About the Center

Rochester Institute of Technology (RIT) was selected by the Alfred P. Sloan Foundation in 2001 to join the family of Sloan Industry Centers located at prestigious universities across the U.S. The Printing Industry Center at RIT is a joint program of the School of Print Media and RIT's College of Business, emphasizing Sloan's long-standing tradition of applying a broad multidisciplinary approach to industry investigations and findings.

Dedicated to the study of major business environment influences in the printing industry brought on by new technologies and societal changes, the Printing Industry Center at RIT addresses the concerns of the printing industry through educational outreach, research initiatives, and print evaluation services. The Center creates a forum for printing companies and associations worldwide to access a neutral platform for the dissemination of knowledge that can be trusted by the industry, to share ideas, and to build the partnerships needed to sustain growth and profitability in a rapidly changing market.

With the support of RIT, the Alfred P. Sloan Foundation, and our Industry Partners, it is our mission to continue to develop and articulate the knowledge necessary for the long-term economic health of the printing industry.

More information on the Printing Industry Center at RIT and its research activities can be found online at http://print.rit.edu.

Industry Partners

Support for the Printing Industry Center at RIT comes from:

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Volume 6: Summer 2009

About the PrintReview

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print review
Volume 6: Summer 2009

For Affiliates of the Printing Industry Center at RIT

Non-CMYK Pictorial Color Image Reproduction

Rules, sometimes, are meant to be broken. For example, printing freshmen learn that lithography works based on the principle of "ink and water do not mix." By the time they are seniors, they learn that emulsified ink is necessary in order for a lithographic press to function properly. After all, ink and water do mix.

Any printing student or professional will admit that a golden rule in pictorial color image reproduction is that process color or CMYK inks should always be used. To challenge the rule, one must ask the question, "Can pictorial color images be reproduced using non-CMYK inks?"

This is the question that is answered in the paper "Non-CMYK Pictorial Color Image Reproduction." The paper was authored by Bob Chung, Gravure Research Professor in the RIT School of Print Media, and was published in *Test Targets 8.0* in the "Gallery of Visual Interest" section.

Reproducing Pictorial Color Images

Achieving pictorial color image reproduction using non-process inks follows the same concept as using process inks, i.e., (1) color printer characterization, (2) color conversion, and (3) color printing. Color printer characterization defines the relationship between device color signals and CIELAB values. Ordinarily, CMYK colorants are chosen for their ability to achieve large color gamut. When characterizing non-CMYK printing device, the key criterion is the ability to render color of interest as oppose to achieve large

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R·I·T Printing Industry Center

inside

Open Publishing Lab Wins Alumni Association Award at Imagine RIT Festival

The Open Publishing Lab (OPL) had a large presence at the Imagine RIT festival on May 2, 2009.

The Imagine RIT: Innovation and Creativity Festival took place on the RIT campus and attracted over 25,000 visitors. Imagine RIT showcased nearly 2,000 exhibitors—students, faculty and staff. They proudly displayed examples of green technology, new ideas for products and services, creative arts and crafts and groundbreaking research.

Photo Credit: RIT University News

Of the over 400 exhibits, the OPL showcased four projects: the **Open Publishing Guide**, **Page2Pub**, **iNews**, and the **Social Networking Game**. (See details about each exhibit below.)

In addition to the crowds of people who checked them out, **the RIT Alumni Association gave the OPL's exhibit their "most innovative" award!**

Open Publishing Guide (OPG)

The OPG exhibit allowed users to try out the site, speak with OPL student researchers about the project, and ask any questions they had about the self-publishing process.

To find out more, visit the OPG at: http://opg.cias.rit.edu/

Page2Pub

Page2Pub lets users gather web content through a Firefox plug-in that the OPL has developed. This software allows users to gather content from the Internet and easily store and organize it, and even put together a printed book. At the festival, users were able to make their own customizable Rochester travel guide using the RocWiki website.

To find out more, visit: http://opl.rit.edu/project/page2pub

iNews

iNews covered the Imagine RIT festival all day. This near-instantaneous newspaper is put together by student writers, photographers, and designers, all writing and gathering content during the event. A new issue is printed hourly discussing the highlights of the festival, while it occurs.

To see the issues from the Imagine RIT fest, visit: http://opl.rit.edu/inews/

Social Networking Game

The Social Networking Game has gotten a huge face-lift! Now called **meetü**, this networking game allow people to talk to and socialize with those who they ordinarily wouldn't meet. Similar to a scavenger hunt, players will have missions to complete for points. This game was played across campus during the event. Afterward, players have the ability to follow up with those they met.

To find out more, visit: http://opl.rit.edu/project/social-networking-game

For more information on the Imagine RIT Festival, visit:
http://www.rit.edu/imagine

Non-CMYK Reproduction *continued*

color gamut. In the color conversion stage, pictorial images are converted from the RGB color space to the printer space via an Application Programming Interface (API). In the color printing stage, color-managed images are printed in registration using the inks that characterize the color printer.

Tools and Materials for Reproducing Color Images Using Non-CMYK Inks

Special software and hardware are necessary to implement pictorial color image reproduction using non-process inks. First, X-Rite's ProfileMaker 5 MultiColor Package is used to define a special color characterization target. In this case, three Pantone colors (32_red, Hex_green, and 2925_blue) are printed by an HP Indigo 5500 digital press capable of printing CMYK plus three spot colors (Figure 2a). X-Rite's Spectrolino/ Spectroscan is then used to measure the printed target. Colorimetric data was used by ProfileMaker 5 to build a custom spot-color ICC profile.

X-Rite's Multicolor Plug-In for Adobe Photoshop serves as the API to convert pictorial RGB image data to non-CMYK color space (Figure 2b). In this case, perceptual rendering is chosen in the color conversion. Converted images are saved as EPS files and placed in the InDesign file. The InDesign file is exported as a PDF file for color printing. Color printing using non-process inks involves printing the same way the spot-color characterization chart is printed.

Figure 1. A pictorial color image reproduced by non-CMYK inks

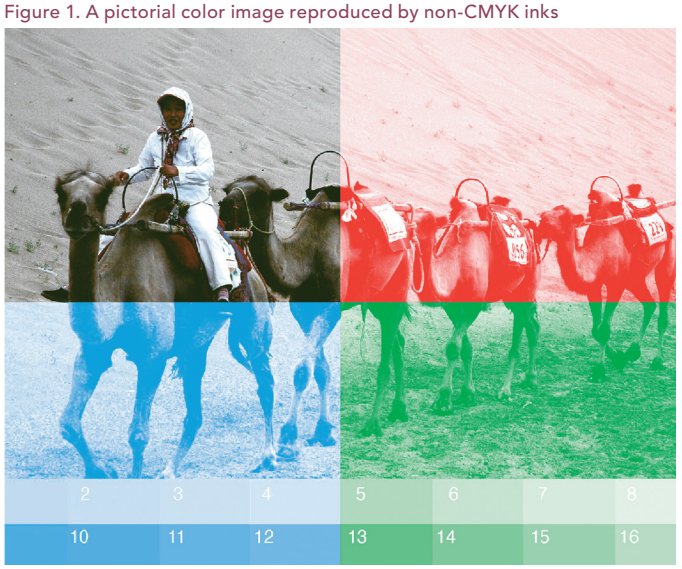


Figure 2a. Color printer profiling target

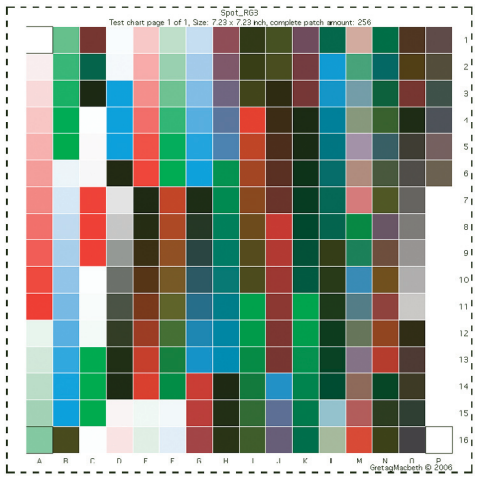


Figure 2b. MultiColor Photoshop Plug-In

Process Color Gamut and Non-process Color Gamut

Process color inks and Pantone certified spot-color inks are transparent in nature. When overprinting different amounts of inks, the resulting color follows subtractive color mixing principle, i.e., starting from white paper, the more inks are overprinted, the darker the printed color becomes. Color gamut refers to limiting colors that an imaging device can render. CMYK-color gamut has generous volume. Non-process color gamut, on the other hand, has small gamut volume.

Using the ProfileMaker 5 tool set, Figures 3a and 3b compare the color gamut between the HP_CMYK and HP_RGB in 2D (3a) and 3D (3b) respectively.

In Figure 3a, the black line is the boundary of the CMYK color gamut of the HP 5500 digital press and the white line is the boundary of the RGB spot color gamut at medium L* level. While its color gamut is smaller, the non-process inks have more saturation towards their primaries, i.e., redder red, greener green, and bluer blue.

In Figure 3b, the color-rendered solid is the CMYK color gamut of the HP 5500 digital press and the white solid is HP 5500's RGB spot-color gamut. Notice that whites and grays are reproducible by either printing process. While CMYK color gamut can accommodate the reproduction of yellows and oranges, the RGB color gamut can be an effective color reproduction process if (1) non-process inks, e.g., red, green, and blue, are already used as brand colors, and (2) color of interest in the pictorial color image is reproducible.

Figure 3a. 2D color gamut comparison between HP_CMYK and HP_RGB

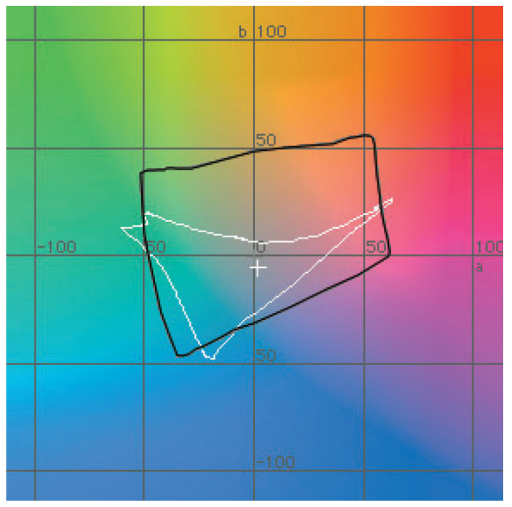
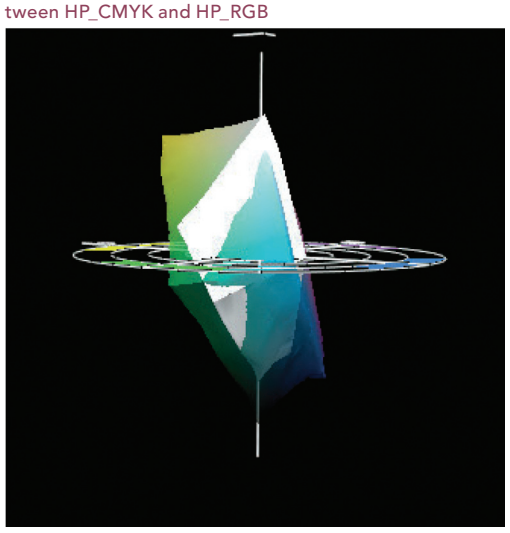


Figure 3b. 3D color gamut comparison between HP_CMYK and HP_RGB



Seeing is Believing

Let's evaluate the gray balance chart, printed by the HP_5500 RGB inks (Figure 4a) as well as by the HP_5500 CMYK inks (Figure 4b). Notice that all patches in Figure 4a have a constant red dot area with green dot areas varying column-wise and blue dot areas varying row-wise. Similarly, Figure 4b has a constant cyan dot area with magenta dot areas varying column-wise and yellow dot areas varying row-wise. If there is a color match in neutral, the match between the two ink sets is metameric, i.e., two objects have the same color, but have different spectral reflectance values.

continued on page 6 >

Non-CMYK Reproduction *continued*

Figure 4a. Gray balance from RGB inks

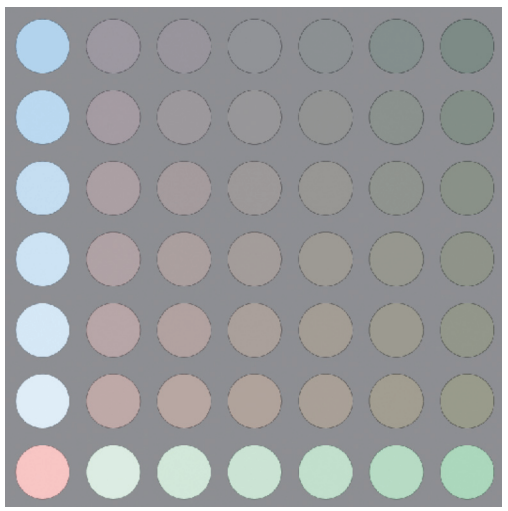
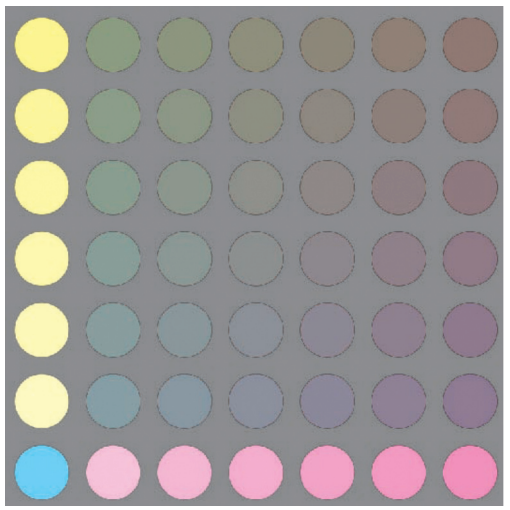


Figure 4b. Gray balance from CMYK inks



Next, let's evaluate an example of color reproduction, Boating, with memory color (Figures 5a and 5b). Blue sky, white cloud, and turquoise water are colors we can associate with the beauty of nature. When these colors are reproduced in a pleasing manner, it does not matter if non-CMYK inks (Figure 5a) or CMYK inks (Figure 5b) are used.

Finally, let's evaluate an example of color reproduction, Glazed Ceramic Pots, without memory color (Figures 6a and 6b). First, a ceramic pot can be any color. So, there is no memory color that can serve as a visual reference. Without a loupe, how would one recognize which printing process is used to reproduce which image? Well, the answer lies in the color gamut capability of the ink sets. Figure 6a has more saturated green and Figure 6b has more color rendering capability in the yellow region of

Figure 5a. Pictorial color reproduction of memory colors using non-CMYK

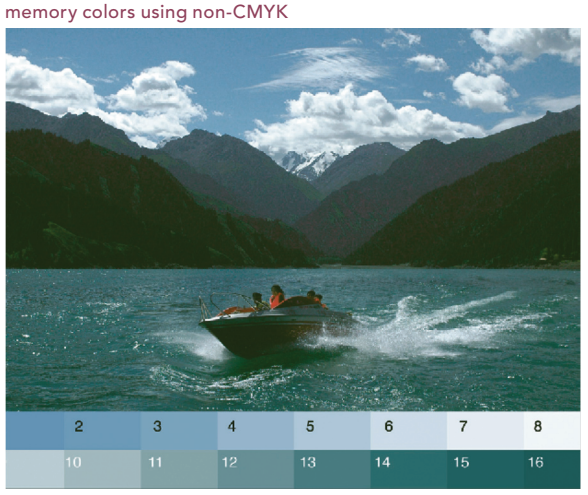


Figure 5b. Pictorial color reproduction of memory colors using CMYK

Figure 6a. Pictorial color reproduction of non-memory colors using non-CMYK

Figure 6b. Pictorial color reproduction of non-memory colors using CMYK

the color gamut. Thus, Figure 6a is printed by non-CMYK colors while Figure 6b is printed by CMYK colors.

Conclusions

This article shows that pictorial color images can be reproduced with CMYK inks as well as non-CMYK inks. Process color or CMYK printing provides a large color gamut in comparison to other 4-color subtractive primaries. This enables hues in all pictorial color images to be reproduced. This is also a liability because the color variations are likely to occur in the color printing stage if there is no strict process control measure.

Non-process colors are primarily used as brand colors as dictated by consumer product companies. Because of the advances in color management, it is possible to render pictorial color image reproduction if colors of interest in the image and the spot color gamut are compatible to each other. One example is to use spot colors to decorate contemporary building materials with wood grains or marble patterns. By carefully selecting spot colors that cover a small range of colors of interest, the color reproduction process is much more stable than CMYK color printing. Each has advantages and disadvantages. The choice lies in the customer's need and technology fit.

About *Test Targets*

Test Targets, published annually by the School of Print Media (SPM) since 2002, is the result of teaching and learning from the SPM curriculum. Students, faculty, and staff work together to create content focusing on process control and color management. In addition to research and content creation, the group also performs pre-media, prepress, and printing tasks using facilities at SPM and PAL. The quality of the publication and its track record have won accolades in the U.S. and worldwide.

Test Targets 8.0 is the latest version of this publication. To purchase a copy, visit the Cary Graphic Arts Press:

http://carypress.rit.edu

To learn more about *Test Targets* and download previous versions, visit the *Test Targets* website:

http://cias.rit.edu/~gravure/tt/

Correlates of Job Satisfaction of Early Career Employees in Printing and Publishing Occupations

The printing industry is in a human resources crisis. With the upcoming retirement wave of Baby Boomer employees, the industry has as many as 5,000 jobs to fill annually and they are having a challenge finding qualified young people to apply. Baccalaureate programs in printing and graphic communications are also finding it difficult to attract applicants to their programs. Even within those who express interest, a large percentage are initially interested in graphic design jobs as opposed to production, workflow or scientific jobs associated with the industry.

The primary goal of the research study *Correlates of Job Satisfaction of Early Career Employees in Printing and Publishing Occupations* (PICRM-2009-01), by Ashley Walker and Patricia Sorce, Ph.D., was to answer this question: what is the perception of recent college graduates about their future careers in the printing and publishing industries? The goal of this research were to determine which factors or constructs have the strongest correlation to overall job satisfaction among RIT School of Print Media alumni who are currently employed in the graphic arts industry. (A control group of RIT School of Design alumni were also surveyed in order to allow for comparisons between the two.)

These alumni were surveyed on the characteristics of their jobs, what they like and dislike about their jobs, and on what their employers could do to change their jobs for the better (if such changes were needed). From these data, the authors determined the factors that were correlated to job satisfaction within this sample. Based on these findings, recommendations were made as to what managers can do to increase the satisfaction of their employees in the hopes of attracting new employees and reducing turnover of the most talented.

Methodology

Procedure

The survey was administered using an online survey service. In April of 2008, an e-mail was sent to the alumni of both the School of Print Media and the School of Design inviting them to complete the survey. The alumni sampled are only those who had provided their e-mail addresses to the RIT Alumni Office and are a subset of all graduates. The sampling frame was n=1,845 for the School of Print Media and n=964 for the School of Design.

Data Analysis

The total number of respondents was 749, with 307 School of Design (response rate of 31.8%) and 442 School of Print Media respondents (response rate of 24.0%). Not all respondents answered all questions, since the survey did not require all questions to be answered. Analysis of the gathered data was conducted using SPSS software (version 16.0). Open-ended responses deemed necessary for further research were coded appropriately.

Research Findings

The results of the survey will be presented in the following order:

- Is there a difference in satisfaction between School of Print Media (SPM) and School of Design (SD) alumni?
- Within the SPM alumni population, are there differences in overall satisfaction by demographic groups as defined by generation, gender, and salary level?
- What are the major predictors of overall job satisfaction?
- What predicts the intention to change industries?

Each question is shown below with the corresponding data analysis and discussion following.

1. Is there a difference in satisfaction between SPM and SD alumni?

To determine if School of Print Media (SPM) alumni were unique in their responses, we included a control group of RIT School of Design (SD) alumni in the research. First, we tested whether there was a difference in overall job satisfaction. There was not a statistically significant difference in overall satisfaction between the two groups, although SPM alumni had a somewhat lower average satisfaction than SD graduates (mean of 2.33 vs. 2.22, p=0.250).*

However, statistically significant differences in satisfaction were found between the graduates of the two programs in two job facet categories: satisfaction with continuing education/in-service programs and satisfaction with work environment or work culture (see Table 1 below). In both cases, SPM graduates had significantly lower average satisfaction scores than SD graduates.

** The question for overall satisfaction was ranked on a seven point scale where 1 = Completely Satisfied and 7 = Completely Dissatisfied. Higher numbers therefore correspond to lower satisfaction.*

2. Within the SPM alumni population, are there differences in overall satisfaction by demographic groups as defined by generation, gender, or salary level?

To test whether there are any generational differences in satisfaction, we grouped SPM alumni into three different age categories: 20-29 years of age, 30-44 years of age, and 45 or more years of age. Although there is a trend that shows a higher level of satisfaction for older workers, no statistically significant differences in overall satisfaction were found among these age groups (ANOVA, F=2.675, p=0.070).

Statistically significant differences in overall job satisfaction were found between gender groups (ANOVA, F=5.355, p=0.021) and between salary levels (ANOVA, F=5.015, p<0.0001). In terms of gender, females were generally less satisfied with their jobs (2.54/7) than males (2.23/7). In terms of salary levels, those with higher salaries were more satisfied, as shown in Figure 1.

Table 1. Categorical differences in satisfaction

Job Facet	SD Mean*	SPM Mean*	P value
Support for continuing education/in-service programs	2.64	2.86	0.023
Work environment or work culture	2.03	2.29	0.002

* Five point scale where 1 = Very Satisfied and 5 = Very Dissatisfied. Higher numbers therefore correspond to lower satisfaction.

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Correlates of Job Satisfaction *continued*

3. What are the predictors of overall job satisfaction?

A regression analysis was conducted using the significant job facet satisfaction measures and the significant demographic item (as determined from prior regression analyses – see the complete monograph for full details) as predictors for overall satisfaction. This resulted in an *r* value of 0.713, an r^2 of 0.508, and an *adjusted* r^2 of 0.499 (ANOVA, F=53.090, p<0.0001). This indicates that 49.9% of the variation in overall job satisfaction can be explained by these six factors. The six factors included the level of satisfaction with:

- Personal gratification from the job,
- Organization's goals/mission/vision,
- Opportunity to be creative,
- Salary, and
- Level of challenge in work.

The last factor was the actual annual income from the current job, which had a negative beta value (all others were positive).

4. What predicts the intention to change industries?

Among SPM alumni, it appears that overall job satisfaction was important in determining future career plans. The difference in overall satisfaction between career planning categories was statistically significant (ANOVA, F=8.9, p<0.0001). As shown in Figure 2, those who had the lowest average satisfaction scores planned to "Return to school to pursue another degree" (mean satisfaction score of 3.08), "Look for a different job within a different company in a different industry" (mean=2.96), and "Look for a different job within a different company in a similar industry" (mean=2.91). This indicates that the most dissatisfied graduates are possibly looking to change their level/rank or field of work, although they may or may not also change industries as a result.

Another potential factor in determining future career plans was the fulfillment of employer promises upon hire. Respondents who felt that their employer had not fulfilled the promises made to them upon hire tended to plan to leave the firm, and a few may also leave the industry. This indicates that companies who do not fulfill promises to their employees are more likely to lose them.

Conclusions: Lessons for Employers

The results have implications for printing and publishing employers who are seeking new and possibly younger employees for their businesses. A starting point is to understand the factors that contribute to overall job satisfaction of employees. The results from this research suggest that the following are important:

- Personal gratification you feel from doing your job,
- The organization's goals/mission/vision,
- The opportunity to be creative,
- The level of challenge in work, and
- The actual salary received.

If employees do not feel that their jobs are worthwhile, that they have the opportunity to be creative within their job, that they are being challenged by what they do, that they are being compensated accordingly for the work that they do, or that the company is going in a viable or worthwhile direction, their overall job satisfaction will suffer as a result.

continued >

Sustainable Print Systems Lab Website Launched

The Sustainable Print Systems Lab (SPSL) has launched its website (http://sustainable.print.rit.edu) in support of the Printing Industry Center at RIT's new research track in sustainable printing.

The SPSL is a collaborative of researchers at RIT focused on understanding sustainability issues in printing systems. The main objective of the Lab is to develop insights and tools specific to the print industry that can be used by product development practitioners to better integrate environmental, social and economic considerations into their R&D decision-making processes. The SPSL will leverage the breadth of expertise at RIT in content creation, workflow management, systems engineering, print production, imaging science, and sustainability to develop end-to-end systems understanding of the print ecosystem that will enable better decision-making within these ecosystems.

The Lab's co-directors are Sandra Rothenberg, Associate Professor in the Saunders College of Business, and Marcos Esterman, Assistant Professor in the Industrial and Systems Engineering Department in the Kate Gleason College of Engineering.

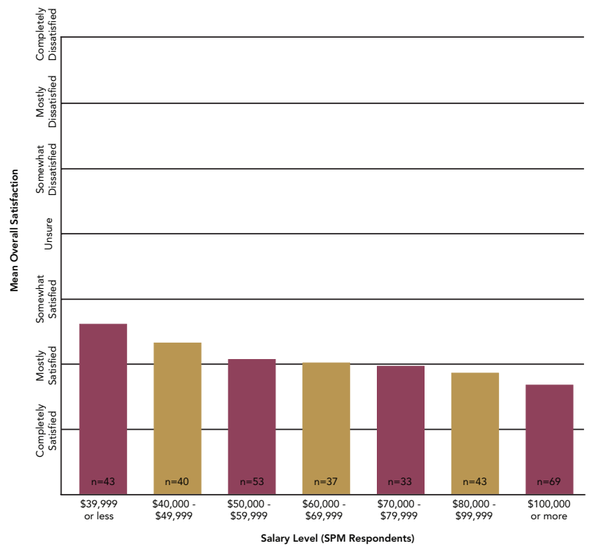
The SPSL website will provide updates on research through the SPSL blog as well as links to papers on related topics by SPSL researchers. A current SPSL project in progress is "A Survey into Metrics and Methods Employed by the Printing Industry to Measure, Track and Integrate Sustainability into Their Business Practices: Phase I", which is funded by the Printing Industry Center at RIT. This project will utilize an industry survey to benchmark what is already being done to measure sustainability in print service systems. (Information on this project is available under the heading "LCA Benchmarking in the Printing Industry" on the Research page of the website.)

More information is available at:
http://sustainable.print.rit.edu

School of Print Media Awards

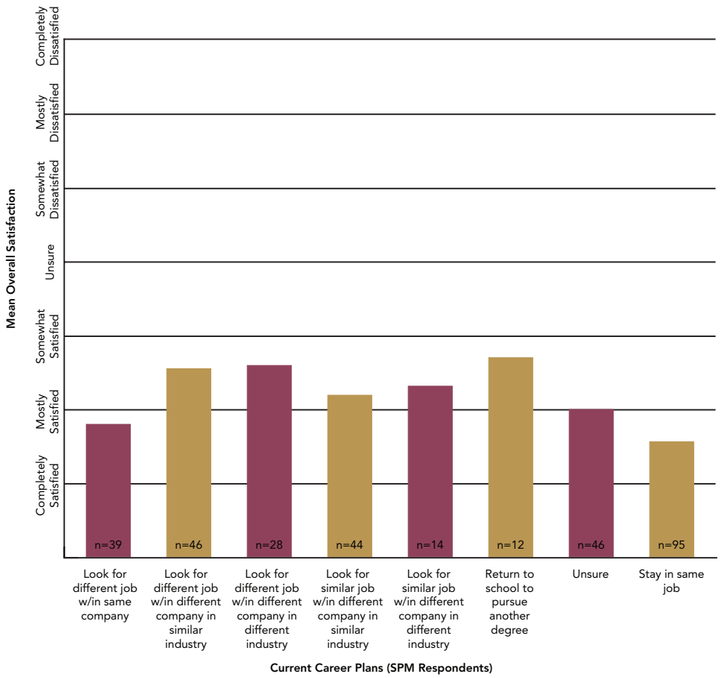
- **Frank Romano,** School of Print Media (SPM) professor emeritus, was named the third Ipex 2010 Champion in Print for his contribution to education.
- **Dr. Scott Williams**, SPM associate professor, was selected as the 2009 FFTA/Sun Chemical Corporation Research Fellow.
- **SPM's student chapter of the Technical Association of the Graphic Arts (TAGA)** won the Helmut Kipphan Cup, better known as the Best TAGA Student Chapter Publication Award, at the 61st TAGA Annual Technical Conference. The SPM student publication also won the 'Conference Attendee's Choice' Award.
- **Andrew Henry**, an SPM undergraduate student, is the 2nd place recipient of the 2009 FFTA Rossini Research Scholarship. Andrew received the award for research on printed electronics that he conducted in conjunction with Dr. Scott Williams.
- The 2008 edition of *Signatures*, RIT's annual student-created and student-produced arts and literary magazine, won a Gold Crown award in the Columbia Scholastic Press Association's 2009 Collegiate Awards Convocation. **SPM students Andrew Henry and Sarai Oviedo** helped to oversee the production of the magazine.

Figure 1. Satisfaction comparison of mean satisfaction by salary level*



** Salary level groupings were created in order to adjust for low numbers of respondents (n) in certain responses. Original categories (as given on the survey) and number of respondents were as follows: $14,999 or less: 6, $15,000 - $19,999: 0, $20,000 - $29,999:10, $30,000 - $39,999:27, $40,000 - $49,999:40, $50,000 - $59,999:53, $60,000 - $69,999:37, $70,000 - $79,999:33, $80,000 - $89,999:28, $90,000 - $99,999:15, $100,000 or more: 69.*

Figure 2. Comparison of mean satisfaction among future career plan responses



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How, then, can employers seek to improve job satisfaction? Some suggestions from the literature review include making sure that the person-job fit and/or person-organization fit are appropriate. Recruiting tactics could include realistic job previews, such as using co-ops or internships, to determine if potential employees will derive personal gratification from the job. Another tactic is providing more information about the values, mission, vision, and goals of the organization during the interview process. Although most companies provide some of this information on their marketing materials and/or Web site, words alone do not convey the true "personality" of a company. It is important to let the interviewee know how the company works so that they can assess for themselves whether or not they think they will fit.

Increasing the level of employee "buy-in" to the organization's goals, mission, and vision may also be important for increasing overall job satisfaction. This could be enacted by senior executive "briefings" on the current goals, mission, and vision in the form of face-to-face meetings where employees are allowed to provide input to help create the organization's goals, mission, or vision. This may not be feasible in very large companies, and some CEOs are using current communications technologies (such as blogs) to reach a large number of employees.

Work design is also important. Do employees have enough challenge in their jobs? Are they given the opportunity to be creative in determining how they accomplish their tasks? These are questions that should be asked when conducting annual reviews to determine if changes need to be made.

The level of satisfaction with salary and the actual salary received were also correlated to overall job satisfaction. In order to make sure that employees are being compensated appropriately for their level of experience and/or job type, employers should conduct industry benchmarking studies of pay rates at companies who have the performance level that the company wishes to aspire to. These benchmarking studies are also provided by some trade associations.

To read about this research in detail, download the monograph from:
print.rit.edu/pubs/picrm200901.pdf

Research Monographs of the Center

Expert faculty from the School of Print Media, the E. Philip Saunders College of Business, and other fields at RIT comprise the cadre of researchers that build and carry out the research initiatives undertaken by the Center.

The research agenda is built through collaboration between Center researchers and Industry Partner companies, resulting in research that is cross-disciplinary and highly relevant to industry concerns.

Take advantage of this resource at:

print.rit.edu/research