Ecole de cometique
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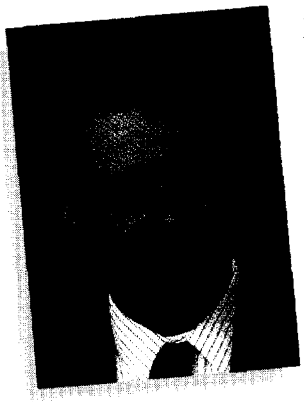
ECOLE DE COSMÉTIQUE

During the darkest days of winter, on the windy, frigid banks of the legendary Hackensack River, a new semester of Cosmetic Science begins...

The Skin Care Formulation Laboratory is well-attended—as are all required courses! Students have literally come from around the globe to be at Fairleigh Dickinson University for this program. India, Thailand, Malaysia, Nigeria, and Italy are some of the nations that have contributed past or present students. How did eager minds from the far corners of the earth catch wind of the unique opportunities in Bergen County, USA? New York Chapter SCC members, lecturing from Europe to Asia, have often fostered awareness of cosmetic science at FDU as an indirect consequence of their appearances.



Of course, there are other venues to study cosmetics in the US and Europe. The Universities of Cincinnati[1] and Rhode Island[2] have offerings in their phamaceutical departments. There are relevant studies at Southern Mississippi in the polymer science area. The British Society of Cosmetic Sciences offers a diploma program both in classroom form and as a correspondence course[3]. In addition, pharmaceutical departments in other universities such as Rutgers and St. Johns offer subjects ranging from aerosol formulation to "Dermaceutics—The Science of Topical Drug Delivery." The Fashion Institute of Technology (FIT) instructs its students in cosmetic science in keeping with the nature of its academic focus.

Every program is unique, being especially a reflection of the course director. The Founding Father of the FDU curriculum is Dr. Salvatore Gimelli, who developed it with the close cooperation of the New York Chapter of the SCC. The curriculum was approved by the Chemistry Department in 1980 and 1984 saw the first graduates. The full history of Cosmetic Science at FDU can be found in Reference 4.

If FDU has a particularly distinguishing feature, it is the character of the adjunct faculty, who have lent it a strong practical bent. The core areas of cosmetic raw materials and formulation have been instructed by individuals with long and distinguished industry careers. Over the years, the most important pillars among the instructors have been Dave Steinberg and Ken Klein.

On his part, Dr. Gimelli has always been open to suggestions from concerned industry representatives. The program thus creates graduates with an academic background uniquely useful to employers. In addition to his academic duties, the assistance Dr. Gimelli has given to the students, as individuals, has been remarkable, indeed inspirational. These graduates, now at positions at companies such as Avon, Mary Kay, Estée Lauder, Avon, Unilever, and Cosmair, to name just a few, can bear witness to his qualities not only as a professor but as a man dedicated to helping others.

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Table 1 shows the core curriculum and elective courses. The Skin Care Formulation Lab will be examined as a specific example of the course offerings. A representative schedule for the lab is shown in Table 2. The topics dealt with might also serve as a guide to laboratory directors faced with new staff having technical, but not specifically cosmetic, back-

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***Greek kosmEtikos, skilled in adornment or decorating.**

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TABLE ONE: Curriculum Fairleigh Dickinson University Master's in Cosmetic Science

Required Courses (18 Credits)
- Skin Care Raw Materials
- Skin Care Formulations
- Skin Care Laboratory
- Hair Care Raw Materials
- Hair Care Formulations
- Hair Care Laboratory

Cosmetic Science Electives (at least 3 courses)
- Microbiology and Toxicology
- Dermal Pharmacology
- Perfumery
- Quality Assurance
- Product Development and Marketing
- Colloid and Surface Chemistry

Free Electives (at least 2 courses)
- Biochemistry
- Natural Products
- Human Behavior in Organizations
- Market Research
- Production Management
- Industrial Psychology
- Introduction to Computer Science
- Introduction to Computer Programming

TABLE TWO: Skin Care Formulation Lab

Week 1	Product Duplication, Rheology & Viscosity
Week 2	HLB theory, PIT, Solubility Parameter
Week 3	Analytical Specs
Week 4	Nonionic formulations
Week 5	Emollients, Esters
Week 6	Anionics
Week 7	Treatment products
Week 8	Sensory Evaluation, Microemulsions
Week 9	Silicones
Week 10	Thickeners, Stearate Sticks, Liquid Crystals
Week 11	Sunscreens
Week 12	Presentation of duplications
Week 13	AP's—Sticks and Gels
Week 14	Color products
Week 15	Final Exam

grounds. All too often these bench workers never get past the "make 500 grams of this and bring it to me" stage.

In addition to the group laboratory activities, the students are assigned a project for the semester involving a label duplication of a commercial skin care emulsion. The duplication requires matching certain key parameters such as percent solids and viscosity. The completed project involves a sample of the duplication, a written report, and sometimes an oral presentation before the class. Writing and presentation skills are as important as formulation for a successful technical career, and must be stressed at every stage of the educational process.

A typical lab session involves a brief introductory lecture followed by several hours of hands-on applications. We will consider the material covered in the first two weeks in some detail, embracing some of the absolutely necessary theoretical foundations for systematic emulsion formulation. The goal is to approach formulation from a basic science, rather than a "cook book" perspective.

An early attempt by an FDU adjunct to make sense of emulsion formulation led to the following description of students by Seldner[5]:

"...I was struck by the general feeling ...that they were completely lost and were desperate for a rationale to guide them in

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what was almost the "black magic" of cosmetic emulsions..."

Hopefully, the "black magic" is now gone. The first week deals with rheology[6] and some basic product parameters such as percent solids[7], pH and a practical application of Stoke's Law to emulsion stability-the centrifuge. The second week considers nonionic theory. There is no flawless theory of emulsion formulation, but the most useful guidance exists on the use of polyol fatty acid esters as primary emulsifiers.

On the edge of the millennium, the greatest gift to emulsion formulators is the half-century old HLB Theory[8]. HLB, the Hydrophilic Lipophilic Balance, assigns a number to the oil mixture to be emulsified and recommends an emulsifier or blend of emulsifiers with the same number. Hydrophilic means "water loving," lipophilic "fat loving," so the balance quantifies the water soluble and oil soluble parts of an amphiphilic (loving two things) molecule. For the simplest case, where the hydrophilic part consists entirely of ethylene oxide,

$$\text{HLB} = E/5,$$

where E is the weight percent of oxyethylene, and the factor of 5 is present as a divisor simply to bring the number down to size—HLB numbers become 20 or less.

Many published HLB values of surfactants and the corresponding required HLB values of emollients are available, but it is possible to make rough estimates of both. For HLB, simply add the surface active material to water, and the following observations can provide a preliminary estimate:

APPEARANCE	HLB
Not dispersible	1-4
Poor dispersion	3-6
Milky after agitation	6-8
Stable milky dispersion	8-10
Translucent to clear	10-13
Clear solution	13+

To determine a starting HLB for emulsification, ICI provides an easy test. A series of surfactants are blended to yield HLB 2,4,6... through 16. Jars containing 20 grams of oil phase, 2 grams of surfactant, and 28 grams of water are shaken. The most stable product in the series indicates the required HLB.

Armed with this knowledge, a basic emulsion can be formed. The added assumptions are: 80% water phase, 20% oil phase, 15% of the oil phase as emulsifier. With this method, a skin care formulation product can be created from basic principles. Additional refinements such as heating and mixing instructions, preservatives, fragrance, thickeners and actives can be added in a systematic way.

Of course, the HLB theory has flaws. It does not take into account phase volumes,

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chemical types, whether certain materials are emulsifiers or part of the oil phase (e.g., cetyl alcohol). HLB theory assumes linear behavior in blending materials. It does not include the change of HLB with temperature, but this "flaw" opens the door for another useful tool, phase inversion emulsification.

HLB values drop with a rise of temperature. The ethoxylates bridge the solubility gap between oil and water through hydrogen bonds, and thermal motion weakens this effect. At a certain point, known as the phase inversion temperature, the emulsifier changes from O/W to W/O. As the temperature drops, an inversion occurs to the final O/W, but with a smaller particle size and consequently greater stability[9].

Another theoretical tool is the solubility parameter, a measure of the cohesive forces in molecules. It takes the simple concept of water or oil solubility and assigns a much sharper numerical value. A simple drop test[10] allows a quick approximation of the Solubility Parameter (SP). A rather odd formula[11] relates the SP to HLB:

$$\text{REQ. HLB} = \left((SP+7)/8 \right)^4$$

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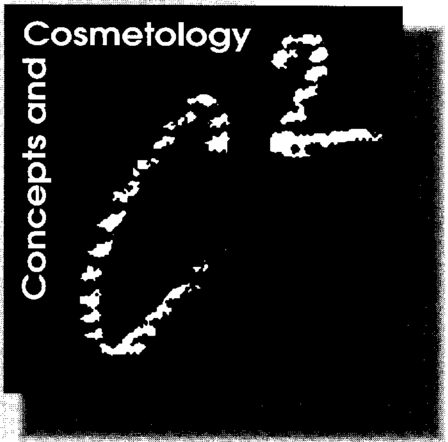

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A final guide to choosing the correct emulsifier was provided by Lin[12]. In a nutshell, the conclusion of Lin was that the more water that could be titrated into an oil/surfactant blend, the smaller the particle size, and thus more stable, the corresponding emulsion would be. A series of titrations employing increasing weight percent ethylene oxide emulsifiers graphed against maximum water solubilization yields a graph indicating the most effective blend.

Thus in a few straightforward experiments with modest equipment, the students are led into the systematic study of emulsions. The theories applied, if not perfect, are a giant progressive leap from the trial and error approach of earlier formulators. This column has considered only a couple of nights in one lab. The cumulative effect of over 32 graduate credits is to create a new generation of cosmetic scientists prepared for the challenges of the next century. ■

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