back excess power to your local utility, offsetting capital costs. As a bonus, the solar collection array intercepts considerable solar energy, so the direct building heating will be reduced.

People often wonder if it makes sense to turn off air conditioning at

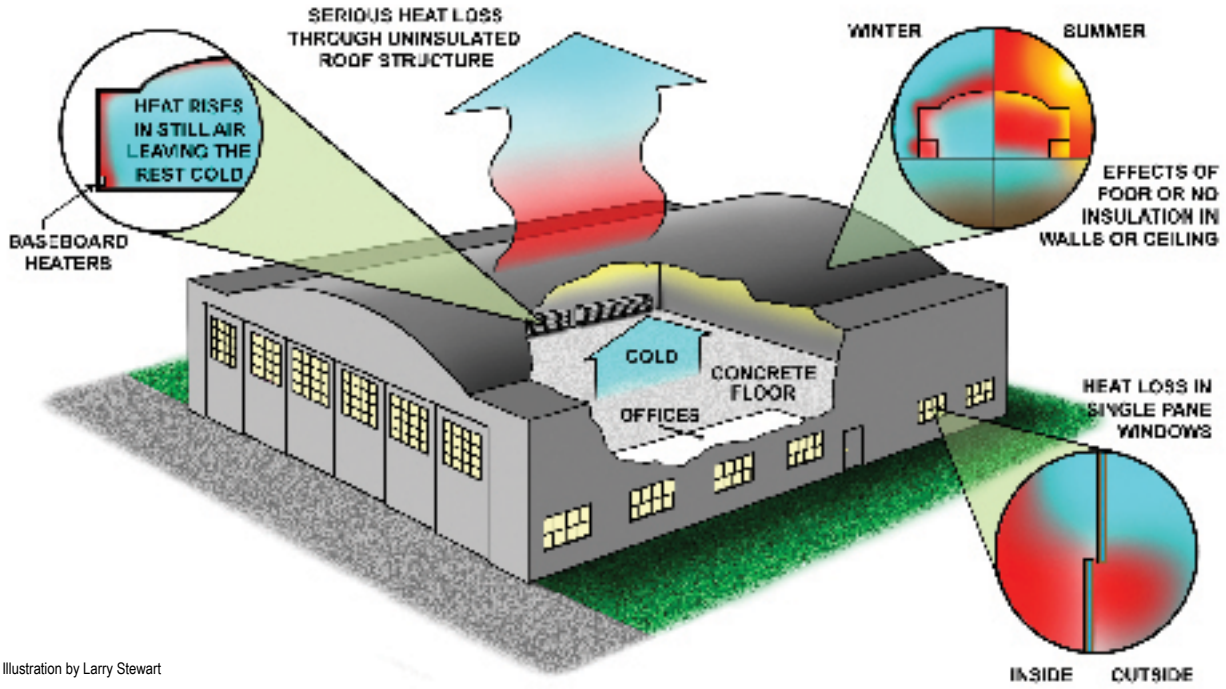

Illustration by Larry Stewart

night and back on in the morning. If the building is still hot at night, this is ineffective, as virtually all air conditioning units are under-rated for the space they cool.

If the building is still hot in the morning, the air conditioning will have to run full (and could ice up and fail) in an attempt to cool the entire space, then get hit with the full solar effect of the day. In this way, the system is always lagging and runs too hard, consuming more energy but achieving less.

If air conditioning is simply set back a few degrees at night (automatic thermostats can do this easily) but allowed to run continuously as needed, the overall cooling effect is better and usually requires less energy.

The same is true with heating. Simply allow a small offset at night, but ensure heating is available if the drop is more than a few degrees; thus, the overall consumption and comfort can be improved.

Building History Revisited

How did people light industrial buildings before electricity, and how were huge churches lit in the 1600s and before? We can learn an important lesson from the past as nearly all of these buildings used what is called "clerestory" lighting, where extensive use is made of high windows at the ceiling line and an open building plan. This provides even, wide-ranging daylight through the building for essentially zero operating cost.

If you are unfamiliar with this simple, but effective, technique, visit Wikipedia at http://en.wikipedia.org/wiki/Clerestory.

Modern industrial building techniques popular for the past 75 years have been to build dark, flat closed boxes with marginal insulation, then heat and light them artificially at great expense.

With great public fanfare in the past year, some huge retailers have suddenly discovered skylights and ceiling windows to provide interior daylight to their stores. The sun has been here all along; we just have chosen to forget this in our architecture until recently.

Hangar ceilings and sides can be lit easily by the clerestory technique, as can many building structures, with a large drop in daytime lighting costs. This is not a simple retrofit; rather it's a critical idea to consider every time a new building is built or remodeled. Many new green-optimized commercial buildings now are lit almost entirely by this method combined with reflectors and light pipes during the day.

Moving Air, Covering Floors

Circulating ceiling fans work in every climate, and a small amount of energy spent here to mix the air and provide gentle currents is effective at increasing comfort and making both heating and cooling systems more effective.

The only heating available in some avionics facilities made from hangar space comes from electric baseboard heaters, which is a significant problem. The conversion efficiency is high, but electric baseboard heaters are not very effective as heaters because the air is not circulated. They produce localized hot spots and nothing else.

To really make baseboard heaters work in a useful manner, active air circulation is required. Adding a few well-placed fans, either by the heaters or as ceiling circulation fans, will produce a big improvement in effective area heating, and thus reduce total energy costs.

In addition, too many cold-climate avionics facilities have concrete floors (part of the hangar area), and for them, this massive heat sink saps a large percentage of their heating dollars.

Adding an insulated floor on top of concrete can make all the difference to your conservation efforts. In a warm climate, if this surface becomes heated, no amount of air conditioning will truly cool it, so an insulation layer generally is useful on top of this surface.

Serious Savings

Some energy companies now are implementing beneficial sliding rates for different times of the day, and there could be an opportunity for you to catch some serious savings by shifting hours or moving certain tasks to a different time or shift. Check with your utility company for details.

Don't forget, many energy companies read the meter only at wide intervals and apply averaging; so, find out your true situation to better gauge your conservation results.

Passive Solar Techniques

To learn more about all types of passive solar techniques and how to adapt them to your home or business, read "The Passive Solar Energy Book" (expanded professional edition) by Edward Mazria. This older book can be found on Amazon.com and elsewhere, and is a treasure trove of valuable information and proven techniques, especially for those interested in methods using virtually zero power to work. I strongly recommend this book for anyone considering serious building renovation.

Water Issues

Most avionics facilities do not use a great deal of water, but most is often inadvertently wasted. This is typically because of toilets. Older generation units are pretty lavish in terms of the water used for flushing. New generation toilets can be up to three times as efficient, a significant improvement, and worth the expenditure in areas with high water costs or for those being remodeled for improved efficiency.

New high-efficiency water fixtures

Continued on following page

Continued from page 53

have the WaterSense marking, and you can get more information from the EPA at www.epa.gov/WaterSense.

Faucets and landscape watering also can be significantly optimized with little effort, such as drip irrigation, which improves overall water consumption. If you are in an area with escalating water costs, take a look to see if these techniques can help you.

Getting From Here to There

In the larger arena, consider how employees get to and from work. If you provide a way for them to find carpooling partners, they might discover some ways to curb their own expenses.

Employees might respond well to company-supplied bus passes as a bonus or as part of a compensation package. Some manufacturing firms even run their own buses to central points to ensure assembly workers can get to their locations effectively. You might want to contact a bus company to see if a better stop can be provided for your location or if your area can be added to an existing route.

Many employees are having problems with escalating expenses, especially the cost of transportation to and from work. Often, employers do not understand how serious of a problem this really is, especially when coupled with secondary work-related costs, such as daycare or baby-sitting. With the urban sprawl pattern in which we live, a distant inaccessible work location can be a negative factor in determining whether or not people will continue to work at your location as costs rise.

The use of fuel-efficient fleet lease vehicles also could be an option, either as part of a compensation package or as an available option to employees.

Use of electric smart cars (or parts shuttles for inside) to and from hangar areas also are appealing, and are a big boost to air quality while providing a reduction in operating costs.

In addition, you might choose to shift some operations, such as equipment overhaul or storage, off a direct airport site to less expensive and more accessible workspace elsewhere.

Funding

Some utility companies have incentive programs for improving efficiency, as do states and federal governments at tax time. If you use natural gas heating, those utilities also have had good incentives to upgrade furnaces to more modern and efficient styles.

Have a look at the Energy Star Small Business Program at www.energystar.gov/index.cfm?c=small_business.sb_index.

For some useful ideas and checklists, as well as available financing resources broken down by individual states, visit Energy Star at www.energystar.gov/index.cfm?c=sb_join.sb_financeproducts.

The comparable main site for Canada is at www.ic.gc.ca/epic/site/dir-ect.nsf/en/uw00952e.html.

If you experiment a bit, there is much room for improvement in the everyday aspects of life — which we don't often think about. You might be amazed at how much you can do with just some small changes and a bit of investigation. ❑

Continued on page 56