Occupational Change in North Carolina and the Future of Work

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Abstract

Occupational change is an on-going process in the economy. This report documents the extent and patterns of occupational change in North Carolina during the period 2002-2015. Distinct differences in occupational change were found based on the condition of the economy. During macroeconomic growth periods (2002-2007; 2010-2015), the number of occupations gaining employment exceeded the number losing employment. But, the average annual rate of job change was greater for occupations with declining jobs than for those with increasing jobs, and during the 2002-2007 period the average median wage rate was significantly higher for losing occupations than for gaining occupations. During the recessionary period (2007-2010) more occupations lost jobs than gained jobs, but the average annual rate of change was greater for occupations adding employment. Also, the average median wage rate was significantly higher for occupations adding jobs compared to those reducing jobs.

During the three sub-periods, there is a large amount of change in both the specific occupations gaining employment and among those losing employment. The greatest commonality in specific occupations experiencing change was for the two growth periods, and the least commonality was between the recessionary period and the two growth periods.

The Frey/Osborne index of potential technological unemployment was found to be a predictor of occupational change during the study period. Using the Frey/Osborne index, the potential size of technological unemployment will vary among the state's geographic Prosperity Zones. Public policy changes in the structure of higher education, unemployment

compensation, and social safety net programs should be examined in anticipation of the likely significant changes ahead in North Carolina's occupational structure.

1. Introduction

The availability of quality jobs for individuals in the labor force is a top priority in both the country and North Carolina. However, concern about this goal has been widespread as employment growth in the economic recovery following the Great Recession has been modest and the relative size of middle-paying jobs has been shrinking.[1]

Yet some analysts see a more significant job issue looming in the decades ahead. This is the possibility of massive *technological unemployment* resulting from the development of new sophisticated technology and machinery substituting for human work.[2] The enhanced technology and machinery will move beyond performing simple routine tasks to applications for more complicated work with cognitive components. As one example, computer programs can now perform the case research for lawyers previously done by paralegals. The implication is that a broader array of tasks and occupations will be susceptible to replacement of human work by technological performance. Indeed, studies have estimated up to half of U.S. occupations could experience the switch from human inputs to technological inputs in coming decades.[3]

SOME STUDIES PREDICT HALF OF TODAY'S OCCUPATIONS COULD REPLACE HUMAN LABOR WITH TECHNOLOGY

Substantial technological unemployment will present challenges for workers, educational institutions, and governments. Displaced workers will bear the burden of lost income and re-training costs for new work. Educational institutions will be pressured to rapidly adjust programs and spending from training for declining occupations to programs for expanding

occupations. Government could face higher costs for long-term unemployment and for re-training assistance to technologically-displaced workers.

Optimally, economists would be able to forecast both the occupations being displaced by technology as well as new occupations being created in expanding or new industries. Unfortunately, this is a tall order with a spotty track record of success.[4] One reason is the inability to reliably predict successful inventions and innovations that transform the labor environment.

This report pursues a more modest goal. It is to examine recent changes in North Carolina's occupational structure with the purpose of answering several key questions, including: has the pace of occupational change slowed or increased; how has occupational change in the state been impacted by the business cycle; which occupations have been shrinking and which have been expanding; how has occupational change been related to technological developments and the potential for technological unemployment; and how has occupational change differed among the geographic regions of North Carolina?

Detailed occupational data from the U.S. Bureau of Labor Statistics are the basis for the analysis. The results suggest a substantial amount of occupational churning has been occurring in North Carolina, and some of it is directly related to the increasing ability of technology to perform human tasks. Furthermore, the degree of occupational change and technological replacement of human labor varies across the state's regions. The conclusion is that occupational change will likely become a more pressing issue in North Carolina in coming decades, with important implications for education of new workers, for re-education and re-training of existing and displaced workers, and for the social safety net provided to workers between occupations.

IN THE FUTURE OCCUPATIONAL CHANGE WILL LIKELY BECOME A MORE PRESSING ISSUE IN NORTH CAROLINA

2. Data and

The Occupational Employment Statistics program of the U.S Bureau of Labor Statistics (BLS) uses a semi-annual mail survey to collect information on occupations. A sample of 1.2 million business establishments is used to develop information for almost 800 occupations. Self-employed workers are not included in the surveys. For each occupation there is information for total employment, the relative size of the occupation's total employment, and the average (both mean and median) hourly wage paid.[5]

Annual data for North Carolina from the BLS occupational series were assembled for four years – 2002, 2007, 2010, and 2015.[6] The data set was begun with 2002 because this is the earliest year for which the occupational categories are consistent with later years.[7] The Great Recession began at the end of 2007, so the occupational data for May (when the surveys are benchmarked) 2007 is the latest prior to the recession's onset. The bottom of the job market during the Great Recession occurred in 2010, and 2015 was the last available year for the occupational data.

Four sets of comparisons - 2000 to 2007, 2007 to 2010, 2010 to 2015, and 2000 to 2015 – were investigated to answer the questions about occupational change. Simple comparative statistics and ordinary regression analysis were the methods used to address the questions.

3. The Picture of Recent Occupational Change in North Carolina

Table 1 shows how the speed and type of occupational change in North Carolina has varied during the recent business cycle. There are several notable findings. First, examining

Table 1. Measures of Occupational Change in North Carolina, 2002-2015.[8]

	Occupations Increasing Employment[a]			**Occupations Decreasing Employment**		
Time Period	**Average Annual Rate (%) of Job Gains**	**Number of Occupations Gaining Jobs**	**Weighted Average Wage of Occupations Gaining Jobs**	**Average Annual Rate (%) of Job Losses**	**Number of Occupations Losing Jobs**	**Weighted Average Wage of Occupations Losing Jobs**
2002-2007	6.72%	355	$13.69	-6.87%	247	$15.06
2007-2010	10.69%	291	$20.00	-9.45%	391	$16.18
2010-2015	5.97%	392	$18.72	-6.18%	309	$18.38
2002-2015	3.35%	322	$14.03	-3.73%	280	$15.53

[a] There were also 6 occupations in 2002-2007, 8 occupations in 2007-2010, 9 occupations in 2010-2015, and 6 occupations in 2002-2015 with no change in employment. The total number of occupations differ for each comparison period due to changing occupational descriptions which precluded matching. The wage is the median wage per hour in nominal dollars.

the pace of occupational change (columns 2 and 5), the average annual rates of change for occupations gaining employment and those losing employment are similar. However, employment change accelerated for both occupations gaining employment and occupations losing employment during the recessionary period of 2007-2010, with the acceleration greater for gaining occupations than for losing occupations. Also, the 2007-2010 recessionary period is the only one where the average annual rate of change for job gainers was greater than the average annual rate of loss for job losers. This suggests there are economic opportunities even in the disruptive period of a recession. During the economic recovery of 2010-2015, the pace of

employment change dropped for both occupations gaining jobs and those losing jobs to levels close to the rates in the period prior to the recession (2002-2007).

There are also significant results looking at the number of occupations gaining and losing employment during the time periods (columns 3 and 6). In the two economic growth periods of 2002-2007 and 2010-2015, the number of occupations adding employment exceeded the number of occupations reducing employment; by a 44% margin in the earlier period and by a 27% margin in the latter period. However as would be expected, during the recessionary period of 2007-2010 the roles were reversed, with the number of occupations having less employment exceeding the number of occupations boosting employment by 34%. During the entire period (2002-2015), the number of occupations adding employment exceeded the number reducing employment by 15%.

Last, the differences in wage rates of gaining and losing occupations are noteworthy (columns 4 and 7). During the pre-recessionary growth period (2002-2007), occupations losing jobs paid higher wages than occupations gaining jobs – by margin of $1.37. But during the recessionary period (2007-2010) the difference was reversed – with occupations gaining jobs paying an hourly wage almost $4.00 more than occupations losing jobs. In the expansionary period following the recession (2010-2015) the wage rate of gaining occupations continued to exceed the wage rate of losing occupations, but by a very small margin of $0.34. For the entire period (2002-2015), the wage rate of occupations losing jobs exceeded the wage rate of occupations gaining jobs by $1.50.

DURING THE RECESSIONARY PERIOD OF 2007-2010, AVERAGE WAGE RATES OF OCCUPATIONS ADDING JOBS EXCEEDED AVERAGE WAGE RATES OF OCCUPATIONS LOSING JOBS BY 24%.

Figures 1, 2, and 3 display the key findings for changes in job growth rates, numbers of occupations, and wage rates in graphical form.

There are three major conclusions from these findings. First, occupational change has been widespread in North Carolina, during both growth and recessionary periods. Over the entire time period, more occupations gained jobs than lost jobs. Second, occupational change accelerated during the recent recessionary period, with the number of occupations losing employment rising and also the rate of employment change increasing in both gaining and losing occupations. But significant is the finding that the rate of employment growth for those occupations adding jobs exceeded the rate of employment decline for those occupations losing jobs. This suggests economic opportunities and entrepreneurial activity may actually increase during recessions.[9] Third, while the average wage rate of occupations gaining jobs was lower than the average wage rate of occupations losing jobs during the entire time period (2002-2015), during the recessionary period (2007-2010) the wage rate of occupations adding jobs was substantially higher than the wage rate of occupations losing jobs, and the margin was the highest of any during the individual time periods. This result implies firms add more high-valued employees during recessions, perhaps as they consolidate jobs into a smaller number requiring greater skills, training, and experience.

4. Expanding and Declining Occupations in North Carolina

Eight tables (Tables 2-9) are presented showing the top 25 occupations gaining employment and the top 25 occupations losing employment during each time period. The median hourly wage rate for each occupation is also provided. Tables 2, 3, and 4 show the top

Figure 1. Average Annual Rates of Job Changes of Occupations Gaining and Losing Jobs.

Figure 2. Numbers of Occupations Gaining and Losing Jobs.

Figure 3. Hourly Wage Rates of Occupations Gaining and Losing Jobs (nominal $).

25 occupations gaining jobs for the three individual time periods; Tables 5, 6, and 7 give the top 25 occupations losing jobs for the three individual time periods; and Tables 8 and 9 show the top job gaining and top job losing occupations respectively for the entire 2002-2015 time period. Each table measures job changes in two ways – by the average annual change in total employment, and by the annual percentage change in total employment.

To facilitate comparisons between the time periods, the following codes are used: capitalized, bold and underlined (**OCCUPATION**) signifies the occupation is on the lists for all three time periods, bold and underlined (**occupation**) indicates the occupation is on the lists for the 2002-2007 and 2010-2015 time periods, bold only (**occupation**) means the occupation is on the lists for 2002-2007 and 2007-2010, and underlined only (occupation) specifies the occupation is on the lists for 2007-2010 and 2010-2015.

First looking at the three tables for occupations gaining employment (Tables 2, 3, and 4), there are several interesting findings. There is a mix of occupations paying different wage rates gaining employment. Additionally, there is more commonality of occupations gaining employment between the two growth periods (2002-2007 and 2010-2015) than between either of the growth periods and the recessionary period (2007-2010). This is logical since recessionary

periods are disruptive and often unexpected. During economically stressful times, firms and organizations likely make different personnel decisions than they would in growth periods. Also, there is little consistency between the top gaining occupations ranked by their average annual job gain and ranked by their annual percentage change in employment.

THERE IS MORE COMMONALITY IN OCCUPATIONS GAINING JOBS BETWEEN GROWTH PERIODS THAN BETWEEN GROWTH AND RECESSIONARY PERIODS

Table 2. Top 25 Gaining Occupations in North Carolina from 2002 to 2007.

By Change in Total Employment				By Percentage Change in Employment		
Occupation	**Average Annual Gain (jobs)**	**Hourly Wage ($)**		**Occupation**	**Annual % Change in Employment**	**Hourly Wage ($)**
home health aides	10164	8.23		**biomedical engineers**	42.12	24.76
FOOD PREP & SERVE	7186	6.70		precision equip. repair	40.99	11.54
retail salespersons	6048	8.42		ambulance drivers	37.60	8.99
administrative assistants	4422	11.31		etchers & engravers	31.95	10.93
CUSTOMER SERV. REP	3838	12.41		shoe & leather repairers	30.25	9.03
team assemblers	2812	10.94		message therapists	29.20	15.25
REGISTERED NURSES	2760	21.66		septic tank/sewer clean.	26.37	12.66
retail sales managers	2544	13.15		home health aides	26.30	8.23
waiters and waitresses	2280	6.53		occup. therapists aides	25.92	12.03
construction managers	1790	19.84		stonemasons	24.57	15.03
restaurant cooks	1696	8.72		pile drive operators	24.57	12.26
freight movers	1686	9.31		**animal trainers**	21.67	8.77
accountants & auditors	1656	21.36		cartographers	21.35	20.79
food prep workers	1640	7.34		refractory material rep.	21.05	18.94
receptionists	1594	9.99		**gaming dealers**	19.57	7.64
construction laborers	1516	10.04		personal finance spec.	18.71	21.76
security guards	1456	9.25		agricultural inspectors	18.63	15.72
landscaping workers	1330	9.35		skin care specialists	17.97	10.90
financial analysts	1276	25.98		home appliance repair.	17.65	13.49
food prep managers	1218	11.88		photo machine operators	17.18	8.71

executive secretaries	1076	14.87		electronic equip. install.	16.94	10.81
office managers	998	17.47		h.s. soc. studies teachers	16.88	n.a.
manufacturing sales reps	942	20.44		machine tool operators	16.74	12.94
counter and rental clerks	920	8.82		epidemiologists	16.72	23.00
high school teachers	910	n.a.		sound engineer. tech.	16.27	16.13

n.a. = not available; dollars are current values in the initial year (2002); hourly wage is the median; median wage for all occupations was $12.35 in 2002

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15;

occupation: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Table 3. Top 25 Gaining Occupations in North Carolina from 2007 to 2010.

By Change in Total Employment

By Percentage Change in Employment

Occupation	Average Annual Gain (jobs)	Hourly Wage ($)		Occupation	Annual % Change in Employment	Hourly Wage ($)
nursing aides & orderlies	5140	10.86		rail yard engineers	95.73	n.a.
REGISTERED NURSES	3546	26.02		music directors	77.27	34.11
other computer occupations	3016	32.75		other computer occup.	68.15	32.75
child care workers	1760	8.60		gas plant operators	67.66	21.34
other human resources occ.	1503	19.77		other transport occup.	65.33	10.53
high school teachers	1410	n.a.		airfield operations	65.08	17.21
computer support	1313	19.82		patternmakers	63.86	15.15
dishwashers	1273	7.62		commercial pilots	59.59	n.a.
software developers	1203	40.63		food scientists	57.39	24.13
FOOD PREP & SERV	1186	7.16		travel guides	55.35	17.43
fire fighters	1100	15.29		arbitrators & mediators	54.66	21.13
market research analysts	1030	29.36		food baking occups.	48.46	14.08
other education occups.	953	17.75		aerospace engineers	44.22	24.65
medical scientists	926	35.06		embalmers	38.66	20.19
health teachers	916	n.a.		farm equip. operators	37.72	9.03
bill collectors	906	14.01		entertainers	36.36	7.04
CUSTOMER SERV REP	870	13.81		microbiologists	35.71	24.57
other transport occupations	856	10.53		translators	34.27	13.97
medical assistants	766	12.83		grounds maintenance	33.88	n.a.
fitness trainers	720	12.75		other social workers	33.62	19.71
other health technicians	626	19.87		psychiatric aides	31.67	11.54

commercial pilots	623	n.a		psychiatric technicians	31.13	11.88
other financial specialists	606	27.65		cooling equip. operators	30.06	11.28
telecomm. equip. installers	590	26.10		tapers	28.05	14.87
administrative assistants	553	13.01		health technicians	27.78	19.87

n.a. = not available; dollars are current values in the initial year (2007); hourly wage is the median; median wage for all occupations was $13.92 in 2007

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15;

occupation: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Table 4. Top 25 Gaining Occupations in North Carolina from 2010 to 2015.

By Change in Total Employment **By Percentage Change in Employment**

Occupation	Average Annual Gain (jobs)	Hourly Wage ($)		Occupation	Annual % Change in Employment	Hourly Wage ($)
FOOD PREP & SERV	7534	8.31		railroad operators	34.49	24.29
office clerks	4860	12.32		highway maintenance	31.95	12.87
nursing aides & orderlies	3874	10.69		electrical repairers	28.37	28.22
CUSTOMER SERV REP	3796	14.39		agents of performers	28.06	21.18
retail salesperson	3666	9.39		**gaming dealers**	27.99	7.69
other sales reps	2538	24.04		graders & sorters	27.58	10.46
REGISTERED NURSES	2284	27.82		physicists	25.16	51.30
freight movers	2214	11.04		fine artists	25.15	19.20
truck drivers	1980	17.76		**biomedical engineers**	25.08	36.69
cashiers	1876	8.55		other math/science occ.	24.57	45.62
restaurant cooks	1714	9.80		court clerks	23.64	13.91
store clerks % office filers	1682	10.29		riggers	23.63	17.43
software developers	1634	41.48		farm equipment mech.	23.59	15.58
business operations spec.	1518	27.37		human resource mgers.	23.58	50.18
computer network admin.	1506	33.12		title examiners	22.79	18.57
child care workers	1382	8.86		foundry mold makers	22.10	n.a.
team assemblers	1272	12.65		financial examiners	21.71	40.62
management analysts	1190	34.93		**animal trainers**	20.79	9.97
waiters & waitresses	1138	8.37		fast food cooks	19.80	8.34
computer systems analysts	1042	37.27		radio mechanics	18.88	22.22
general operations analysts	1012	49.26		power plant operators	18.82	29.09

food prep managers	990	14.01		orthodists/prosthetists	18.06	29.03
fast food cooks	960	8.34		metal refining operators	17.69	n.a.
landscaping workers	950	10.73		medical equip. repairers	17.61	22.45
food counter attendants	838	8.47		statistical assistants	17.60	18.53

n.a. = not available; dollars are current values in the initial year (2010); hourly wage is the median; median wage for all occupations was $14.95 in 2010

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15;

occupation: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Table 5. Top 25 Losing Occupations in North Carolina from 2002 to 2007.

By Change in Total Employment				By Percentage Change in Employment		
Occupation	**Average Annual Loss (jobs)**	**Hourly Wage ($)**		**Occupation**	**Annual % Change in Employment**	**Hourly Wage ($)**
nursing aides % orderlies	-4846	8.91		door to door sales work.	-38.99	16.68
general managers	-2724	29.26		travel guides	-27.52	12.92
fast food cooks	-2346	6.61		choreographers	-26.77	13.52
sewing machine operators	-1580	9.55		lay-out workers	-24.21	14.84
general office clerks	-1506	10.76		forming mach. oper.	-23.97	13.86
textile machine setters	--1372	10.51		conveyor operators	-23.30	10.83
medical secretaries	-1226	11.34		**embalmers**	-22.88	18.12
cafeteria cooks	-1202	8.30		food/tobacco mach. op.	-21.95	8.53
chief executives	-1190	61.63		psychiatric aides	-21.95	10.16
stock clerks & order fillers	-1176	9.29		electro-mechanical tech.	-21.71	18.78
bill collectors	-938	12.78		foundry mold makers	-21.54	14.07
textile knitting mach oper	-882	11.00		chief executives	-21.40	61.63
cashiers	-860	7.23		model makers	-20.18	12.21
shipping clerks	-794	11.00		fast food cooks	-19.80	6.61
meat packers	-734	8.84		aircraft cargo super.	-19.72	16.87
manufacturing sales tech.	-690	21.97		advertising managers	-19.27	24.82
telemarketers	-678	10.18		riggers	-18.87	16.54
inspectors, testers, sorters	-672	11.12		agriculture equip. oper.	-18.83	8.14
administrative service mgr.	-644	21.42		pump operators	-18.80	10.98
forming machine operators	-640	13.86		airfield operation spec.	-18.52	36.36

hand packers	-628	8.47		audio-visual specialists	-18.48	15.78
order clerks	-562	12.01		music directors	-17.21	n.a.
conveyor operators	-548	10.83		plaster & stucco masons	-16.75	11.95
auto service tech. & mech.	-534	15.08		**proofreaders**	-16.74	11.30
machine feeders	-522	10.37		tapers	-16.73	12.53

n.a. = not available; dollars are current values in the initial year (2002); hourly wage is the median**;** median wage for all occupations was $12.35 in 2002

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15;

occupation: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Table 6. Top 25 Losing Occupations in North Carolina from 2007 to 2010.

By Change in Total Employment **By Percentage Change in Employment**

Occupation	**Average Annual Loss (jobs)**	**Hourly Wage ($)**		**Occupation**	**Annual % Change in Employment**	**Hourly Wage ($)**
team assemblers	-6713	11.63		plant system operators	-44.96	23.71
retail salespersons	-4096	9.39		judicial law clerks	-43.68	19.31
administrative assistants	-3963	16.77		terrazzo workers	-37.57	14.44
freight laborers	-3916	10.04		wood patternmakers	-37.00	13.55
construction laborers	-3860	11.29		carpet installers	-35.63	13.54
truck drivers	-3586	17.21		biomedical engineers	-34.90	35.37
carpenters	-3483	14.67		baggage porters	-33.01	14.83
construction supervisors	-2673	22.43		electronics repairers	-32.81	26.33
bookkeepers & accountants	-2310	14.41		metal pourers & casters	-32.01	14.55
home health aides	-2193	9.18		etchers & engravers	-30.66	11.99
computer network admin.	-2140	30.07		private detectives	-30.47	20.49
production helpers	-2126	10.32		stonemasons	-27.89	14.68
production supervisors	-1886	21.77		agents of performers	-27.88	20.64
general managers	-1883	45.05		graduate teaching assts.	-27.73	n.a.
truck drivers	-1853	12.75		other woodworkers	-27.01	13.62
sales managers	-1826	40.70		electronic equip. assem.	-26.42	12.50
packers & packagers	-1766	8.70		pile drive operators	-26.32	15.65
personal care aides	-1763	8.64		home appliance repair.	-25.95	14.04
construction equip. opers.	-1643	14.76		farm graders & sorters	-25.84	7.32
general office clerks	-1590	11.14		legal secretaries	-25.70	15.55

packaging machine opers.	-1530	11.45		other religious workers	-25.48	12.94
industrial truck operators	-1443	12.41		electronics installers	-25.05	18.84
electricians	-1363	16.86		fiberglass workers	-24.98	12.15

n.a. = not available; dollars are current values in the initial year (2007); hourly wage is the median; median wage for all occupations was $13.92 in 2007

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15;

occupation: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Table 7. Top 25 Losing Occupations in North Carolina from 2010 to 2015.

By Change in Total Employment				By Percentage Change in Employment		
Occupation	**Average Annual Loss (jobs)**	**Hourly Wage ($)**		**Occupation**	**Annual % Change in Employment**	**Hourly Wage ($)**
home health aides	-3888	9.25		other media workers	-43.50	14.91
executive secretaries	-3768	18.65		special education wkers	-34.89	n.a.
computer support specs.	-2718	22.88		admin. law judges	-32.23	28.22
other teachers	-2654	n.a.		other material movers	-30.57	12.55
special education teachers	-1676	n.a.		respiratory therapy tech.	-29.72	19.77
teacher assistants	-1612	n.a.		metal patternmakers	-28.89	14.49
food prep workers	-1436	8.70		funeral service managers	-26.27	25.11
preschool teachers	-1160	10.09		gas plant operators	-24.67	24.45
information security analys.	-1010	36.82		mobile home installers	-24.58	13.00
other financial specialists	-990	29.69		drilling machine setters	-23.12	13.71
other healthcare workers	-956	12.37		desktop publishers	-22.60	15.07
retail sales supervisors	-878	15.96		actors	-22.33	15.61
manufacturing sales reps	-818	29.59		**embalmers**	-21.84	22.68
social service assistants	-812	12.85		computer support spec.	-21.22	22.88
secondary school teachers	-806	n.a.		other teachers	-20.83	n.a.
other vehicle operators	-680	13.61		healthcare practitioners	-20.53	18.83
dishwashers	-626	8.50		other vehicle operators	-20.31	13.61
short order cooks	-568	9.09		broadcast news analysts	-20.25	24.11
other media workers	-524	14.91		transportation attendants	-19.72	9.66

painters	-476	14.26		chemical plant operators	-19.48	21.38
bill collectors	-446	14.36		microbiologists	-18.06	27.27
computer programmers	-430	35.67		other financial special.	-18.02	29.69
other sales workers	-356	14.66		**proofreaders**	-17.81	16.33
janitorial service managers	-332	14.60		other plant operators	-17.80	21.18
bookkeepers & accountants	-330	15.57		ianformation system anal.	-17.71	36.82

n.a. = not available; dollars are current values in the initial year (2010); hourly wage is the median; median wage was $14.95 for all occupations in 2010

OCCUPATION: occupation found all time periods; **occupation**: occupation found in 2002-07 and 2010-15; **occupation**: occupation found in 2002-07 and 2007-10; occupation: occupation found in 2007-10 and 2010-15

Tables 5, 6, and 7 repeat the three time periods for the top occupations losing jobs. The most notable result is the fewer number occupational matches for the time periods. And, as with the top occupations adding jobs, there are few matches in the rankings for each period between the two alternative measures of employment change. One observation is the relatively large number of construction related occupations (construction laborers, carpenters, construction supervisors, construction equipment operators, and electricians) that were among the top job losers during the 2007-2010 period. This is consistent with the fact that the 2007-2010 period was led by a strong downsizing in the residential building industry.

Tables 8 and 9 show the changes in employment for the top job gaining and job losing occupations over the entire time period of 2002-2015. The period spans two growth periods and one recessionary period. Focusing on occupations ranked by their average annual job change, the occupations gaining employment are predominantly service jobs in the food, retail, health, personal service, and technology sectors. In contrast, the occupations losing employment include service jobs in the construction, food, education, and administrative sectors; some technology occupations which are changing (computer programmers); and production employment in the textile and food processing sectors.[11]

FOR THE ENTIRE TIME PERIOD (2002-2015), THE TOP OCCUPATIONS ADDING JOBS WERE IN THE FOOD, RETAIL, HEALTH, PERSONAL, AND TECHNOLOGY SERVICE SECTORS. THE TOP OCCUPATIONS LOSING EMPLOYMENT WERE IN CONSTRUCTION, FOOD, EDUCATION, COMPUTER PROGRAMMING, AND ADMINISTRATIVE SECTORS, AND IN THE TEXTILE AND FOOD PROCESSING SECTORS

Table 8. Top 25 Gaining Occupations in North Carolina from 2002 to 2015.

By Change in Total Employment **By Percentage Change in Employment**

Occupation	Average Annual Gain (jobs)	Hourly Wage ($)		Occupation	Annual % Change in Employment	Hourly Wage ($)
food prep and serving	5935	6.70		massage therapists	20.31	15.25
customer service reps	3136	12.41		gaming dealers	18.20	7.64
retail salespersons	2790	8.42		sailors & marine oilers	15.03	12.8
registered nurses	2260	21.66		animal trainers	14.79	8.77
home health aides	1907	8.23		biomedical engineers	13.01	24.76
administrative assistants	1801	11.31		septic tank cleaners	12.79	12.66
restaurant cooks	1405	8.72		translators	12.02	13.39
waiters & waitresses	1263	6.53		skin care specialists	11.76	10.9
software application devs.	1127	34.29		radio mechanics	10.82	15.58
child care workers	1037	7.74		highway maintenance	10.66	10.39
accountants & auditors	965	21.36		court clerks	10.56	11.97
general office clerks	923	10.76		nonfarm animal care.	9.82	8.59
management analysts	876	28.21		occupational ther. aides	9.71	12.03
security guards	805	9.25		cargo & freight agents	9.69	16.01
landscaping workers	804	9.35		power plant operators	9.48	24.03
food preparation managers	793	11.88		personal finance advice.	9.47	21.76
employment placement sp.	772	18.20		employment place. spec	9.16	18.20
computer systems analysts	764	29.36		athletic trainers	8.82	n.a.
firefighters	603	13.28		correctional off. mgers.	8.76	16.97
freight movers	596	9.31		management analysts	8.30	28.21
medical assistants	540	11.42		cartographers	8.21	20.79
pharmacy assistants	518	9.51		manicurists/pedicurists	8.18	9.29

receptionists	490	9.99		software app. Develop.	8.15	34.29
manufacturing sales reps.	472	20.44		medical equip. repair.	8.07	16.53
police patrol officers	470	15.67		aerospace engineers	8.06	31.37

n.a. = not available; dollars are current values in the initial year (2002); hourly wage is the median; median wage was $12.35 for all occupations in 2002

Table 9. Top 25 Losing Occupations in North Carolina from 2002 to 2015.

By Change in Total Employment **By Percentage Change in Employment**

Occupation	**Average Annual Loss (jobs)**	**Hourly Wage ($)**		**Occupation**	**Annual % Changea in Employment**	**Hourly Wage ($)**
executive secretaries	-1950	14.87		dentists	-21.20	62.01
general managers	-1093	29.26		mobile home installers	-17.03	9.31
sewing machine operators	-831	9.55		respiratory therapy tech.	-16.13	15.13
carpenters	-800	13.26		correspondence clerks	-15.66	13.43
computer support spec.	-731	20.27		food science technicians	-15.14	24.72
fast food cooks	-729	6.61		electro-mechanical tech.	-13.46	18.78
textile winding mach. oper.	-722	10.51		fiberglass laminators	-12.86	13.71
manufacturing sales reps.	-643	21.97		metal model makers	-12.79	12.21
textile knitting mach. oper.	-623	11.00		desktop publishers	-11.56	14.01
packers	-586	8.47		embalmers	-11.25	18.12
teacher assistants	-539	n.a.		advertising managers	-11.03	24.82
preschool teachers	-496	7.94		extraction work helpers	-10.33	9.52
shipping clerks	-493	11.00		drilling machine setters	-10.24	13.37
production supervisors	-472	19.47		conveyor operators	-10.00	10.83
machine feeders	-449	10.37		legal secretaries	-9.95	15.37
computer programmers	-442	30.20		proofreaders	-9.92	11.30
bookkeepers & accountants	-437	12.78		chemical plant operators	-9.71	19.18
institutional cooks	-436	8.30		plasterers	-9.67	11.95
legal secretaries	-377	15.37		paperhangers	-9.52	11.62
order clerks	-371	12.01		computer operators	-9.30	14.32
meat packers	-365	8.84		fabric patternmakers	-9.29	12.88
construction laborers	-350	10.04		wood patternmakers	-9.19	13.37

medical secretaries	-338	11.34		textile cutting mach. op.	-9.08	10.45
switchboard operators	-329	10.19		Metal lay-out workers	-9.05	14.84
chief executives	-323	61.63		word processors	-8.64	12.78

n.a. = not available; dollars are current values in the initial year (2002); hourly wage is the median; median wage was $12.35 for all occupations in 2002

5. Occupational Change and the Likelihood of Technological Unemployment

This section examines a potential linkage between occupational change and the likelihood of technological unemployment. To investigate the link, a new measure is added to the data. The measure is the "probability of technological replacement" (PTR) developed by economists Frey and Osborne.[12] The PTR is unique for each occupation and is based on an assessment by Frey and Osborne about each occupation's susceptibility to being performed by existing or soon-to-be-developed technology. Values for PTR range from 0 to 1, where 0 is no likelihood of job replacement by technology and 1 is complete job replacement by technology.

Table 10 reports the results of a statistical analysis called regression analysis, where occupational change (here measured by the average annual change in the occupation's number of jobs) is statistically related to PTR and a measure of aggregate change in the North Carolina economy. Two alternative measures of aggregate economic change for the state are used – the annual percentage change in total state employment, and the annual percentage change in aggregate state production of goods and services (termed GDP). The relationships are derived by combining occupational job change for the three time periods and relating job change to PTR and the aggregate growth measure.

The results in Table 10 show that using either measure of aggregate economic change, PTR is negatively related to occupational job change. The estimates show that every 0.1 unit increase in the likelihood of an occupation having jobs downsized by technology results in a 0.3 percentage point decrease in the occupation's annual job growth rate.[13] The results also show every 1 percentage point increase in the aggregate job growth rate is related to a 0.715 percentage point increase in the occupation's job growth rate, and every 1 percentage point increase in the state GDP growth rate is associated with a 1.03 percentage point increase in the occupation's job growth rate.

Table 10. Estimated Statistical Links between Occupational Change and the Likelihood of Technological Unemployment.

	Using Annual Change in NC Jobs	**Using Annual Change in NC GDP**
Technology Unemployment Index (PTR)	-3.401***	-3.45***
Aggregate Growth Control	0.715***	1.03***

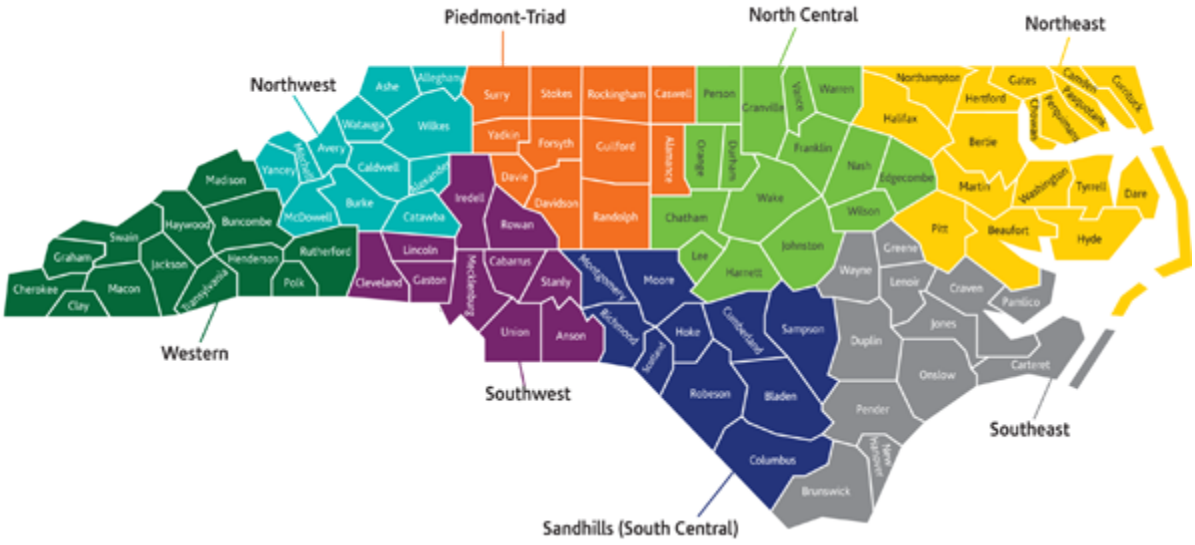
Statistical level of significance: ***: 0.01; **: 0.05; *: 0.10.

STATISTICAL ANALYSIS REVEALS A MEASUREABLE INVERSE LINKAGE BETWEEN THE PROBABILITY OF AN OCCUPATION BEING PERFORMED BY TECHNOLOGY AND RECENT EMPLOYMENT CHANGE IN THE OCCUPATION

6. Implications of the Findings for North Carolina's Prosperity Zones

North Carolina is composed of 100 counties. However, many counties share common characteristics. Also, for economic planning and business development purposes, using 100 counties is sometimes cumbersome. Therefore, as a convenience for coordination of business recruitment, the state has been divided into eight "Prosperity Zones" as shown in Figure 4.

Figure 4. North Carolina's Prosperity Zones.



The previous sections revealed two important findings. First, occupational change in North Carolina has been significant. Second, occupational change is related to differences in the likelihood of technology replacing human labor in accomplishing tasks associated with the occupation.

This section applies these two findings to North Carolina's Prosperity Zones. An *Index of Technological Unemployment* (ITU) is developed for each zone. The ITU is a weighted index derived by multiplying the Frey-Osborne PRT for each occupation by the share of that occupation's jobs in the zone's total employment, adding the results over all occupations in the zone, and then multiplying the result by 100 to express it in percentage terms. The latest occupational data for the zones for 2015 are used.[14] The resulting ITU is interpreted as the percentage of the zone's current (2015) total employment that is susceptible to replacement by technology in future decades.

If the Frey-Osborne expectations are correct, then Figure 5 shows technological unemployment will be an issue everywhere in North Carolina. The statewide ITU is 61.4%, suggesting that 61% of current employment in the state is susceptible to replacement by technology. However, there is variation in the ITU between Prosperity Zones. The North Central zone has the lowest ITU value (58.1%) followed by the Southwest zone at 60.3%. These are the two zones including the large metropolitan areas of Raleigh-Durham-Chapel Hill (Northcentral) and Charlotte (Southwest). The economies in these two regions have made significant adaptations and adjustments to the 21st century labor market that reduces – but certainly does not eliminate – the possibilities for technological unemployment. At the other end of the spectrum, the Northwest and Western zones have the highest ITU values.

Table 11 looks at the future of technological unemployment in the Prosperity Zones in another way. For each of the Prosperity Zones, the table shows the percentage of their current (2015) employment in the 50 occupations with the lowest probability (1% or less) of replacement of human labor by technology, as well as the percentage of their current (2015) employment in the 50 occupations with the highest probability (97% or more) of replacement of human labor by

technology. Lists of the occupational categories are in Appendices A and B. For most of the zones, the percentage of employment in the occupations with the most likely possibility of technology replacement is almost twice as great as the percentage of employment in the occupations with the least likely possibility of technology replacement.

Figure 5. Index of Technological Unemployment (ITU) in North Carolina's Prosperity Zones, 2015.

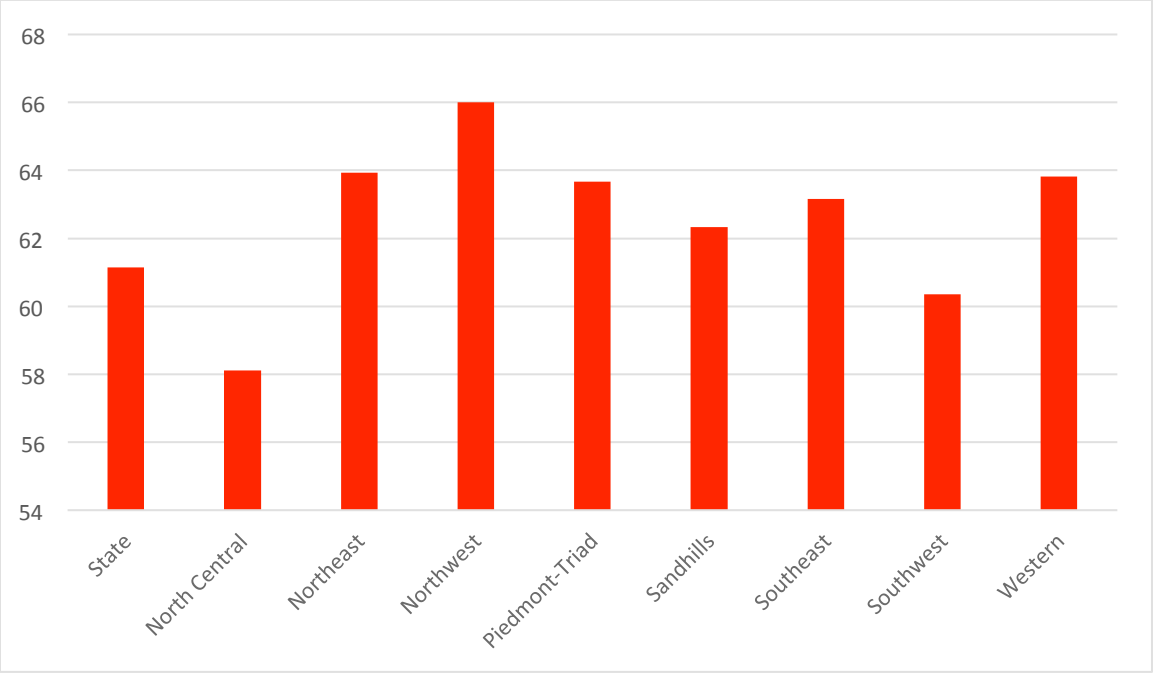


Table 11. Percentage of Total 2015 Employment in the Fifty Least-Likely and in the Fifty Most-Likely Occupations for Technological Unemployment.

Prosperity Zone	Percentage in Fifty Least-Likely	Percentage in Fifty Most-Likely
North Central	5.69%	9.00%
Northeast	5.61%	9.63%
Northwest	4.36%	12.05%

Piedmont-Triad	4.59%	10.95%
Sandhills	6.15%	8.70%
Southeast	5.25%	9.49%
Southwest	5.05%	9.47%
Western	5.66%	9.94%

THE DEGREE TO WHICH TECHNOLOGICAL UNEMPLOYMENT WILL OCCUR IN NORTH CAROLINA VARIES BY GEOGRAPHIC REGION. THOSE REGIONS WITH THE STATE'S LARGEST METROPOLITAN POPULATIONS HAVE LOWER – BUT STILL SIGNIFICANT – OUTLOOKS FOR TECHNOLOGIAL UNEMPLOYMENT

7. What Can Be Done?

This report has documented that significant occupational change is occurring in North Carolina and will likely continue to occur, possibly at accelerated rates as technological capabilities advance. The process will create issues and challenges for individual workers and for communities. To ease the transition to a new occupational structure, what programs, processes, and policies should North Carolina consider?

The logical process is to first forecast what occupations will be downsized, what existing occupations will expand and new occupations developed, and then ensure that educational and training programs are in place to both retrain existing workers losing their employment and train new workers seeking employment for the occupations of the future. I term this process the *engineering model of workforce development.* In a predictable world, the engineering model is the process to follow.

The obvious problem is, the economic world is not predictable. Certainly there are forecasts of occupations that will downsize – the Frey/Osborne forecasts are an example – but while this report has shown a correlation between occupational change and the Frey/Osborne probabilities of technological unemployment, the correlation is certainly not perfect. There are also forecasts of what occupations will expand[15], but the analysis in this report of recent occupational change in North Carolina demonstrated how inconsistent the specific expanding occupations are over different time periods. One important reason for both of these conclusions is the unpredictability of technological development. Several studies of invention and innovation suggest the almost whimsical way in which technological advances are discovered and implemented.[16]

The implication is, that while occupational change will certainly occur in future decades, where it will occur and the degree to which it will occur is not completely known. This means programs and processes for addressing occupational change will need to be flexible. Fields of study in the state's higher education institutions (community colleges and four-year and higher colleges and universities) may have to be rapidly altered and resources quickly reallocated to meet the rapidly changing needs of the workplace. It will become increasingly important for training in core competencies necessary for any occupation to be separate from training requirements directed at a specific occupation.

If occupational downsizing and change do proceed at a more rapid pace in future decades, then the composition of college students will likely change to include larger proportions of older, more mature students, with many having families to support. This may require two adjustments, one for support of unemployed workers, and the second for the delivery of higher education (Figure 6).

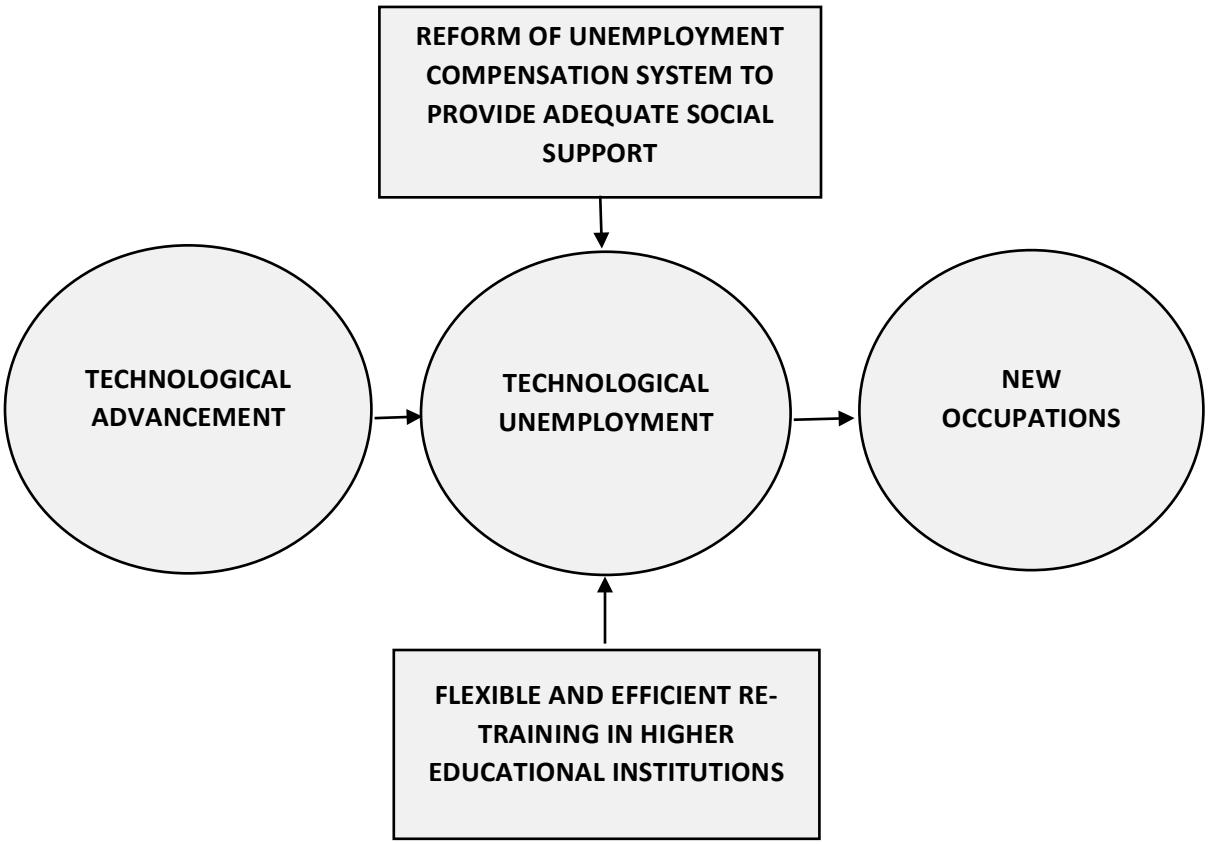
The current unemployment compensation system was designed for situations of temporary unemployment occurring with economic downturns. Workers were laid-off from their jobs during recessions, but were recalled to the same jobs once the economy recovered. This type of unemployment is termed *cyclical*. Workers received support – compensation – at some fraction of their full-time pay while they were temporarily unemployed.

However, the unemployment resulting from technological change and occupational downsizing is *structural* in nature, meaning it results from permanent – not temporary – changes in the economy. To end a worker's structural unemployment requires finding work in another occupation. For many workers facing such structural unemployment, this will require re-training for a new occupation. Therefore, the unemployment compensation system may need to be altered and augmented to provide upfront aid to be used by the worker for re-training costs, plus a monthly amount to help support the worker and any dependents of the worker during the retraining period.

At the same time, as more adult workers with dependents require public support during their training for a different occupation, it will be important for institutions delivering that retraining, such as community colleges and 4-year and beyond colleges and universities, to offer certificates and degrees in an efficient and timely manner that speeds the retraining process. To meet this goal may require modifications in how higher education institutions conduct courses and training and in the scope of educational requirements for a certificate or degree.

ADDRESSING TECHNOLOGICAL UNEMPLOYMENT WILL REQUIRE CHANGES IN THE STATE'S UNEMPLOYMENT COMPENSATION SYSTEM AS WELL AS IN THE STRUCTURE OF HIGHER EDUCATIONAL INSTITUTIONS

Figure 6. Addressing Technological Unemployment.



8. Conclusions

Occupational change is a major factor in the North Carolina labor market. During the 2002-2015 period, slightly more than 300 occupations in the state gained employment, while slightly less than 300 occupations lost employment. The average annual rate of employment change for both occupational gainers and losers was between 3.5% and 4%, and the occupations gaining jobs paid a lower wage rate than the occupations losing jobs. Interestingly, during the recent recession, the latter finding was reversed, with occupations gaining employment paying significantly more than occupations losing employment. This may reflect employers' preferences for hiring higher-valued employees to help them survive the economic downturn.

Occupational change appears to be related to technological unemployment. An index of potential technological unemployment was found to be statistically related to changes in an occupation's employment, with higher probabilities of technological unemployment inversely related to employment. The potential for technological unemployment was also found to vary between regions of North Carolina. Among the state's eight Prosperity Zones, the two Zones containing the state's largest metropolitan areas (Research Triangle, Charlotte), had the lowest measures of technological unemployment.

As technology advances and provides employers more opportunities to downsize human labor in a wide variety of occupations, it will become imperative for public policy to proactively respond to the resulting disruption in the labor market. The response will follow two channels. First is providing adequate financial support to individuals requiring occupational re-training. Importantly, the unemployment compensation system will need to be revised for the increasing numbers of workers who become structurally – rather than cyclically – unemployed. Second is

altering the higher education system in the state to accommodate larger numbers of adult students who need to be re-trained in a timely and efficient manner. This need will have major implications for curricula and teaching methods.

There's an old saying stating "you can't stop progress". In today's world, the phrase can be restated as "you can't stop technological advancement". Even if true, we can attempt to anticipate technological change and its impacts, and then design policies and programs to alleviate any negative impacts.

Appendix A. The 50 Occupations with the Lowest Probabilities of Replacement by Technology.

Occupation	Median Hourly Wage ($)	Probability
recreational therapists	20.22	0.0028
supervisors of mechanics, installers, and repairers	29.36	0.0030
emergency management directors	33.44	0.0030
mental health % substance abuse workers	21.41	0.0031
audiologists	35.19	0.0033
occupational therapists	37.82	0.0035
orthotists & prosthetists	29.48	0.0035
medical & public health social workers	23.76	0.0035
oral & maxillofacial surgeons	90.00	0.0036
supervisors of firefighting & prevention workers	24.78	0.0039
dieticians & nutritionists	24.78	0.0039
lodging managers	23.25	0.0039
choreographers	n. a.	0.0040
sales engineers	46.61	0.0041
physicians & surgeons	n. a.	0.0042
instructional coordinators	27.38	0.0042
other psychologists	45.48	0.0043
supervisors of police & detectives	30.94	0.0044
general dentists	90.00	0.0044
elementary school teachers, except special education	n. a.	0.0044
medical scientists, except epidemiologists	42.99	0.0045
elementary & secondary school administrators	n. a.	0.0046
podiatrists	71.22	0.0046
clinical, counseling, & school psychologists	27.44	0.0047
mental health counselors	22.17	0.0048
fabric & apparel patternmakers	19.22	0.0049
set & exhibit designers	21.52	0.0055
human resource managers	49.77	0.0055
recreation workers	11.27	0.0061
training & development managers	55.34	0.0063
speech language pathologists	31.65	0.0064
computer systems analysts	42.24	0.0065
social & community service managers	29.96	0.0067
curators	20.41	0.0068
athletic trainers	n. a.	0.0071
medical & health service managers	45.47	0.0073
Ppeschool teachers, except special education	12.48	0.0074
farm & home management advisors	22.25	0.0075
anthropologists & archeologists	24.23	0.0077
secondary school special education teachers	n. a.	0.0077
secondary school teachers, except career education	n. a.	0.0078
clergy	22.59	0.0081
foresters	28.26	0.0081
educational & vocational school counselors	22.60	0.0085
secondary school vocational education teachers	n. a.	0.0088
registered nurses	n. a.	0.0090
rehabilitation counselors	16.84	0.0094
other teachers & instructors, except substitute teachers	n. a.	0.0095
forensic science technicians	20.28	0.0095
theatrical & performance makeup artists	n. a.	0.0100

Source: probabilities from Frey and Osbourne; wage data from U.S. BLS (2015); n. a. = not available

Appendix B. The 50 Occupations with the Highest Probabilities of Replacement by Technology.

Occupation	Median Hourly Wage ($)	Probability
data entry keyers	14.48	0.9900
library technicians	14.43	0.9900
new account clerks	18.14	0.9900
photographic process & processing machine workers	11.44	0.9900
tax preparers	15.00	0.9900
cargo & freight agents	19.02	0.9900
watch repairers	13.67	0.9900
insurance underwriters	35.71	0.9900
mathematical technicians	n. a.	0.9900
sewer operators	12.98	0.9900
title examiners, abstractors, & searchers	18.51	0.9900
telemarketers	11.52	0.9900
models	n. a.	0.9800
inspectors, testers, sorters, samplers, & weighers	14.78	0.9800
bookkeeping, accounting, & auditing clerks	17.15	0.9800
legal secretaries	22.60	0.9800
radio operators	n. a.	0.9800
driver & sales workers	n. a.	0.9800
claims adjusters, examiners, & investigators	29.37	0.9800
parts salespersons	14.05	0.9800
credit analysts	37.46	0.9800
milling & planning machine setters, operators, & tenders	16.43	0.9800
shipping, receiving, & traffic clerks	14.39	0.9800
procurement clerks	19.02	0.9800
packaging & filling machine operators & tenders	13.13	0.9800
etchers & engravers	17.79	0.9800
tellers	13.50	0.9800
umpires, referees, & other sports officials	n. a.	0.9800
insurance appraisers for auto damage	30.25	0.9800
loan officers	31.17	0.9800
order clerks	14.91	0.9800
brokerage clerks	21.15	0.9800
insurance claims & policy processing clerks	18.33	0.9800
timing device assemblers & adjusters	n. a.	0.9800
bridge & lock tenders	n. a.	0.9700
woodworking machine setters, operators, & tenders	12.67	0.9700
team assemblers	13.07	0.9700
shoe machine operators & tenders	n. a.	0.9700
electromechanical equipment assemblers	16.01	0.9700
farm labor contractors	n. a.	0.9700
textile bleaching & dyeing machine operators & tenders	12.17	0.9700
dental laboratory technicians	20.18	0.9700
crushing, grinding, & polishing machine setters	14.43	0.9700
hand grinding & polishing workers	12.41	0.9700
vegetation pesticide handlers, sprayers, & applicators	13.99	0.9700
log graders & scalers	16.29	0.9700
ophthalmic laboratory technicians	11.07	0.9700
cashiers	8.86	0.9700
camera & photographic equipment repairers	24.51	0.9700
motion picture projectionists	9.48	0.9700

Source: probabilities from Frey and Osbourne; wage data from U.S. BLS (2015); n. a. = not available

Endnotes

[1] Pew Research Center, *The American Middle Class is Losing Ground*, Washington, DC, December 9, 2015.
[2] The term "technological unemployment" was coined by John Maynard Keynes in 1930 (John Maynard Keynes. "Economic Possibilities for our Grandchildren", In *Essays in Persuasion*, New York: W.W. Norton, 1963, pp. 358-373).
[3] See Carl Frey and Michael Osborne, "The Future of Employment: How Susceptible are Jobs to Computerization?" Oxford Martin School, Oxford University, UK, September 17, 2013; and Jerry Kaplan. *Humans Need Not Apply* (New Haven: Yale University Press, 2015.
[4] Alan Reynolds. "Workforce 2005: The Future of Jobs in the U.S. and Europe", in *OECD Societies in Transition: The Future of Work and Leisure*, Paris: OECD, 2005.
[5] U.S. Bureau of Labor Statistics, "Occupational Employment Statistics", www.bls.gov/oes/
[6] The data were measured for May of each year.
[7] BLS began using the North American Industry Classification System (NAICS) for occupations in 2002. Prior to 2002 the Standard Industrial Classification (SIC) system was used. There are enough differences between the two systems to result in a significant number of "non-matched" occupations when comparing them. However, even using the NAICS system, there are some changes in classifications from year to year that precluded matching all occupations. Occupations which could not be matched were not included in the analysis. This is the reason there is some variation in the number of occupations in each of the comparisons.
[8] The values for column 2 [average annual rate (%) of job gains] and for column 5 [average annual rate (%) of job losses] are from the following calculations. First calculate X = (total employment at end of time period/total employment at beginning of time period). Then calculate X^{p}, where p=0.2 for 2002-2007, p=0.33 for 2007-2010, p=0.2 for 2010-2015, and p=0.077 for 2002-2015. Last, calculate $(X^{p} -1) \times 100$ to express the result in percentage terms.
[9] The Kaufman Index of Entrepreneurial Activity showed an increased during the Great Recession (Robert Fairlie, *Kaufman Index of Entrepreneurial Activity, 1996-2010*, Ewing Marion Kaufman Foundation, 2010).
[10] For Tables 2 – 9, column 2 (average annual % change in employment) is calculated as: X = [((total employment at end of time period – total employment at beginning of time period)/ (total employment at beginning of time period)) + 1]. Then calculate X^{p}, where p has the same values for the time periods as indicated in footnote 9. Last, calculate $(X^{p} -1) \times 100$ to express in percentage terms. Column 5 [(annual % change in employment) is simply calculated as (total employment at beginning of time period – total employment at end of time period)]/n, where n is 7 for 2000-2007, 3 for 2007-2010, 4 for 2010-2014, and 14 for 2000 -2014.
[11] One factor impacting declining employment prospects for computer programmers is the increasing ease of outsourcing the work to programmers in foreign countries (U.S. Bureau of Labor Statistics, *Occupational Outlook Handbook*, 2016).
[12] Frey and Osborne, op. cit.
[13] Regressions run for each time period, which precluded controlling for the aggregate growth rate variables, also showed a negative and statistically significant relationship between the occupation's job growth rate and PTR of a similar magnitude.
[14] The occupational data for the Prosperity Zones are from the North Carolina Dept. of Commerce.
[15] For example, the U.S. Bureau of Labor Statistics develops detailed occupational forecasts every two years.
[16] See, for example, Pagan Kennedy. *Inventology: How We Dream Up Things that Change the World*, Boston: Houghton Mufflin Harcourt, 2016; and Eric Weiner. *The Geography of Genius*, New York: Simon and Schuster, 2016.