HOUSEHOLDS **R**ESEARCH **U**NIT
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New Products of the 80s & 90s: The Diffusion of Household Technology in the Decade 1985-1995

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Introduction

As technology continues to evolve at a rapid pace, it has exerted substantial influence on everyone's lives. Over the years various inventions have made their way into homes and have substantially changed the way people work, rest and play. Specifically, the industrial revolution in the home has radically altered the way we maintain and manage our households and the way we spend our leisure time[1]. Although the promise of household appliances to reduce time spent on household chores has been largely unrealised, these devices have undoubtedly changed the way we cook and clean. The way people spend their leisure time while at home has also changed radically in the past 100 years. These changes are still being felt in households, especially with regard to leisure related devices. DVD players[2], digital radio[3] and digital television[4] are the latest leisure related appliances to be introduced on to the market. In the next decade it will be interesting to observe the way households adopt these new "convergent technologies" -where one appliance could serve all households audio-visual and datacasting demands. With the commencement of digital TV transmissions in Australia on January 1, 2001 and the introduction of DVD players onto the market, it is timely that we examine the extent and rate of household adoption of new technologies, such as colour televisions or personal computers.

This paper reviews some of these developments and attempts to estimate the extent of these changes with regard to the introduction of five types of household appliances. The diffusion of colour television, video cassette recorders, compact disc players, microwave ovens and personal computers during the 1980s and 1990s will be examined. McMeekin and Tomlinson (1998) have demonstrated differences in the rates of adoption of new technologies (dishwashers, freezers, microwave ovens)[5]. It is to be expected that some of these differences depend on disposable income (and hence the ability to afford these novelties). The present paper demonstrates differences in the extent and rate of diffusion of new household technology according to a broad household type classification.

Although the extent and rate of this diffusion process depends on household type all household types show substantial changes. In this paper results are obtained for four main groups, namely, all households, those with children, those without children and single adult households. Results are given for the diffusion of various sorts of technology into households and the likely patterns up to 2005 for these four groups. Based on the findings of this study it is apparent that different types of Australian households adopt new household technology at different rates.

The diffusion of new consumer goods has been typically modelled in terms of logistic or Gompertz curves as reviewed in Ironmonger (1972)[6]. Other possibilities include the Bass model reviewed in Mahajan, Muller and Bass (1990)[7] and the flexible logistic growth model introduced in Bewley and

Fiebig (1988)[8]. Mansfield (1961)[9] has advanced a heuristic argument as to why a logistic model should be expected, subject to a few plausible hypotheses.

In this paper it is found that mathematical models based on the logistic curve provide a good description of these changes over the period 1985 to 1995 for products which are still diffusing into households. The likely adoption of various household technologies are predicted up to the year 2005 on the basis of these models, including the expected degree of saturation (expressed as a percentage of households owning that type of technology). This paper also presents estimates of the year when the diffusion of each technology reached the halfway point to saturation. This is especially relevant in terms of the logistic model since the halfway point occurs precisely when the rate of diffusion is greatest.

Five types of household appliances were considered in this investigation, namely, CD players, personal computers, colour TV, VCRs and microwave ovens. Other household appliances were not considered in this study as this study's focus was on technology that was first introduced into Australian household during the 1980s and 1990s.

Logistic models

Ironmonger (1972)[10] has reviewed the use of the logistic and Gompertz models for the diffusion of new commodities, including their basic properties. The fundamental idea is that the diffusion process starts when a few households adopt a brand new technology for the first time. Afterwards more households follow suit. Thus the diffusion process becomes more rapid. Eventually the rate of diffusion declines when a substantial number of potential users of that technology have already adopted it. Ultimately the new technology becomes a standard accessory in a certain proportion of households. Thus a saturation limit is eventually reached. If the proportions are plotted against time the graph resembles a stretched figure S. These curves can be mathematically represented in various ways, e.g. by using logistic or Gompertz curves. In this paper only logistic curves are used as they generally gave reasonably satisfactory fits to the data.

The actual method used in this work is based on the formulation of the logistic curves given in the SPSS software system as documented in Norušis (1993)[11]. The particular form of the logistic is as follows:

$$Y = 1/(u^{-1} + b_0 b_1^{\,t}) \qquad (1)$$

where

$$\begin{cases} Y = \text{Proportion of households possessing the technology} \\ b_0 = \text{constant} \\ b_1 = \text{slope coefficient} \\ u = \text{saturation limit} \\ t = \text{number of years since reference year} \end{cases}$$

In our work the year 1984 is used as a reference point as the data used were from 1985 to 1995 inclusive. The saturation limit *u* is the limiting proportion of households of a given type that adopt a particular technology, e.g. a personal computer. Mathematically it is the limit as $t \to \infty$. It is a positive quantity that cannot exceed 1 (which corresponds to the case where all households adopt that technology). However *u* has to be preset when fitting a logistic. In this paper the 'optimal' choice of *u* is determined by two sets of factors. First we seek to maximise the correlation between the data points and their corresponding fitted values, i.e. we wish to minimise their mean square error. Second it is necessary to impose consistency requirements on the forecast saturation limits so that estimates obtained for different classes of households will be compatible.

The consistency requirement broadly means that the results for different classes of households shall add up to that for all households. Obviously the saturation limit must lie strictly between 0 and 100 per cent. That is that saturation limit is defined as proportion or percentage of households possessing a given appliance. As a result, the saturation limit can be no greater than 100 per cent or 1.0.

From Table 4 of the 1996 Australian Bureau of Statistics (ABS)[12] publication on household estimates it is apparent that the proportion of households with children is declining and is now very close to 0.3. The consistency requirement suggests that the saturation limits u_{all}, u_{kids} and u_{nokids} should approximately satisfy the condition $u_{all} = 0.7u_{nokids} + 0.3u_{kids}$. Obviously this condition can only be approximate since the proportions of households with and without children is not expected to settle indefinitely on 0.3 and 0.7 respectively but it will serve as a guide to setting up reasonable forecasts up to 2005.

Also we need a consistency condition for one adult households. Clearly households without children can be divided into two mutually exclusive groups, namely the one adult households and those with two or more adults but no children. Table 4 of the ABS's household estimates[13] suggests that the proportion of households without children, which contain just one adult, is close to 0.34. A plausible consistency requirement is that the saturation limits u_{nokids}, u_{1A} and u_{2+A} should approximately satisfy the condition $u_{nokids} = 0.34u_{1A} + 0.66u_{2+A}$. While we are not especially interested in the limit u_{2+A} we do need to ensure that the implied value of u_{2+A} is reasonable, given our choice of u_{1A} and u_{nokids}. If we think of saturation limits as probabilities that households of the types indicated will eventually own a certain type of household technology it is clear that $u_{2+A} > u_{1A}$ should hold. If we regard the members of an adults only household as deciding independently whether to acquire certain household technology then u_{2+A} can be calculated exactly as a probability, provided we know the size distribution of adults only households. In practice we can only obtain a heuristic guide as to the likely value of u_{2+A}.

The logistic is strictly increasing for all *t* and has one inflection point t_0 given by

$$t_0 = -\frac{\ln ub_0}{\ln b_1} \tag{2}$$

This is the point where the slope of the logistic attains its maximum. At this point $Y = u/2$. This corresponds to the maximal rate of diffusion of a given technology into households and represents the time when "half-saturation" for that technology is reached.

It is important to remember that the saturation limit must be strictly larger than the largest proportion in the dataset for the logistic method to work. This is not a problem if saturation is still in the future (that is, at a time later or beyond the latest observation). Also it is strongly desirable that observed data lie on both sides of the expected inflection point, otherwise inaccurate estimates of the inflection point may occur.

Data sources

Data on the percentage of household ownership or possession of the five technologies of interest (namely colour televisions, video cassette recorders, microwave ovens, compact disc players and personal computers) were obtained from various sources. Primarily, this information was obtained from Roy Morgan surveys of consumer purchasing choices from 1985 to 1995. Secondary analysis of the Roy Morgan data was conducted via

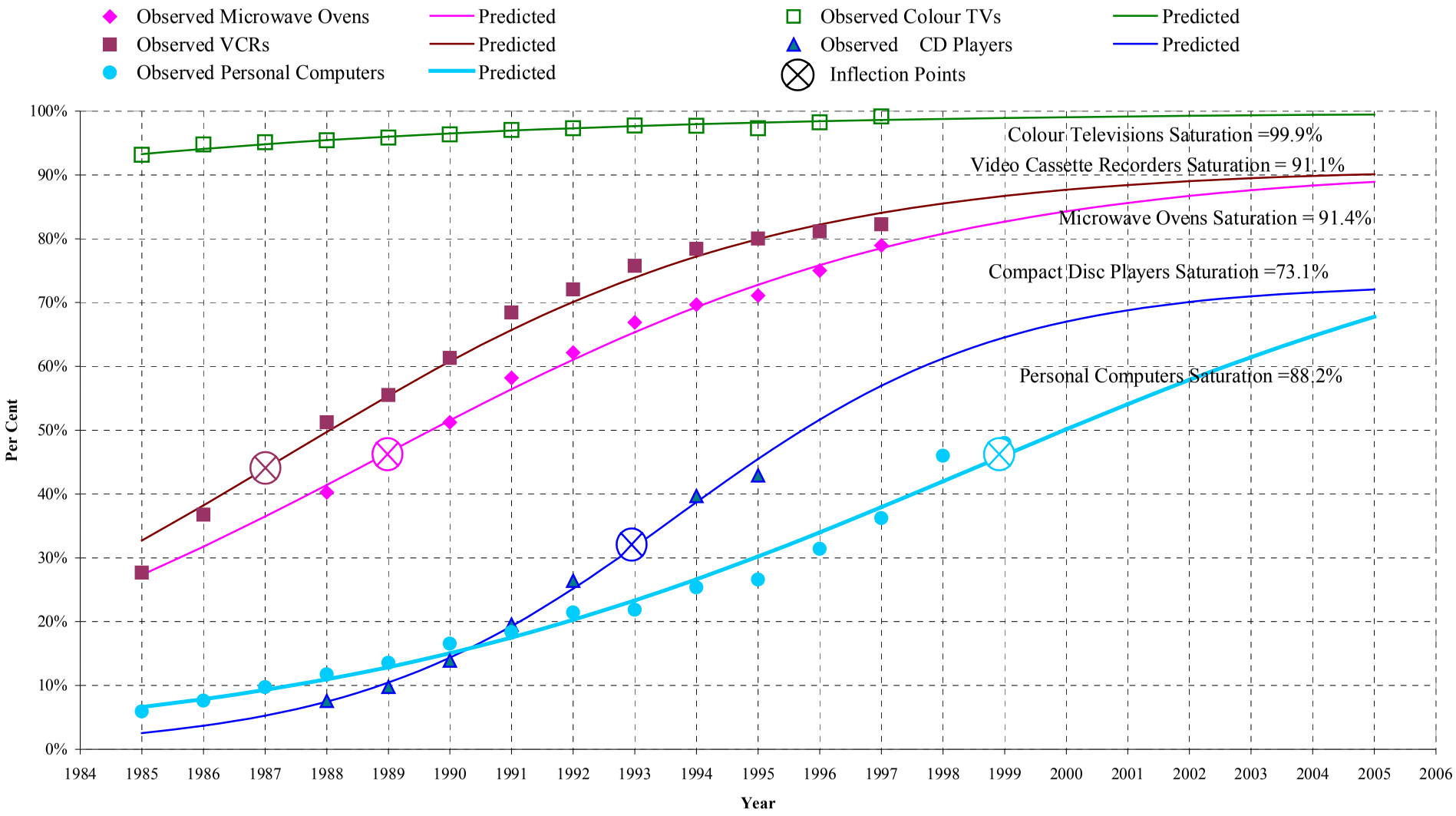
ASTEROID Software (Roy Morgan Research's Survey Analysis Software)[14]. Supplementary data for 1997 for colour television, personal computers and VCRs were obtained from the Australian Bureau of Statistics survey of time use (ABS, 1999a)[15]. In addition, 1998 and 1999 data on the ownership of personal computers were obtained from ABS surveys of household use and adoption of information technology (ABS, 1999b[16], 1999c[17]).

The ABS data publish proportions of households owning a given type of household technology whereas the Roy Morgan data must be converted to proportions. The Roy Morgan sample data gave numbers of persons in households of various types (classified by number of adults and number of children under 15) owning a certain type of household technology. The number of adults ranged from 1 to 4+ and the number of children ranged from 0 to 3+. The data were derived from the Roy Morgan Research survey results obtained in March of each year from 1985 to 1995 inclusive for each of the following items: VCRs, colour TVs and personal computers. Data for the years 1985, 1986, 1987 were not available for microwave ovens and CD players. Counts for persons were converted to counts of households owning these forms of technology using information on the number of persons in the household.

Demographic data on persons and households were obtained from ABS (Publication No. 3229.0), published in 1996 [18]. Table 4 in this publication gives numbers of households by numbers of adults and children under 15 for 1986, 1991, 1992, 1993 and 1994. The number of adults ranged from 1 to 4+ and the number of children ranged from 0 to 3+. Table 5 has the same structure as Table 4 but it gives counts of persons, not households. From these tables it is possible to estimate the average size of households containing at least 4 adults or at least 3 children for the years 1986, 1991, 1992, 1993 and 1994. For other years in the range 1985 to 1995 inclusive we can linearly interpolate or extrapolate the numbers of persons and households and then divide these estimated counts of persons by the corresponding estimates for households to obtain average household sizes as before. These average household sizes were applied to the Roy Morgan data.

From these data we calculated the proportions of households owning a given type of technology for the household types for each of the years 1985 to 1995 inclusive. The reference year for most commodities was 1985. In contrast, the reference year for CD players and microwave ovens was 1988. The proportions from ABS for 1996 onwards were included as well. The household types of greatest interest in this paper are: All households, households with children, households without children and one adult households.

Chart 1: Ownership of Five Household Technologies, Australia 1985-2005



Overview of results

Results were obtained for five types of household technology. Other forms of household technology have been introduced but the five cases considered here do represent the types of changes of changes that have taken place in Australian households. The five types of household appliances examined can be classified in terms of function in the household as follows:

Kitchen use	Microwave ovens
Entertainment	Colour TV, VCRs, CD players
Personal computers	

This paper examined the rate of diffusion of the above technologies into Australian households. The case of colour television is especially interesting, due to its rapid acceptance by Australian households since its introduction in 1974 (Australian Consumer Association, 1978)[19]. By 1985 the proportion of households owning a colour TV set was over 93%. The four commodities which showed substantial increases over the period 1985 to 1995 were VCRs, microwave ovens, CD players and personal computers. Indeed it is expected that CD players and personal computers will be present in almost all households as early as 2005. It is noted that this situation will change significantly if any of these technologies were to be superseded by newer appliances as a result of future developments, for example DVD players and digital television. The likely advent of "convergent technology" may affect these projections. At any rate such devices will probably incorporate several features of current technology, such as TV, telecommunications, computing and CD (visual and audio) playing facilities.

It is also noted that the ownership level of these appliances is generally higher in households with children. We can only speculate the reasons why this is the case. It could be that these technologies are used by households with children as labour-saving devices when substantial amounts of time must be given to child care or to provide children with amusements.

In contrast, households consisting of only one adult tend to have a lower level of ownership of the appliances. Again we can only speculate to the reasons why single adult households tend to adopt household technology at a significantly lower rate. This lower rate of adoption may have something to do with the demography of these single adult household, however further investigation is required.

The expected saturation levels for various household appliances for four demographically different household types are summarised in Table 1. The ultimate extent of household ownership of the new cooking and leisure related technologies are discussed below.

Table 1
Expected Saturation Levels of Various Household Appliances by Household Type
Per cent

	All households	Households with Children	Households without Children	One Adult Households
Colour Television	99.9	99.9	99.8	99.5
Microwave oven	91.4	97.1	89.2	82.3
VCR	91.1	95.2	82.0	65.1
Personal computers	88.2	95.3	85.0	70.3
Compact Disc Player	73.1	80.0	70.2	50.0

In addition, the rate of diffusion of these technologies into households are also examined. Table 2 lists the years when the rate of diffusion of various appliances into Australian households is highest (i.e. when the penetration into households is half of the expected saturation level).

Table 2
Year when rate of Diffusion of Various Household Technologies is highest by Household Type

	All Households	Households with Children	Households without Children	One Adult Households
VCR	1987	1986	mid 1987	1990
Microwave oven	1989	late 1988	1990	1993
Compact Disc Player	early 1993	late 1993	1994	1997
Personal computers	mid 1999	1996	2000	2004

Microwave Ovens : A New Appliance for the Kitchen

Microwave ovens showed substantial increases over the period 1988 to 1995 (for which data are available). They were first imported into Australia in 1969 but householders did not buy them in large numbers until the mid-1980s. By 1980 only 150,000 (3 per cent) of Australian households owned a microwave oven. See Aitken and Ironmonger (1996) for details[20].

It is evident from Table 1 that microwaves have become widespread in Australian homes. Although about 91 per cent of all households will eventually have a microwave oven, about 97 per cent of households with children will have a microwave oven in their homes. According to our

results households without children and single adult households will not adopt this microwave technology at such a high rate.

This finding is best illustrated by the investigation of the approximate times when diffusion microwave ovens into households is half of the expected saturation levels (see Table 2). This corresponds approximately to the time when the rate of diffusion is highest. Diffusion of microwave ovens in households without children and single adult households was at its highest in 1990 and 1993 respectively. In contrast households with children adopted this technology at a much quicker pace reaching a peak in the diffusion rate in late 1988.

Chart 1 highlights the diffusion of microwaves ovens into Australian households. The fitted values generally match the actual results closely for the years 1988 to 1995 as the R^2 illustrates (R^2 = .99).

Table 3
Predicted Percentages of Households that Own a Microwave Oven

	All Households	Households with Children	Households without Children	One Adult Households
1985	27.3	35.1	23.9	12.2
1990	51.5	61.9	47.6	30.7
1995	72.7	82.0	69.6	55.1
2000	84.3	91.6	81.7	71.8
2005	89.0	95.2	86.5	78.7
Saturation	*91.4*	*97.1*	*89.2*	*82.3*

Colour TVs, VCRs and CD Players: New Appliances for Entertainment

The relevant appliances in this study are colour TV, VCRs and CD players. The results show some variation. For instance VCRs did not reach Australia until 1978 (Australian Consumer Association, 1979)[21]. CD players did not enter the market until 1983 and available data on ownership in households of CD players only goes back to 1988.

As noted above the diffusion of colour TV into households was rapid with over 93% ownership in households by 1985, only 11 years from its introduction into Australia. For colour TV the expected saturation levels for each of four basic household types ranged from 99.5 per cent for single adult households to 99.9 per cent for households with children.

It is probable that the time of "half-saturation" for colour TVs occurred close to 1979 or 1980 since the level of ownership rose from zero at the beginning of 1974 to over 93% in 1985.

Results shown below in Table 4 indicate that households with children adopted colour TV technology at a significantly quicker pace than single adult households. In 1985, nearly 95 per cent of households with children owned a colour TV, while approximately 86 per cent of one adult households had a colour TV.

Table 4
Predicted Percentages of Households that Own a Colour TV

	All Households	Households with Children	Households without Children	One Adult Households
1985	93.3	94.9	92.6	86.4
1990	96.5	97.3	96.2	93.3
1995	98.1	98.6	98.6	96.8
2000	99.0	99.2	98.9	98.3
2005	99.5	99.6	99.4	98.9
Saturation	*99.9*	*99.9*	*99.8*	*99.5*

The expected saturation levels for each of four basic household types for the acquisition of VCRs follows a trend similar to that observed for most household appliances. Specifically, households with children have adopted VCR technology at a rapid rate, while households without children, especially those with one adult, have lagged significantly behind. The rate of diffusion of VCRs into households with children reached its maximum in 1986, soon after its release into the market. In contrast, the rate of diffusion was highest for one adult households as late as 1990. In fact, only 65 per cent of one adult households are likely to own or acquire a VCR according to our findings. As a comparison, VCRs will probably reach a saturation level of about 95 per cent of households with children.

Table 5 illustrates the general conclusion that households with children tend to adopt new technology, such as VCRs, at a fast pace. One adult households seem to have adopted VCR technology at a much slower rate.

Table 5
Predicted Percentages of Households that Own a VCR

	All Households	Households with Children	Households without Children	One Adult Households
1985	32.7	43.4	24.6	9.6
1990	60.8	77.6	56.7	32.3
1995	80.0	91.2	75.6	55.3
2000	87.6	94.3	80.7	63.0
2005	90.1	94.9	81.8	64.7
Saturation	*91.1*	*95.2*	*82.0*	*65.1*

For CD players the expected saturation levels for each of four basic household types indicate that 80 per cent of households with children and only 50 per cent of households with a lone adult will have a CD player. Overall however it appears that CD players will be present in most households by 2005 having already reached its highest rate of diffusion into households by 1993.

The logistic curves for CD players for 1988 to 2005 show that by the year 2000 over three quarters of households with children will own a CD player. However not even half of one adult households are likely to own this technology by 2005.

Table 6
Predicted Percentages of Households that Own a CD Player

	All Households	Households with Children	Households without Children	One Adult Households
1985	2.6	1.9	2.8	1.7
1990	14.4	15.6	13.9	7.8
1995	45.5	56.1	41.7	24.7
2000	67.0	76.7	62.8	41.9
2005	72.0	79.6	68.7	48.3
Saturation	*73.1*	*80.0*	*70.2*	*50.0*

Personal computers: First New Convergent Technology

The results show that personal computers are still diffusing fairly rapidly into households. Indeed it appears that a substantial majority of households will have at least one personal computer by 2005. These are probably best seen as a general purpose tool since personal computers may be used for

entertainment, office work, letter writing and communication. The expected saturation levels of personal computers for four different household types follow the pattern of households technology ownership established above. It is expected that probably over 95 per cent of households with children will eventually own a computer. In comparison only 70 per cent of single adult households will invest in a PC. Overall, there will probably be a personal computer in nearly 90 per cent of all households.

The higher saturation limits for households with children reflects the frequent use of computers for entertainment such as games and netsurfing. Note that the latest ABS figures on home ownership of personal computers only gives the proportions taken over all households. However we use the consistency conditions described earlier in this paper to set reasonably compatible

saturation levels for the remaining household categories of interest in this paper.

It is worthwhile to give the approximate times when diffusion of personal computers is half of the expected saturation level. The rate of diffusion of PCs in households with children was highest in 1996, while the rate of diffusion of personal computers into one adult households has yet to reach its peak.

The significant lag in single adult households and the rapid adoption of personal computer technology by households with children is best illustrated by the predictions in ownership levels made for 1985 to 2005. By 1995 nearly half of all households with children owned a personal computer, while only 11 per cent of single adult households had purchased a PC. Moreover, our logistic equations predict that by the year 2005 PCs will be present in well over three quarters of children households, but in only 40 per cent of lone person households.

Table 7
Predicted Percentages of Households that Own a Personal Computer

	All Households	Households with Children	Households without Children	One Adult Households
1985	6.6	13.8	4.1	1.9
1990	15.1	26.3	10.4	4.8
1995	30.2	44.1	23.3	11.3
2000	50.1	62.8	43.1	23.5
2005	67.8	77.4	62.7	40.0
Saturation	*88.2*	*95.3*	*85.0*	*70.3*

Summary

For most technologies the findings follow a consistent pattern. Levels of ownership of various household technologies are highest for households with children. In general one adult households are slower to adopt new household technology. However the ultimate level of ownership for colour TV seems to be almost independent of household type. For nearly all household technology one adult households have a lower level of ownership than other major household types. Further research is required to identify the factors that may be contributing to this low level of household technology ownership amongst one adult households. The reasons why one person households are slower to purchase the latest in cooking and entertainment technology needs to be focus of further research.

Until further research is undertaken it can be surmised that households with children are more likely to own various household appliances for a number of

reasons. It is widely acknowledged that more household work is done in households with children. As a result households with children are eager to adopt labour saving devices, like microwave ovens. As well as being fed and clothed, children also need to be entertained. TVs, VCRs, CD players and personal computers (amongst other uses) all serve as sources of entertainment for both children and adults. In addition the time use patterns of parents and children in households who own various household technologies must be examined before we can surmise who in the household actually uses the technology.

Demographically, single person households tend to be older and female. It is often assumed that older individuals tend to be reluctant to purchase new household technology. However, younger single males may adopt new technology at quite a rapid pace. To begin to identify the reasons why one adult households adopt technology at a slower rate, household characteristics such as age and sex of persons in household, and household income, need to be taken into account in our household breakdowns. Although these factors may contribute to the non-adoption of various household technologies by one person households, qualitative research from Belgium found that perceived need for the new technology accounts for most non-adoption.[22] That is, reasons broadly classifiable as "no need for one", rather than cost, may account for the slow rate of adoption of a new technology, like computers, by certain types of households.

Further developments

A number of new technologies are likely to be introduced into homes between 2001 and 2008. Various possibilities include miniaturised telephones, hand-held computers, electronic commerce, home health monitors, digital TV, virtual reality products, voice-activated products and personal security. There is significant private and public sector interest in the diffusion of these new consumer technologies.[23] As a result forecasts are high in demand. It remains to be seen at what rate and extent these innovations will be adopted by Australian households. However, based on the diffusion rates of current household technologies we can expect that households with children will be one of the first to adopt these new devices, while single adult households will adopt this new technology at a much slower rate. More qualitative research is required to ascertain the reasons for this consistent pattern in the rate of adoption of household technology.

The possible impact of new "convergent technologies" on the diffusion on current household technology should be investigated. Will DVD players and digital TV (which allows one unit to operate as a TV, audio and visual CD player, and computer) make analogue TVs, VCRs, CD players and personal computers redundant in the near future?

According to an Australian Senate Committee Report, Digital Video Disc (DVD) players and Digital televisions are about to change the way people in households watch movies, listen to music and transfer and download data from the Internet.[24] Apart from the promise of superior sound and picture quality, DVDs have the capacity to store and quickly access large amounts of data. At present DVDs for home use are only available in read-only format. This means that digitial information cannot be recorded onto a disc. Although rewriteable DVDs exist for computer, it would be difficult to produce an inexpensive recordable video version for home use at present. Therefore, at this stage in DVD development VCRs are needed if households would like to record their favourite TV program.

However, it is anticipated that the real advance in "convergent technology" will occur when Australia begins Digital Terrestrial Television Broadcasting (DTTB). Digital TV promises better picture, sound quality and reception. Most importantly digital TV will carry a range of multi-media services in the form of audio, images, data and text that may impact the ownership of CD players, analogue TVs, VCRs and personal computers in Australian households. Households will also be able to connect to the Internet via digital TV. There is provision for a service called datacasting where unused parts of the spectrum can be used for transmitting text, sounds, picture, video or Internet services. Currently, datacasting is a one way service. Households would download Internet data via a digital TV but would still need a modem and a telephone line to upload information or data.

However, the first digital TV sets introduced onto the market will be very expensive. It is anticipated that the first digital TV sets will range in price from $2,000 to $10,000 Australian dollars. The Australian Government[25] anticipates that the price of digital TVs will be outside most people's budget for at least 8-10 years. However, Australian households will be able to purchase a set-top converter box (for about $200 -$300) that will allow the reception of digital transmissions on existing TV sets. A Senate committee report expects that most people may continue to use their analogue TVs with desk top converters for up to 8 to 12 years by which time the price of digital TV sets might be more affordable.[26] Although the cost of upgrading one analogue TV might be financially feasible, many households have more than one set and upgrading all of them would be quite expensive.

Investigating the impact and rate of diffusion into households of these new technologies will be the basis of further work. Identifying the detailed characteristics of households most and least likely to adopt new technologies needs to be focus of future research. One suspects, however, that the rate of diffusion into households of most of these new technologies would follow an S shaped curve and that household with children will be amongst the first to adopt these new household technologies.

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Appendix 1
Variables in the Logistic Equations* for the Diffusion of Household Technologies

	b_1	b_0	u	R^2
All Households				
Microwave oven	0.80	1.65	0.91	0.99
Colour Television	0.87	0.34	0.99	0.87
VCR	0.77	2.53	0.91	0.98
Compact Disc Player	0.69	17.37	0.73	0.99
Personal computers	0.83	16.72	0.88	0.98
Households with Children				
Microwave oven	0.80	1.15	0.97	0.99
Colour Television	0.87	0.24	0.99	0.88
VCR	0.72	1.72	0.95	0.99
Compact Disc Player	0.63	20.19	0.80	1.00
Personal computers	0.85	7.30	0.95	0.96
Households without Children				
Microwave oven	0.80	1.94	0.89	0.99
Colour Television	0.86	0.41	0.99	0.86
VCR	0.72	3.97	0.82	0.99
Compact Disc Player	0.70	16.79	0.70	0.99
Personal computers	0.82	28.25	0.85	0.99
One Adult Households				
Microwave oven	0.78	4.27	0.82	0.99
Colour Television	0.85	0.96	0.99	0.88
VCR	0.71	12.60	0.65	1.00
Compact Disc Player	0.72	29.75	0.50	0.99
Personal computers	0.82	61.52	0.70	0.97

* See Equation (1): $Y = 1/\left(u^{-1} + b_0 b_1^{\,t}\right)$ where

Y = Proportion

b_0 = constant

b_1 = slope coefficient

u = saturation limit

t = number of years since reference year

[1] Ruth Schwartz Cowan, 'The industrial revolution in the home', in D. MacKenzie and J. Wajcman (eds), *The Social Shaping of Technology: How the refrigerator got its hum*, Open University Press, Philadelphia, 1980, pp. 181-201.

[2] Digital Video Disc (DVD) players are about to revolutionise the way households watch movies in much the same way as audio CDs changed the face of music. An entire movie, with superior picture and sound quality, can be stored on one side of a conventional sized compact disc or DVD. There is the potential with DVD to be able to store up to 8 hours of video and audio or up to 17 Gigabytes of data. With a large data capacity and fast access to data, DVDs also have applications for computers. With more and more potential applications for the format, it has now become known as Digital Versatile Disc. However, at this stage DVDs are provided in a read-only format for household use. There is already a rewriteable version of DVDs for computers, however at present it would be too costly to produce a recordable audio-visual version for home use.

[3] At the same time as the announcement of Digital Television, the Government announced that Digital Radio is also to be introduced. Although not setting a firm date for its introduction, planning is to proceed on the basis that digital radio will commence at the same time as digital television. Digital radio will provide greatly improved sound quality and reception.

[4] Digital terrestrial television broadcasting (DTTB) is a new type of broadcasting technology that provides a more effective way of transmitting television services. Digital TV offers households better picture, sound quality and reception. Basically the difference between analogue and digital TV is similar to the difference between analogue and digital cellular phones. DTTB systems use advanced digital techniques to convert an analogue signal to digital signal which is then compressed, along with other signals, before being broadcast from a transmitter. With digital transmission, sound and pictures are converted electronically into binary digits (bits) - a series of zeros and ones. Various countries are planning to commence DTTB in the near future (Japan, Canada, Germany, France, Finland, Denmark, Sweden and New Zealand) while others have already adopted the technology (UK, USA).

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[14] ASTEROID is Roy Morgan Research's interactive software system used to analyse and tabulate market research surveys. The ASTEROID program contains data from number Roy Morgan's Industry Monitor Surveys. The data in this software package is obtained using face-to-face interviews or a self completion leave behind questionnaire with a cross-section of Australians on the weekly Australia wide omnibus survey, Consumer Opinion Trends (COT). 60,000 interviews are conducted continuously over a 12 month period. Results are weighted to reflect the geographic, age and sex distribution of the population(or households) according to the latest ABS figures. A useful check on the reliability of the Roy Morgan data can be made by comparing these results for 1985 with those given by the Australian Bureau of Statistics (1992)[14]. Referring to page 320 (op. cit.) we find data for three of the appliances considered in this study, namely, clothes dryers, microwave ovens and dishwashers. For all dwellings the ABS figures are:

Clothes dryer	48.1%
Microwave	29.9
Dishwasher	19.7

Our results for clothes dryers and dishwashers agree broadly with the ABS figures but the results for microwave ovens are slightly smaller (27.3%) than the ABS estimate (29.9%).

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